CHINHOYI UNIVERSITY OF TECHNOLOGY

SCHOOL OF HOSPITALITY AND TOURISM

AN EXPLORATION OF VALUE ADDITION PROCESSES FOR INDIGENOUS ROOT VEGETABLES IN ZIMBABWE: TOWARDS OPTIMISING INDIGENOUS ROOT VEGETABLE CONSUMPTION FOR HEALTH AND WELLNESS SUSTENANCE.

BY

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A THESIS SUBMITTED IN FULFILMENT OF THE REQUIREMENTS OF THE MASTER OF PHILOSOPHY DEGREE IN HOSPITALITY AND TOURISM IN THE DEPARTMENT OF HOSPITALITY AND TOURISM.

4 JUNE 2025

APPROVAL FORM

The undersigned certify that they have read and recommended to the Department of Hospitality and Tourism, School of Hospitality and Tourism, Chinhoyi University of Technology for acceptance: a thesis entitled, “An exploration of value addition processes for indigenous root vegetables in Zimbabwe: Towards optimising indigenous root vegetable consumption for health and wellness sustenance” submitted by Patience Chitupa (C24160082M) in fulfilment of the requirements for the Master of Philosophy degree in Hospitality and Tourism.

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DECLARATION

I, **Patience Chitupa**, Student No. **C24160082M**, do hereby declare that this research submitted to Chinhoyi University of Technology, for the requirements of Master of Philosophy Degree in Hospitality and Tourism under the topic, **"An exploration of value addition processes for indigenous root vegetables in Zimbabwe: Towards optimising indigenous root vegetable consumption for health and wellness sustenance"** is my own independent work except for quotations and citations which have been duly acknowledged. This research complies with the code of academic integrity as well as other relevant policies, procedures, rules and regulations of Chinhoyi University of Technology. This research has not been submitted before to any institution by myself or any other person in fulfilment or (partial fulfilment) of the requirements for the attainment of any qualification.

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DEDICATION

I dedicate this work to the Almighty God, thank you for the guidance, strength, and power of mind, skills, protection, and the gift of life.

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ABSTRACT

Value addition processes to enhance the consumption of Indigenous Root Vegetables (IRVs) for health and wellness remain under-researched in Zimbabwe, negatively impacting their overall consumption. The consumption of IRVs has been declining, affecting human health and wellness sustenance. Therefore, this study explored value addition processes for optimizing the consumption of IRVs for health and wellness sustenance in Zimbabwe. Specifically, the study sought to explore indigenous root vegetables that are consumed for health and wellness sustenance in Rusape; assess value addition processes for optimizing indigenous root vegetables consumption; evaluate challenges and opportunities for value addition processes of indigenous root vegetables and recommend value addition processes to optimize indigenous root vegetable consumption for health and wellness sustenance. A qualitative methodology and phenomenology research design guided the data collection process. Data was collected in Rusape rural from a sample of 25 participants, comprising farmers, consumers, nutritionists, and food processing experts. Non-probability theory comprising snowball sampling method was used to select participants. The study capitalised on semi-structured interviews to gain deep insights and observations were augmented by photography. Participants' voices were audio recorded. Research permission was obtained from various stakeholders, and approvals were granted accordingly. Data was analysed thematically and presented through themes, verbatim quotes, and figures. Findings indicate that value addition processes are practiced at household level, primarily using traditional techniques, except for solar dryers. These processes include milling, fermentation, sun-drying, and solar drying. Findings revealed that value addition processes being used are not effective enough to meet the current dietary trends and optimize consumption. Very little attention has been given to the value addition of IRVs by food processing companies. Findings also support that general consumption is declining and that available value addition processes are not doing much to minimize the decline. Neglecting value addition by food processing companies limits market potential, consumer accessibility, and consumption, underscoring the need for intervention. These challenges hinder the achievement of Sustainable Development Goals (SDGs) two (2) of zero hunger and three (3) of health and well-being. One of the way forward is to capitalize on value addition processes to align with changes in consumer tastes and preferences. This study advocates for collaboration between small-scale farmers and food processing companies to drive innovation in the value addition of IRVs, thus increasing consumer appeal and overall consumption for health and wellness sustenance. Future studies should explore IRVs that still need profiling, as well as experimental research to validate medicinal claims learned through trial and error by past generations

Key words: Indigenous vegetables, Root vegetables, Value addition, Health and Wellness Sustenance, consumption

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LIST OF ABBREVIATIONS/ACRONYMS

FAO:	Food and Agriculture Organisation
HBM:	Health Belief Model
IVS:	Indigenous Vegetables
IRVs:	Indigenous Root Vegetables
NGO:	Non-Governmental Organisation
MAP:	Modified Atmosphere Packaging
NCDs:	Non-Communicable Diseases
NUS:	Neglected and Underutilised Species
SDGs:	Sustainable Development Goals
SSA:	Sub-Saharan Africa
WHO:	World Health Organisation

CHAPTER 1

PROBLEM AND ITS SETTING

1.1 Introduction

The sharp rise in non-communicable diseases, particularly in developing nations, necessitates solutions to sustain health and wellness (Singh, Chand, S., Ahmed, Singh, & Roy, 2018). Indigenous food crops, such as root vegetables, could be part of the solution. These vegetables contain vital nutritional and medicinal properties that can be leveraged to combat various ailments (Cereda, Vilpoux, & Sørensen, 2024); however, their consumption remains very limited, as they are typically included in diets only during droughts and periods of hunger (Nyaruwata, 2019). Value addition processes aimed at optimizing the consumption of indigenous root vegetables (IRVs) for health and wellness sustenance have yet to be thoroughly researched (Mazike, Chipurura, & Macheka, 2023). Furthermore, indigenous foods, including roots, are often perceived as food for poor people (Chemura, Kutywayo, Hikwa, & Gornott, 2022). This perception has fostered negativity towards IRVs, and one way to combat this is to bring these crops back into prominence through value addition, as posited by Kodzwa, Madamombe, Masvaya and Nyamangara, (2023). Against this background, this study aimed to explore value addition processes to increase the consumption of IRVs for health and wellness sustenance in Zimbabwe.

This chapter sets the tone and lays the foundation for the entire study. It provides the background to the problem, including a brief history of IRVs, their value addition, usage and; consumption, while identifying major gaps that necessitated the study. It also presents a synopsis of the problem in the form of a problem statement, outlines the research objectives and questions that guide the entire study. Additionally, the chapter outlines and justifies the delimitations of the study, research assumptions and define key terms.

1.2 Background to the problem

There is a dearth of literature on IRVs in general (Akinola, Pereira, Mabhaudhi, Bruin, & Rusch, Let, 2020a), much less on the documentation of their value addition processes (Okello, 2019). Moreover, Chemura et al. (2022) indicated that IRVs are under-researched and classified as

neglected and orphan crops. Thus, this background give the history that led to this study, explaining why the value addition processes towards optimizing the consumption of IRVs matter. The background also identified gaps in knowledge and justifies the relevance of this research. It was guided by the themes.

Consumption as an issue: Root vegetables in general are abundant all over the world, but they are being consumed less and less, worse with indigenous counterparts (Cereda *et al.*, 2024; Chopera, Zimunya, Mugariri, & Matsungo, 2022; Knez, Ranic, Gurinovic, Glibetic, Savic, Mattas & Yercan, 2023). More so, they fall under neglected and underutilised species (Kodzwa *et al*., 2023; Saranraj, Behera, & Ray, 2019). From the beginning of human history, IRVs have been considered as some of the major sources of health and wellness-promoting properties due to their active ingredients (bioactive compounds with antioxidant activity) (Kulshrestha, 2018). From the time when the Green Revolution started, in the 1960s, most attention has been given to exotic vegetables, replacing many locally produced species (Akinola *et al*., 2020a; Onomu, 2023). This transition changed consumer patterns (Magbalot-Fernandez & Umar, 2018), from consuming indigenous foods to other varieties with limited nutrients, hence a rise in diet-related diseases (Chopera *et al.*, 2022). As years passed by, indigenous foods, inclusive of roots, were portrayed as poor man's food, fuelling the challenge of under consumption, especially by the young urban dwellers (Lotter, Marshall, Weller, & Mugisha, 2014). In the rural areas, consumption did not significantly change, but it could not be compared with ancient times, where there was more dependence on these vegetables as a major source of energy, minerals and medication (Nxusani, Zuma, & Mbhenyane, 2023). With the continuous change in trends, consumption patterns also shifted towards exotic root vegetables (ibid). Similarly, Sarkar, Swaney, and Shetty, (2020) stated that subsequent changes in dietary patterns and consumption of more ultra-processed foods has to a certain degree promoted the quick surge of diet related non-communicable chronic diseases (NCDs) worldwide.

In the Andean Region (South America), IRVs are experiencing a decline in consumption, where their intake has been observed in small isolated regions and the aggregate level was said to be below 10% (Cereda *et al.*, 2024; Sarkar *et al.*, 2020). In addition, Park, Hongu and Daily, (2016) postulated that the introduction of food from Asia and Europe shifted American diets, and at present only a few consume foods inherited from their ancestors. This being said, public health

reports indicates that Native American communities are suffering increased health challenges (Sarkar *et al*., 2020), which can be ameliorated if consumers resort to indigenous foods inclusive of root vegetables as they contain health benefits that go beyond basic nutrition (Nayak, Barik, Tiwari, Kumar & Kumar 2025).

In Ghana, consumption has been neglected, leading to under exploitation and underestimation of its value in combating diet-related diseases (Atuna, Djah, Achaglinkame, Bakker, Dari, Osei-Kwarteng, Mahunu, Koomen, & Amagloh, 2022). Similarly, in the Kingdom of Eswatini, these vegetables have been undervalued and considered as food for the impoverished with no research prioritization, affecting their consumption (Masarirambi, Nxumalo, Kunene, Dlamini, Mpofu, Manwa, Earnshaw & Bwembyaet, 2020). This indicates the need to promote locally naturalized produce. Chopera *et al*. (2022), who conducted a study on barriers and facilitators of consumption of these foods, indicated that indigenous foods (roots included) are not widely present in the Zimbabwean diet, with only 9.3% consuming them daily. This under-consumption is not only being experienced in the countries mentioned above by multiple nations across the world (Shrestha, 2013). Since various nations have IRVs in abundance at their disposal (Jamir, Devi, Ningombam & Verma., 2024; Atuna *et al*., 2022), promoting their consumption by bringing them back to the map can alleviate health and wellness-related challenges. IRVs are not just a basic nutrient provider but possess several medicinal properties that can sustain health and wellness if fully harnessed. Although consumption has declined, available literature does not specify data on the tonnes of IRVs consumed in earlier times versus now, the quantitative comparison is missing. Various indigenous root vegetables found in Zimbabwe include: Sweet potato (Ipomoea batatas/mbambaira), taro root (Colocasia esculenta/madhumbe), Livingstone potato (Plectranthus esculentus/tsenza), Babiana hypogea (hwenya), boscia silicifolia, umthwebebe, umqwente, amagonsi (Ipomoea spp), harunwa, manyani, shungwa, Cassava, Yam (Dioscorea steriscus), Cocoyam (Colocasia esculenta (L.) Schott), Tiger nut (Cyperus esculentus/pfende), typhonodorum, plectranthus esculentus, Manyanya (dioscorea steriscus), idiya (Dioscorea bulbifera), African arrowroot (taccaleontapetaloides/bepe), and mupana (boscia anguistifolia) [Manduna & Vibrans, (2025), Chemura et al., (2022), Helliker, Chadambuka, & Matanzima, (2022), Kujeke,Mazarura, Ngadze, Gasura, Rugare, Matikiti, & Masekesa, (2019) Mupakati, Tanyanyiwa, & Tanyanyiwa, (2017), Washaya, Mupangwa & Murandaet , (2016), Matikiti. et al., (2017), Chivenge, Mabhaudhi, Modi, & Mafongoya, (2015), Gomez, (1989)]. Among the

preceding IRVs, relative attention has been given to plants that were introduced and became part of Zimbabwean tradition, norm and culture. Very minimum attention has been given to the native plants. Examples of exotic root vegetables include but not limited to potatoes (solanum tuberosum), carrots (daucus carota), onion (allium cepa), ginger (Zingiber officinale), beets (beta vulgaris), turnips (brassica rapa), parsley (Petroselinum crispum) and radishes (raphanus sativus).

The value of IRVs*:* According to Akinola et al. (2020) and Nxusani et al. (2023) IRVs have several uses within communities; however, their benefits and value within African settings remain inadequately explored and integrated. Moreover, they have gained minimal attention from researchers or even commercial markets (Chopera *et al*., 2022; Singh et al., 2018). They are usually looked down upon as food for the poor (Masarirambi *et al*., 2020) and at times seen as weeds as the case with tiger-nut (Li, Shen, Liu, Wei, & Wangl, 2024). Irrespective of negative connotations by some consumers, IRVs feature prominently as superior sources of calories, nutrients, and minerals vital for health and wellness sustenance (Kulshrestha, 2018). Root vegetables like yam (Dioscorea spp.) not only provide food but also provide vital pharmaceutical solutions supporting millions across the globe mainly in humid and semi-humid climatic areas (Verma & Nandan, 2023). Similarly, In Northern Philippines IRVs are not only sustaining everyday diet requirements but they are also used for curative purposes due to their high medicinal value (Publishers, 2017). In Korean culture, IRVs are normally considered as the first medicine due to countless health benefits used for centuries to maintain health and harmony (Oktay & Ekinci, 2019). One of their key characteristics is the richness in bioactive compounds that go beyond basic nutrition (Knez *et al*., 2022; Cereda *et al.*, 2024; Mbhenyane *et al*., 2015). Despite their contribution to human health and wellness, in southern Africa, IRVs are undervalued (Nxusani *et al., 2023)*. Since they contain health-promoting properties (Masarirambi *et al*., 2020), considering them in our regular diets can play a substantial role in meeting the desired Sustainable Development Goals by 2030. One of the ways to promote consumption of these vegetables is by tapping into value addition processes (Atuna *et al*., 2022; Kuo, Danikou, Dinssa, Roothaert, Rugalema, Simon, Wopereis, & Zonneveld, 2022), hammering on their appearance, taste, texture, and colour so that they can become attractive to all consumers.

The aspect of value addition: According to Nayak *et al*. (2025), globally, root vegetables are associated with limited value addition and weak market access. Cereda *et al*. (2024) argued that

the devaluation of some of the IRVs, which started after colonization, is a process that requires a lengthy time to undo. Furthermore, the youth and urban folks perceive that IRVs are for the poor; however, among the rich, native root vegetables are highly regarded as nutritive (Akinola et al., 2020;Verma & Nandan, 2023). Therefore, much effort towards bringing back IRVs on the map is needed. Thus, the aspect of value addition to increase the consumption comes into play, mainly considering their organoleptic factors. According to Okello (2019) value addition is an essential path for getting large urban and rural consumers. The demand for value added vegetables is on the rise and it can be attained by low cost processing methods, retaining nutritive and sensory quality (Kannaujia, Kale, Dukare, Mahawar & Kumaret, 2019). For instance, India, one of the world's vegetable producers is encountering high post-harvest losses due to very minimum participation in value addition (2.5% only is being value added), leading to under consumption (Singh, 2020). It is worth noting that currently, Nigeria's agricultural transformation agenda is pointing towards engineering the greater part of root and tuber crops into value-added products to meet the heightened interest in unique products across the world (Nanbol & Namo, 2019). This concept can be adapted by multiple countries facing challenges associated with the under-consumption of IRVs. Furthermore, Chopera *et al.* (2022) posited that difficulties in preparation also decreases consumption as most preparation methods are time-consuming, burdensome and require familiarity and skills which results in them being abandoned for other convenient vegetables. Therefore, investing in value addition processes to combat the above mentioned challenges is the way to go.

Coming back home, in an African context, Mazike *et al.* (2023) who conducted a study on value addition of indigenous vegetables paved the way for other scholars. The preceding author stated that value addition being done in Africa is still premised on traditional processes and the use of modern techniques needs to be put into play. However, the geographic scope was broad as the study focused on Africa as a whole. Contextually, the study mainly focused on indigenous 'leafy vegetables'; therefore, attention on IRVs in Zimbabwean context is still desired. It is due to this and above mentioned gaps that this study seeks to explore value addition processes to increase consumption of IRVs for health and wellness sustenance in Zimbabwe. The study focused on IRVs in general not a specific species. As such, the section below present the statement of the problem and the objectives guiding the study

1.3 Statement of the problem

Value addition processes to increase the consumption of indigenous root vegetables for health and wellness sustenance remain under-researched in Zimbabwe (Mazike *et al.*, 2023), negatively impacting their overall intake. Consumption of indigenous vegetables has been on the decrease (Chopera *et al*., 2022), affecting human health and wellness and one of the ways forward is to capitalize on value addition so as to meet changes in consumer tastes and preferences (Kodzwa *et al*., 2023). In 2020, non-communicable diseases accounted for 47.6% of recorded deaths in Zimbabwe (Nyabani, 2021). Indigenous root vegetables contain crucial micro and macro-nutrients that can be leveraged (Verma & Nandan, 2023). If value addition processes gain attention, the consumption of indigenous root vegetables will likely rise, positively affecting health and wellness sustenance. Therefore, this study adopted qualitative research approaches to explore value addition processes towards optimizing the consumption of indigenous root vegetables for health and wellness sustenance in Zimbabwe. The findings from this study can be used to optimize the consumption of indigenous root vegetables for health and wellness sustenance, enhance economic viability through improving the value chain, and contribute to the attainment of Sustainable Development Goals (SDGs) 2; Zero hunger and 3; Health and Wellbeing. Findings obtained can also be used in coming up with innovative indigenous vegetable products that can be commercialized.

1.4. Main Objective

The main objective of this study was to explore value addition processes to optimize indigenous root vegetable consumption for sustaining health and wellness in Zimbabwe

1.4.1 Specific objectives

Specifically, the study was guided by the following objectives;

1. To explore indigenous root vegetables that are consumed for health and wellness sustenance in Rusape.

2. To evaluate value addition processes for optimizing indigenous root vegetables consumption in Rusape

3. To evaluate challenges and opportunities for value addition processes of indigenous root vegetables in Rusape.

4. To recommend value addition processes to optimize indigenous root vegetable consumption for health and wellness sustenance in Rusape.

1.5. Main research question

Which value addition processes can be adopted to optimize the consumption of IRVs for health and wellness sustenance in Zimbabwe?

1.5.1 Specific research questions

Specifically, the study sought to answer the following research questions;

1. Which IRVs are consumed for health and wellness sustenance in Rusape?

2. How do value addition processes optimize indigenous root vegetables consumption in Rusape?

3. What are the challenges and opportunities for indigenous root vegetables value addition processes in Rusape?

4. Which value addition process can be recommended to optimize consumption of indigenous root vegetables for health and wellness sustenance in Rusape?

1.6 Research assumptions

This study is guided by the following assumptions;

i. Indigenous root vegetables are under consumed
ii. Indigenous root vegetables are often neglected in value addition.
iii. Value addition of IRVs can increase consumption and sustain health and wellness of consumers.

1.7 Justification of the study

Contextually, a closer study on value addition focused on Africa particularly indigenous leafy vegetables as noted in work done by Mazike *et al.* (2023). In relation to knowledge gap, IRVs are often neglected in research in favour of other plant parts as posited by Knez *et al*. (2022). Moreso, there is limited scientific research and their documentation (Kujeke *et al.,* 2019; Turner et al., (2011). Practically, all commercialised exotic root vegetables have gone through various stages of value addition however, many IRVs lag (Onomu, 2023). In addition, Batcha, Amirnordin and Yudin, (2023) indicated that IRVs are less industrialised in developing countries. Considering the preceding gaps, it was imperative to focus on IRVs.

1.8 Delimitations

To narrow down the scope and focus of the study, the following delimitations have been considered;

Conceptually, the study is delimited to value addition process of IRVs. IRVs herein include underground edible plant structures such as tiger-nut, yam, taro, and dwarf babiana exclusive of groundnuts and round nuts. The study opted for root vegetables because of their abundance in nature, under-consumption, and availability of health promoting properties that can be harnessed to mitigate various ailments and enhancing health and wellness of consumers.

Theoretically, this study is guided by the Health belief model, The Quantum and Tempus Theories, The Sustainable Livelihoods Framework and The Expectance Value Theory. IRVs are often neglected in research in favour of other plant parts (Knez *et al*., 2022), indicating a gap in the literature that requires attention. These theories helps in understanding consumer behaviours towards IRVs, health impacts of consuming indigenous foods and motivations behind consumption.

Methodologically, the study is guided by the principles of qualitative research to gain deep understanding of the phenomenon under study, rather than just surface-level information, considering multiple factors and their interactions from various informants. To collect data, the study made use of interviews, audio recorders and photography excluding lab based approaches.

Geographically, this study focuses on IRVs found in Rusape rural. Rusape falls under Makoni District and this district is located in Zimbabwe's Eastern Highlands (Manicaland Province), Zimbabwe *(as indicated by Figure 1*). This is because Rusape is one of the areas where IRVs are abundant and thrive well due to favourable humid weather conditions. The production of numerous IRVs is facilitated by its humid weather conditions.

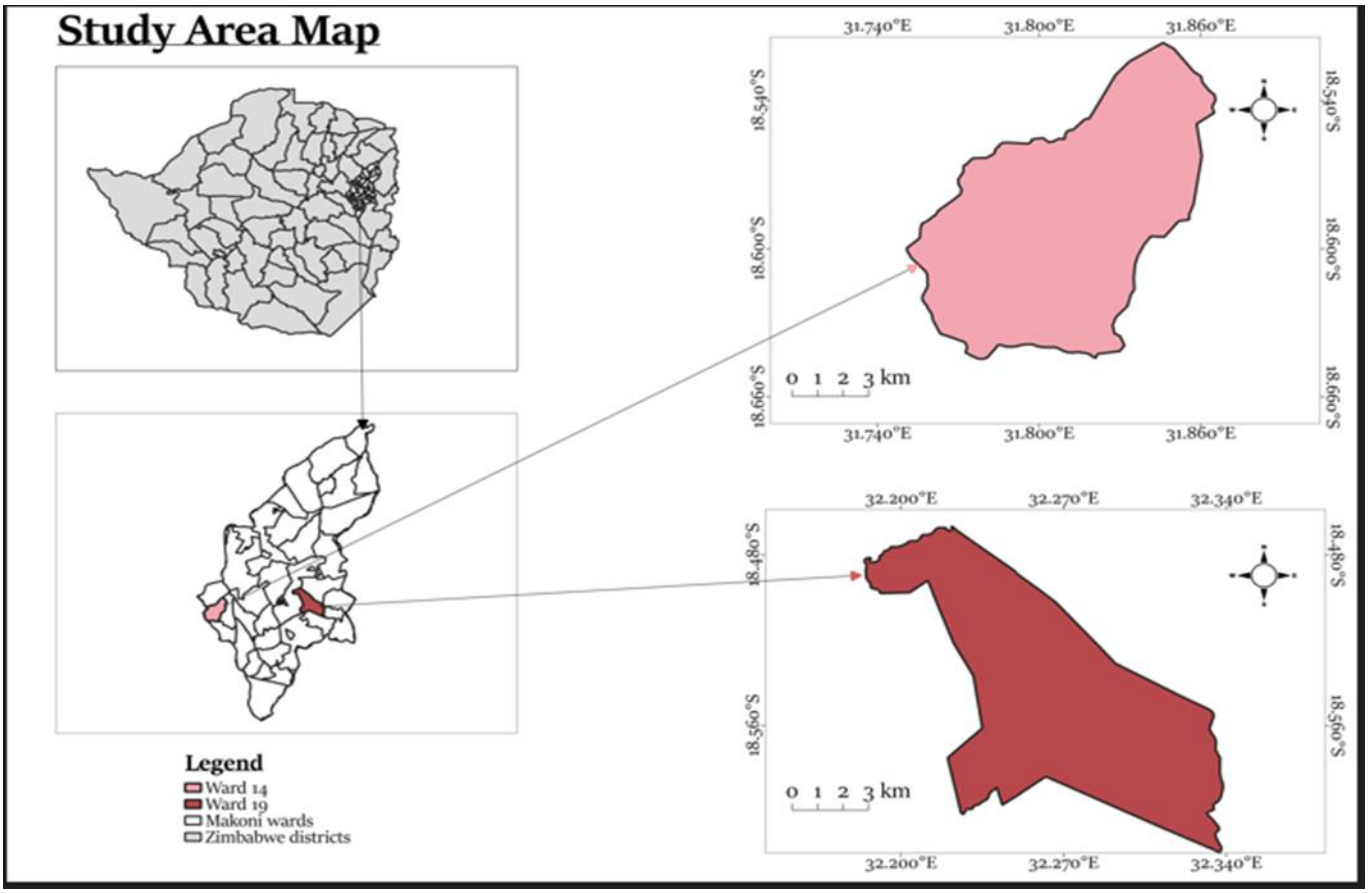

Figure 1. Study Area Map.

Population and participants- It was prudent to delimit the study to the rural community small scale farmers, consumers, nutrition and food processing experts. Specifically the study considered participants from twenty years of age and above. This is because there is indigenous knowledge erosion among the youngsters and acquiring knowledge from the elder generation yields positive outcomes.

1.9 Definition of Key Terms

Table 1.1 Definition of key terms

Term	Definition	Author(s)
Root vegetables	Root vegetables are fleshy underground plant structures which depending upon the crop may be a root, tuberous root, or a taproot.	Kalia, 2004;Siddiq & Uebersax, 2018
IRVs	These are underground plant structures that are either genuinely native or introduced to that region in the past and have since evolved through natural processes.	Elolu *et al*., 2023; Maseko, Mabhaudhi, Tesfay, Araya, Fezzehazion & Plooyet, (2018)
Value addition	In the context of food this term refers to the enrichment of a product's value using procedures that enhance its appearance, nutritive value, life span as well as convenience for the consumer	Verma, Chauhan, Singh, Chandra, Sengar, & Author, (2022)
Health	Health is a state of complete physical, mental and social well-being and not only the absence of diseases	Sze, (1998)
Wellness	It is an active process through which one becomes aware of, and makes choices toward, a more successful existence.	Hettler, (1984)
Functional properties	In the context of food science, this term refers to the health benefits and characteristics that foods can offer beyond basic nutrition, and these properties may include the ability to improve general health or reduce the effects of chronic diseases.	Gur, Mawuntu, & Martirosyan, (2018)

1.10 Chapter Summary

This chapter introduced the problem that necessitated this study and the background to the problem. This chapter also uncovered the challenge of under-consumption of IRVs due mainly to perceptions and changes in dietary patterns. The value of IRVs was also highlighted, including their contribution to health and wellness sustenance. This chapter presented the problem in the form of a statement and this guided the researcher in formulating research objectives, questions, defining the scope and determining the significance of conducting this study. Justification on why this study matters was given. Delimitations were presented followed by the definition of terms that were crucial in this study.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

This chapter provides a comprehensive review of the existing literature related to value addition processes towards optimizing indigenous root vegetable consumption for health and wellness sustenance in Zimbabwe. The main objective of this study was to explore value addition processes to optimize indigenous root vegetable consumption for sustaining health and wellness in Zimbabwe. Specifically, the study sought to: Explore indigenous root vegetables that are consumed for health and wellness sustenance in Rusape; Evaluate value addition processes for optimizing indigenous root vegetables consumption in Rusape; Evaluate challenges and opportunities for value addition processes of indigenous root vegetables in Rusape and lastly to recommend value addition processes to optimize indigenous root vegetable consumption for health and wellness sustenance in Rusape. In addition, the chapter gives an overview of the current knowledge, highlights key findings, identifies existing gaps, and demonstrates how this study contributes to theory. Key terms are conceptualized, followed by a review of related studies on value addition processes towards optimization of indigenous root vegetable consumption. Objective-by-objective and funnel approaches are used to systematically and sequentially address the issues of concern.

This research adopted a narrative literature review stance, also known as the traditional review in drawing conclusions and identifying gaps from secondary data. According to Gregory and Denniss (2018) narrative reviews allow authors to describe the state of current topic while providing insights on advancing current evidence from a different angle. It is also ideal in exploring topics that are under-researched (ibid), making it ideal for this research. The next session unpacks the key concepts that are crucial to this study.

2.2 Conceptualization of key terms

Conceptualization of key terms in research involves identifying and defining critical terms that play an important role within the context of a study (Hlynsdottir, 2020). Concepts may have multiple elements or dimensions depending on the context used hence the need to provide a unified explanation that puts both the writer and the reader on the same page. Moreover, it is also not about

giving a random definition but meanings given should make sense to the reader; while avoiding confusion and misinterpretation. Therefore, the following paragraphs break down complex ideas into more unified explanations that address the objectives of this study.

2.2.1 Vegetable

The definition of the word vegetable can be complex as it has various meanings in different contexts. A vegetable is any edible part of a plant, including leaves, seeds, and roots, that is usually consumed raw or cooked as an accompaniment to a meal, excluding fruits (Varadaraju, 2019). Vaclavik and Christian, (2008) defined vegetables as the edible part of a plant consumed, with the main course providing the aroma, colour, and texture to the meal. On the contrary, FAO, (2021) defined the term vegetable is 'any' vegetable part consumable by humans, inclusive of roots, tubers, bulbs, stems, leaves, flowers, fruits, and seeds that play a crucial role in human nutrition. In line with the preceding definitions, it is evident that there is no precise definition for the term vegetables but one can adopt a definition depending on the context of the study. This study adopted the definition by Varadaraju, (2019). Since this study is on indigenous vegetables, the following section conceptualizes its meaning.

2.2.2 Indigenous vegetables (IVs)

The terms indigenous vegetables can vary depending on the context, institution and country. Perkasa and Petropoulos (2020) defined IVs as plant species that are native to a certain region or environment, having evolved within a specific geographical area, sometimes from foreign plants introduced over a long period of time. Similarly, Kansiime, Kessy, Karanja, Romney, & Afari-Sefa, (2018) defined IVs as all plants that originated in that region or have a long farming and domestication history and whose roots, leaves, and fruits are acceptable and consumed as vegetables through tradition and customs. Towns and Shackleton (2024) also defined IVs as plant species that originated in that nation or have a long history of domestication and cultivation and that have been accepted by consumers through habit, custom or tradition. On the same hand Kuo et al. (2022) defined IVs as naturalized or species that were introduced long ago and now accepted as indigenous to local food and farming systems after generations of interactions with humans and the environment. In support of the above definitions Maseko et al., (2018); Mungofa, Sibanyoni, Mashau and Beswaet (2022) defined IVs as plant species that are either genuinely native or that

were made known to that region years ago and progressed through natural processes. The preceding definitions considers a broader spectrum, from plants that are native to those that have been introduced years ago in a certain environment, such as the taro root and cassava.

On the contrary, Lanzes and Bhushan, (2022) are of the view that IVs are crops that are native and unique to a specific area, grown and produced using traditional methods. This definition only considers vegetables that originated in a particular area and specifically whose methods of cultivation are still traditional. Some IVs could have originated in a certain geographical area, grown using indigenous ways but farmers may decide to cultivate them using modern techniques due to changes in technology. In this study, IVs as plant species that originated in Zimbabwe or have a long history of domestication and cultivation and that have been accepted by consumers through habit, custom or tradition.

2.2.3 Indigenous Root Vegetable

Root vegetables in cuisine and nutrition is an underground part of a plant eaten as food. Root vegetable is a culinary category rather than a botanical one, it is not composed of true roots only but also bulbs, corms, rhizomes, tubers and other underground plant structures (Kalia & Selvakumar, 2023;Siddiq & Uebersax, 2018). Many IRVs are highly nutritious, containing important nutrients important for one's health and well-being (Britannica.com). With reference to literature reviewed, there is no specific definition for IRVs although a number of those that fall in this category are usually found under the umbrella term 'indigenous vegetables'. Therefore, the term indigenous root vegetable herein refers to all edible underground plant parts that are either native or have been introduced in Zimbabwe from time immemorial and these include but not limited to Sweet potato (Ipomoea batatas/mbambaira), taro root (Colocasia esculenta/madhumbe), Livingstone potato (Plectranthus esculentus/tsenza), Babiana hypogea (hwenya), boscia silicifolia, umthwebebe, umqwente, amagonsi (Ipomoea spp), harunwa, manyani, shungwa, Cassava, Yam (Dioscorea steriscus), Cocoyam (Colocasia esculenta (L.) Schott), Tiger nut (Cyperus esculentus/pfende), typhonodorum, plectranthus esculentus, Manyanya (dioscorea steriscus), idiya (Dioscorea bulbifera), African arrowroot (taccaleontapetaloides/bepe), and mupana (boscia anguistifolia), with an exclusion of groundnuts and round nuts. IRVs play a central role to human health mainly due to the availability of health-promoting properties called functional properties.

The terms “indigenous root vegetables” herein are abbreviated to IRVs. The following section highlights what functional properties are and their significance to human health.

2.2.4 Functional properties

In the context of food science, the term functional properties refer to the health benefits and characteristics that foods can offer beyond basic nutrition, and these properties may include the ability to improve general health or reduce the effects of chronic diseases (Gur *et al*., 2018). They provide health benefits beyond basic nutrition due to the availability of non-nutritive compounds known as phytochemicals that have various health properties. IVs have antioxidant properties that protect cells from harm caused by free radicals, free radicals are the chief precursors of cancer. In addition, consuming IVs can minimize the possibility of developing chronic ailments like heart disease, diabetes, and cancer (Chandrasekara & Kumar, 2016). IVs also contain polyphenols that have the potential to reduce the risk of oxidative stress (Gunathilake & Ranaweera, 2018). These preceding benefits are the ones which are referred to as functional properties in this study. Although IVs contain vital health benefits, they are often neglected and one of the ways to optimize their consumption is through value addition which is elaborated in the following paragraph.

2.2.5 Value addition

Value addition is a strategic method that aims to improve the quality, market value, and economic potential of agricultural goods, like vegetables (Raleng & Singh, 2021). Gauchan, (2023) also defined value addition as a process by which the value of a commodity is enhanced during different stages in the value chain that is from production, processing, marketing and use. It aims at transforming raw produce into value-added products with improved attractiveness and usefulness to the consumer. The concept of value addition includes diversification of products for example the transformation of raw vegetables into juices, snacks, pickles, canned products and frozen items. Apart from diversification, it also includes the aspect of quality enhancement which can be achieved through appropriate post-harvest handling, processing, and packaging, enhancing nutritional value, appearance, taste, and extending shelf life (Boakye, Manu, Chronakis, & Gudjónsdóttir, 2018). It also includes the aspect of processing and packaging vegetables into convenient, products that are ready to use, increasing their perceived worth. Value addition

processes also include the extension of the vegetable's shelf life through methods such as drying, freezing, canning, or pickling, fortification, branding, and pasteurization, even in off-seasons (Tejaswini, Thomson, & Raoet, 2020). This broader explanation of value addition is clear as it covers the key facets of value addition that are nutritional value, quality and shelf life oriented.

According to Anderson, (2023) value addition is the process of enhancing the economic value of an agricultural product by changing its original state with the primary goal of meeting consumer demand for convenience, variety and availability all year round. All definitions by the above authors cover crucial aspects of value addition and they also align with the demand of this study. This study adopted a definition by Onomu (2023) who defined value addition as various modalities and expertise applied to agricultural products to increase nutritional value, acceptability, consumption, market visibility, shelf life, convenience and availability throughout the year.

2.2.6 Health

According to Hastings, (1973), World Health Organisation in 1948 defined health is more than just the absence of illness or disability; it is a state of whole physical, mental, and social well-being. This definition places emphasis on an all-encompassing conception of health that takes into account an individual's general state of well-being in addition to the absence of disease. It emphasizes the interconnectedness between these elements by encompassing social, mental, and physical well-being. This definition incorporates social and mental health which are often overlooked. In its own time, this definition was comprehensive and still holds value today because it captures the goals that many organizations and health professionals strive for. However, the definition also establishes a high bar that may not be achieved by everyone.

Tonkin, (2023) defined health as a multidimensional concept that includes societal efforts to optimize well-being. It includes factors like play, sleep, nutrition, and activity, emphasizing a holistic approach to children's health and well-being. To add on, it is not only the absence of disease but a proactive approach to maintain and improve overall health and wellbeing. Maintaining a healthy lifestyle or practicing wellness can have numerous benefits, including reducing the chances of contracting chronic diseases. Health is observable and dependable; therefore, making the right food choices is crucial. This study adopts the traditional definition by

WHO in (1948) which comprehend that health is more than just the absence of illness or disability but a state of whole physical, mental, and social well-being.

2.2.7 Wellness

The terms health and wellness are linked, but they are not entirely substitutable. Wellness is a multidimensional concept that goes beyond mere health but rather encompasses mental, emotional, and sometimes spiritual dimensions. The Global Wellness Institute (GWI, 2015) defines wellness as the active pursuit of activities, choices and lifestyles that lead to a state of holistic health. The definition by GWI (ibid) has two important aspects, firstly where wellness is not a static state but rather an active quest associated with positive intentions, choices and actions as one works toward an optimum state of health and wellbeing. Secondly, wellness is interconnected to encompassing more than physical health but integrates many different dimensions that should function in accord. Wellness is one's pursuit meaning that individuals have self-responsibility for their own choices, conduct and lifestyles but it is deeply shaped by the physical, social and cultural environments surrounding them. According to Stoewen, (2017), people typically associate wellness with physical health, diet, exercise, and weight control. However, wellness covers eight equally inter-reliant dimensions which are physical, intellectual, emotional, social, spiritual, vocational, financial, and environmental and all of them require attention. In this study, wellness is an active pursuit of activities, choices and lifestyles that lead to a state of holistic health as defined by the Global Wellness Institute.

2.2.8 Health and wellness sustenance

Ahmann, Saviet, Conboy, & Smith, (2024) defined health and wellness sustenance as the upkeep and constant improvement of physical, mental, and social well-being over time. It also involves engaging in behaviours that promote health as well as the adoption of a lifestyle that supports ongoing wellness. Health and wellness in the context of the food industry refer to the promotion of food choices and behaviours that contribute to physical, mental, and emotional well-being (Mcmahon, Williams & Tapsell, 2010). The food industry shapes dietary habits through product formulation, nutrition labelling, marketing practices, and adherence to nutrition standards in food procurement policies (Piekarz-Porter, Schermbeck, Leider, 2020). The concept of health and wellness in the food industry also involves efforts to offer healthier food options and encourage

dietary patterns that support overall well-being. This study adopted the definition of health and wellness sustenance by Ahmann *et al*. (2023). The following sections reviews literature related to the first objective of this study which sought to establish IRVs in Zimbabwe.

2.3 INDIGENOUS ROOT VEGETABLES IN ZIMBABWE

Indigenous vegetables can be produced all year round and can withstand harsh environments (Cereda *et al*., 2024), however, their consumption is declining. Many of them are overlooked and are gradually being replaced by modern varieties (Shrestha, 2013). Like other indigenous vegetables, the root part plays a vital role in human health (Knez *et al*., 2022; Turner, Luczaj, Migliorini, Pieroni, Dreon, Sacchetti & Paolettiet, 2011).This section gives a broader perspective with regards to their typology, significance, nutritional value, health benefits, consumption patterns and challenges and opportunities for promoting them.

2.3.1 Types of IRVs in Zimbabwe

Since this study is grounded in Zimbabwean context, the following table shows types of IRVs that have been identified in Zimbabwe.

Table 2.1 Typology of IRVs in Zimbabwe

Classification/type	Name(s) of indigenous root	Area of Study	Author(s)
Tuberous roots	Sweet potato (Ipomoea batatas), taro root *(Colocasia esculenta)*	Sub-Saharan Africa	Chivenge, Mabhaudhi, Modi, & Mafongoya, (2015)
Tuberous roots	Livingstone potato (*Plectranthus esculentus*)	A review in Zimbabwe	Kujeke,Mazarura, Ngadze, Gasura, Rugare, Matikiti, & Masekesa, (2019)
True Roots Bulbs	Babiana hypogea, boscia silicifolia, umthwebebe, umqwente, amagonsi (ipmoea spp), harunwa, manyani, shungwa,	A review, Zimbabwe	Gomez, (1989)
Tuberous root	Cassava	Chiredzi, & Zvishavane, Zimbabwe	Mupakati, Tanyanyiwa, & Tanyanyiwa, (2017)
Tuberous roots	Yam **(*Dioscorea steriscus*)**	Bindura, Zimbabwe	Washaya, Mupangwa & Murandaet , (2016)

Tuberous roots	Cocoyam (*Colocasia esculenta* (L.) Schott)	Manicaland, Zimbabwe	Chemura et al., (2022)
Tuberous roots	Tiger nut (Cyperus esculentus), typhonodorum, plectranthus esculentus	Honde Valley, Manicaland	Manduna & Vibrans, (2025)
Tuberous roots	Manyanya (*dioscorea steriscus*), idiya (*Dioscorea bulbifera*), bepe (*taccaleontapetaloides*), mupana (*boscia anguistifolia).*	Hurungwe	Helliker, Chadambuka, & Matanzima, (2022)
Tuberous root	Cocoyam	Makoni District, Zimbabwe	(Matikiti. *et al*., 2017)

IRVs can be classified as true roots, bulbs, corms, tubers and rhizomes (Turner et al., 2011). Literature reviewed within the Zimbabwean context reveals three major classes of IRVs that are consumed, as indicated in Table 2. Since a number of these vegetables were consumed before the Green Revolution, examining traditional knowledge and practices regarding these native root crops is prudent.

2.3.2 Traditional knowledge related to IRVs

According to Turner et al. (2011), starchy plants played a fundamental role in human nutrition throughout history. Serving as a primary source of energy, these plants have been crucial for the continued existence of both hunter-gatherer societies and agricultural communities. Among them, underground storage organs like true roots, bulbs, rhizomes, and tubers, known for their richness in starch deserve particular attention. Considering various nations and states, IRVs served as essential dietary staples for various populations across North America, Siberia, Central Asia as well as hunters and gatherers in Kalahari (ibid). According to Singh et al., (2018) indigenous plants play a significant role in the traditional food and health systems of rural and tribal societies in tropical regions that are in South America, Central America, Asia, and Africa.

In America, traditional knowledge, discovery, and ongoing observation guided early humans to embrace and incorporate plant-based foods in their diet and for therapeutic uses depending on availability and nutritional properties applicable to human well-being (Sarkar *et al*., 2020). Sarkar added that the fundamentals inclusive of food resources, medicines, cultures, sacraments, and spiritual uprightness of aboriginal Native American people have long been embedded. They are associated with their native and localized edible plants and IRVs are not an exception. The majority

of Native American tribes were farmers until the early 20th century, gathering foods and medicinal plants from the forests. Low-fat, high-protein, complex carbohydrate-based whole meals with dietary fibre and enriched phytochemicals could make up the majority of their diet. Kuhnlein, Erasmus, (2022) highlighted that these foods played a vital role in sustaining livelihoods of the populace but it is due to the introduction of new foods that shifted dietary patterns of consumers to highly processed foods that have several health implications.

In East Asia, Chinese culture to be precise, there is no clear difference between food and medicine (Press, 2025). People used to rely on the gathering of wild plants and this sustained their health and wellness during their ancient times (Akinola, Pereira, Mabhaudhi, Bruin, & Rusch, 2020a; Turner *et al.*, 2011). Moreover, indigenous plants (root vegetables included) have been used since to cure and heal various ailments. Even at present, some people in various parts of the world still use native root vegetables to cure diseases. It was observed that as people adopted western foods and living standards, an increase in the prevalence of diseases began to emerge (Sarkar *et al.*, 2020). Traditional diets provide protection against illnesses common in Western societies, as indigenous populations historically experienced very low rates of chronic and degenerative diseases. The increasing susceptibility to diet-related conditions is attributed to the interplay between evolving dietary habits and genetic factors.

According to Punchay *et al.* (2020) who conducted a study on traditional knowledge of wild food plants in Thailand (South East Asia), the gathering of wild food inclusive of indigenous root vegetable plants signifies the original practices of aboriginal people. The uses of indigenous root vegetable species are not only significant in traditional dishes but also in human health due to the availability of medicinal properties (Tapera *et al*., 2020). In Thailand, pastoral societies still hold a rich traditional knowledge which is mirrored by the fact that they gather above 1700 indigenous plant species for nourishment, medications and other social uses (ibid). Several IRVs are believed to be medicinal foods that contain health benefits and some of their properties have even been authenticated by pharmacological studies. Communities in Thailand have kept a rich traditional knowledge on medicinal properties of their indigenous foods and this has played a crucial role in sustaining food security, healthy diets, and well-being under globalization and socioeconomic change. However, traditional knowledge is gradually fading, highlighting the importance of

continued research to preserve it. Akinola *et al*., (2020) indicated that the aspect of knowledge erosion is not only affecting this nation but it is rather a far-reaching global phenomenon.

According to Turner *et al*., (2011) some may think that indigenous knowledge on IRVs no longer applicable to contemporary people, however there are several reasons why there is a need to preserve the rich knowledge of the food systems. Furthermore, many indigenous foods are vital to people's values and ethnic identity and in these cases, their use is important for spiritual, emotional, as well as physical health and well-being. Bearing the aspect of health and wellness, Sarkar *et al*. (2020) worked on the framework and strategies to revive and revitalize the traditional plant-based food diversity and to integrate such foods into contemporary healthy dietary patterns as part of overall public health solutions for non-communicable diseases.

In Sri Lanka, indigenous and traditional foods boast a rich history and unique heritage that has endured for thousands of years. The country's food traditions are deeply connected to nutritional, health-related, and therapeutic aspects, emphasizing the reasoning behind food ingredients and preparation methods. According to Mihiranie *et al.* (2020), the varied culinary practices and recipes serve multiple purposes, blending profound knowledge of flora and fauna with a focus on human well-being and therapeutic health benefits.

In an African context, Tapera *et al.* (2020) indicated that indigenous plants (vegetables included) have served as sources of nourishment and medicine for humanity since ancient times. Moreover, medicinal plants were discovered time immemorial through trial and error methods to treat medical conditions, combating disease epidemics, and to preserve food (Dar, Shahnawaz, & Qaziet, 2017). Like what has happened in multiple countries, medicinal plant knowledge has been identified as mainly susceptible to loss and degradation (Santosh-Kumar *et al.*, 2019). Chacha and Laswai, (2020) conducted a study on traditional practices and consumer habits regarding the consumption of underutilized vegetables in Tanzania and discovered that indigenous vegetables serve a significant purpose in the well-being of many people who live in the pastoral areas. In Nigeria for instance, Livingstone potato is used for making special dishes in traditional ceremonies in remembrance of the ancestors (Schippers, 2000). The adoption of Livingstone potato alone, without considering other root vegetables for the same ceremony shows its significance in one's well-being. Apart from Livingstone potato, yam tubers have been used as sources of traditional

medicine to treat several ailments, including diarrhoea and diabetes (Sakthidevi & Mohan, 2013). In Africa, people used to rely on similar indigenous vegetables to combat various ailments.

In Zimbabwe, the use of plants for therapeutic purposes has long been practiced by the local people (Maroyi, 2013; Tapera *et al*., 2020). Traditional or wild plant medicine has long been a recognized form of healthcare in addition to nourishment by great-grandfathers in the African continent and Zimbabwe is not an exception. To add on, IRVs have long been utilized to cure illnesses in both humans and animals. (Mujuru *et al*., 2020). For instance yam (dioscorea steriscus/manyanya) that is normally found in Zimbabwe and southern Africa, is popularly used as food and as a source of traditional medications in the northern parts of Zimbabwe (Tapera *et al*., 2020). Similarly, Kujeke *et al*. (2019) conducted a study on Livingstone potato and highlighted that the vegetable has been used as food traditionally, not neglecting economic and medicinal benefits. To add on, Helliker *et al*. (2022) conducted a study on resource management, livelihoods and ethnic minorities in Doma, Zimbabwe and discovered that its people are still relying on gathering various tubers including dioscorea steriscus (manyanya), dioscorea bulbifera (idiya), taccaleontapetaloides (bepe) and boscia angustifolia (mupama) for food and medicinal purposes. The author added that the Doma people do not seek medical attention since they trust their herbs. The long standing historic use of plants as therapeutic resources may serve as a proof of their efficacy. The following section looks at the broader picture on the nutritional value of IRVs from a scientific point of view.

2.3.3 Nutritional value of IRVs

The nutritional value is the primary consideration when considering a crop as a food source. Given consumers' emphasis on the nutritional quality of food, there is a significant demand for information regarding the nutritional composition of root crops (Temesgen, 2015). Additionally, many individuals fail to recognize or fully value the vital role that indigenous root vegetable plants continue to play in meeting nutritional and dietary requirements (Turner *et al.*, 2011). This section looks at nutrient content of various IRVs, such as vitamins, minerals, proteins, carbohydrates, fats, and fibre. It also gives an overview of how a particular root vegetable contributes to daily nutritional needs and overall diet. With reference to **Table 2.1.** This section reviews literature related to IRVs that were identified in Zimbabwe however, nutritional knowledge from the global space is considered. The section begins with the native roots followed by those that were

introduced and became part of our tradition, norm and culture; and which today also falls in the "indigenous category".

1. **The Livingstone potato**

Figure 2.1 Livingstone potato (*Plectranthus esculentus/tsenza*)
Adopted from https://africanorphancrops.org/

Limited literature exists regarding Livingstone potato, possibly due to its classification as a neglected and underutilized species, which has resulted in minimal research attention (Ezeocha & Ironkwe, 2017;Ofoeze, Omohimi, Adegoke, Ogbete, & Kajihausa, 2024). Livingstone potato is a nutritious native African root vegetable that holds potential for food security and medicinal use; its local name in Zimbabwe is *tsenza* (Kujeke *et al*., 2019). This vegetable is cultivated for its edible roots, which typically grow underground, and it has been identified as a rich source of carbohydrates (Chauhan *et al.,* 2022). Due to its high carbohydrate content, it can serve as a substitute for other root vegetables like sweet potatoes and regular potatoes. Not only does it provide a high carbohydrate content, but it also offers significant amounts of protein, vitamin A, calcium, and iron. Scientific studies show that Livingstone potatoes contain greater quantities of protein than cassava and sweet potatoes (Moore, 2006). Additionally, it contains seven (7) of the eight (8) essential amino acids required for human health and well-being. Moore (2006) also noted that, besides amino acids, this root vegetable has higher mineral contents compared to cassava, taro, and sweet potatoes.

Eleazu and Eleazu (2015), who conducted a study on Livingstone potato in Nigeria, indicated that the root contains significant amounts of carbohydrates, proteins, and lipids, as well as bioactive compounds with antioxidant properties. Furthermore, the preceding author added that the root vegetable can alleviate glomerular complications and liver hypertrophy in diabetics. Despite its nutritional value and potential for the agro and pharmaceutical sectors, Livingstone potato remains underutilized and understudied, particularly in Zimbabwe (Kujeke *et al*., 2019). The author indicated that further research is needed to evaluate its diversity, improve productivity, and establish strong value chains to promote its cultivation (Kujeke *et al*., 2019). Due to this gap, this study takes previous studies by Kujeke (2019) as a stepping stone towards the optimization of consumption through value addition. Since this root vegetable is beneficial to one's health and well-being, promoting its production and consumption can be a breakthrough in meeting the SDGs by 2030.

2. The Tiger-nut

Figure 2.2 Tiger nut (*Cyperus esculentus/pfende*)-native

Adopted from Biological flora of Central Europe. Photos by Follak *et al*. (2016)

Tiger nut, despite its name, it is not a true nut but rather a tuber (Sánchez-Zapata *et al*., 2012) .It is largely underutilized in various parts of the world where it propagates mostly on its own as a weed (Adenowo & Kazeem, 2020; Ogunlade *et al*., 2015). It is an edible grass-like perennial plant and is a lesser known vegetable that yields sweet, nut-like tubers referred to as "earth almonds."(Bazine & Arslanoğlu, 2020). Certain researchers suggest that its origins lie in Africa and tropical Asia, while others believe it is native to tropical and subtropical areas globally (Bazine & Arslanoğlu, 2020; Akinola *et al.*, 2020b; Follak *et al*., 2016). It is also recognized by several terms as chufa (in Spanish), earth nut, yellow nutsedge, groundnut, rush nut and as *pfende* in Shona. According to Adenowo & Kazeem (2020), this root is loved by children and adults for its milky sugary taste albeit nutritional and health benefits are not known by many consumers. The root vegetable has been considered a foodstuff since ancient times in Egypt (600 years ago), where they were roasted and used as a sweetmeat (Yu *et al*., 2022; Bazine & Arslanoğlu, 2020). Since its benefits are not known by the majority, consumer awareness to foster informed decisions is imperative.

According to Sánchez-Zapata *et al*. (2012) tiger nuts are currently cultivated in Northern Nigeria, Niger, Mali, Senegal, Ghana, and Togo, where they are primarily consumed uncooked as a side dish. They are also grown in countries such as Chile, Brazil, New Mexico, and Florida. However, in Africa, particularly Zimbabwe they are often regarded as a weed and an invasive species. In Spain, this indigenous root vegetable is most famous for its use in producing *"horchata de chufa*" (tiger nut milk), which also serves as a flavouring agent in ice cream (Roselló-Soto *et al.*, 2018). Additionally, tiger nuts are utilized in making flour products, which are sometimes incorporated into biscuits and other baked goods. Yu *et al*. (2022) highlighted that plant-based milk offers numerous health benefits, particularly for individuals with milk allergies or lactose intolerance, making it a valuable alternative to animal milk.

Tiger nut has been reported to be high in starch, dietary fibre content, proteins, sugars, good quality oil, higher essential amino acids, helpful in combating various ailments inclusive of colon cancer (Edo, Onoharigho, Jikah, Oloni, Samuel, Rapheal, Ikpekoro, Akpoghelie, Agbo, Ekokotu, Ugbune, Ezekiel, Abere, Oghroro, Ojulari, Okoronkwo, Owheruo & Akpoghelie, 2023;Yu *et al*., 2022; Roselló-Soto *et al*., 2018). Apart from the aforementioned benefits, the root vegetable is

highly appreciated for its health benefits and nutritive value. According to recent studies, the mineral compositions of tiger nut tubers are low in magnesium, manganese, phosphorus, iron, zinc, and copper and high in calcium, sodium, potassium, and copper. (Arafat, 2019; Roselló-Soto *et al*., 2018). The high values of calcium in tiger nuts are sufficient for bone and teeth development in toddlers (ibid). The presence of other minerals, such as iron, is greatly significant for blood formation. With regards to the multiple nutritional benefits of tiger nuts, Sánchez-Zapata *et al*. (2012) recommended that the root vegetable should be interrogated further for its use and other benefits. Adenowo and Kazeem (2020) further recommended that tiger nut cultivation should be promoted among farmers to ensure its tubers are easily accessible for consumption and various uses.

3. The African Yam

Figure 2.3 Yam *(Dioscorea steriscus/manyanya)*-native. Photo by Tapera, M., *et al.* (2020)

There are diverse yam species across the globe (Ojimelukwe, Muoasinam, & Omodamiro, 2021), but D. Stericus originated in Africa (Washaya *et al*., 2016). Yams in general are abundant but they are often classified as an orphan crop (crops that are important in food security, nutrition and wellbeing but have been neglected) worldwide (Singh, 2022). Despite this negative classification, they play a central role in human health and wellness due to their richness in nutritional and medicinal value (Ojimelukwe *et al*., 2021). Moreover, people used to make use of this root as food as well as to combat the prevalence of various ailments (Tapera *et al*., 2020). Today, in many

developing countries as well as tropical countries, yams remain essential for food security, medicinal applications, and economic activities (Verma & Nandan, 2023). In terms of nutritive value, yams have a high water content, which is ninety-three percent (93%) of their fresh weight. They are also rich in starch (Singh, 2022), which makes up eighty percent (80%) of their dry weight, providing a vital energy source mainly in sub-Saharan Africa. Apart from starch, they are a good source of dietary fibre which supports a healthy digestive system. Yam species are also packed with essential minerals vital for metabolic processes and these are potassium, sodium, calcium, phosphorus, and magnesium, as well as trace elements like copper, iron, manganese, zinc, iodine, and selenium. Studies indicate that the nutritive value of yams surpass other root and tuber crops (Verma & Nandan, 2023) such as cassava, potatoes, and sweet potatoes in potassium content, making them a particularly valuable dietary component.

In northern parts of Zimbabwe, D. steriscus species known as *manyanya* in Shona, and are popularly used as food as well as a source of traditional medications (Tapera *et al*., 2020). A study by Washaya *et al.* (2016) focused on the nutritional value and use of these yams among residents of Bindura, Zimbabwe, and indicated that consuming just 100g of D. steriscus can surpass an average daily energy needs of an adult, providing 93.6 calories/kg of dry matter. The author indicated that the vegetable contains a high quantity of iron, relative ash, and fibre; however, its protein content is less than what is required by a human body per day. This native root vegetable can fulfil the daily iron needs for all age groups. The preceding findings indicate that yams do not only play a vital role by supplying required nutrients but also can sustain one's health and wellness.

4. The African Arrowroot

Figure 2.4 African Arrowroot (Tacca leontopetaloides)
(Source: Flora of Zimbabwe and https://doi.org/10.1079/cabicompendium.52596 *respectively)*

African arrowroot is an indigenous root vegetable found in Zimbabwe and other regions, locally known as *Bepe*. It is a wild perennial herbaceous and underutilized tuber crop. A dearth of literature on this particular species in a Zimbabwean context was observed and this necessitates investing in its exploration. Despite scarcity of literature, this root vegetable is beneficial to human health but profiling is still desired as recommended by Munsaka (2018). In Nigeria, this root is mainly consumed in times of food shortages to prepare puddings, porridge as well as rich medicinal value (Anyim et al., 2020). Apart from starch, this root vegetable contains crude protein, crude fibre, crude fat, and the following trace elements: sodium, potassium, calcium, magnesium, iron, zinc, manganese, copper and phosphorus (AI *et al*., 2017; Uarrota, 2018). The availability of multiple nutrients in this root vegetable cannot be overemphasized.

5. Taro root

Figure 2.5 Taro root /cocoyam *(colocasia esculenta/madhumbe/magogoya)*-introduced. *(*Adopted from Deep Roots. Photo by Brazier, (2024))

Taro root, also used interchangeably with cocoyam, which is an important ancient crop in the Pacific Islands, Asia, and Africa (Bammite *et al*., 2018; Otekunrin *et al.*, 2021). However, from a closer look, taro and cocoyam are not identical but are often used interchangeably by scholars (Wireko-Manu *et al.*, 2018). These two species share similarities in appearance and usage but they have different characteristics, history and cultural applications as observed by Ubalua (2016). Taro is a member of the Colocasia genus, whereas cocoyam is part of the Xanthosoma genus. It is believed that taro root originated in Southeast Asia and the Indian subcontinent, making it one of the oldest cultivated crops in human history. On the other hand, cocoyam has its roots in Central and South America, where it was domesticated by native societies prior to its spread in Africa and other tropical regions through trade and migration. Taro corms are typically smaller, rounder, and characterized by ring-like patterns on their skin. On the other hand, cocoyam produces larger, elongated corms with rougher, fibrous skin. Both crops are valued for their starchy corms, which can be boiled, mashed, fried, or used in soups and stews. Despite these differences, some scholars like Boakye et al. (2018) use these terms interchangeably. Similarly, these terms will also be used interchangeably in this study.

Taro (also known as Madhumbe in Zimbabwe), is a crop that is not native to the region but was introduced as part of the broader spread of root and tuber crops across Africa. Taro and cocoyam

are rich in carbohydrates, dietary fibre, vitamins, and minerals, making them an excellent source of nutrition. (Otekunrin *et al*. 2021; Ubalua, 2016). Dissimilar to other root crops, cocoyam and taro have been found to possess highest levels of dietary fibre (Temesgen, 2015). Although they do not contain larger amounts of protein, the minimum quantity available is greater than many other root crops (Ferdaus *et al*., 2023; Otekunrin *et al*., 2021). This characteristic makes them valuable to consumers with limited access to protein-rich foods. They are also a good source of thiamine, riboflavin, iron, phosphorus, and zinc and a very good source of vitamin B6, vitamin C, niacin, potassium, copper, and manganese (Kaushal, Kumar, & Sharma, 2015). The abundance of micronutrients makes them vital for overall health, especially in combating micronutrient deficiencies.

In summary, IRVs play a crucial role in human nutrition by providing bioactive nutrient molecules such as dietary fibre, vitamins, and minerals, along with non-nutritive phytochemicals like phenolic compounds, flavonoids, and bioactive peptides. These components help lower the risk of chronic diseases, including cardiovascular conditions, diabetes, various types of cancer, and obesity. The following sections explore the broader health benefits offered by IRVs.

2.3.4 Health benefits of IRVs

A healthy lifestyle is largely ruled by the food people consume. One of the main causes of obesity and chronic diseases linked to diet is the current shift in food consumption patterns from traditional nutrient-dense diets to processed, energy-dense, and micronutrient-poor foods (Al-Jawaldeh & Abbass, 2022; Mtenga & Ripanda, 2022; Mihiranie *et al*., 2020). This shift has resulted in the "threefold burden" of obesity, nutritional deficiencies, and malnutrition-undernourishment (Borrego-Ruiz *et al*., 2024; Sarkar *et al*., 2020). Vegetables are thought to be the best way to address micronutrient deficiencies, often known as "hidden hunger," because they are a good source of vitamins, minerals, dietary fibre, and phytochemicals. (Divya *et al*., 2023). Vegetables are abundant all over, making it an ideal way to combat the aforementioned challenges.

Considering the aspect of health, roots are the most commonly utilized plant parts for medicinal purposes (Punchay, Inta, Tiansawat, Balslev, & Wangpakapattanawong, 2020). Additionally, the close relationship between food and medicinal uses of plants is widely recognized (ibid). Around one-third of wild food plant species have also been employed to address health conditions affecting

the digestive system, infections, infestations, and musculoskeletal disorders (Punchay *et al*., 2020). The preference for roots in traditional remedies stems from their typically high concentration of bioactive compounds.

Moreover, Cereda *et al*., (2024) noted that many underground starchy crops are rich in antioxidants, such as phenols, along with other bioactive compounds possessing medicinal properties. Among the indigenous Philippine communities, roots and tubers serve multiple purposes including meeting household food needs, being traded, serving as medicinal resources, and functioning as gifts or offerings (Gayao, 2017). However, certain root vegetable species should not be consumed raw due to the presence of antinutritional factors, such as cyanide in cassava and oxalates in taro.

Table 2.2. The health benefits of IRVs consumed in Zimbabwe.

Name of IRV	**Health benefits/Functional properties**	**Authors(s)**
Tiger nut *(pfende)*	Contains arginine, which stimulates the release of the hormone responsible for insulin production. Prevents colon cancer, cardiovascular disease, coronary heart disease, gastrointestinal diseases, obesity, and diabetes, promotes iron absorption, and maintains Vitamin E levels. Improves fertility to both men and women.	(Sánchez-Zapata *et al.*, 2012);Adenowo & Kazeem, (2020)
Taro root ***(madhumbe)***	It is gluten free, helpful to people with celiac disease, who are allergic to milk. Possess antitumor, antimetastatic, antioxidant, anti-inflammatory effects. Have potential therapeutic agents for the treatment of eczema, rheumatism and bone fracture. Taro extracts accelerate healing from snake bites and septic wounds.	Boakye *et al*., 2018; Ferdaus et al., 2023
Livingstone Potato ***(tsenza)***	Treats stomach aches and digestive problems. It is also used as an anthelmintic to treat pains, and has anti-tumour and anti-cancer properties.	Kujeke *et al*., (2019)
Yam (*Dioscorea Stericuss/manyanya)*	Contains vanillic acid and kaempferol.	Tapera *et al.* (2020)

Sweet potato *(mbambaira)*	Relieves constipation	Gauria & Champaran,(2016)
Cassava *(Mufarinya)*	Helps in managing diabetes	Onodu, Culas & Nwose (2018)

2.3.5 Health implications of root vegetables

Root vegetables significantly contribute to human health and wellness, but they are also associated with toxins that can negatively affect well-being if consumed in excess (Aworh, 2023; Ferraro, Tomlins & Pintado, 2016; Knez *et a*l., 2022) Research indicates that vegetables may act as carriers of toxic substances, such as pesticide residues and heavy metals, which can lead to various disorders in consumers if consumed in larger amounts (Manzoor, Sharma, & Wani, 2018). They are particularly vulnerable to contamination since soil may be polluted with substances like sewage sludge or fertilizers (Knez *et al*., 2022; Manzoor *et al*., 2018). Consuming contaminated vegetables can increase the risk of cancer due to the formation of carcinogenic nitrosamines (Bayata, 2022; Kaushal *et al*., 2015;Nabeshima *et al*., 2020). While scholars like Knez *et al.*, (2022) acknowledge that root vegetables are vulnerable to contamination, they argue that the low levels of toxic elements in most vegetables do not pose major health threats to the average consumer. Moreover, primary processing such as cooking, peeling, chipping, drying and parboiling can reduce contaminant levels by over 50% making various root vegetables that contains toxins fit for safe consumption (Bayata, 2022;Kalia & Selvakumar, 2023;Kiran Thirumdasu, 2018;Nabeshima et al., 2020). To mitigate the multiple risks mentioned, farming communities should be encouraged to reduce the use of synthetic fertilizers and pesticides, opting instead for compost and manure (Manzoor *et al*., 2018). Manzoor *et al* (2018) added that there is also need to take caution when farming near areas where there is a lot of exposure to heavy metals and other toxins.

2.3.6 Consumption patterns of IRVs

IRVs are recognized all over the world, but consumption has been steadily declining (Knez *et al*., 2022). Sarkar et al. (2020) who conducted a study in America indicated that its people used to

gather foods and medicinal plants from the forests to sustain their nutritional needs, health and wellness. Until the 20th century, the development of industry and technology caused a shift from home-based food to intensive intake of commercially produced foods which are calorie-dense. Sarkar *et al*. (2020) opined that changes in dietary patterns triggered intake of more hyper processed and calorie-dense foods which partly contributed to the swift rise of diet related non-communicable chronic diseases (NCDs) across diverse societies worldwide.

In the Northern Philippines, its indigenous people have at all times considered root crops as a staple food and vegetable. However, with changing dietary lifestyles of the younger generation, consumption has dwindled. This has been fuelled by lack of documentation and indigenous knowledge on IRVs (Gayao *et al*., 2018). In Tanzania, as well as in other Sub-Saharan African countries, there has been a shift toward exotic root vegetables by urban dwellers, driven by the opinion that indigenous foods are for the poor (Lotter et al., 2014). Moreover, modern superstores in major SSA towns have fresh produce sections much like those of supermarkets in Europe and North America, but often omit IRVs (ibid). The absence of IRVs in such supermarkets serves as a big communication signal to the consumer.

In Ghana, consumption of vegetables that are high in micronutrients is below the recommended amount (Atuna *et al*., 2022). The same author pointed out that main barriers to consumption of indigenous vegetables are cost, lack of availability, palatability and cultural issues. The aforementioned challenges call for strategies to increase availability all year round and palatability using cost effective measures. Mbhenyane *et al.*, (2015) conducted a study on the consumption of indigenous vegetables and health risk in Limpopo province, South Africa. The team indicated that indigenous foods form an important part of the diet of its non-urban populations as more than 90% of them use wild edible roots. Although the majority is using IRVs, the frequency in consumption is declining, negatively impacting on health and wellness sustenance (ibid). To add on, Onomu, (2023) highlighted that native food intake and demand are continuously diminishing because of exotic foods. More so, several native foods are hindered by low-status perception, poor value addition, insufficient awareness of their potential, limited market infiltration, and global acceptability issues.

In Zimbabwe, IRVs have superior nutritional composition; however, they are largely absent from the Zimbabwean diet (Chopera *et al*., 2022). In addition, indigenous root vegetable consumption has gradually decreased over the years despite their health benefits. The Zimbabwean older generation places more emphasis on indigenous and traditional foods than the younger generation (ibid). The young generation often side-line nutritious indigenous foods due to exposure to Western nourishments (Nyaruwata, 2019). In relation to literature reviewed, it is worth noting that changes in dietary patterns is not a Zimbabwean phenomenon only, but also a global challenge. To come up with possible strategies, the following paragraph looks at challenges and opportunities that have been previously studied to promote indigenous root vegetable consumption.

2.3.7 Challenges and opportunities for promoting indigenous root vegetable consumption

The promotion of indigenous root vegetable consumption can be positively or negatively impacted. The following section highlights challenges faced along the way and opportunities that can be tapped.

2.3.7.1 Challenges

- ✓ **Limited awareness** - Many consumers are unacquainted with the nutritional, health and wellness benefits of IRVs (Gido, Ayuya, Owuor, & Bokelmann, 2017).
- ✓ **Market accessibility** - IRVs often lack a robust supply chain, making them less available in various markets (Nyaruwata, 2019; Onomu, 2023).
- ✓ **Perception issues** - IRVs are often regarded as "poor man's food," and this can discourage consumption.(Chadha *et al*., 2007; Masarirambi *et al*., 2020).
- ✓ **Research Gaps** - There is limited scientific research and documentation on IRVs affecting their promotion (Kujeke *et al*., 2019; Turner *et al*., 2011).

2.3.7.2 Opportunities

- ✓ **Nutritional benefits -** IRVs are rich in nutrients and health benefits that can help fight malnutrition and diet-related diseases (Cereda *et al*., 2024; Sarkar *et al*., 2020).
- ✓ **Climate Resilience -** Indigenous roots are often well-adapted to local climates, making them sustainable in the face of climate change (Cereda *et al*., 2024).
- ✓ **Economic Potential -**Promoting these vegetables can create revenue for smallholder farmers.
- ✓ **Cultural Preservation** - Encouraging consumption helps preserve indigenous food practices, biodiversity, and cultural food identity (Gauria & Champaran, 2016; Mihiranie *et al*., 2020; Turner *et al*., 2011).

In summary, the first objective of this study reviewed literature on IRVs that are consumed. IRVs that have been previously studied across Zimbabwe were highlighted in relation to their nature, nutritional value as well as health benefits and it was noted that IRVs play a central role in human health and wellness due to the abundance of medicinal properties. The aspect of indigenous knowledge was also explored in order to understand how the consumption of root vegetables contributed to overall health and wellness sustenance. The section concluded with challenges and opportunities for promoting indigenous root vegetable consumption. Since consumption of IRVs is dwindling, affecting human health and wellness sustenance, it is crucial to gain insights on what can be done to increase consumption. Kodzwa *et al*., (2023) postulated that value addition

processes are some of the avenues that can be tapped into to promote consumption of the various types of indigenous vegetables. Therefore, the following section gives a broader picture of the second objective which is on value addition processes used to optimize the consumption of IRVs

2.4. VALUE ADDITION PROCESSES TO OPTIMIZE CONSUMPTION

As indicated earlier, value addition in this study refers to various modalities and expertise applied to agricultural products to increase nutritional value, acceptability, consumption, market visibility, shelf life, convenience, and availability throughout the year (Onomu, 2023). The consumption of IRVs can rise if they are readily available all year round (Boakye, Wireko-Manu, *et al*., 2018) and if the product attracts the consumer. On the other hand, these root vegetables have limited shelf-life, which contributes to post-harvest losses due to transpiration and microbial spoilage (Skåra *et al*., 2023). These challenges can be minimized by taking value addition into consideration. Meanwhile, processed vegetables are a fast-growing segment in the food industry and it is occupying an important place in the global commerce of various countries (Siddiq & Uebersax, 2018). Therefore, this section gives an overview of the concept of value addition in the context of IRVs, importance of value addition in optimizing consumption, types of value addition processes, its impact on nutrient content and shelf-life as well as socio-economic benefits of value addition.

2.4.1 Types of value addition processes

Value addition processing enhances the value, functionality, and marketability of an agricultural product. The process can be classified into three stages, which are primary, secondary, and tertiary processing as supported by Kannaujia *et al*. (2019). Wireko-Manu *et al*. (2018) highlighted that these stages not only add economic value but also improve convenience, quality, and shelf life for consumers

2.4.1.1 Primary processing

The primary stage is the basis of food processing that involves basic operations performed on raw agricultural products to prepare them for consumption or further transformation (Mohankumar, 2020). The goal of this stage is to ensure that the product retains its natural qualities while achieving cleanliness, safety, and protection against spoilage (Ogino, 2022). Examples include cleaning, sorting, and grading of root vegetables. Simple preservation techniques, such as drying,

freezing, or vacuum packing, also fall under this category (Ferri, Moscetti, Raponi, & Massantini, n.d.). Primary processing is essential in maintaining the integrity of raw materials while making them more suitable for market delivery or later stages of processing.

2.4.1.2. Secondary processing

Secondary processing builds upon the primary stage by transforming raw materials into intermediate or semi-finished products (Mohankumar, 2020). This stage often requires specialized techniques and equipment to create products with enhanced functionality or versatility such as milling produce into flour (Anywar, 2022). Examples of secondary processes are milling, fermentation, canning, dehydrating, pasteurization and extrusion. These operations add substantial value to raw produce by making it adaptable for various culinary uses. Additionally, secondary processing allows producers to cater for diverse consumer preferences and increase profitability by offering differentiated products in the market.

2.4.1.3 Tertiary processing

The tertiary processing stage focuses on creating fully finished, consumer-ready products that often emphasize convenience, flavour, and aesthetic appeal (Ristic, Bender & Jaeger, 2024). At this point, processed ingredients from the earlier stages are combined, prepared, and packaged into goods that can be consumed directly (Ogino, 2022). Examples include ready-to-eat meals, pre-packaged snacks, desserts, and canned soups. Tertiary processing often involves the use of advanced food technologies and innovation to cater for changing consumer demands for convenience and health-conscious options *(ibid)*. This stage reflects the culmination of value addition efforts, transforming raw agricultural produce into a broad range of commercial products. In line with various value addition processes that can be adopted in transforming raw root vegetables into a higher value product. The following paragraphs look at the impacts of traditional and contemporary value addition processes on nutrition and health benefits.

2.4.2 Traditional value addition processes for IRVs

Traditional value addition processes for food involve methods that enhance food preservation, flavour, texture, or nutritional value using techniques passed down through generations. The

following section outlines various traditional processes and their impact on nutrient content and health benefits.

2.4.2.1 Fermentation and its impacts on nutritional and health benefits

Fermentation is an ancient food preservation technique that is commonly practiced across the world, particularly in native communities (Knez *et al.*, 2022). Fermentation of root crops dates back to over 1000 years but only gained real scientific attention and perfection in the past 50 to 60 years (Ray & Sivakumar, 2009). Due to wide application and significance in food preservation, it is commonly used in Africa, where modern food preservation methods are still uncommon (Sharma *et al*., 2020). Fermentation helps to preserve food products, provides a wide variety of flavours, and improves the nutritional properties (ibid). Borrego-Ruiz *et al*. (2024) stated that this ancient practice prolongs the shelf life of perishable items, reduces the toxicity of raw ingredients, and improves digestibility.

By definition, fermentation involves the controlled use of microorganisms like bacteria, yeast, or fungi to ferment sugars into acids, alcohols, or gases and to improve the flavour, texture, and nutritional value of food (Ray & Sivakumar, 2009). The primary processing procedure takes into account steps like pre-treatment of raw materials, brining, and seasoning, and natural fermentation or fermentation facilitated by specific starter cultures, which can last from several days to months. The major fermentation techniques are dry-salting and brine-pickling (Tan *et al*., 2024). Root crops like cassava, yams, sweet potatoes, taro, and arrowroot have traditionally been involved in fermentation processes, enhancing culinary culture along with food security in most areas. For instance, the bulk of cassava in Africa and Latin America is processed into fermented foods and food additives such as organic (acetic, citric and lactic) acids and monosodium glutamate (Ray & Sivakumar, 2009). Sweet potatoes can be fermented into soy sauce, vinegar, lacto-juices, lacto-pickles, and *sochu* (an alcoholic drink produced in Japan), and yams into fermented flour (ibid). Most of these fermented food products are functional foods rich in phytochemicals, dietary fibres, antioxidant compounds (β-carotene and anthocyanin) and probiotic components (lactic acid bacteria and yeasts) (Asogwa, Okoye & Oniet , 2017). Fermentation enhances the bioavailability of nutrients by converting complex molecules into simpler, more absorbable compounds. Fermentation also raises the vitamin content, especially B and K vitamins, and introduces

beneficial probiotics. Certain native root vegetables contain anti-nutritional factors or toxins such as cyanogenic glycosides in cassava. The fermentation process effectively depletes or reduces such compounds, thereby making the vegetables palatable (Borrego-Ruiz *et al*., 2024). It also extends the shelf life of root vegetables since it inhibits the growth of microorganisms that cause spoilage. Moreover, this reduces food loss, especially where refrigeration is not readily available. Sweet potato fermentation has also been done in East Asian cultures to make drinks, pastes, or pickles (Sheikha & Ray, 2017). However, it is significant to ensure that the process is sanitary and properly controlled to avoid contamination by harmful microorganisms.

In Poland, Knez *et al*. (2025) conducted a study on microbiological safety and health properties of marketed fermented root vegetables using exotic root vegetables and discovered that in the case of microbiological analysis, no bacteria were found in pasteurized products. None of the tested products were contaminated with Bacillus cereus, Salmonella spp. Enterococcus spp., or spore-forming anaerobic bacteria. The author added that the process that is believed to make vegetables even healthier is fermentation because of lactic acid bacilli (LAB) that multiplies during fermentation which leads to higher antioxidant potential. Moreover, fermented vegetables can be called probiotic foods according to the criteria set by the Food and Agriculture Organization and World Health Organization. Fermented root vegetables, due to their antioxidant activity and microbiological composition, hold significant potential to enhance the human diet and contribute to maintaining optimal health. Knez *et al*., (2022) highlighted that vegetables contain high levels of anti-nutrients, which reduce the bioavailability of some nutritionally essential components such as zinc or iron but fermentation process reduces those antinutrients, which results in greater bioavailability of vitamins and minerals. Fermented foods show a variety of positive effects on health, and microbiologically produced new bioactive substances make them functional products (Borrego-Ruiz *et al*., 2024;Tan *et al*., 2024). Moreover, fermented foods appear to be beneficial against viruses. However, Knez *et al*., (2025) indicated that fermented root vegetables are probably the least analysed group among vegetables and this is a cause for concern because root vegetables are becoming more and more popular in the consumer's world. This is also a reason why future research about food fermentation should focus on IRVs.

Fermented vegetables are considered to be beneficial because the benefits outweigh the challenges (Knez *et al*., 2025;Tejaswini *et al*., 2021). Consuming fermented vegetables benefits human health,

including antibacterial effects, regulating intestinal bacterial populations, and promoting health (anti-cancer effects, anti-diabetes effects, and immune regulation) as postulated by Borrego-Ruiz *et al*. (2024). However, fermented vegetables have chemical and biological safety concerns such as the existence of pathogenic microorganisms. To reduce hazardous components and to control the quality of fermented vegetables, unique starter cultures, high pressure, ultrasound, cold plasma, photodynamic, and other technologies can be used to solve these problems (Tan *et al*., 2024). In support of the fermentation process, Ray and Sivakumar (2009) argued that value addition of root crops by fermentation can help in coming up with many novel food products such as anthocyanin-rich sweet potato wine and vinegar that have functional and nutraceutical properties. Modification of traditional fermentation techniques to meet modern dietary requirements and tastes could increase their availability, appeal, acceptance and value. The next section unpacks sun-drying.

2.4.2.2 Sun-drying and its impacts on nutritional and health benefits

Sun drying is the process of reducing solid product water activity by eliminating the bulk of its water content (Oliveira, Brandão, & Silva, 2016). Preservation of indigenous vegetables through sun-drying dates back to many centuries as an efficient technique to preserve and increase shelf life (Hii, Jangam, Ong & Mujumdar, n.d.; Skåra *et al*., 2023). The conventional method of sun-drying plays a central role in food processing and value addition, but end products are generally of low quality as compared to that of their fresh counterparts (Hasan et al., 2019). Apart from low quality, the process was found to be slow and is prone to contamination by dirt, dust, insect infestation, and other foreign particles (Hasan, Malik, Ali, Imtiaz, Munir, Amjad & Anwar, 2019). The most antique and traditional way involves placing agricultural products on beaten earth, floor covering or floor exposed to the sun. Although sun-drying presents economic advantages, being for this reason largely used in tropical countries, the product quality parameters and food safety-related issues often become difficult to monitor and control.

It is widely recognized that vegetables are vital sources of essential nutrients, including vitamins, antioxidants, proteins, and fibre (Atuna *et al*., 2022). Epidemiological studies suggest that consuming vegetables plays a key role in protecting against various chronic diseases, such as cardiovascular disease, type II diabetes, dementia, macular degeneration, and certain cancers (Jamir *et al*., 2024). However, the nutrients responsible for these health benefits are often reduced,

altered, or completely lost during drying processes. To add on, Batcha *et al.* (2023) postulated that sun-drying causes chemical modifications in vegetables due to the sensitivity of phytochemicals to heat and light, as well as nutrient losses through leaching.

To mitigate these challenges, certain pre-treatments are applied to vegetables before drying. Pre-treatments are processes applied before drying vegetables to improve efficiency in drying and enhance the quality of the end product (Laveriano-Santos, López-Yerena, Jaime-Rodríguez, González-Coria, Lamuela-Raventós, Vallverdú-Queralt, Romanyà, & Pérez, 2022). Pre-treatments can deactivate enzymes that cause spoilage, preserve nutrients, colour, and taste, and improve the drying rate (Skåra *et al*., 2023). Examples are salting, blanching, chemical treatments, and physical treatments (Sawada, Koyano,Yamamoto, & Yamada 2021). Water blanching is generally unfavourable, as it affects nutrients such as vitamin C, kaempferol, total polyphenols, carotene, ash content, and antioxidant activity. In contrast, steam blanching offers better results, particularly for retaining β-carotene and chlorophyll. Acid pre-treatments are another recommended approach to enhance the nutritional quality of vegetables.

Although drying inevitably decreases the nutritional value of vegetables, resulting in a reduction of phytochemicals with health benefits and lowering the overall quality of the final product, pre-treatments can significantly improve nutrient retention. Oliveira *et al*. (2016) indicated that the effectiveness of pre-treatments depends on careful selection and design, tailored to the characteristics of the specific vegetable, to minimize nutrient loss while preserving the maximum number of health-promoting compounds. The following section looks at solar drying.

2.4.2.3 The impacts of solar drying on nutritional and health benefits of IRVs

Solar drying is a traditional, eco-friendly and affordable method of preserving root vegetables normally used in pastoral environments in Sub-Saharan Africa by small-scale farmers *(*Skåra *et al*., 2023). This method falls both under traditional and modern techniques depending on the technology used. Solar drying of vegetables overcomes the weaknesses of traditional open sun drying such as, contamination from dust, insects, birds and animals and lack of control over drying conditions *(ibid).* This technique uses solar energy to remove moisture, extend shelf life and reduce post-harvest losses (Hii *et al*., n.d.). Solar drying has a number of advantages however, it also has notable effects on the nutritional and health benefits of root vegetables. The process retains stable

nutrients like carbohydrates, dietary fibre, and minerals (such as potassium and magnesium), which are essential for energy and overall health. The heat involved in solar drying can reduce harmful compounds, such as cyanogenic glycosides in cassava (Nainggolan, Banout & Urbanova, 2024), making the vegetables safe for consumption. However, just like sun-drying, prolonged exposure to sunlight and heat can degrade vitamins such as vitamin C and β-carotene, as well as some antioxidants, reducing the overall nutritional value. Inconsistent drying conditions, such as fluctuating temperatures and humidity, can lead to uneven nutrient retention and potential microbial contamination.

Concerning food quality, solar drying is reported to dry foods successfully without altering the colour, taste, and appearance. It also reduces the risk of microorganisms, prevents insect infestation, and contamination by foreign matter and toxins (Skåra *et al*., 2023). Solar drying is a practical and environmentally friendly method for preserving root vegetables, offering benefits such as extended shelf life and reduced anti-nutritional factors. However, optimizing drying conditions and minimizing nutrient losses are crucial to maintaining the nutritional and health benefits of the final product. The next section looks at pickling.

2.4.2.4 Pickling and its impacts on nutritional and health benefits

Pickled vegetables are obtained using knowledge accumulated since ancient times (Sawada *et al.,* 2021). Pickling involves soaking vegetables in an acidic substance, typically vinegar or brine, to improve their shelf life, taste, and nutritional value (Tejaswini *et al*., 2021). This process preserves heat-sensitive nutrients such as vitamin C and antioxidants that may otherwise be lost through cooking or other preservation methods (Tan *et al.*, 2024). Tejaswini *et al*. (2021) added that this process introduces health-supporting microorganisms such as lactic acid bacteria that promote gut health and digestion. The acidic environment formed during pickling reduces anti-nutritional factors, making minerals in IRVs more bioavailable. Probiotics derived from fermented pickles are friendly to the gut microbiome, inducing digestive processes and enhancing the absorption of nutrients (Borrego-Ruiz *et al*., 2024). The antimicrobial nature of pickling agents discourages the growth of spoilage microorganisms, making food safer for consumption and minimizing waste (Jamir *et al*., 2024). Though pickling has numerous advantages, it also possesses some weaknesses that must be considered.

Excessive salt or vinegar levels in pickling solutions can, however, increase sodium consumption, potentially causing hypertension (El-Sayeed & Youssef, 2019). Added sugars in certain recipes used for pickling can also decrease the overall health value of the product. Pickling IRVs is a vital preservation method that can effectively enhance flavour, maintain nutrients, and provide health benefits. The correct pickling methods and the moderation of additional ingredients are required to enhance beneficial effects and reduce possible adverse effects (Aljahani, 2020). Despite having observed the advantages and disadvantages of this method, literature specific to root vegetables seems to be missing, reflecting a knowledge gap.

2.4.2.5 Pounding and its impacts on nutritional and health benefits of IRVs

Pounding is a traditional food processing technique widely practiced in many cultures, particularly in rural areas, for the preparation of root vegetables such as cassava, yams, and sweet potatoes (Ariyo, Balogun, Atojoko & Ogundare, 2022; Jack, Bello, Akpa & Inyang, 2022). The manual process involves the crushing or mashing of root vegetables to obtain pastes, flours, or dough-like textures for various culinary uses (Ogiemudia & Orhorhoro, 2016). Efficient pounding disrupts the cellular walls and fibrous tissue of root crops, hence improving digestion and nutrient absorption (Otegbayo, 2018). In comparison with other thermal processes, pounding facilitates the retention of heat-sensitive nutrients such as vitamin C and antioxidants because the process is usually undertaken in the absence of heat. In addition, when followed by fermentation, pounding can eliminate anti-nutritional compounds such as cyanogenic glycosides in cassava, thereby rendering the food safe for consumption *(Ariyo et al*., 2022). Mechanical breakdown of fibre during pounding may decrease dietary fibre content to some extent, based on the degree of processing. Microbial contamination is likely to happen if pounding is done under unhygienic conditions, which would affect food safety and result in health problems (Womboh, Ajumobi & Ebute, 2022). Pounding is still a significant way of processing root vegetables in most indigenous food cultures, with advantages including enhanced digestibility and retention of nutrients. However, Jack *et al.* (2022) posits that proper care should be taken to manage the loss of nutrients and maintain hygiene thus, safeguarding the nutritional and health value of the final product.

2.4.3 Modern value addition processes for IRVs

Various value addition techniques can be applied to agricultural produce. However, this section reviews literature on modern methods applicable to root vegetables, including extrusion, hot-air drying, vacuum drying, freeze-drying, hybrid, fortification, and modified atmosphere packaging.

2.4.3.1 Extrusion and its impacts on nutritional and health benefits of IRVs

Extrusion is a high-temperature, short-time processing technique widely used in the food industry to transform raw materials into value-added products (Gulati, Brahma & Rose, 2020; Omojokun, Ojokoh & Akinyosoye, 2021). It involves forcing a product through a die or nozzle to create uniform shapes (Adekola, 2016). When applied to vegetables, extrusion offers several advantages, including improved digestibility, enhanced sensory properties, and extended shelf life (Egal & Oldewage-Theron, 2020). However, it also impacts the nutritional composition and health benefits of the end product.

The extrusion process can preserve certain nutrients, such as proteins and dietary fibre, while reducing heat-sensitive nutrients like vitamin C and B (Singh *et al*., 2007). It can also inactivate enzymes and reduce antinutritional compounds, increasing nutrient bioavailability. On the other hand, some bioactive compounds, such as phenolic and flavonoids, may degrade during extrusion, potentially diminishing antioxidant activity (Bamidele & Emmambux, 2021). The gelatinization of starch and the breakdown of dietary fibre during extrusion improve the digestibility of root vegetables, making them easier to consume and absorb (Egal & Oldewage-Theron, 2020). Extrusion results in degradation of starch, releasing of reducing sugars such as maltose and the sweetness, imparted by sugars, is positively connected with consumer acceptability (KC *et al*., 2021). Furthermore, extruded root vegetables can be fortified with additional nutrients or functional ingredients, such as probiotics or vitamins, to enhance their health benefits. This process also produces ready-to-eat products that retain the natural flavours and textures of root vegetables, encouraging their inclusion in a balanced diet.

Extrusion can be used to produce food items like noodles, pasta, cereals, and snacks by creating products with consistent types, sizes, and shapes (Omojokun *et al*., 2021). To add on, the demand for healthy ready-to-eat foodstuffs like snacks is on the rise. Extrusion of edible roots based flour

is gaining status in both research and commercial (KC, Rajbanshi, Katuwal, Dhungana, & Subba, 2021). The author added that production of extruded snacks from root crops helps in coming up with diverse products. For instance, other countries are producing extruded products from tiger-nut, a super food which is highly regarded as an invasive species and as a weed (Gasparre, Pan, Alves, Rosell & Berrios, 2020). This technology presents a promising approach for processing root vegetables, balancing the trade-offs between nutritional retention and functional improvements. Continued research is necessary to optimize extrusion parameters, maximizing health benefits while minimizing nutrient losses. Adekola (2016) stated that the use of extrusion technology in developing countries of Asia and Africa are still far from being satisfactory. Despite its advantages, extrusion technology involves high machinery maintenance costs. Nevertheless, its numerous benefits outweigh these challenges, making it an ideal method for processing root vegetables in the food industry.

2.4.3.2 Hot air drying and its impacts on nutritional and health benefits of IRVs

Hot air drying is a widely used method for preserving root vegetables among various effective drying techniques available (Zhang, Yang, Mujumdar, Ju, & Xiao, 2022). This process involves exposing the vegetables to heated air, which removes moisture and inhibits the growth of spoilage-causing microorganisms (Zhang *et al*., 2022). While hot air drying is effective in extending shelf life and maintaining food safety, it has both positive and negative impacts on the nutritional and health benefits of vegetables. By reducing the moisture content, hot air drying prevents microbial growth and enzymatic activity, significantly prolonging the storage life of root vegetables. Some nutrients, such as carbohydrates, dietary fibre, and minerals like potassium and magnesium, remain stable during drying. Heat application can reduce certain anti-nutritional compounds, such as cyanogenic glycosides in cassava, improving the safety and digestibility of the vegetables. Heat-sensitive nutrients, such as vitamin C, β-carotene, and some polyphenols, are often degraded during hot air drying *(*Askari, Emam-Djomeh, & Mousavi, 2009). The extent of nutrient loss depends on the drying temperature and duration. While some antioxidants may be retained, others can be diminished due to thermal degradation, which affects the overall health-promoting properties of the dried product (Oliveira *et al*., 2016) The process can lead to changes in the texture and flavour of the vegetables, potentially impacting their sensory appeal and use in traditional dishes (Askari *et al*., 2009). Hot-air drying is less costly but has numerous drawbacks such as loss

of nutritive value and bioactive compounds, change of physicochemical characteristics and rehydration capacity can be reduced due to lengthy exposure to high temperatures (Kittibunchakul *et al*., 2023). However, careful control of drying temperature and duration is crucial to minimize nutrient loss and maintain the nutritional and health benefits of the final product

2.4.3.3 **Vacuum drying and its impacts on nutritional and health benefits of IRVs**

Vacuum drying is a processing method where food is dried using low pressure while the boiling point of moisture in food decreases and evaporates at minimum temperatures (Bazyma and Kutovoy, 2006). This is typically done through the conduction process. This method is also typically applied to heat-sensitive foods and those that are susceptible to changes in colour, appearance, nutrient content, and vitamin availability (Bazyma & Kutovoy, 2006). This method has been extensively used in drying foods with high bioactive compounds due to its ability to inhibit oxidation thus, making it ideal for processing vegetables (Zhang *et al*. 2022). The end product usually comes in the form of powder, flakes, granules or particles in various shapes. This technique has a myriad of advantages that include energy efficiency, long-term storage, prevention of microbial contamination, nutrient retention (proteins, fibre, sugars, vitamins, and minerals), and the preservation of bioactive compounds (Hasan *et al*., 2019). However, this method is time consuming and the end product can harden more than what is intended.

2.4.3.4 Freeze drying and its impacts on nutritional and health benefits of IRVs

Freeze-drying is one of the preservation techniques that successfully preserves the nutritional and bioactive qualities of vegetables (Fan, Zhang, & Mujumdar, 2019). This method reduces the deterioration of vital nutrients like vitamins, minerals, and antioxidants by first freezing the vegetables and then sublimating them to remove moisture (Hasan *et al*., 2019). According to studies, freeze-drying retains the health-promoting qualities of root vegetables by preserving phenolic compounds, carotenoids, and ascorbic acid better than traditional drying techniques (Fan *et al*., 2019; Bhatta, Janezic, & Ratti, 2020). The fibre content remains the same, promoting digestive health. Freeze-dried vegetables are a sustainable way to cut down on food waste because of their longer shelf life and decreased vulnerability to microbial spoiling (Donno, Neirotti, Fioccardi, Razafindrakoto, Tombozara, Mellano, Beccaro, & Gamba, 2025). However, depending on the moisture content of the vegetable, the energy-intensive process may cause the loss of some

water-soluble nutrients *(ibid).* Freeze-drying is also the most expensive process for producing dehydrated products (Bhatta *et al*., 2020), and it may be hard to be adopted by small-scale farmers.

2.4.3.5 Hybrid drying and its impacts on nutrition and health benefits of IRVs

Hybrid drying involves blending various drying methods, such as solar, hot air, microwave, or freeze-drying, to optimize the root vegetable preservation (Hasan *et al*., 2019). It is a recent method that utilizes the advantages of various techniques to improve efficiency, minimize drying time, and improve the quality of the dried product (Hii *et al*., 2021). Hybrid drying significantly affects the nutritional value and health-promoting properties of root vegetables. By using a combination of methods like freeze-drying and microwave drying, hybrid drying reduces nutrient loss, particularly in heat-volatile compounds like vitamin C, β-carotene, and polyphenols (Donno *et al*., 2025). Hybrid drying reduces shrinkage and maintains root crops' structural integrity, conserving their sensory characteristics (Hii *et al*., 2021). Integration of solar drying technology with electric or microwave drying decreases energy usage while preserving high drying efficiency. Hybrid drying processes significantly lower the levels of toxic substances, for example, cyanogenic glycosides in cassava, guaranteeing food safety (Carvalho, Santos, Guedes, Bitencourt, Rojas, & Augusto, 2023). Nevertheless, the process demands sophisticated equipment and expertise, which can be a limiting factor. Despite its benefits, incorrect calibration of hybrid drying techniques can result in the degradation of specific nutrients. Hybrid drying is an encouraging technology for the preservation of root vegetables with improved retention of nutrients, flavour, and energy efficiency. However, optimization and accessibility should be carried out carefully to provide maximum benefits with minimum disadvantages.

2.4.3.6 Fortification and its impacts on nutritional value and health benefits of IRVs

Food fortification is the addition of crucial nutrients such as vitamins and minerals to food products to enhance their nutritional value (Olson, Gavin-Smith, Ferraboschi, & Kraemer, 2021). This method is often used in addressing specific nutrient deficiencies in person and supports overall health. In the Netherlands, food-to-food fortification of yellow cassava flour with leafy vegetable powders was used to come up with cassava-vegetable spaghetti-like pasta products (Lawal, Fogliano, Rotte, Fagbemi, Dekker, & Linnemann, 2022). Many root vegetables lack larger

quantities of proteins (for example, cassava) and vitamins, hence the need for fortification (Cai Meng, Nyirenda, Mandala, Li & Yang, 2021). This strategy meets the demand for functional foods with extra health benefits, which is growing worldwide due to an increase in consumer awareness of the role of these foods in preventing the development and growth of chronic diseases. Considering that various countries are facing health and wellness challenges, the concept of fortification can be employed in alleviating those challenges.

2.4.3.7 Modified Atmosphere Packaging (MAP) and its impacts on nutritional and health benefits

Respiration and microbial infection are major causes of postharvest spoilage of vegetables, and one of the solutions is the use of modified atmosphere packaging (Fang & Wakisaka, 2021). Fang and Wakisaka (2021) also defined MAP as the packaging of food in a modified environment conducive for that product to increase shelf life without compromising food quality. Currently, MAP is widely used worldwide to preserve the quality and extend the shelf-life of whole fresh vegetables, but is also increasingly used to extend the shelf-life of minimally processed fresh vegetables (Wilson, Stanley, Eyles, & Ross, 2019). In the case of fresh vegetables, it involves packaging them in polymer films that maintain the required atmosphere. This technique not only increases shelf life but also enhances appearance of the product and minimizes spoilage without incorporating chemicals, making it ideal for farm produce like vegetables (Mudau, Soundy, Araya, & Mudaue, 2018). Although MAP minimizes spoilage, it does not slow the growth of harmful bacteria, hence the need for refrigeration after packaging. Shelf life can be affected if the packaging gets broken. For instance, in Zimbabwe, IRVs can be consumed raw such as tiger-nut need this type of preservation and packaging for market availability and exposure. Considering MAP in meeting consumer needs in this era is one effective strategy.

2.4.4 The current state and nature of value addition of IRVs

There is scarcity of literature on IRVs in general, worse on their value addition (Nayak *et al*., 2025) This notion can also be supported by Meldrum, Padulosi, Lochetti, Robitaille and Diulgheroff, (2018), who conducted a systematic review on vegetables in general and emphasized that root vegetables have received significantly less research attention than other types of vegetables. Meldrum *et al*. (2018) also highlighted that root vegetables stood out for having significantly fewer Google Scholar records compared to all other types of vegetables, calling attention to this group

as potentially deserving of greater research attention. Underground plant structures are well known as natural energy warehouses, but due to changes in people's lifestyles, attention is slowly diminishing. This has led to the rise of a market for value-added foods with enriched nutritional content (Wireko-Manu, *et al*., 2018). Additionally, underground plant species have a short life span due to their high water content, hence they can easily rot and decay if not properly handled, preserved and processed for future use (Kiran Thirumdasu, 2018). Kalia and Selvakumar (2023) also pointed out that it is important to go ahead with vegetable quality enhancement to meet evolving global requirements, owing to the current evolution of consumers' demands. Therefore, it is worth reviewing what has been done as far as the value addition of IRVs to promote consumption is concerned.

Cereda et al. (2024) conducted a study on underground starchy crops of Andean origin in Brazil and indicated that their root vegetables have a localized distribution, with little processing and use, essentially in traditional communities, with a habit of consumption that often falls into disuse. India is the largest producer of vegetables in general around the world, but it is the one of the countries minimally participating in value addition (Nagil & Chamroy, 2020). According to Kannaujia *et al*. (2019), only 2.5% of India's vegetables are value added, the rest are exported in their raw state. If this challenge is affecting "vegetables in general" then the IRVs may be very far from being given maximum attention as supported by (Onomu, 2023). Despite limited research ,attention, Reang, Banik, Baishnab, Majumdar, Datta, Prasad and Sarma, (2023) conducted a study on value addition and bioprospecting of *Amorphophallus bubifer* (Voodoo Lily corm) in India. The author discovered that the corm is processed to make a food cake known as *Batema*. This product is high in carbohydrates and is sold in the local markets as a substitute for soybeans and tofu, and it could be a resource for dietary supplements, which improve the helpfulness of novel foods for human consumption. Like other IRVs, this corm is often regarded as a humble source of sustenance for the local community although it is valued for nutritional profile. Irrespective of minimum recognition of this wild root vegetable, Reang *et al*. (2023) indicated that the value added flour made from this root vegetable is being sold at a good price in local markets and there is potential for industrial production to suit the commercial markets. Consumers are willing to pay for value added products as compared to raw vegetables and the demand for such products is on the rise (Kannaujia *et al*., 2019).

Prithiani, Pushpa and Kumari, (2023)also conducted a study on tuber crop-based value addition in India and indicated that root vegetables such as elephant foot yam, taro, cassava, and sweet potato are less exploited for therapeutic food preparations of other value-added products. These root vegetables are not having universal acceptance and there is a great scope and urgency for value addition. In support of the value addition mandate, Thirumdasu, (2018) and Prithiani *et al*. (2023) identified various products that are being made out of IRVs in India, and they are presented in Table 2.3 below.

Table 2.3 Value-added products from IRVs in India

Root vegetable	**Value-added products**
Sweet potato	Flour, candies, noodles, Sweet Potato Jam, Sweet Potato Sauce, Sweet Potato Beverage, Sweet Potato Chips
Cassava	Parboiled chips, Nutrichips, Fermented Cassava Starch, Unfermented Cassava Flour, flour chapattis, Cassava Crisps, Cassava hot sticks, Fried cassava chips, *fufu, gari, uppuma, puttu, idlies* and *dosa*, bread, biscuits, cutlets, doughnuts, custard powder, ice cream powder, flakes, and chin-chin cassava croquette
Taro	slices, bolls, chips, flakes, noodles, starch, soup thickener
Elephant Foot Yam	Pickles, cake, sweet meat, porridge, cutlets, chips

Adapted from Thirumdasu, (2018) and Prithiani *et al*. (2023)

Despite the fact that only 2.5% of vegetables are being value added in India as indicated by various scholars, there is a leading institute investing a lot in root and tuber crops. Thiruvananthapuram is home to the ICAR-Central Tuber Crops Research Institute (CTCRI), which plays a significant role in research and development related to tropical tuber crops. The city is recognized for its contributions to agriculture, particularly in promoting food security and sustainable farming practices through advanced technologies and value addition of crops like cassava, sweet potato, and yams. CTCRI has advanced equipment used for harvesting and chipping cassava, promoting a seamless quality post-harvest produce (Kumar, Chaitanya, Semotiuk, & Krishna,). This institution is also producing starch, flour, and chips at large scale. Parvathi, Nithya, Umamaheshwari and Subbulakshmi, (2016) also conducted a study on the development of value-

added food products from tropical tubers (India) and highlighted the importance of diversification for the production of value-added products to retain minor root vegetables in the existing cropping systems. The study developed puffed snacks and *papad* from elephant foot yam and taro. Based on results obtained from sensory evaluation, overall acceptability and likeability by consumers were noted, indicating the importance of value addition on neglected and underutilized species (Parvathi *et al*., 2016).

In Nepal, the value addition, value chain and market for niche products are often poor, fragmented, and underdeveloped. The collection and processing suffer from a multitude of problems such as poor market for niche products, underdeveloped markets, constrained collection and processing , due to marginality and inaccessibility mountainous areas, and inability of small scale producers to interact and negotiate with experienced buyers (Gauchan, 2023). This indicates the need to come up with interventions that promote indigenous root vegetable value chain.

In Ghana, there are limited value addition interventions and a lack of policies to their implementation. According to Boakye, Wireko-manu & Chronakis, (2018), recent efforts to promote and grow roots and tubers have mainly been undertaken by the West African Agricultural Productivity Programme (WAAPP) and the Root and Tuber Improvement and Marketing Programme (RTIMP). This program introduced high-quality cassava flour production. However, this technology has not been successfully accepted and adopted by local processors. Boakye *et al*. (2018) added that there seems to be no available market for cassava flour. Furthermore, this program neglected sweet potato and yam. Value addition through processing is a crucial step in promoting root vegetables (including indigenous species), as it allows for the production of shelf-stable products with increased consumer appeal, as well as longer storability and convenience for year-round supply. Moreover, there is an increasing consumer demand for convenience in food preparation and use, as well as diversity and year-round availability (Boakye *et al*., 2018). Additionally, Thirumdasu (2018) emphasized that these under-utilized and minor root crops have great untapped potential to support food and nutrition security while also sustaining the resources needed to address present and future environmental challenges. The author also indicated that there is an urgent need to expand the development of indigenous root crops marginalized by current research and agricultural policies.

Apart from efforts being made by Root and Tuber Improvement and Marketing Programme (RTIMP), in northern Ghana, the most famous and preferred locally made beverages are tiger nut drinks. This local beverage is mostly produced and sold by street vendors however, there is a new trend where this beverage is gaining popularity in occasions, like weddings, child naming ceremonies and funerals (Adam & Fawzia, 2021). This drink is said to be served more often than the usual carbonated drinks like Fanta, Coca Cola, and Sprite. Adam and Fawzia (2021) added that this is a timely moment for health professionals to ride on and intensify their healthy eating campaigns on dietary renaissance. Campaigns can enhance health and reduce the alarming prevalence of non-communicable diseases such as overweight, diabetes, hypertension, strokes and obesity as reported in numerous research findings in major cities of Ghana. Therefore, value addition of IRVs to promote consumption for health and wellness sustenance in Ghana is the way to go.

In Nigeria, the National Root Crops Research Institute (NRCRI) embarked on massive training and extension of technologies of new and improved food forms of root/tuber crops to rural farmers/women groups (Aniedu, Nwakor and Aniedu, 2012). Food items such as cassava *fufu* flour, high-quality cassava flour for confectionery production, and other products were developed. The essence is to ensure that these crops can be put to wider uses in the home, for income generation, and possibly for export purposes. Equipped with value-added products of the root/tuber crops the NRCRI participated in World Food Days in Abuja and other parts of Nigeria and also took part in many other food shows in which NRCRI was adjudged the best food exhibitor. Apart from what is being done at this institute as far as value addition is concerned, consumers are also playing their role using traditional methods. Ray and Sivakumar (2009) indicated that Nigeria is also producing flour from fermenting cassava, and products made from this flour are loved by many consumers.

Kenya, Uganda, Zambia, and Zimbabwe coordinated an action project with the Alliance of Biodiversity International and CIAT. In each of the four countries, the project piloted value-chain development work to identify priority neglected and underutilized species (Adokorach *et al*., 2023). Among the neglected and underutilised, one of the root vegetables cultivated by farmers in western Kenya mainly is cassava. With the help of the alliance, the community has been imparted with value addition skills and one of the main new neglected and underutilised added-value

products developed is "*power unga*" or flour which is made from cassava, sorghum, and yellow maize. This flour can be used to make porridge for adults and young children at schools, hospitals, and homesteads. Among four countries in this alliance, only Kenya had the privilege to embark on value addition of root vegetables (cassava). Malawi collaborated with The Bill and Melinda Gates Foundation in the project termed Cassava Adding Value for Africa C: AVA) to produce two high-quality cassava flours using sun-drying as well as artificial drying technology, flash drying to be precise (Bennett, Naziri, Mahende, & Towo, 2019). The flour made from cassava in Malawi is used in the production of baked products.

In Zimbabwe, it seems little is being done regarding value addition of IRVs. Unlike other countries, there is a lack of literature on products that have been derived from its IRVs, especially tiger-nut, Livingstone potato and dwarf bibiana. Apart from native species, little has been done on IRVs. In support of this argument, Batcha *et al.*, (2023) indicated that yam and sweet potato are less industrialized in developing countries as they are mostly usually consumed directly. This indicates a major gap in both literature and production to be covered (Kodzwa *et al*., 2023). Apart from health and wellness benefits derived from value addition of IRVs, they also have great impacts on both the economy and social welfare of the communities. The following section looks at socio-economic benefits of participating in root vegetable value addition.

2.4.5. Economic and social benefits of indigenous root vegetable value addition

Value addition of root crops through processing, packaging, and improvement in quality has tremendous economic and social benefits. Economically, value addition enhances profitability for farmers and producers as it allows them to get higher prices for their commodities. In developing countries, value addition offers small-scale farmers a chance to export in global markets. Cereda *et al*. (2024) conducted a study in Brazil on value addition of underground crops and observed that processed products facilitate consumption by unfamiliar consumers, proving advantageous for export markets. Cereda *et al*. (2024) argued that it may be difficult for a European or North American consumer to buy fresh cassava, yams, or *arracacha* because the customer may not know how to prepare it. On the other hand, in the form of processed products, such as French fries, chips, or even pre-cooked and frozen pieces, marketing is more straightforward, as the product is similar

to products already known to Western consumers, such as potatoes. The information on the packaging makes it easier to prepare at home.

Reang et al., (2023) conducted a study in India on value addition of indigenous ethnic foods (Amorphophallus bulbifer) and observed that this vegetable is usually sold in an open and unhygienic way, and it market share is still limited to the rural section of the consumers. Challenges associated with hygiene present an opportunity for food producers to tap into this gap by providing hygienic and well packaged products in securing food for the majority. Reang *et al.*, (2023) added that *Amorphophallus bulbifer* is of great importance in income generation for the local people. Moreover, diversification and commercialization of indigenous products is required concerning common changes in food habits. Value addition also minimizes post-harvest losses, which have been a big problem in agriculture, and it ensures economic sustainability and minimizes wastage. Therefore, investing in the value addition process will not only benefit the consumer and the producer but the economy at large.

Maroyi, (2019) conducted another study on untapped potential of Livingstone potato, an indigenous and underutilised root crop in Zimbabwe. The study discovered that current research developments in Africa show that Livingstone potato is extremely nutritious and can afford raw materials for the agro and pharmaceutical sectors. However, Maroyi (2019) indicated that more research needs to be done, especially in Zimbabwe where there is very little researched information on its production and utilization. The economic impact could potentially be at household, farmer and national level through establishing strong value chains. This is important in order to increase awareness and promote the crop, whose production is on the decline.

Value addition helps rural societies because it opens up employment opportunities in processing, packaging, and distribution industries. It improves food security through the extended shelf life of root vegetables, thus having them available year-round. Furthermore, it improves the well-being of farm producers and their households through higher incomes and lowers dependency on conventional farming systems. These advantages emphasize the necessity to promote programs aimed at facilitating value addition in root vegetables and enhancing sustainable economic development and well-being. Therefore, value addition processes towards optimizing indigenous root vegetable consumption for health and wellness sustenance is vital to various stakeholders. As

such it is essential to evaluate the challenges experienced during value addition processes as well as the existing opportunities.

2.5 CHALLENGES AND OPPORTUNITIES FOR VALUE ADDITION OF IRVS

According to Onomu (2023), nearly all commercialized exotic vegetables go through various stages of value addition. However, most of the indigenous vegetables lag behind in this regard. Such disparity in value addition does not facilitate consumption, commercialization and adoption of indigenous vegetables on a large scale (Gauchan, 2023). More so, limited product diversification, low innovation, and limited industrial processing with regards to these vegetables have impeded their visibility in modern commercial markets, thereby reducing their appeal, convenience, and availability (Mazike *et al.,* 2023;Elolu *et al.,* 2023). As a result, indigenous vegetables continue to suffer from issues of low acceptance in both domestic and global markets. Apart from the preceding challenges, Kannaujia *et al.* (2019) postulated that developed countries are experiencing an approximate of 10 to 15% post-harvest losses and 20 to 50% in developing countries. This observation necessitates value addition processes. Despite these challenges, native vegetables offer significant benefits to society, including the maintenance of cultural heritage, creation of job opportunities, medicinal use, enhanced food security, nutritional value, and economic opportunities. The next section unpacks economic factors.

2.5.1 Economic factors

Economic factors shape economic decisions and outcomes, including pricing, investment, employment, and overall economic growth. There are negative economic factors hindering or promoting value addition of indigenous foods in different nations. Aworh, (2023) highlights that small and medium enterprises (SMEs) are key contributors to food processing in Africa and often face constraints like limited capital investment. Value addition to be effective often needs one to invest in infrastructure and this is one of the major challenges with small holder farmers as most of them have inadequate financial base (Melembe *et al.*, 2021). Moreover, due to lack of collateral securities, small holder farmers often have limited access to agro-loans and this impedes their participation in agro-processing. In Zimbabwe value addition is hampered by inadequate electricity supply (Aworh, (2023). A number of rural farmers lack reliable electricity and this affects refrigeration processes and other processing like milling which require electricity. Apart

from limited access to electricity, developing countries have underdeveloped roads that impede the timely transportation of vegetables from one point to another, leading to post harvest losses (Imathiu, 2021 ;Elolu *et al*., 2023). According to Melembe *et al*., (2021) farmers are willing to engage in value addition but limited resource opportunities restrict them.

Despite these challenges, indigenous vegetables empower vulnerable communities, including women and youth, by providing stable income opportunities (Onomu, 2023). They also support economic activities like food tourism, where visitors eagerly explore and pay for indigenous cuisines (Fam, Sayed Annuar & Tan, 2020). Additionally, Zimbabwe has favourable conditions for cultivating indigenous vegetables making them cost-effective to produce, highlighting their potential for broader commercial success (Moyo *et al*., 2024). Indigenous root vegetable farmers can tap into these opportunities and benefit from them using minimum resources available. The following section looks at technological factors.

2.5.2 Technological factors

Technological factors in value addition are advancements and innovations that impact agricultural practices, improve efficiency, and increase productivity. In Nepal, Gauchan, (2023) postulated that the country lacks modern postharvest and value addition technologies, forcing producers to rely on laborious, traditional processing methods. Many rural and economically disadvantaged households depend on indigenous knowledge for food preparation due to the unavailability of modern processing, preservation, or value addition facilities (Kuyu and Chala, 2020). This technological shortfall hampers the development of improved, reliable indigenous food production practices.

In the same way, in Africa, indigenous vegetable value chains face severe challenges with postharvest losses reaching up to 50%, largely due to poor postharvest management and outdated processing technologies (Elolu et al., 2023). African food production systems are the least mechanized across all continents. Current practices remain largely traditional and require significant upgrading to support a nutrition-sensitive value chain (Mazike *et al*., 2023; Elolu *et al*., 2023). The slow pace of adopting modern food processing and preservation techniques is further exacerbated by limited knowledge, poor education, and inadequate extension services (Melembe et al., 2021). Moreover, Mazike *et al*. (2022) indicated that common processing methods for

African indigenous vegetables (such as drying, blanching, canning, boiling, fermentation, malting, milling, popping, roasting, steaming, and wet milling) are dictated by available equipment and the form of raw materials, with drying being the most prevalent technique.

In today's fast-paced world, time constraints further discourage the preparation of indigenous foods, pushing consumers toward more convenient alternatives (Asogwa *et al*., 2017). The fact that up to half of the economic value of African indigenous vegetables is potentially lost due to inadequate postharvest management and processing highlights the significant opportunity for targeted interventions along these value chains. Therefore, there is a need to adopt advanced value addition processing to meet current trends. The following section looks at cultural factors.

2.5.3 Cultural factors

Cultural factors are the shared beliefs, values, customs, traditions, and social practices of a group of people or society that influence decision-making, behaviours, and practices. Concerning indigenous foods, underground starchy crops play a crucial role by contributing to diverse culinary traditions and meeting the dietary needs of various populations (Cereda *et al.*, 2024). Understanding local preferences and traditional preparation methods are essential for successful value addition.

In Brazil, most of their IRVs have a cultural and religious identity in the native tribes of this region, playing an essential role in the subsistence of low-income. They make a unique contribution to traditional marriage, festivals, and ritual performances as main cultural objects that are shared among the people (Unya, 2021). In other words, these foods are a means of defining the identity of the local people or ethnic group (Mnguni & Giampiccoli, 2019). However, increasing or even maintaining the production of underground starchy crops is a significant challenge due to the devaluation of some of these crops, which essentially began after colonization, a process that takes time to reverse (Cereda *et al*., 2024). Aware of the challenges that lead to declining production and the disappearance of these crops, scholars advocate the recovery of native foods and ancestral tubers to preserve identity and food traditions. For them, it is necessary to maintain the transfer of knowledge and preserve the identity associated with these ancestral foods. In this scenario, altering processing methods may affect acceptance by the native people hence the need to understand their tastes and preferences before bringing new derived products.

Columbia is experiencing the devaluation of their indigenous vegetables with their classification as “crops for the poor.” This classification leads to decreased consumption and production, which are difficult situations to reverse. This situation is not exclusive to Andean crops, as cassava is experiencing a similar situation in Brazil. With this image, it is difficult to access private investment to modernize these crops. However, there is a growing interest of young chefs in these products, with the desire to recover traditional local values, could give a new face to these crops (Onomu, 2023). Due to the respect and value placed on the knowledge of indigenous foods by the local people, those who promote them earn respect and reverence as preservers of the cultural identity.

Taking a closer look at the preceding findings, it is evident that other countries may not participate in value addition due to the nature of their culture. Taboos may dictate farming choices, such as avoiding specific crops. Cultural food habits and preferences can also determine the demand for certain agricultural products. Cultural openness (or resistance) to adopting new technologies or practices in agriculture can also hinder value addition processes. The next part examines environmental factors.

2.5.4 Environmental factors

Environmental factors are external elements that influence the survival and growth of root vegetables. The impact of climate change forecast on agriculture has posed a threat to the sustainability of global food security and nutrition. Smallholder rural farmers mainly depend on rainfall for their agronomic practices and changes in climate have a great impact on their output (Elolu *et al*., 2023). Tanimonure, (2021) conducted a study on underutilised indigenous vegetables in Nigeria and found out that farmers’ perceptions on climate change are high temperature and a high variability in rainfall pattern that has affected the yield, increases pests and diseases. Farmers can adapt to climate changes but the more the revenue generated from the business, the more likely the producer will be willing to adopt adaptation strategy. This implies that adoption of adaptation strategies is not free and resources for the implementation must be available for farmers to adopt (Tanimonure, 2021). In most cases, IRVs are associated with low market price, a case that might hinder farmers to consider them under climate change conditions. Apart from climate change, (Maroyi, 2013) posited that the size of land often allocated for indigenous vegetables is very small.

Moyo *et al*. (2024) indicated that this is also true for most of the sub Saharan African countries where most farmers involved in AIV production are small scale farmers and only allocate an average of one-quarter of a hectare or less to the vegetables.

Despite climate change, various studies reported that indigenous vegetables (root included) are more adaptive, resilient, and tolerant to adverse climatic conditions than exotic species which can be heavily affected by insects, pests, and diseases infestations, and reduced soil fertility (Cereda *et al*., 2024; Elolu *et al*., 2023; Kodzwa *et al*., 2023; Mabhaudhi *et al.* 2016; Onomu, 2023). This is one of the opportunities that farmers can fully embrace in promoting cultivation, value addition and consumption of IRVs.

2.5.5 Market related factors

Market factors are elements of general market environments outside the farmer's influence, which affect agronomic practices. So far, there has been inadequate research and innovation to bring indigenous foods to the front of global acceptability while showcasing their holistic roles (Onomu, 2023). According to Kannaujia *et al*. (2019) conducted a study in India and observed that there has been a drastic shift of eating habits by consumers towards junk foods and this habit cannot be changed but that which is often shunned can be enhanced to meet consumer demand. The author added that the demand for processed value-added foods is on the rise however, the country lacks regular access to good quality reliable raw materials for processing, lack of transport, proper storage facilities, access to cheaper packaging materials and cold storage facilities which hinder the value addition processes.

In Nepal, markets are often secretive and small producer providers lack the capacity to interact effectively with more experienced buyers and traders (Gauchan, 2023). Value chains and markets for niche products are often poor, fragmented and underdeveloped negatively affecting value addition. Another reason why IRVs are not being promoted is that they are not regarded as cash crops even if they are sustaining livelihoods of the majority in rural areas. Those who are willing to participate in value addition are experiencing the absence of a ready market.

In Sub-Saharan Africa, the rate at which exotic food is replacing indigenous food might drive indigenous foods to extinction. This has hindered the growth and development of indigenous

vegetables, despite the desire of many smallholders and rural dwellers engaged in indigenous food farming to see them commercialized. Moreover, these indigenous food stakeholders are challenged by limited practical procedures to follow when commercializing indigenous foods. It is yet more challenging as research and development targeting indigenous food commercialization is costly and laborious. The association of indigenous foods with the poor, the nature of their harvest and processing, and the lack of additives have a negative impact on their market status (Cloete and Idsardi, 2013). These and many other complex constraints have also influenced the psychology, perceptions, and disposition of buyers towards the consumption of these indigenous foods, despite their nutritional benefits.

In a study on value addition of cowpea leaves conducted in Kenya by Okello, (2019) in Kenya results obtained indicated that a number of consumers are not willing to pay extra charges that come with value addition. Although this study focused on value-added cowpea leaves, it may also mean that consumers may not be willing to pay extra charges when IRVs are value added. Therefore, consumer willingness to pay for extra changes needs research prior to commercialisation.

2.5.6 Policy factors

Policy factors are elements that impact the creation, implementation, and effectiveness of policies such as subsidies and support programs, trade policies, environmental regulations, food security goals, market access initiatives and technology adoption.

In Nepal for instance, there is poor and unfavourable seed regulatory framework and policy incentives for various crops and varieties (Gauchan, 2023). This results in economic losses and reduced raw materials for value addition initiatives. The lack of a clear guide to best production practices is another pitfall hindering indigenous food crop development(Wang, Ouyang, Liu, Zhu & Zhao, 2014). This requires proactive government policies like India (Kannaujia *et al*., 2019). Another challenge is that the majority of research and research-related institutions have focused primarily on exotic staples and export crops; however, there appears to be a dearth of indigenous crop domestication procedures and cultivable development processes (Onomu, 2023). Reang *et al*., (2023) emphasized the need for intimate connection between science and policy to help

nutrient-rich native vegetables for transformation among the diverse like what is being done by the Indian government.

Coming closer to home, Melembe *et al*. (2021) indicated that South Africa needs access to training and information on value addition to support smallholder farmers in improving income and reducing food insecurity as well as improving their livelihoods . A number of farmers lack knowledge and skills on how to transform their raw produce into better quality products. In Zimbabwe, the policy framework to support domestication and production is still very weak (Moyo *et al.*, 2024). The current National Agricultural Policy Framework (2018–2030) in Zimbabwe supports the production of exotic vegetables but does not support the production of indigenous vegetables (Nyaruwata, 2019) contributing to the low adoption of value addition processes by both large scale and smallholder farmers (Kodzwa *et a*l., 2023). Literature reviewed clearly indicates that it is necessary for various policy makers to recognize indigenous vegetables in policies so as to promote their adoption by various stakeholders.

2.5.7 Interaction and interdependence among factors

Diversification for the production of value-added products is one of the methods to retain minor tubers within existing cropping systems (Parvathi *et al*., 2016). Value addition of IRVs can significantly boost the demand for end products, leading to increased consumption. This rise in consumption has a direct relationship with health and wellness sustenance and indirectly contributes to the generation of employment opportunities. Furthermore, standardized foods derived from selected tubers have the potential to be exploited at a commercial level. The creation of employment and commercialization of value-added products enhances living standards for various stakeholders, stimulates economic growth, and increases foreign currency earnings through exports.

However, as evidenced in the reviewed literature, the value addition of indigenous foods faces several challenges, including a lack of technology and processing knowledge, climate change, shifts in customer tastes and preferences, and insufficient policies supporting the value addition of native foods (Aworh, 2023; Elolu *et al*., 2023; Mazike *et al*., 2023). Limited processing of IRVs presents an opportunity for product diversification through improved processing methods. If effectively leveraged, this opportunity can transform the indigenous vegetable value chain by

reducing food loss and waste, creating more value for the actors within the chain, and strengthening its capacity to be nutrition-sensitive and to promote rural development.

The subsequent section explores recommendations made by other scholars concerning value addition processes aimed at optimizing consumption for health and wellness sustenance.

2.6 RECOMMENDATIONS ON VALUE ADDITION PROCESSES TO OPTIMIZE INDIGENOUS ROOT VEGETABLE CONSUMPTION FOR HEALTH AND WELLNESS SUSTENANCE

Since value addition processes are diverse, there is a need to recommend processes that can be adopted to increase consumption without distorting health and wellness sustenance properties. IRVs offer a unique opportunity for sustaining human health through innovative processing techniques. This section reviewed literature which focused on recommendations on value-addition processes which not only preserve nutritional and medicinal value but also prolong their shelf life, increase consumer appeal, and meet current market demands. By integrating traditional knowledge with contemporary food processes, the proposed processes contribute to sustainable health and wellness, ensuring that these culturally significant crops can be optimized to support both individual health and local economies while reinforcing food security and culinary heritage in the process.

2.6.1 Yam processing

According to Adepoju, Boyejo and Adeniji, (2017), yam is consumed in various forms, primarily boiled, fried, or baked. In addition to culinary uses, tubers can be dried and milled into flour for making various products. There are an assortment of products that can be derived from yam which include dried yam chips, flakes, flour, pickles, cakes, sweetmeat, porridge, cutlets, chutney, and extruded food products (Carvalho *et al*., 2023). Except for extruded products, the production and processing of the other items require minimal capital, which can be managed by small-scale businesses or farmers interested in value addition. Currently, the processing of yam-derived foodstuffs is mainly carried out by small to medium-scale processors who use traditional methods. Dried yam chips are produced by peeling, slicing, blanching, steeping, and sun-drying. Yam flakes are produced using the same process as yam chips. However, these traditional methods can lead to variations in quality from one processor to another. These disparities call for the adoption of low-

cost processing equipment to enhance quality and ensure safer food products. Yam is a good source of carbohydrates, and in addition, yam-derived foodstuffs provide essential minerals. Furthermore, yam-derived foodstuffs can be used to produce gluten-free commodities, catering to consumers with coeliac disease (Omohimi *et al*., 2019). Regarding processing, Adepoju *et al*. (2017) noted that yam processing significantly enhances macronutrients and energy content while also reducing all antinutrients. Given the numerous advantages associated with yam processing, small-scale producers are encouraged to adopt the highlighted cost-effective processes to meet the current consumer demand for convenient, ready-to-eat foods. Implementing these processes can promote consumption and positively impact human health and wellness sustenance.

2.6.2 Sweet potato processing

Sweet potato value addition involves its transformation from its raw state into a more usable form (Wu, 2024). According to Ferraro *et al*. (2016) sweet potatoes can be processed into fermented beverages, curd, vinegar, yoghurt, pickle, broths, purees, baby foodstuffs, ice cream, noodles, fries, breakfast cereals, flour, flakes, and various snack, dessert items as well as industrial products like starch, fortified sweet potato, alcohol, chemicals and natural food colourants (Aidoo *et al*., 2019). Aidoo further posits that value addition in the root and tuber crops is less expensive and it also retains nutritional value taking for example the processing of puree. Apart from the previous processes, Truong *et al*. (2018) stated that sweet potatoes can be frozen in different sizes, that is whole roots, halves, quarters and slices. Processing steps include peeling, sizing, cutting, blanching, packaging, and freezing. Similar to yam processing, the production of various value-added products require low-cost equipment with an exception of an extrusion and the production of starch, chemicals and food colorants (KC *et al.*, 2021). These low cost techniques help maintain the nutritional value and enhance functional properties of the end product (Vithu, Dash & Rayaguru, (2019). Considering that several products can be produced with low capital this makes it practical to small-scale farmers and food processors who may be willing to venture in value addition. Bearing in mind the current economic hardships in Zimbabwe, low-cost processing of flours, snacks, purees, flakes and various previously mentioned products can be recommended in meeting the current demand for convenient but healthy diets by modern consumers.

2.6.3 Cassava processing

According to Howeler, (2015) cassava can be value added to products gluten free flour which can be used in the production of various baked products. Apart from gluten free flour, cassava can be processed into fermented paste, unfermented paste, fortified cassava, dried chips, pasta, beer and spirits (Kouakou *et al*., 2016; Mihu *et al*., 2024). Given the availability of resources, the utilization and application of cassava as flour and starch in industrial scale is one of the paying options that can be considered by various processors in tapping into an untapped opportunity especially in Zimbabwe. Apart from industrial application, cassava flour can be prepared using the traditional way of grating, pounding or milling of peeled roots. Verma *et al*. (2022) posited that this flour is low in calories, fat, and sugar as compared with other gluten-free flours like coconut or almond flour. Engaging in this niche market increases food options for the gluten intolerant consumers, safeguarding their health and wellness.

Another promising area is the fortification of cassava to address nutritional deficiencies. Fortified flours or snacks enriched with vitamins and minerals can play a crucial role in combating malnutrition, particularly in regions with high rates of micronutrient deficiencies (Egal & Theron, 2020). This aligns with the increasing consumer preference for health-focused and functional foods (Mironeasa *et al.*, 2023). Considering that cassava is abundant and can be cultivated in huge quantities, the production of flour for industrial use is a good avenue. To small scale farmers and processors who usually rely on low capital, the adoption of low-cost processing equipment and traditional ways can play a vital role in enhancing consumption in the present day.

2.6.4 Tiger nut processing

Since thousands of years back, many people enjoy eating raw tiger-nut with less emphasis in processing it into more useful products (Yu *et al.*, 2022). Apart from raw consumption, Gambo and Da'u, (2014) indicated that this root vegetable can be used to produce the following value added products; gluten-free flour, starch, oil, milk, ice cream flavouring agent, tiger nut protein, pasta, beverages, and fermentable sugars. The main popular product made from tiger-nuts is a milky beverage called Horchata de chufa (Roselló-Soto *et al*., 2018). According to Gambo and Da'u, (2014), the production of this milky beverage involves soaking in water, wet milling, sieving then sweetening them and adding flavours. The preceding authors added that the nuts can also be

toasted then soaked to produce the same products and this process is known for the reduction of anti-nutrients as compared to soaking only. This process can be done using both traditional and industrial methods (ibid). Nutrition and medicinal wise, tiger nut products help in fighting against cardiovascular diseases, dysentery, diabetes, hyperlipidaemia, cancers, hernia, fibrosis, and abnormal menstruation (Adenowo & Kazeem, 2020). With regards to the preceding findings, Oladele *et al*. (2009) recommended toasting and soaking of this root vegetable in producing a more functional food product. This being said, it is evident that the production of milky beverages can be done by both small-scale and large-scale producers considering the methods of production used. Considering that this process is less costly, it can also mean its feasibility in Zimbabwe where the majority of small scale farmers rely on a limited financial base. More so, this indigenous root vegetable is abundant and often neglected by many as an invasive species. This challenge can be turned into an opportunity like what other nations are doing.

2.6.5 Livingstone potato processing

Livingstone potato is an underutilized root vegetable native to Zimbabwe. However, its value addition has been neglected. More so, this indigenous root vegetable is uncommon in industrialized countries, contributing to the scarcity of information on its value addition. According to Kujeke *et al*. (2019) tubers are usually boiled but they can also be roasted, baked or fried. Despite this neglect, a study by Ezeocha *et al*. (2016) indicated that the root can be used in the production of flour by washing, peeling, blanching, cutting, drying and milling. It can also be blended with wheat to produce composite flours. Apart from composite flours, Livingstone potato can be used to derive starch for pharmaceutical uses (Khalid *et al*., 2018). However, this technique requires expertise and specific technologies making it harder for small scale producers to embark on this process. Given that Livingstone potato can be used to produce flours, it can also be used in coming with different flour products like pasta, bread, biscuits and other baked products (Kulshrestha, 2018). Processing of the aforementioned products do not require much capital and can be done even by smallholder farmers.

2.6.6 Dwarf babiana processing

At present, there is dearth of literature on value addition of dwarf babiana. Available literature only indicates that this root vegetable is usually consumed raw or baked (Roux *et al*. (n.d); Youngblood, (2004). This indicates the gap in value addition processes which require attention.

2.6.7 Preservation methods

IRVs can be preserved using both traditional and modern methods, each offering unique advantages. Traditional preservation methods such as drying, fermentation, salting, and root cellaring have been practiced for generations and are well-suited to rural communities with limited access to advanced technology (Materia *et al*., 2021). Drying removes moisture, preventing microbial growth, while fermentation, as seen in products like cassava *gari*, enhances both shelf life and nutritional value (Kulshrestha, 2018; Sharma *et al.*, 2020;Shukla & Ramchandra, 2021). Salting combines well with other methods like drying to create an unfriendly environment for bacteria, and root cellaring utilizes naturally cool and dark spaces to store vegetables like potatoes and yams effectively. On the other hand, modern preservation techniques include freezing, vacuum sealing, and advanced dehydration processes. Freezing maintains the texture and nutritional content of vegetables, while vacuum sealing prevents contamination and oxidation, extending the shelf life significantly. These methods, although requiring more infrastructure and energy, cater to the growing demands for convenience and quality in both local and international markets. Together, traditional and modern preservation methods ensure that IRVs remain accessible, nutritious, and economically viable for diverse consumers.

2.6.8 Packaging and storage solutions

Packaging and storage play a crucial role in maintaining the quality and extending the shelf life of IRVs (Monteiro, Lawrence, Louzada, & Machado, 2019). Proper packaging ensures that vegetables are protected from physical damage, contamination, and moisture loss during transportation and storage (Mihu *et al*., 2024). Traditional methods, such as storing in woven baskets, are still widely used in rural areas due to their cost-effectiveness and environmental friendliness (Lesseri, 2016). Modern packaging techniques, such as vacuum sealing and biodegradable materials, offer enhanced protection and appeal to eco-conscious consumers

(Mungofa *et al*., 2022). Storage methods vary depending on the type of vegetable and the period. Root cellaring, a traditional method, provides a cool and humid environment ideal for IRVs like sweet potatoes and yams. Modern storage solutions, such as refrigerated facilities, are effective for preserving the texture and nutritional content of root vegetables over extended periods. Together, these packaging and storage methods ensure that IRVs remain fresh, nutritious, and marketable, supporting local consumption and international trade.

2.6.9 Food safety and quality control measures

Food safety and quality control measures are essential to ensure that IRVs are safe for consumption and meet market standards. These measures begin with good agricultural practices, which include proper soil management, pest control, and the use of safe water for irrigation to minimize contamination risks (Manzoor *et al.*, 2018). During harvesting, care must be taken to avoid physical damage to the vegetables, as bruises can lead to microbial growth (Thirumdasu, 2018;Mutandwa & Gadzirayi, 2007). Post-harvest handling involves thorough cleaning and sorting to remove dirt, damaged produce, and foreign materials. Processing methods such as drying, fermentation, or freezing must adhere to hygiene standards to prevent contamination. Packaging plays a critical role in maintaining food safety, as it protects the vegetables from external contaminants and preserves their quality (Saraswati *et al*., 2023). Modern packaging techniques, such as vacuum sealing, are particularly effective in extending shelf life and preventing spoilage (Ferdaus *et al*., 2023). Storage facilities should be clean, temperature-controlled, and pest-free to maintain the freshness and nutritional value of the vegetables. Quality control measures include regular inspections, microbial testing, and compliance with food safety regulations. Certification processes, such as Hazard Analysis and Critical Control Points (HACCP), ensure that the entire production chain meets safety standards. These measures also enhance the marketability of IRVs, supporting both local and international trade.

2.6.10 Cost benefit analysis of value addition processes

The transformation of raw products into enhanced goods increases their worth, marketability, and usefulness (Ejechi, 2023;Gauchan, 2023). While the initial costs of investing in processes such as grinding and drying equipment, energy usage, and labour are high, the benefits are significant (Mazike *et al.*, 2023; Melembe *et al.*, 2021). Value addition also opens access to urban and

international markets, significantly increasing revenue potential (Mihu *et al.*, 2024). Packaging and branding are other processes which require expenditure on materials, design, marketing, and possibly certifications. Costs associated are offset by the ability to sell the products at premium prices. Attractive branding helps build consumer trust and loyalty.

Fortification is another value addition process with notable benefits (Cai *et al*., 2021;Tan *et al*., 2024). Although it requires specialized equipment, additives, and compliance with regulations, fortified root vegetable products address micronutrient deficiencies effectively, particularly in regions facing malnutrition. The health benefits of fortified root vegetable products are undeniable, as they offer essential vitamins and minerals that contribute to wellness sustenance (Lawal *et al.*, 2022). Similarly, the production of chips or snacks involves costs related to machinery for slicing, frying, and packaging, as well as energy consumption. However, chips and snacks are in high demand, offering good profit margins and catering to diverse consumers. Fermentation and preservation also provide value addition by extending the shelf life of root vegetables and introducing unique flavours. These processes promote gut health through probiotic-rich fermented products, making them an excellent choice for wellness-focused consumers.

Preparing root vegetable products for export involves expenses such as meeting regulatory standards, securing certifications, and addressing logistics. Despite these challenges, the financial benefits of accessing international markets and diversifying income streams are significant. Additionally, processed root vegetables such as flour, fortified snacks, or fermented products provide direct health benefits by supporting balanced nutrition and reducing the prevalence of diet-related health issues (Tan *et al*., 2024). Overall, while value addition processes require substantial initial investment, they yield long-term benefits by enhancing food security, increasing revenue, and supporting economic development, while also promoting health and wellness sustenance as purported by (Parvathi *et al*., 2016; Shukla & Ramchandra, 2021).

2.7 Recommendations

Scholars have provided various recommendations for value addition processes to enhance the utility and marketability of indigenous vegetables (Mazike *et al*., 2023; Mihu *et al.*, 2024; Shukla & Ramchandra, 2021). One key recommendation is the adoption of processing methods that improve shelf life and nutritional value such as milling. For instance, converting root vegetables

into flour or starch is widely suggested as it allows for diverse applications in food products such as bread, cakes, and porridges. Kulshrestha, (2018) also advocate for fortification processes to address micronutrient deficiencies. This involves enriching products with essential vitamins and minerals, making them more appealing to health-conscious consumers. Post-harvest handling techniques, such as drying and fermentation, are also recommended to preserve the quality and extend the shelf life of root vegetables (Materia *et al*., 2021). These methods not only reduce post-harvest losses but also create opportunities for developing unique products. Additionally, packaging and branding are emphasized as critical components of value addition (Shukla & Ramchandra, 2021;Wilson *et al*., 2019). Scholars suggest investing in attractive and eco-friendly packaging to enhance consumer appeal and meet international market standards (Saraswati *et al*., 2023). This aligns with the growing demand for sustainable and high-quality products. Another recommendation is the commercialization of indigenous root vegetable value chains (Materia, Linnemann, Smid, & Schoustra, 2021). Aworh, (2023) also highlighted the need for coordinated efforts among farmers, processors, and marketers to ensure efficient production and distribution. Therefore, collaboration among these stakeholders is prudent to foster seamless value chain. Although various products has been made from IRVS, Zimbabwe lags. It is therefore, crucial to conduct an empirical study and see what has been done as far as value addition of IRVs in concerned.

2.8 Chapter summary

Chapter two conceptualized vegetable, indigenous vegetable, indigenous root vegetable, functional properties, value addition as well as health and wellness sustenance. The chapter also looked at specific root vegetables that are consumed in Zimbabwe, traditional knowledge associated with them, nutritional value as well as health and wellness aspects. Literature indicated their importance despite their susceptibility to heavy metals and other toxins. Consumption patterns, challenges, and opportunities for promoting them were also discussed. Value addition processes and their impacts were also assessed. It also gave an overview of recommendations that have been made by other scholars as far as value addition is concerned. The next chapter unpacks theories that were adopted to help in guiding this study.

CHAPTER 3

THEORETICAL FRAMEWORK

3.1 Introduction

The preceding chapter reviewed literature using a narrative approach to understand what other scholars said concerning the value addition of IRVs. The main objective of this study was to explore value addition processes to optimize indigenous root vegetable consumption for sustaining health and wellness in Zimbabwe. Specifically, the study sought to: Explore indigenous root vegetables that are consumed for health and wellness sustenance in Rusape; Determine value addition processes for optimizing indigenous root vegetables consumption in Rusape; Determine challenges and opportunities for value addition processes of indigenous root vegetables in Rusape and lastly to recommend value addition processes to optimize indigenous root vegetable consumption for health and wellness sustenance in Rusape. This chapter discusses theories as well as the conceptual framework which guided this research. According to George (2023), a theoretical framework explains theories that support the research study, proving that the research topic is relevant and grounded in established ideas. This study adopted the Health Belief Model, Quantum and Tempus theories of functional food, and the Expectancy Value Theory as theories that could guide the current study.

3.2 The Health Belief Model

The Health Belief Model (HBM) was developed by a group of social psychologists in the early 1950s at the United States Public Health Service to understand the common failure of people to take disease prevention or early screening and detection of diseases. The model suggests that one's belief in a threat of illness and the effectiveness of the recommended health behaviour predict the probability of adopting that behaviour (LaMorte, 2019). The basic principles of the HBM were derived from a psychological and behavioural theory whose models assume that behaviour depends chiefly on two variables which are the value placed on a particular goal and one's estimation of the likelihood of achieving a goal by doing a certain action. The tenets of this model became: the need to avoid illness (or if one gets ill then desires to get well) and the confidence that a particular health action prevents illness. Precisely, the HBM consists of these dimensions;

1. Perceived susceptibility - this dimension speaks of one's perception of the risk of having a certain ailment.

2. Perceived severity - this entails the feeling, concern and seriousness of contracting an illness and even leaving it untreated.

3. Perceived benefits of taking a correct action.

4. Perceived barriers which entail that a probable adverse aspect of a particular health action may act as a barrier to undertake the suggested behaviour. In this case, a sort of cost benefit analysis is believed to transpire where one evaluates the effectiveness of taking action in relation to opinions that it might be costly, dangerous (like having side effects), painful, ill-timed, time-consuming, and other opinions.

5. Self-efficacy which is the confidence in one's ability to take the recommended action

These tenets are summarized below;

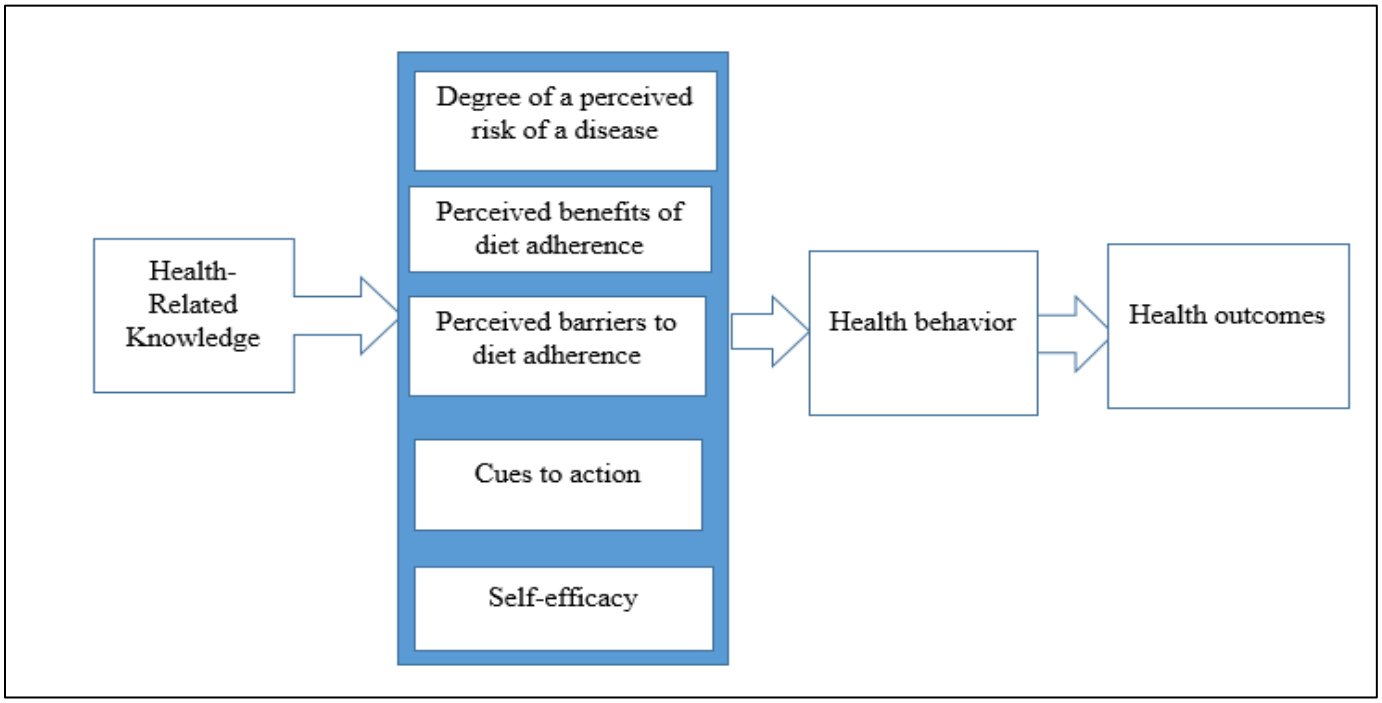

Figure 3.1 The Health Belief Model *(Source: Wilson et al., 2019).*

In this study, the Health Belief Model can be used to inform people about the risks associated with poor dietary habits, including chances of having chronic ailments like diabetes, heart diseases, and obesity. Available statistics can support these risks and make them immediate and more relevant. This can be achieved by using the perceived susceptibility dimension (Igartua, Rodríguez-Contreras, Guerrero-Martín, & Honorato-Vicente, 2023). The chances that one embraces a healthy

behaviour to avoid related consequences depends on how serious the consequences will be (Boskey, 2024). For instance, a teenager is unlikely to quit junk food until he/she sees someone who is obese *(ibid)*. This model can also be used to pinpoint the severe costs of unhealthy eating habits, associated health problems and a reduced quality of life. Consumers are unlikely to change their health behaviours unless they see that they are at risk (Kelly & Barker, 2016a). For example, those who do not think that they are at risk of micronutrient deficiency are not likely to consume vegetables. However, this challenge can be achieved through giving practical examples of those who experienced such challenges (testimonials). It can also be used to emphasize the advantages of healthy eating especially in the case of IRVs that are known for an array of health benefits.

Giving clear and tangible benefits can encourage consumers to shift their dietary habits (Bublitz & Peracchio, 2015). It is quite challenging to convince someone to change their diet if the person does not know or see the benefits of that change (Kelly & Barker, 2016b). Consumers may be less likely to give up what they enjoy if there is no good substitute for that. For example, the elite may not consume IRVs until they come to know that it guarantees good health. Whittall, Warwick, Jackson, & Appleton (2024) indicated that issues that hinder consumption (perceived barriers) such as accessibility, availability, cost and organoleptic factors can be analysed and solutions can also be offered such as coming up with new easy recipes.

Cues to action is another tenet that can be used; these are external events that prompt one to make a positive shift. To encourage regular consumption of indigenous vegetables, various techniques can be employed, such as social media, community events, and even publishing research articles that discuss the benefits of consuming indigenous vegetables. Lastly, the model can be used to boost one's confidence in making healthy dietary changes, achievable through nutrition workshops and support groups (this is called self-efficacy). Healthy eating can lead to healthy behaviour, and healthy behaviour can support health and wellness sustenance.

The Health Belief Model is a powerful tool that can be used; however, it has challenges. The theory does not consider internal factors like how one feels about the health behaviour, be it positive or negative feelings. It also overlooks the belief on whether consumption of certain products can improve health and other factors like culture, norms and personal motives (LaMorte, 2019). This model does not consider habitual behaviours that may play a role in the decision-making process

to consider the recommended action. Issues to do with environment (availability and accessibility of indigenous vegetables) and finance (availability of money to buy) are also overlooked although they play a role in decision making. The model works on the assumption that everyone has equal access to health and illness related information, however, this is not the case. However, the HBM is a crucial tool and it should be integrated with other models to cover up for the loopholes.

3.3 The Quantum and Tempus Theories of Functional Food

According to Martirosyan and Stratton (2023), the Quantum theory was first discovered by Max Planck, then Albert Einstein in (1921), in the field of physics and mechanics. The theory was then adopted and integrated with the Tempus theory by Danik Martirosyan and Sarah Stratton at the Functional Food Institute (USA) in 2023. These proponents integrated these two theories to better understand the complex relationship between food, chronic disease and health. According to the proponents, integrating the Quantum and Tempus theories in functional food science provides a comprehensive approach to understanding the potential of functional foods for nutritional interventions and overall well-being. In light of these advantages, it became imperative to also adopt these theories as they touch the determinants and goals of this research.

According to Martirosyan and Sanchez (2022), there is an increase in the prevalence of chronic diseases and an increase in the need for food that can prevent and minimize them. IRVs are one of the sources of bioactive compounds that have proved beneficial to human health (Roselló-Soto et al., 2019); however, there was a need for appropriate quantities of bioactive compounds that can be safely consumed in a product. Thus, how the Quantum and Tempus theories arose. The Quantum emphasizes appropriate quantities and the Tempus is concerned about appropriate times bioactive compounds should be consumed. Martirosyan and Stratton (2023) indicates that these theories are used to better understand the multifaceted bond between food, chronic diseases, and health.

Martirosyan and Stratton (2023) crafted sixteen (17) steps that are necessary to take before presenting the functional food to the consumer. This study adopted some of the steps in understanding the theory's applicability to this research. The first step is to establish the goal of coming up with a functional food. In this study it is evident that IRVs are under consumed (Knez *et al.*, 2023; Chopera *et al.*, 2022), shunned and neglected (Musasa, n.d.), hence compromising

health and wellness sustenance. Therefore, the goal is to enhance consumption for health and wellness sustenance. The second and third steps are to determine relevant compounds and establish appropriate quantities. These steps help to understand the quantities one can ingest without causing negative effects to the body. Various studies done on root vegetable consumption can help in determining safe quantities for human consumption (Ariyo *et al.*, 2022; Manzoor *et al.*, 2018; Ferraro *et al.*, 2016). The fourth step is to establish an appropriate time of consumption. According to Antaryami, Nedunchezhiyan, Jata & Biswanath, (2012), the specified recommended daily allowance for root and tuber crops is 500g. The fifth step is to identify biological processes through which bioactive compounds affect the body. Since some IRVs contain toxins (Ferdaus *et al.*, 2023 ; Knez *et al.*, 2023), this step can be used as a guide on which plants to add value and which plant to exclude. The sixth step is to establish relevant biomarkers. Since this study is not aiming at producing a drug, it did not fully incorporate this concept but only indicated the specific benefits of consuming IRVs.

The seventh step is to choose an appropriate food vehicle for the intended bioactive compounds. This step emphasizes a medium that can be used to deliver nutrients and bioactive compounds. This step helps food processors in determining the perfect vehicle or the perfect way to add value to a food product without distorting nutritive and medicinal values. The eighth step is to provide pre-clinical studies on efficacy and safety. Secondary data sources can be used to determine the safety of various bioactive compounds as well as amounts that are safe to consume. The ninth step is to create a special label that informs the consumer on how to use or prepare the product. This step can guide one in coming up with directions to use or cooking instructions without compromising nutrient and bioactive compound availability. In short, the Quantum theory is used to ensure that a functional food contains bioactive compounds enough to attain desired health benefits. It is crucial to note that IRVs also contain toxins, hence the need to mitigate this risk by incorporating the Quantum and Tempus theory in establishing appropriate quantities one should consume. This can be achieved by determining the upper tolerance limit (UTL) which is a representation of the maximum amount or quantities that are safe for consumption at a given time. The other steps are presented in Table 3.1 below.

Table 3.1 Steps of inducting functional foods into the market

Step Number	**Description of the step**
1	Establishes a goal of the functional food product
2	Determines relevant bioactive compound(s)
3	Establishes the appropriate dosage of bioactive compound(s)
4	Establishes the appropriate time of consumption of bioactive compound(s)
5	Determines the specific pathway and mechanism of action
6	Establishes relevant biomarker(s)
7	Chooses an appropriate food vehicle for bioactive compound(s)
8	Provides preclinical studies on efficacy and safety
9	Provides clinical trials for dosage, efficacy, and safety
10	Creates a special label that informs consumers of the most effective way to consume the product
11	Publications are submitted to peer-reviewed journals, preferably in open access
12	Educates the general public
13	Sends information to credible governmental agencies, such as the FDA, for approval
14	Official establishment of the accredited functional food product
15	Release the functional food product to the market. (Receive the basic category (level C)
16	Provides epidemiological studies. (Reapply for the approval for a new category (level B))
17	Provides after-market research. (Reapply for the approval for a new category (level A))

Source: Martirosyan and Stratton (2023)

In this study, these theories play a very crucial role as they explain issues to do with health, safety, and overall well-being of the consumer. However, they were mainly designed or linked to pharmaceuticals, although it can be applied to the food industry. Given the fact that one theory may not be all-encompassing, the following section looks at the other theory which informed this study.

3.4 The Expectancy-Value Theory (EVT)

The EVT was developed by Atkinson in 1964 and was expanded by Eccles in 1983 in the field of education (Spott, 2022). The theory explains the relationship between motivation and behaviour. This theory has two major constructs which are expectancy and value, which will influence motivation. The Expectancy Value Theory is mainly used in education, behavioural studies, and psychology to understand human decision-making. In this study, the theory is used to understand consumer motivation in line with healthy eating.

Motivation to perform a certain behaviour is determined by expectancy (how probable a desired outcome will be attained through a certain behaviour) and value (how much value is placed on the desired outcome), (Atkinson, 1964). If the expectations/value is zero then motivation automatically becomes zero, but if any one determinant increases, then motivation also increases. A person is motivated to eat healthy food when they know that they are going to stay healthy (expectation) and when they know that being healthy is precious (value). Therefore, this theory can be used to enhance self-efficacy by helping consumers in making them believe that they can successfully adopt a habit of healthy eating. It can also be used to encourage consumers to have attainable goals like incorporating at least one indigenous vegetable in their everyday meals.

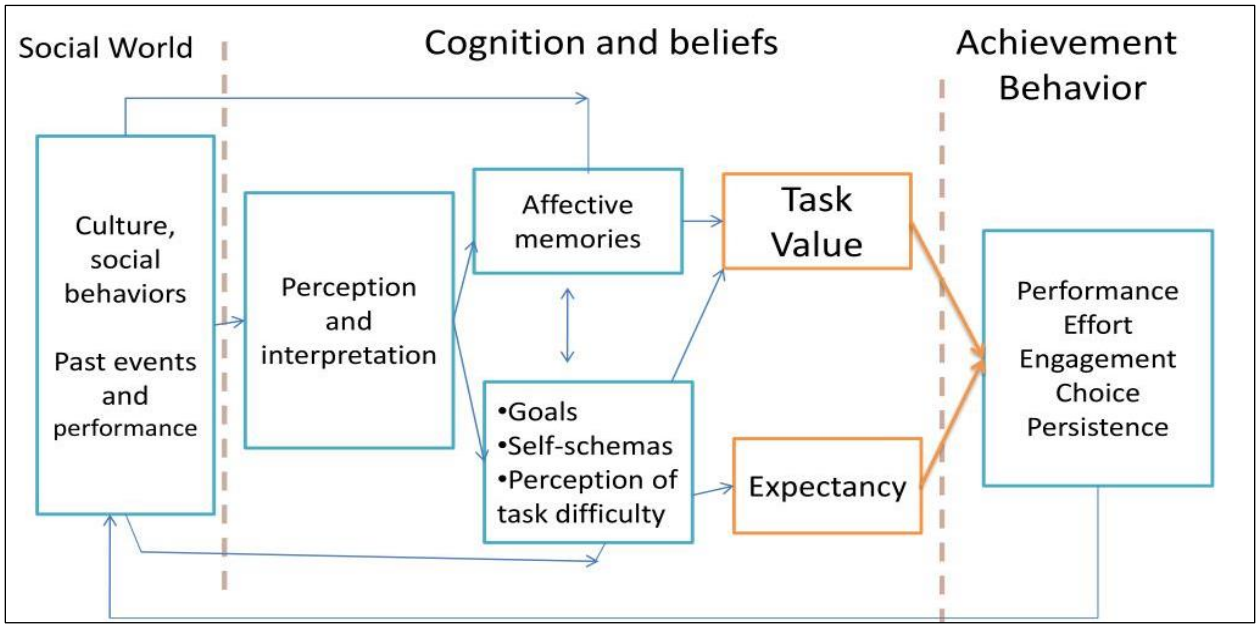

Figure 3.2 Expectancy Value Model by Eccles (1983)

Motivation = Expectancy × Value

Lastly, the EVT can be used to highlight the enjoyment that comes with eating healthy and other positive results such as improved immune system, prevention of chronic diseases and the overall wellbeing. However, this theory only emphasizes on three major aspects that are motivation, expectancy and value, leaving other factors such as cost, beliefs, and culture that might have an impact on one's behaviour. The following section unveils the overarching theory of this study and justifies its applicability.

3.5 The Sustainable Livelihoods Framework (Chambers & Conway, 1992)

The Sustainable Livelihood Framework (SLF) is a tool used to understand and analyse the livelihoods of individuals, households or communities. This framework was adopted because it links food, nutrition and health outcomes to a wider livelihood strategies.

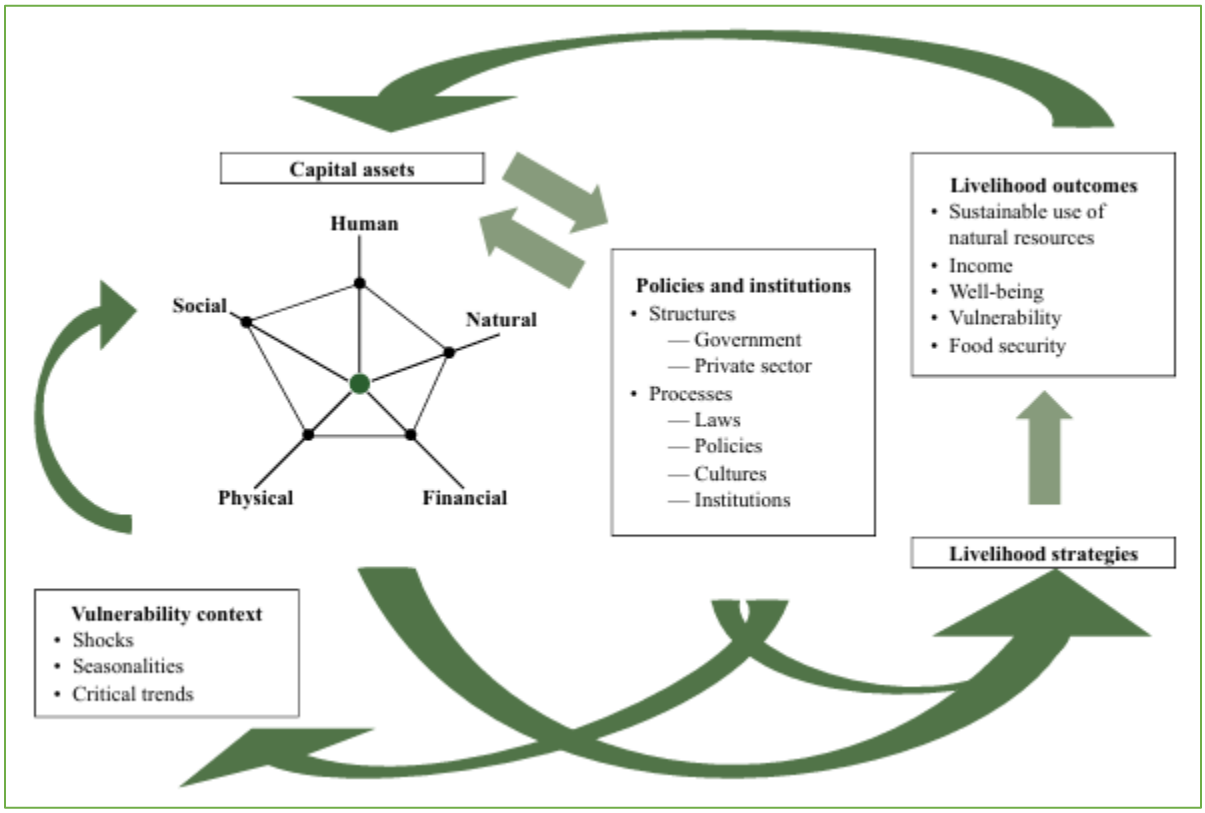

Fig 3.3. The Sustainable Livelihood Framework. Source. Department for International Development of the United Kingdom.

The SLF leverage can be used to understand how communities leverage IRVs (natural resources) and local knowledge (human capital) to generate income, enhance food security and resilience. The framework connects the micro-level household practices (yam and sweet potato milling) to macro-level development goals (Health and Wellbeing, Zero Hunger and Poverty Reduction).

This study on value addition processes to optimize indigenous root vegetable consumption for health and wellness sustenance in Zimbabwe can be meaningfully interpreted by the SLF. Originally, the framework was developed by Chambers and Cornway (1992) and it was letter resurfaced by the UK Department for Development (DIF, 1999). This framework gives an all-

encompassing approach on how individuals and communities manage available resources, skills and policies to achieve improved well-being. Applying the SLF help situating IRVs not as source of nutrition only but also as livelihood assets that can sustain human health, wellness, income and resilience.

The SLF fits into this study because IRVs are mainly cultivated and consumed in rural settings where food security, income generation and cultural identify are inter-connected. To add on, value addition processes such as drying, fermentation and milling represent livelihood strategies that increase usability, storability and marketability of IRVs thus, strengthening community resilience. The SLF is also in line with SDGs specifically zero hunger (2), good health and well-being (3), responsible consumption and production (12) as well as climate resilience. The use of this framework in this study facilitate an understanding of how value addition supports health and wellness sustenance in Zimbabwe. IRVs play a crucial role as a natural capital. More so, they are drought-intolerant, making them ideal for communities which are prone to climate change (Mabhaudhi *et al.,* 2016). Value addition techniques such as drying and milling promotes sustainable utilization of IRVs by reducing post-harvest loses, increasing shelf-life and well as promoting all-year-availability.

Apart from natural capital, the human capital that is knowledge, skills and labour play a pivotal role in value chain. Financial capital also facilitate value addition for income generation. Infrastructure and technologies (physical capital) enhance the efficiency and effectiveness of IRV processing. Integrating various forms of capital, value addition can lead to significant livelihood outcomes, making the framework fit for this study.

3.5 The Overarching Theory

The previous sections discussed selected theories upon which this study is underpinned. The strengths and weaknesses were also unpacked as a means to isolate the ideal theory in guiding this study. Thus, this section presents the theory that has tenets suitable for guiding the study. The section justifies why the Health Belief Model was chosen as the overarching theory in this study. The Health Belief Model is the overarching theory because it directly addresses health-related behaviours and decision-making processes concerning indigenous root vegetable consumption for health and wellness sustenance. The Quantum and Tempus theories mainly focus on quantities one should consume as well as time issues. The Expectancy Value Theory mainly focuses on

motivation, value, and expectation. These theories play a pivotal role in understanding dietary habits, but the Health Belief Model is grounded in health psychology and provides a framework for understanding consumer attitudes and actions that align with the nature of this study. The core components of the model, which are perceived susceptibility, severity, benefits, and barriers, help in assessing how consumers perceive health risks associated with non-consumption of indigenous vegetables. The Health Belief Model also considers cues to action and self-efficacy, which are essential in encouraging consumers to include root vegetables in their diets. Considering that the Health Belief Model considers psychological, economic, and cultural influences, barriers, and motivations surrounding indigenous vegetable consumption can be systematically addressed. Its inclusivity makes it the most appropriate model for this study.

3.6 The Conceptual Framework

A conceptual framework illustrates the expected relationship among variables (Swaen and George. (2022). It also helps in defining relevant research objectives and maps out how they come together in drawing coherent conclusions (ibid). The conceptual framework of this study focuses on value addition processes to optimize indigenous root vegetable consumption for health and wellness sustenance. It depicts the relationship that exists between value addition, consumption and health and wellness sustenance. Value addition is the independent variable that can be manipulated in order to attain the desired level of consumption (dependent variable). Based on existing literature, it is assumed that indigenous root vegetable value addition processes are under-researched, consumption of IRVs has dwindled, and that regular consumption of value added IRVs sustains health and wellness. The following diagrammatic representation shows a conceptual framework of this study guided by the Systems Model.

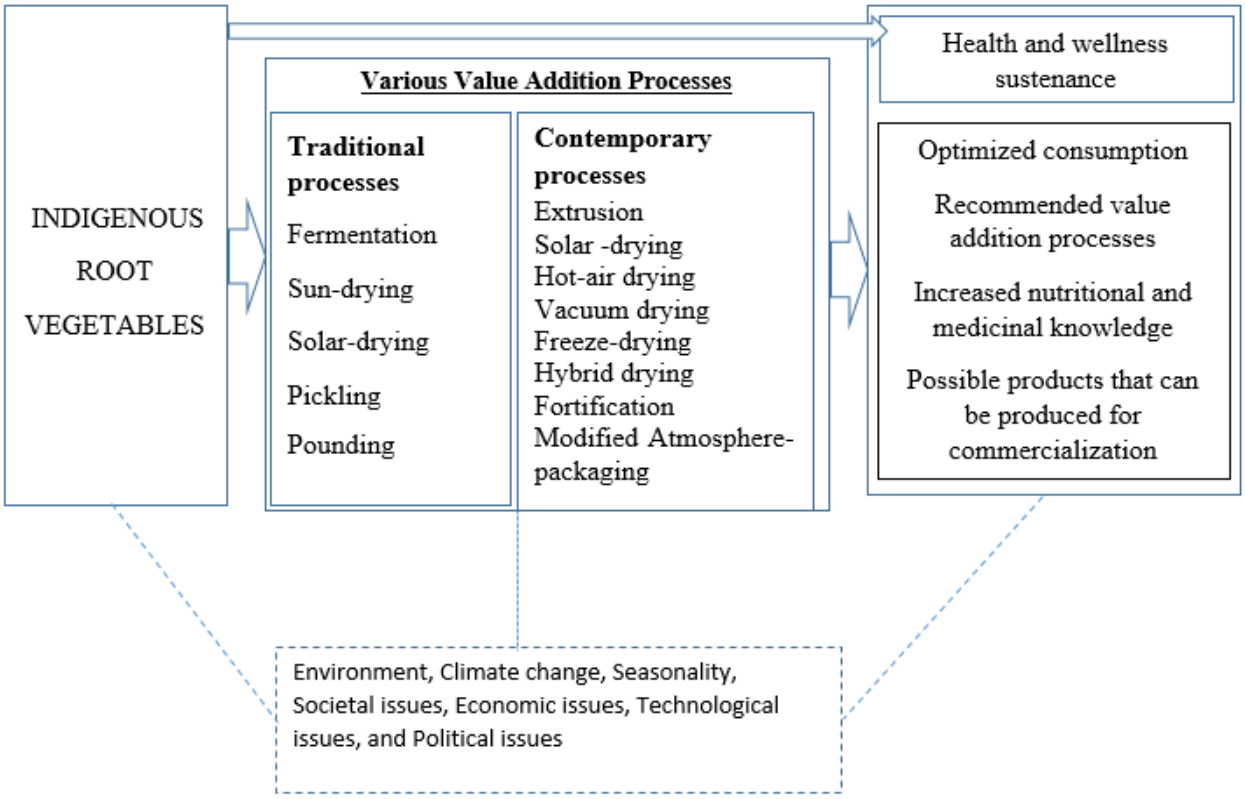

Figure 3.4 Conceptual Framework for the study. Researcher's own compilation

3.6.1 Indigenous root vegetables

The framework above commences with exploring IRVs available for health and wellness sustenance. The majority of consumers often shun locally found crops that are nutrient-dense in favour of highly processed colourful foods introduced by globalization (Mbhenyane *et al*., 2015). Zimbabwe is endowed with a variety of IRVs that were once a hub of both food and medicine during the times of our ancestors. With changes in trends, tastes, and preferences have also changed (Chopera *et al*., 2022). While this change came with its advantages, it also brought about the prevalence of cancers, diabetes, and other non-communicable diseases that were once rare *(ibid).* Since IRVs still exist, there is an opportunity to tap into their benefits by encouraging regular consumption (Shrestha, 2013). In line with changing consumer tastes and preferences, it is ideal to consider value addition, which in this context means offering convenience, novelty, and additional health benefits beyond consuming raw vegetables. In this study, value addition

processes are crucial elements believed to enhance the consumption of IRVs with the goal of sustaining health and wellness. The following section is on value addition processes.

3.6.2 Value addition processes

The aspect of value addition is broad however, this study is more concerned with the 'processing part', which can either be traditional or modern. Processing includes, but not limited to cleaning, sorting, preservation, cooking, pre-cooking, drying, milling, fortification, flavour enhancement, and packaging. Indigenous root vegetables are often shunned due to their texture, taste, colour, and appearance, whereas other consumers perceive them as food for the poor (Masarirambi *et al*., 2020). Other scholars indicated that these vegetables are side-lined because of the way they are presented to consumers, palatability, difficulties in preparation, and processing techniques (Chacha & Laswai, 2020; Nyaruwata, 2019; Onomu, 2023). Akinola *et al*. (2020) highlighted that IRVs are generally perceived negatively in international markets, and yet they can be packaged in a way that improves their acceptability and preference for consumption. In line with current trends, IRVs can be processed into value-added products such as jams, flours, and snacks for global markets where the exotic appeal of such products and their nutritive value could be liked (Thirumdasu, 2018). To add on, Onomu (2023) argued that all commercialized exotic root vegetables have gone through various stages of value addition however, many IRVs lag. Examples of exotic root vegetables include but not limited to potatoes *(solanum tuberosum),* carrots *(daucus carota),* onion *(allium cepa),* ginger *(Zingiber officinale),* beets *(beta vulgaris),* turnips *(brassica rapa),* parsley *(Petroselinum crispum)* and radishes *(raphanus sativus).* The aspect of limited value addition is a major issue hindering the commercialization of indigenous vegetables and this causes these root vegetables to suffer from low acceptability status. It is due to these gaps that the author found it necessary to gain more insights on value addition processes that are used and that can be used to bring back IRVs on the vegetable map. In this study, one assumes that value addition of IRVs have a positive impact on consumption which in turn contributes to health and wellness sustenance

3.6.3 Intervening variables

Value addition processes can be affected by economic, environmental, political, social and cultural factors. Some consumers may argue that they do not add value to these indigenous vegetables due to financial constraints, challenges associated with the surroundings, associations and cultures. Other communities may have varied concerns over their health and wellness and this may impact value addition processes. Political stability and supportive policies can foster investment in cold storages, processing plants and roads that facilitate value addition processes. Bearing these and related beliefs in mind, value addition processes can be impacted either positively or negatively.

3.6.4 The outcomes

Considering that the conceptual framework herein is guided by the Systems Model, the outcomes of this study include optimized consumption, enhanced health and wellness and increased nutritional knowledge. Holding other variables constant, it is assumed that there is a direct link between IRVs and health and wellness sustenance.

3.7 Chapter Summary

This chapter examined the Health Belief Model which is the overarching theory, Quantum and Tempus theories and The Expectancy-value theory and their applicability to this study. The Health Belief Model helps in pointing out what people think about the benefits and challenges of eating IRVs, along with their confidence in trying them, affects their willingness to add these foods to their diets. The Expectancy Value Theory looks at what motivates people to make food choices, showing that awareness and perceived value can really affect what they choose to eat. The Quantum and Tempus Theories give help in understanding measurements and appropriate times. This chapter also looked at the conceptual framework which guided the study. The next chapter presents the methodology used in this study.

CHAPTER 4

RESEARCH METHODOLOGY

4.1 Introduction

The main objective of this study was to explore value addition processes to optimize indigenous root vegetable consumption for sustaining health and wellness in Zimbabwe. Specifically, the study sought to: Explore indigenous root vegetables that are consumed for health and wellness sustenance in Rusape; Evaluate value addition processes for optimizing indigenous root vegetables consumption in Rusape; Evaluate challenges and opportunities for value addition processes of indigenous root vegetables in Rusape and lastly to recommend value addition processes to optimize indigenous root vegetable consumption for health and wellness sustenance in Rusape. This chapter presents the research methodology. It commences by giving a detailed explanation of research philosophy, design, population, sampling methods, data collection methods and procedures, instruments, data analysis and presentation, validity issues, as well as ethical considerations. The primary objective of this study was to assess value addition processes towards optimizing indigenous root vegetable consumption for health and wellness sustenance in Zimbabwe. This study was guided by the principles of qualitative research.

4.2 Philosophical underpinnings

In research, it is essential to establish a clear research philosophy early in the process. This preliminary step provides transparency, informs decisions concerning the research design, and aids in choosing a suitable approach (Asmawi & Alam, 2024). Philosophical underpinnings are concerned with foundational beliefs, theories, and assumptions that shape and guide a field of study. According to Boswell and Babchuk (2022), philosophical underpinnings help in answering questions about the nature of reality (ontology), the nature of knowledge (epistemology), and methods used to acquire knowledge (methodology).

This study is guided by a phenomenology research philosophy. Phenomenology is both a philosophy and a research design that helps researchers to understand phenomena in a subjective way (Qutoshi, 2018). It focuses on how people experience things and it helps them to understand those lived experiences by expressing their feelings, thoughts, and the attached meaning. Since

this study sought to gain insights through exploration, lived experiences, and how people perceive the phenomena, it became ideal to adopt this philosophy.

In this study, value addition of IRVs was viewed as a socio-economic and cultural phenomenon, acknowledging the interplay between indigenous knowledge systems and modern health and wellness trends. It is believed that reality is shaped by cultural and social contexts. Epistemologically, knowledge about value addition processes is gained using qualitative insights and lived experiences with the indigenous root vegetables. Phenomenology as a research philosophy allows interaction between the researcher and those who lived the experience such as the local farmers, consumers and food experts. This study embraces Husserrl's phenomenological stance (1859-1938), which focuses on the study of lived experiences from a first-person perspective.

4.3 Research approach

This study adopted a qualitative stance as the researcher recognised that reality is shaped by cultural and social contexts. Qualitative research aims to comprehend phenomena by examining subjective perspectives, focusing on meanings, interpretations, and individual experiences. This approach helped the researcher to understand the community's lived experiences with indigenous root vegetables, their contribution to human health and wellness sustenance and how they add value to increase consumption. Qualitative researchers emphasize that the knowledge and skills possessed by individuals and communities are invaluable resources for social research. This approach perfectly suits the nature of this study due to its extensive application in fields like health sciences and education by various scholars providing deep insights into several facets of human behaviour, culture, and societal dynamics (Asmawi & Alam, 2024). Qualitative techniques allowed the author to explore these dimensions in a more rigorous way (Boswell & Babchuk, 2022). This helped the study to explore issues that needed deeper insights. Moreover, qualitative approaches such as interviews and focus groups were ideal for capturing rich data insights from local communities. Since this study was exploratory, qualitative methodology was used to uncover deep insights. More so, the study was not concerned about quantities but lived experiences, views and opinions, reflecting the need for a qualitative approach.

4.4 Research design

According to Kumatongo and Muzata (2021), a research design is a scheme or a plan used by the researcher to generate answers to research questions. Zikmund, Babin, Jon , & Griffin, (2013) also defined a research design as a master plan that specifies methods and procedures for data collection and analysis to solve a problem. This study adopted phenomenological research design (Qutoshi, 2018), to focus on exploration and identification of the fundamental nature of human experiences related to indigenous root vegetables, their value addition processes and how they sustain human health and wellness. It emphasizes the interpretation of lived experiences, positioning phenomenology both as a philosophical approach and as a research design (Creswell, 2003). This involves engaging deeply with a small group of participants over an extended period to discern patterns and meaningful connections. During this process, the researcher sets aside personal experiences and perspectives, a practice referred to as "bracketing," to authentically understand the experiences of the participants.

In this study, phenomenology was used to deeply explore and understand the lived experiences and perceptions of individuals involved in value addition processes and the consumption of IRVs. By prioritizing participants' history and experiences, phenomenology helped in revealing the deeper patterns, meanings, and values associated with IRVs. Phenomenological stance by Husserl, with its ability to unveil subjective meanings and lived experiences, became ideal for exploring how individuals perceive the health benefits of consuming IRVs and how they integrate them into their wellness practices. However, phenomenology is subjective in nature, the reliability and validity of data can be challenging. To offset this limit, this study used scholarly scientific literature to support and validate the nutritional and medicinal properties of IRVs found in Makoni District. Communication barriers through the use of English was overcome by translating the interview guide into Shona language.

4.5 Population

The population refers to a broader group with similar features within a specific context (Willie, 2024). A population is a cornerstone in research methodology, encapsulating a collective of individuals who exhibit shared characteristics within a defined geographic or institutional domain. This group resembles a broader group that fits into the relevance of the research question. This study used heterogeneous population particularly rural communities because IRVs are often deeply

rooted in their cultural heritage. However, collecting data from all communities was close to impossible, so there was a need to target a specific population.

4.5.1 Target population

Mohsin (2021) defines a target population as all members who meet the specified criteria for a research investigation. Willie (2024) argues that a target population is a portion of a population which a researcher intends to draw conclusions from. This is because including the entire population in the study can be costly, time consuming, difficult to access, close to impossible and can result in too many errors, hence the need to have a target population. In addition, a sample is also drawn from a target population and if the sample is chosen correctly, it can give reliable, valid and rich insights about the entire population.

This study targeted a heterogeneous population comprising community farmers, consumers and experts in nutrition as well as experts in food processing from companies and tertiary institutions from the age of twenty years (20) and above. The rural community farmers are the primary producers of IRVs and their knowledge and practice play a crucial role in the production and preservation of crops. They are also key stakeholders in the value chain and their involvement is essential for developing effective value addition processes. This group of people provided first-hand information on IRVs that are found in Makoni District, consumption patterns, health related issues, value addition processes and even the challenges being faced along the value chain. The other population which are nutrition and food processing experts have skilled knowledge about nutrition, health and wellness. Their knowledge informed the development of value addition processes that promote health and wellbeing. This group acted as key informants, providing right data on value addition processes that can be used, limitations associated with processing and what can be done to enhance value addition. Consumers are the end-users and their perceptions, preferences and needs determine the market forces. In this study, every participant acted as a consumer since they also consume IRVs. The consumer's perspective helped in understanding preferences, acceptance, reasons for consumption and what can be done to optimize consumption. The following section looks at the aspects of sampling techniques. The study also targeted both the domesticated and wild IRVs. The following section is on sampling.

4.6 Sampling Theory

This study adopted non-probability sampling, which does not provide elements of a population with an equal chance of being selected into the sample (Steinmetz, 2016). In non-probability sampling, the researcher chooses elements to sample, and it is predominantly used in qualitative studies, making it fit for this study.

4.6.1 Sampling Methods

Common types of non-probability sampling are convenience, quota, self-selection, snowball, and purposive. They all play major roles in data collection, but this study adopted snowball sampling technique. Snowball sampling as a technique helped the researcher to gather real-time accurate information without consuming much time as the participants had proper knowledge of the subject being studied. Snowball sampling allowed participants to recruit each other and this technique was useful because it was hard for the study to identify participants that could provide the required data. Data collection began with one participant then continued through referrals until data saturation point was reached. In this study, snowball sampling was used because of its versatility in areas where participants are hard to reach. Rural communities are often marginalized hence the need to factor this technique as researchers connect participants through referrals. This technique saves time and resources by leveraging existing networks. Food processing experts were also recruited using snowball sampling. Since participants recruit other participants, this technique is grounded in trust. As such, it was necessary to determine a sample size that was appropriate to collect meaningful qualitative data. The following paragraph justifies the sample size adopted for this study.

4.6.2 Target Sample Size

According to Andrade (2020) samples are crucial because it is close to impossible to study the entire population but samples drawn can be a true representation of the entire population. Too small or too large a sample size is not ethical and necessary (Subedi, 2021). Sim *et al.*, (2018) argue that there is no straightforward way to determine a sample size in qualitative research but one can stop collecting data upon reaching data saturation point. Exploratory studies are often more about the quality of information than mere quantity. Hennink and Kaiser, (2022) conducted a systematic review on sample sizes for qualitative research and found out that a number of studies

that used empirical data reached data saturation within a narrow range of nine to seventeen (9 to 17) participants regardless of varied topics and approaches.

Table 4.1 Target population and sample

Target population	**Source of Population**	**Target sample size**	**Justification**
Small scale farmers	Village heads	15	IRVs are usually cultivated by small-scale farmers for family consumption (Asem, Nyaku, Kolog, Blay Adjei, Ankrah, & Opperman., 2024)
Commercial farmers	Village Heads	5	Commercial farmers are more inclined to cash crops (Shonhe, Scoones & Murimbarimba, 2020)
Food processing experts	Food processing companies	5	Key informants
Nutrition experts	Health and Harvest (NGO)	5	Key informants
Total		30	Ahmed (2025)

To facilitate planning and organizing resources, this study targeted a sample size of thirty (30) participants in support of the suggestions by Ahmed (2025) who argues that a sample size ranging from five (5) to thirty (30) participants is adequate for a qualitative research that uses a phenomenological design. However, such a sample size is not rigid as it can be influenced by data saturation point

4.7 Data Collection Methods

Data collection is the process of gathering information to get insights (Taherdoost, 2021), and methods are strategies and techniques used to gather data from the sample. These techniques are but not limited to surveys, interviews, observations, experiments, case studies, focus group discussions, document analysis and ethnography (Johnson & Christensen, 2017). Each method serves a specific purpose depending on the nature of objectives, resources and time. This study

adopted qualitative data collection methods paying particular attention to face to face and telephone interviews to collect primary data from participants. Face-to-face interviews were done with farmers and nutrition experts found in Makoni District. Telephone interviews were done with food processing experts from various food processing companies irrespective of their location in Zimbabwe.

An interview is an interpersonal encounter where the interviewer collects data from the interviewee either face to face or online (Taherdoost, 2022). Interviews are a resourceful method of qualitative data collection commonly used by researchers in social sciences to allow participants to explain their own understanding and interpretation of the world around them (Knott *et al.*, 2022). Interviews complement this approach by offering depth rather than breadth, ensuring researchers can extract meaningful data from individual experiences and perspectives.

This study used semi-structured interviews in order to blend consistency and flexibility. This method allowed the interviewers to adapt to changes in responses given by the participant. It also helped the interviewers to explore unexpected topics that arose during conversations, gaining in-depth insights. With semi-structured interviews, the concept of free-listing was also co-opted to explore how groups of people perceive or think about a particular health-related domain. Quinlan (2017) defined free-listing as a qualitative but quantifiable method that allows a participant to simply list all things they think are part of the domain regardless of the order they use.

4.7.1 Data Collection Instruments

This study used a semi-structured interview guide. An audio recorder was used to record the interview sessions. This study used the same interview guide to collect detailed, qualitative data directly from farmers, consumers, and nutrition and food processing experts. A semi-structured interview guide ensures consistency across participants while giving room for participants to elaborate on unique aspects of the topic (Taherdoost, 2021). An interview guide allowed the interviewer to get context-specific data. IRVs have cultural and localized knowledge tied to them, and interviews were an excellent way to capture this wisdom. The interview guide used in this study included a consent form, demographic information, and open-ended questions that sought to address the demands of specific objectives for the study and to gain deeper insights as well as a closing section.

To enhance accuracy and to capture participants' voices and narratives without relying solely on note-taking, the study made use of an audio recorder. An audio recorder also facilitated revisiting the material during analysis to minimize loss of key themes and nuances. Voice tone, pauses, and emphasis captured in audio provided critical insights into the responses that facilitated effective data analysis. The study also made use of photographs as tangible evidence of existing practices and conditions related to the value addition processes of IRVs**.** A blend of these tools facilitated in enhancing the richness and reliability of data.

4.7.2 Pilot Testing

A pilot study is a preliminary investigation designed to assess the feasibility of data collection methods planned for a larger and more comprehensive study (Lowe, 2019). Its primary purpose is not to address specific research questions but to help researchers identify and mitigate critical flaws that could render a large-scale study inefficient or costly in terms of time and resources. Tate *et al*. (2023) also emphasized that pilot testing allows researchers to evaluate question clarity, gather feedback on validity, minimize ambiguity, and assess readability.

In this study, the pilot testing of the interview guide was crucial for ensuring the effectiveness, appropriateness, and clarity of the questions for the main investigation. A sample of four (4) participants was drawn from the university staff to check the usefulness of the tool. Pilot testing provided an opportunity to identify and resolve issues, such as unclear phrasing and the overall flow of the interview process. Moreover, the pilot study assessed the practicality of the guide, allowing for refinements to enhance its reliability and validity. This procedure helped minimize the risk of encountering problems during the main study and ensured that the data collected aligned with the research objectives. This test also reflected the need to translate the English guide to Shona language to facilitate seamless conversations with the respondents. Interview questions that were not very clear were clarified. Lastly, pilot testing helped in determining the number of minutes each respondent could be given and in this study and a range of thirty (30) to forty-five 45 minutes per respondent was used.

4.8 Data collection procedure

Permission to conduct research was sought from the School of Hospitality and Tourism, Research and Graduate Studies, Makoni Rural District Council, the councillor, Village heads as well as

participants. A semi-structured interview guide was crafted with open-ended questions to allow participants to exercise freedom in giving detailed responses. Pilot testing was done with four (4) participants to check and see if the interview guide designed would work best. An English interview guide was translated to Shona language for effective communication. Closed ended questions were restructured to allow respondents freely express their views in thirty (30) to forty-five (45) minutes. It also helped in identifying and amending questions that participants were struggling with. In this study, appointments were made with various participants before data collection. This enabled the setting of preferred dates and time for interviews. Participants were assured of maximum confidentiality and that the interviews were strictly for educational purposes. Face-to-face and telephone interviews were conducted under a voluntary basis. Data was collected in two distinct areas, Maungwe area (Ward 14 from 2 December to 5 December 2024); and Nyabadza (Ward 19 from 17 March to 20 March 2025). Although Makoni District have many villages, snowball sampling facilitated the entire data collection process. Data collection was facilitated by three research assistants. One of the assistants from Maungwe area provided directions and locations of referred participants. The second assistant came from Nyabadza and also facilitated with locating, coordinating and making appointments with various village heads. The third facilitator was a professional research assistant who was roped in from one of the institutions to facilitate the overall data collection process. Data was collected with the aid of an audio recorder and a camera. Data collected was stored in safe places and kept for the purpose of this study only.

4.9 Ethical considerations

According to Cacciattolo (2015) there is no means to acquire absolute truths and solve the real problem without adhering to ethics as this guide defines professional research. Cacciattolo (2015) added that research ethics start from the beginning of research by acknowledging what other scholars contributed in relation to your study. It also includes the aspect of using scholarly materials to avoid misinforming the audience. Ethics for qualitative research and for data collection were considered in the entire process. The aspect of seeking permission from relevant stakeholders is also crucial in protecting the dignity and rights of each stakeholder. Ethical clearance was obtained from the university and permission from the following stakeholders was

sought; rural district council, the councillor, the herdsman and participants. Apart from these stakeholders, information obtained from various sources is cited and referenced.

Obtaining permission from relevant authorities and individuals was vital for ensuring the ethical integrity and smooth execution of the study. Permission from the institution and the district council ensured compliance with legal and institutional guidelines, demonstrating adherence to ethical research practices. Engaging with community leaders, such as the ward councillor and herdsmen fostered trust and cooperation within the community, which was crucial for gaining access to participants and collecting accurate data. Seeking consent from participants respected their autonomy and upheld the principle of informed consent, ensuring voluntary participation. Furthermore, seeking approval from local leaders highlighted cultural sensitivity, making the study more relevant and acceptable within the community context. Proper citation of all data sources further enhanced the credibility and reliability of the research, upholding academic integrity. These actions collectively ensure ethical, credible, and culturally aware research practices contributing to the overall validity and reliability of the study findings.

4.10 Data presentation and analysis

Bhatia, (2017) defines data analysis as the process of examining unprocessed data to draw meaningful conclusions. The primary aim of this process is to transform cluttered data into a format that is easy to understand, legible, and conclusive for decision-making (Clarke & Braun, 2017). In this qualitative study, the thematic data analysis method was used to identify, analyse, and interpret themes within a dataset. Thematic analysis involves familiarisation where researchers immerse themselves in data to gain deeper understanding. After familiarisation, the aspect of coding comes into play where initial codes are assigned to the data for the identification of patterns and themes. The codes will then be grouped into potential themes for review and refinement. Reviewed themes will then be defined named to capture their essence and lastly a write-up. Data was presented in themes and verbatim augmented by participants' voices and quotes. Tables and figures were also used where and when data required summarising. This method is commonly applied in studies involving interviews and focus groups, making it ideal for exploring deeper meanings and insights related to research questions. Moreover, it is particularly effective in uncovering participants' perceptions, practices, and experiences, which aligns well with the purpose of this study. Braun and Clarke (2014) stated that qualitative research has long been a cornerstone of studies in health

and wellbeing. In addition, thematic analysis can be used extensively for health and wellbeing research, but it also requires wisdom (Braun & Clarke, 2014). Due to its wide application in studies related to health and wellness, it became imperative to consider it for this research. Table 4.1 below shows 6 steps involved in thematic analysis

Table 4.2 Steps involved in thematic analysis

Steps involved	*Description*
Step 1 *Familiarization*	This step was used to have a thorough overview of data collected prior to analysis. Audios were listened to repeatedly to grasp the social context. Audios were then transcribed and text was read over and over again. Notes were taken and data was familiarized with.
Step 2 *Coding*	Data was broken into smaller units and assigning codes to relevant pieces of information. Participant's number such as (P1 and P2) was used to highlight sections, phrases and coming up with codes to describe content.
Step 3 *Generating themes*	This step was used to look over the codes created, identifying patterns among them and coming up with themes. Themes are broader than codes as they are a combination of codes although some codes might become themes on their own. This being said, related codes were grouped into broader categories to identify potential themes.
Step 4 *Reviewing themes*	This step was used to ensure usefulness and accuracy of themes generated against data available, checking if anything was missing. This step helped in validating generated themes ensuring that they are meaningful, consistent, and well-linked to the data.
Step 5 *Defining and naming themes*	This stage helped in formulating the meaning of generated themes and its importance in understanding available data.
Step 6 *Writing up*	The final stage helped in writing up analysed data. This step was also used to present findings in a coherent narrative, enriched with supporting quotes, themes, tables and photos.

Source: Braun & Clarke, (2006)

4.11 Research Credibility Issues

Korstjens and Moser, (2018) defined research credibility as the confidence that can be given to research findings. This study was conducted with a strong commitment to ethical guidelines. Permissions were secured from all necessary authorities, including the School of Hospitality and Tourism, Research and Graduate Studies, community leaders (that is the ward councillor and

herdsmen), the district council, and individual participants. This ensured respect for participants' rights, voluntary participation, and compliance with legal and institutional regulations, thus strengthening the integrity of the study. Secondly, conducting a pilot study with the interview guide significantly enhanced the credibility of the research. It allowed for the evaluation and refinement of the data collection tool, ensuring that the questions were clear, relevant, and capable of eliciting meaningful responses. Issues such as ambiguous phrasing and the flow of interviews were addressed, improving the reliability and validity of the instruments. This step minimized potential errors and increased confidence in the data collection process.

The qualitative approach adopted in this study facilitated an in-depth exploration of complex social phenomena, allowing for a deeper understanding of the participants' perspectives. The use of thematic analysis ensured a systematic and reliable interpretation of data, adding rigor to the study's findings. By clearly outlining the methodology, steps taken, and data sources used, it demonstrated a commitment to openness and allowed for the verification of findings. Proper citation of data sources safeguarded academic integrity, acknowledging the contributions of other researchers and avoiding plagiarism. Engaging with community leaders demonstrated cultural awareness and respect for local traditions and hierarchies. This approach fostered trust within the community, facilitating participant cooperation and enhancing the relevance and acceptance of the research. The study minimized bias by using systematic procedures for data collection and analysis. By pilot testing the interview guide, potential researcher bias in the questions was reduced; ensuring that the data collected genuinely reflected the participants' perspectives.

The study's design and methodology were tailored to the specific research context, ensuring that the findings were not only valid but also meaningful within the chosen setting. Through thematic analysis, the study captures the depth and richness of qualitative data. This approach reinforced the authenticity and trustworthiness of the results.

4.11.1 Research Confirmability

Confirmability is the degree to which findings are grounded in the data and not the researchers' own preferences (Connelly, 2016). In this study, the research process, results, and interpretations are traceable and auditable. Other researchers can follow the same path of analysis and verify conclusions drawn from raw data. The connection between raw data and findings is transparent.

All interpretations and themes are linked to data, and participants' voices are intertwined to ground findings in data. To enhance confirmability, the study also combined data collection instruments (interview guide, photography, and an audio recorder). Peer-debriefing with colleagues and other experts was done to provide valuable insights as well as help with the identification of potential biases and blind spots. Due to time constraints and other commitments, some peers could not manage to bring feedback in time. However, those who managed to bring feedback did so effectively.

4.11.2 Research transferability

According to Drisko (2024), research transferability is the extent to which findings obtained in one study can be applied and relevant to other contexts outside the specific research context. It is also called external validity. Findings obtained in this study can be used in multiple disciplines and settings namely; gastronomy and culinary arts, food science, food production and processing, agriculture, indigenous vegetable value chain, and other stakeholders who can be affected by the vegetable value chain like consumers.

4.11.3 Research Validity and Reliability

Validity is the degree to which a study measures accurately what it intends to measure (Patino & Ferreira, 2018). Validity can be measured by checking how well results match established theories and other findings on the same concept. In this study, the results obtained were validated by other scholarly findings. However, the study uncovered certain insights that still require scientific enquiry to be validated. The measurement is deemed reliable if the same outcome can be reliably obtained under the same conditions using the same techniques. Results obtained in this study are valid and reliable; a different researcher can conduct a similar study using a similar data collection procedure and come with similar results. In this study, a well-structured interview guide withn open ended questions was developed. The interviewing technique was consistent across all interviews and audios were recorded to capture accurate data. Pilot testing and triangulation was also used. The use of proper sampling methods and tools that align with the objectives of this study enhances the validity of research findings.

4.12 Chapter Summary

This chapter gave an overview of the research methodology employed in this study, detailing the processes and approaches designed to ensure valid and reliable results. It begins by discussing the philosophical underpinnings of the research and justifies the adoption of a qualitative approach and the phenomenological research design. The chapter also outlines and defends the decisions regarding the study's population, sample size, sampling techniques, and data collection procedures. Ethical considerations, including adherence to guidelines to ensure compliance are thoroughly addressed. The emphasis on qualitative data collection methods is highlighted for its ability to provide rich and in-depth insights into participants' perspectives. The interview guide was pilot-tested to evaluate clarity, readability, and effectiveness in eliciting meaningful responses. Thematic analysis is also presented as the central tool for organizing and systematically interpreting qualitative data. Finally, measures to enhance research credibility, such as ensuring transparency, cultural sensitivity, and methodological accuracy, are discussed, further supporting the reliability and trustworthiness of the study's findings. The next chapter is on data presentation, analysis, and interpretation

CHAPTER 5
DATA PRESENTATION, ANALYSIS AND INTERPRETATION/DISCUSSION OF FINDINGS

5.1 Introduction

This chapter presents the research findings of the study based on the data collected through interviews in Makoni District as well as from key informants drawn from various food processing companies in Zimbabwe. The results are logically organized and analysed to answer the main objective which sought to explore value addition processes towards optimizing IRVs for health and wellness sustenance in Zimbabwe. Research findings are presented using the objective-by-objective approach, and each objective is presented as a standalone. Chapter 5 presents, analyses, and interprets findings on the first objective, which sought to explore IRVs that are consumed for health and wellness sustenance in Makoni District. Since the study is exploratory, thematic analysis by Braun and Clarke (2006) was adopted. The data is presented using tables, pie charts, figures, and themes to foster clarity, readability and easy interpretation. Due to the nature of this research's target population and geographical location, an English interview guide was translated into Shona. Therefore, data analysis chapters present complex Shona words that carry a significant meaning as they are. The analysis and interpretation of data is also based on the participants' lived experiences with IRVs found in Makoni District.

5.2 Response Rate

This study targeted thirty (30) participants and managed to collect data from twenty-five (25) participants that translated to eighty-three (83%). The sample had five (5) food processing experts which translated to sixteen-point six percent (16.6%), three (3) nutrition experts, that is, ten percent (10%), twelve (12) small-scale farmers, that is, forty percent (40%) and five (5) commercial which is also sixteen point six percent (16.6%). The consumer category is embedded within this heterogeneous population because all participants were indigenous root vegetable consumers. Therefore, concerning the response rate on this study, one can conclude that the data presented herein is valid and reliable. Response rate contributes to data reliability and validity (Taherdoost, 2025). In qualitative research, response rates reflect the willingness of participants to share their perspectives, experiences, or understanding of a phenomenon. A suitable response rate is not merely about collecting enough data but about ensuring that the data collected accurately reflects

the target population. Although the preceding sentiment is crucial, in qualitative studies numbers do not matter much, but the quality of data as well as data saturation point matters. Data saturation was observed upon reaching participant number twenty-two (22) and the interviews were stopped on number twenty-five (25).

Table 5.1 Target sample and actual sample size

Population	**Target sample size**	**Actual sample size**
Small scale farmers	15	12
Commercial farmers	5	5
Food processing experts	5	5
Nutrition experts	5	3
Total	**30**	**25 (83%)**

5.3 Demographic Characteristics of Respondents

Table 5.1 presents the gender, age, marital status, and occupation of respondents to understand respondents' experiences, opinions, and their ways of living as far as value addition, health and wellness, and IRVs are concerned.

Table 5.2 Summative demographic profile of respondents

Characteristic	Detail		Percentage%
Gender and marital status	Male and married	5	20%
	Female and married	5	20%
	Male and single	3	12%
	Female and single	4	16%
	Female and widowed	8	32%
	Total	**25**	**100%**
Age range	20 – 30 years	2	8%
	30 – 39 years	3	12%
	40 – 49 years	3	12%
	50 – 59 years	3	12 %
	60 – 69 years	6	24%
	70 – 79 years	4	16%

	80 – 89 years	2	8%
	90 – 99 years	2	8%
	Total	**25**	**100%**
Occupation	Small-scale farmers/consumers	12	48%
	Commercial farmers/consumers	5	20%
	Experts in nutrition from an NGO/consumers	3	12%
	Experts in food processing from companies and tertiary institutions/consumers	5	20%
	Total	**25**	**100%**

Source: Research Data

Table 5.1 above indicates the dominance of female participants, accounting for more than half of the response rate. This active participation stem from the fact that females typically live longer than their male counterparts, as indicated by the World Health Organisation (WHO,2019). Another reason is that adult males often migrate to cities in search of better opportunities, leaving their wives and the elderly to manage the rural homesteads [International Organisation for Migration (IOM), 2009]. Additionally, women are usually at home during the day to care for the children while the fathers seek employment, as noted by (Thebe, 2018). This situation makes female participants more available and accessible. The widowed are disproportionately represented among females, highlighting potential gender inequalities in spousal survival rates. In this study, gender and marital status helped in understanding gender-based trends and household dynamics.

The dominance of the age range sixty to sixty-nine (60 – 69 years) is a reflection of willingness to participate in a study by the elderly people. Apart from willingness, interviews were guided by snowball sampling, where one participant recruited another (Bhardwaj, 2019). Taking a closer look, the data shows that participants within this age range possess a unique type of information than other groups. The age range of seventy to eighty-nine (80-89) years also shows a notable number of participants, indicating the availability of indigenous knowledge among older generations (Mungofa *et al.*, 2022). The middle age range of twenty to fifty-nine (20-29) had fewer participants, reflecting the current standpoint of indigenous knowledge (IK) erosion among younger generations (Gayao, 2017). This indicates the need for mechanisms to spread the indigenous knowledge among the younger generation to minimize the loss of IK. Participants

beyond eighty years are also few, and this may be due to changes in life expectancy in Zimbabwe. In chapters five (5) and six (6), age was given special attention to understand indigenous knowledge among different age groups.

Concerning occupation distribution, the majority of participants came from small-scale farmers who were also consumers, indicating the dominance of small-scale farmers who usually rely on traditional methods, producing agricultural products mainly for household consumption. A notable number was also observed among commercial farmers who grow their produce for resale. This indicated their significance in the indigenous food value chain. However, the majority of commercial farmers in Rusape rural are now mainly relying on the cultivation of tobacco. Despite a shift towards tobacco farming, indigenous data gathering could not be hindered. In this study, the nutrition and food processing experts played a central role. Nutrition experts once worked as advocates for value addition under a certain NGO in Makoni District that trained the community to grow, prepare, and process nutritious foods. Food processing experts were drawn from different food processing companies in Zimbabwe using telephone interviews. Herein, participant occupation helped in understanding their professional background and their input in the research study. A combination of these demographics helped the researcher to focus and collect relevant data from true representatives that contribute to the requirements of the main research question. The following section presents the research findings.

5.4 Research Findings and Discussion

The first research question sought answers on IRVs that are consumed in Makoni District. The second question sought answers on the current value addition processes used to optimise the consumption of IRVs. The third question sought answers on factors affecting indigenous root vegetable value addition processes, and the last question sought answers on recommendations that can be made to optimize consumption for health and wellness in Zimbabwe. Research findings are analysed and presented using thematic analysis by Braun and Clark (2006). Regarding the aforementioned, this chapter presents findings on the first objective.

5.5 Indigenous root vegetables that are consumed in Makoni District for health and wellness sustenance.

This section acted as an umbrella, shielding various sub-sections. Under this umbrella, the following subheadings (in Table 5.2 below) are discussed in relation to the main objective of the study. Each theme is articulated in its paragraph.

Table 5.3. Themes that emerged under the first objective.

Major themes	Sub themes
IRVs found	➢ Common roots ➢ Unique roots
Consumption patterns	➢ Decline in consumption ➢ Regular consumption ➢ No longer consuming
The state in which IRVs are consumed	➢ Raw ➢ Cooked
Reasons for consumption	➢ Nutritional and medicinal reasons ➢ Life-longevity ➢ Taste and enjoyment ➢ Feeling of satiety
Contributions of IRVs/Medicinal claims	➢ Diabetes, cramps, and HIV remedy ➢ Belly button remedy ➢ Immune system boost and disease prevention ➢ Longevity and sustenance ➢ Controversial views

5.5.1 Root Vegetables Found in Makoni District

This section presents the indigenous root vegetables found in Makoni District as a baseline to ensure contextual relevance of the study. These were the results obtained during free-listing process which can be viewed as the baseline study. This baseline also helped in documenting IRVs that are at risk of disappearing and those that are lesser known. This aspect also paved the way for in-depth research as far as value addition, consumption, and health and wellness sustenance are concerned. With regards to this, findings indicate that Makoni District is home to a variety of indigenous root vegetables. One of the elderly participants from Kamba village listed the following;

"*Ndekede (dwarf babiana), mbambaira (sweet potatoes), madhumbe (yams), pfende (tiger-nut), tsenza (Livingstone potato comes with different types such as ndurwi, mabvumbe), mugwira, mufarinya (cassava), mazvimbirirwa"*

Another elderly participant from Sabhabha village listed the following;

"Sweet potatoes, Livingstone potato (have various species-nziye, sasanwi, ndorwe, musande), hwenene, hwenya (dwarf babiana), yams, cassava, derere rechijonga (rinoitwa zvekucherwa pasi)"

From a social science perspective, these vegetables are more than just a list of IRVs found in Makoni District. IRVs like *dwarf babiana* and *hwenene* still require research attention due to dearth of literature related to these crops. They are a true reflection of indigenous knowledge embedded within the community. The ability of the elderly participants to identify several species using local language reflects cultural identity and connection to the land. Deeper insights on indigenous knowledge among the elderly support findings from Gaski (2019), who indicated that elders hold a wealth of knowledge and experience that indigenous cultures have always valued. With regards to this, relying on the elderly when looking for rich cultural knowledge can be recommended. Among various IRVs mentioned, common roots were identified.

5.5.1.1 Common Roots

Findings indicate the availability of common IRVs in Makoni District. Regarding this, a thirty-three (33) year-old man said,

In this province, you can find the likes of yam, cassava, and sweet potatoes.

Another 37-year-old lady who was a small-scale farmer said,

You can find wild and domesticated Livingstone potato, yams, cassava and sweet potatoes

Results indicate the recurrence of cassava, sweet potato and yams. This may mean that these root vegetables are usually included in diets or that they are still cultivated by various communities. Since indigenous knowledge is passed down orally from generation to generation, the preceding findings also show that there are disparities as far as indigenous knowledge is concerned. Lack of commonness of native vegetables among the younger generation is a true representation of indigenous knowledge erosion. This sentiment concurs with Akinola *et al.* (2020) who highlighted that knowledge among the present generation is gradually fading away. Overall, findings indicate that Makoni District is still rich in IRVs and the elderly possess deeper knowledge as compared to

the youngsters. Since knowledge is gradually fading and those who possess it can die without passing it to the next generation, it is important to document what is currently known instead of relying on oral transmission only. With regards to this observation, there is a need for an urgent action in documenting IKs before it becomes too late. Among various root vegetables listed, some unique species were unveiled. These species are presented in the following section below.

5.5.1.2 Unique Native Root Vegetables

The majority of participants are conversant with IRVs that were introduced and became part of our traditional cuisine as time continued to unfold. However, there are particular participants who identified unique root vegetables that are not so common to the majority. A 92-year-old widow said;

"*Here in Makoni you can find hwenene, ndekede and mugwira".*

Furthermore, another 72-year-old widow from Mutewere village said; *"You can find tsenza, hwenya, pfende and tsombori.* These findings reflect unique indigenous knowledge among the elderly. Some unique species mentioned are depicted in Figure. 5.1 below.

Figure 5.1 Unique native root vegetables. *Primary data (Tiger-nut and Dwarf babiana, December 2024; Hwenene and Mugwira, March 2025)*

The study noted that some IRVs are not very popular. Figure 5.1 is a snapshot from the findings of some of the native species that are not widely known by the younger generation. Although

findings identified more than four native species, some photos could not be taken due to seasonality and proximity issues. According to some participants, these underground plant structures are usually small in size but very significant in one's well-being. One of the participants had his to say concerning her lived experiences with the unpopular IRVs,

> *They are commonly found in forests as they grow naturally, without human intervention. Although they can grow naturally, room for domestication is feasible*

This observation is an indication of an opportunity that can help in preserving such species for consumption. The next section presents a summary of IRVs found in Rusape (Makoni District) in a tabular format.

Table 5.4. IRVs found in Rusape

Typology	**Local name**	**Botanical/English name**	**Native/Introduced in Zimbabwe**	**Cultivated/Not cultivated**
Tuberous root	*Tsenza* species-*nziye,sasanwi, ndorwe, mabvumbe*	Livingstone potato	Native	Both
True root	*Derere rechijonga*	Okra	Native	Not cultivated
Tuberous root	*Pfende*	Tigernut /nutsedge	Native	Not cultivated
Tuberous root	*Hwenene*	Identification is still desired	Native	Not cultivated
	Hwenya/ Ndekede	Dwarf babiana	Native	Not cultivated
True root	*Mugwira*	Identification is still desired	Native	Not cultivated
Tuberous root	*Mbambaira* *Mufarinya* *Madhumbe*	Sweet potatoes Cassava Yam	All introduced	Cultivated

Table 5.3 above summarised IRVs found in Rusape. In this study, botanical or English names of some species could not be identified, indicating a gap that requires further studies. Having known what is found, it is prudent to understand the nature of indigenous root vegetable consumption. Thus, the following section unpacks consumption patterns related to both the wild and domesticated root vegetables.

5.5.2 The State in which IRVs are consumed

According to the findings from the study, IRVs vary, some require cooking and some can be consumed raw. One of the community members who was a consumer said, *"The state is determined by various factors"*. Some IRVs require cooking and some can be consumed raw. The following section unpacks root vegetables that can be cooked raw, and those that require cooking.

5.5.2.1 Raw

Findings indicate that the state at which IRVs are consumed varies according to type as well as preferences. One of the elderly participants who was a small-scale farmer as well as a consumer highlighted IRVs that are consumed in their natural state and said;

> *...we could eat tiger-nut we could consume it raw, sometimes we could add salt to enhance the taste. Tiger-nut that is found in areas where there is excessive water is less tasty than the one found in dry land. Dwarf babiana is eaten raw, but these days it is becoming scarce.*

Another participant also said,

> *We used to eat dwarf babiana, wild-Livingstone potato and mugwira in their raw state while heading cattle. Livingstone potato and sweet potato can be cooked or eaten raw.*

Findings indicate that wild root vegetables, such as tiger-nut and dwarf babiana, are consumed in their natural state, with the exception of Livingstone potato, which is versatile. From a social scientist's perspective, this may be driven by traditional norms and the palatability of some roots in their natural state. It is also key to note that many vegetables tend to lose their nutritional and medicinal value when exposed to heat. Consuming them in their raw state means consuming all beneficial nutrients in good quantities (Wilson et al., 2019), which in turn positively impacts human health. This could be one reason why people in ancient times rarely got sick. Findings also revealed that apart from raw consumption, other roots can be cooked. Although findings indicated that tiger-nut is consumed in its raw state. In other countries, this vegetable can be subjected to heat (Roselló-Soto *et al.*, 2018). However, in Zimbabwe, there is dearth of literature to support the notion that it can be subjected to heat or cooked. From a cultural perspective, this gap can be attributed to different traditions and a lack of knowledge among local consumers. That said, it may be prudent to provide consumers with new knowledge to enhance their choices.

5.5.2.2 Cooked

Although IRVs like Livingstone potato and tiger-nut can be eaten raw or cooked, findings indicate that other root vegetables require cooking for them to be edible. One of the participants said, "Yams*, cassava and sweet potatoes can be boiled or fried",* and another participant who was a consumer said,

> *Livingstone potato can be consumed raw but it temporarily darkens your teeth, one can tell that this person ate this root. It also retards one's appetite because of its bitter taste. You can also boil it; this way it will not darken your teeth plus children tend to favour the boiled than raw.*

From the participants' views and lived experiences, boiling is the most common method of cooking yams, sweet potatoes, cassava and even Livingstone potato. These findings indicate that consumers use this technique to improve taste and enhance acceptability especially among children. Livingstone potato is usually associated with bitter taste and cooking can help in improving its taste. The aspect of bitter taste is in tandem with findings by Kujeke *et al.* (2019). According to the analysis made from the reasons given by the participants, the boiling method is less costly and can be adopted by almost everyone in a rural setting. Apart from boiling methods, participants pointed out an aspect of frying yams. Frying is a cooking method that generally enhances flavour, reflecting an adaptation to modern-day cooking styles.

The researcher also noted that the state in which IRVs are consumed show various consumption practices among participants which are shaped by convenience, sensory preferences and modern diet influences. The preference for dwarf babiana, tiger nut, *mugwira*, and *hwenene* in raw state is rooted in cultural traditions, norms and convenience. For instance, in Zimbabwe's diverse social settings, cattle herders historically relied on these roots as a reliable energy source when far from home cooked food. According to Kuhnlein and Erasmus (2022), indigenous communities usually consume foodstuffs in their natural state because of cultural norms and convenience. Apart from raw consumption, boiling is widely used for its simplicity, efficient in rural settings, and effective in enhancing taste (Chivenge *et al.* 2015). Having known the state at which IRVs are consumed, it is crucial to uncover value addition processes in play among people in Rusape rural.

5.5.3 Consumption Patterns

This section looks at a broad theme "consumption patterns" which refer to the way consumers consume IRVs over time. Data unearthed the manner in which IRVs were consumed and underlying reasons behind this. Voices captured during interviews are presented in the table below;

Table 5.5. Participant and responses provided

Participant	The response
P3	*"Yams and sweet potatoes are regularly consumed as a substitute for bread. Even on daily basis. However, you can only consume them when they are in season but the likes of Livingstone potato, both the wild and domesticated is now rare".*
P10	*"We used to consume these root vegetables very often. That was our day to day food, especially yam. It was our daily bread now people no longer regularly consume".*
P13	*"The consumption of these IRVs has decreased, the children have lost the indigenous knowledge, and wetlands are now scarce".*
P15 (Key informant)	*"We rarely consume these wild root vegetables. The thing is, times are changing, some of the species we used to find in abundance are becoming scarce. The young people do not consume because they are not acquainted with knowledge. Plus these vegetables are no longer cultivated as they used to be. We could eat these vegetables nearly every day because those days we depended on hunting and gathering. These days consumption has frequently declined, maybe 5% only consume from 95% as an example".*
P16	*"These roots are now rarely consumed because our children are now used to foods that came through globalisation. But during our time, we could go for cattle heading without any lunchbox knowing that we will find such foods in the forest. But now our children don't eat such".*
P17	*"These days we rarely consume the likes of Livingstone potato, dwarf babiana and even tiger nuts. Because of the availability of bread, people no longer want to cook meals that are time consuming. The affluent rarely consume but those with little income often consume. The poor can even consume these crops on a daily basis".*
P20	*"These wild roots were usually consumed by cattle headers in the forest. You know the state of cattle herders, most of them struggle. Livingstone Potato can be found all year*

	round even now it's available in abundance. Consumption has decreased due to lack of knowledge. Wild Livingstone potato is bitter than the domesticated".

Findings indicate that there is a great decline in consumption of IRVs among the majority of the population, as depicted in **Table 5.4** above. The analysis from the participants' voices shows that the consumption patterns for IRVs are determined by factors that include what someone prefers to eat at a given time. The other factors include the choices that are made by people of different age groups exacerbated by taste and availability of the vegetables. Some participants said they enjoyed the taste while others ate the vegetables because they had no choice. However, the elderly seemed to prefer the root vegetables for their health benefits and that they kept them going despite that they are shunned by the young generation. As such, the themes that emerged from the data analysed in relation to consumption patterns of IRVs in Rusape are; rare consumption, decline in consumption and no longer consuming. These themes are discussed in detail in the paragraphs below.

5.5.3.1 Decline in Consumption

Participants (P10, P13, and P20) mentioned that they used to consume IRVs regularly years back but nowadays the consumption has declined. With regards to this, another participant, a 59-year-old lady from Mugari village said;

> *These days we rarely consume the likes of Livingstone potato, dwarf babiana and even tiger-nuts. Because of the availability of bread, people no longer want to cook time-consuming meals. The affluent rarely consume, but those with little income often consume. The poor can even consume these crops daily.*

Findings indicate a decline in consumption mainly on wild root vegetables like dwarf babiana and Livingstone potato. This decline in consumption indicates dietary changes from traditional foods, signifying the dominance of modern influences overriding indigenous practices. This observation concurs with Cereda *et al*. (2024) and Sarkar *et al.* (2020) who observed a decline in consumption of IRVs indicating that this is not only a Zimbabwean phenomenon but a challenge impacting other nations. Apart from the quest for modern foods among the majority, data obtained indicates the relationship between consumption and socio-economic status. Findings indicate that low-income earners tend to rely more on indigenous foods while wealthier individuals tend to prefer modern vegetables. Taking a close stance, relative consumption of indigenous foods among the poor is not

by choice but due to lack of required disposable income. This may mean that nowadays consumption of IRVs among populations is closely associated with poverty. This observation concur with findings by Chemura *et al.* (2022) who highlighted that indigenous foods are usually looked down upon as food for the poor, often used during times of shortages. Therefore, economic factors play a central role in dietary choices, signifying that IRVs may serve as a vital food source for the economically disadvantaged societies. On the other hand, these findings contradict with Elolu *et al.* (2023) who postulated that generally consumption of indigenous foods has slightly increased as people are more health conscious. However, low consumption may be attributed to the time it takes to prepare and cook these root vegetables. This then calls for value addition processes that can limit cooking times and increase consumption, especially to consumers who are inhibited by time factors.

5.5.3.2 Regular consumption

Although there is a significant fraction of the population under-consuming these vegetables, from the findings only one participant indicated that they consume (as a family) yams very often as a substitute for bread. The participant said,

> *Yams are regularly consumed as a substitute for bread. Even daily. However, you can only consume yams when they are in season*

The participant also pointed out that they only consume these root vegetables when they are in season. This regular consumption may be attributed to the fact that there are a few individuals among the population who still value what they eat as far as health and wellness is concerned. This minority population displays a willingness to depend on indigenous foods, although seasonality issues act as a barrier. This therefore shows the need for addressing seasonality issues through processing these root vegetables so that they can be available throughout the year. Generally, the aspect of rare consumption among the majority concur with Nyaruwata (2019), who stated that IRVs are rarely consumed and often used as a temporary measure in times of drought and food shortages.

5.5.3.3 No longer consuming

Participant 15 highlighted that there are people who are no longer consuming IRVs as indicated by their voices in **Table 5.4 above**. Generally there is very minimum acceptance of IRVs among

children, teenagers, and young adults. Another view was clearly articulated by one of the participants who was a peasant farmer from Sabhabha village who said,

> *Our children no longer like these vegetables, this generation is different from us, and they are too selective. Maybe the children can adapt if you teach them but the young generation can be problematic"*

Similarly, another participant who was a farmer from Mudonhi village said;

> *The children and youngsters do not even want to eat these vegetables with the exception of a few who like yams. They say they have a bitter taste especially the Livingstone potato but the adults like IRVs"*

Another participant also said*;*

> *"The generation of today does not even like these foods. One can just eat a small portion and say I'm now ok. We used to eat on one plate, competing with each other, this could help us to consume more and also build relationships. Nowadays it has become very rare "vanhu vakutya kuroiwa" (people are now afraid of witchcraft).*

Another insight which emerged is the abandonment of IRVs among the children and younger generation **(as indicated by P10 and P16 in Table 5.4)**. One of the participants highlighted the aspect of limited indigenous knowledge transfer. According to literature, indigenous knowledge on food is passed down through generations (Nyarota et al., 2022), but it is evident that there is a knowledge gap (P15) among the current generation as far as indigenous foods (roots included) is concerned. This may be one of the reasons why the generation of today no longer lives long. Another reason for the under-consumption of IRVs among the younger generation is attributed to changes in dietary patterns towards modern foods, as highlighted by P17 and P16. The introduction of readily available food options that appeal to younger generations such as bread is seen as a barrier to the consumption of IRVs. These findings concur with Chopera et al., (2022) who highlighted that consumers nowadays are more inclined to ready-to-eat foods that came with globalisation. Therefore, there is a need to process root vegetables in a form that is more appealing and easier in terms of preparation whilst adding value. This may encourage the consumption of IRVs as they can minimize the prevalence of diet related diseases.

Root vegetables are not inferior as implied by P20 who indicated that it was food for cattle herders but they contain micronutrients and bioactive compounds which are beneficial to human health.

However, these negative sentiments were also noted by Chemura et al. (2022) who indicated that indigenous foods are often looked down upon as food for the poor. These findings reflect the need to impart positive knowledge amongst consumers especially the young so that they change the way they perceive indigenous foods.

Apart from inferiority, an aspect of bitter taste was mentioned by P20 in relation to Livingstone potato. This native root vegetable is minimally consumed due to its bitter taste. This shared experience shows the relationship between organoleptic properties and consumption. An inviting taste stimulates one's appetite to eat more especially amongst the young as posited by Bawajeeh et al. (2020). The aspect of bitter taste also concur with Masarirambi et al., (2020) who posits that indigenous vegetables are often side-lined due to their appearance, taste and colour. These findings necessitate the need to look for mechanisms that can be adopted to enhance their organoleptic properties.

Apart from organoleptic properties, this generation's dietary preferences are highly influenced by modern day food and exposure to Western diets. According to Cereda et al., (2024) the aspect of the devaluation of some of indigenous foods which essentially began after colonization, is a process that takes time to reverse. Therefore, it is crucial to adopt contemporary value addition processes so as to re-value our native vegetables. However, some of the participants blamed exposure to education amongst the young generation. In line with this view, one of the participants actually said,

> *Nowadays these children no longer like these roots and even their young mothers. They say "hatidyi midzi, mishonga, zvinodyiwa nemabhoyi, ndezvetsvina" (we do not eat root vegetables, they are not hygienic, and its food for the lower class). These roots are looked down upon. These children see themselves as superior. That's why cancers are now more common than how it was years back. I blame their education!*

There is a percentage of the population who believe that the generation of today is more exposed to modern foods and lifestyles, which is closely linked to cancers and other diet-related diseases. Time immemorial, people used to rely on word of mouth on what to eat and what not to eat. However, the present generation is exposed to a wider knowledge on the benefits and challenges of consuming certain foods. Apart from this, today's generation prefers foods that are scientifically proven. Considering the case of IRVs in Zimbabwe, it is evident that plant profiling of many

varieties is yet to be considered, as highlighted in a study conducted by Munsaka, (2018). This may be one of the reasons why the present generation tends to doubt the capacity of scientifically unproven foods in sustaining their health and wellness. In order to gain the attention of present-day consumers, it is crucial for all indigenous to go through quality checks. This concept also resonates with the Quantum and Tempus theories which stresses the importance of intensive examination of functional foods before presenting to the general public.

Although the younger generations have negative perceptions about IRVs, some participants have confidence that youngsters can adapt if they are taught about their benefits, as one of the participants said,

> *Today's generation do not like eating these foods but what we can do is to encourage mothers to cook these foods and force their children to eat. Children should not challenge their parents on what to eat and what not to eat.*

This highlights the importance of education and parental influence in promoting health and wellness. These shared sentiments indicate the importance of knowledge transfer, exposure and coercion. This finding resonates with Haines *et al.* (2019) who postulated that many parents struggle to establish healthy eating patterns in their children due to exposure to modern lifestyle. From a social science perspective, these findings may mean that children inherit dietary behaviours from those with whom they spend most of their time. With regards to this, one can recommend parents and guardians to foster a habit of healthy eating in their children so that they grow with indigenous knowledge embedded in them. To add on, the Health Belief Model and the Quantum and Tempus Theories can help in understanding the importance of consumer education in fostering informed decisions.

Although the present generation have a negative attitude towards IRVs, the older generation choose these foods to a greater extent as one of the participants said "*I prefer yams than bread, in fact I don't buy bread because it is causing diseases"* and another participant also said *"People are loving and consuming yams and sweet potatoes".* This confidence in indigenous foods among adults can be attributed to the lived experiences during their olden day era. It is evident that people used to rely on wild and indigenous foods for their survival, and there were rare cases of non-communicable diseases (Tapera *et al.*, 2020). Despite a notable appreciation of native foods by

adults, it is crucial to note that the majority prefer yams and sweet potatoes over other IRVs. This preference can be closely linked to taste and appearance. Yams and sweet potatoes have an inviting taste and aroma as compared to the Livingstone potato which is widely known for its bitter taste. Even though the elderly still value these native root vegetables, findings indicate that the general consumption has dwindled and there are other root vegetables that the elderly rarely consume such as tiger-nut and dwarf babiana. Therefore, value addition of native vegetables is the way to capture consumers of different demographics.

The big picture coming out in this theme is that there is a generational difference in acceptance and consumption of IRVs in Rusape. The majority of those with low acceptance and minimal consumption in this case are the children, young adults and their young parents which is basically those below the age of forty (40). Responses related to children emphasize stigma, superiority of consumers and exposure to modern lifestyles. The minority which are in their 50s and above acknowledge these native foods although consumption has also declined. The evidence gained under this theme proves right the assumption that IRVs are under consumed. Younger generations are more receptive to yams and sweet potatoes than to other root vegetables, such as the Livingstone potato, which is one of the least popular because of its bitter flavour. Nonetheless, older generations continue to value it because they understand its nutritional advantages.

In relation to responses given by participants, this under-consumption is said to likely contribute to diet related diseases. Younger generations may not recognize and accept the health advantages of these foods due to a lack of exposure or negative perceptions. By reconnecting younger people with their cultural heritage through food education and community projects, acceptance and dietary diversity may be enhanced. Therefore, it is an urgent matter to find mechanisms that can be adopted to enhance indigenous root vegetable acceptance and consumption. Although consumption is on the decline, it was prudent to know the reasons behind consumption. Thus, the following section unpacks the underlying reasons.

5.5.4 Reasons for indigenous root vegetable consumption

People consume IRVs for different reasons. In this section, the themes that were generated from the participant's' recurring word and voices on reasons why communities consume IRVs included; nutrition and medicinal benefits, life-longevity, satiety, taste and enjoyment.

5.5.4.1 Nutrition and medicinal benefits

A number of consumers pointed out that they consume IRVs because of their nutrition and health benefits as one of the participants said, "*These foods sustain health, these foods are healthy. Ancient foods were not associated with Sugar and BP problems, diseases were few".* This response indicates the significance of IRVs in sustaining health and wellness. Among various responses, the majority believe that consuming native root vegetables prevents blood pressure and sugar problems. Another participant gave a similar response and said,

> "*We used to eat these roots to prevent BP and sugar. That's why in these diseases were rare. These roots could work as medicine". But a lot of people would consume not knowing that they will be preventing certain diseases, some of us could consume the likes of tiger-nut just for fun"*

These responses indicate that some people could consume native root vegetables with an aspect of health and wellness sustenance in mind. Although there is a certain group that could eat unknowingly, later people could discover the benefits. From a social science perspective, these findings reflect long-standing indigenous knowledge and wisdom that was time tested. One of the participants who mentioned that IRVs could work as medicine concurs with Sarkar *et al.* (2020), who stated that there is no difference between food and medicine and that native root vegetables have been used as a source of traditional medicine by native communities. IRVs are viewed by participants as being healthier than processed foods. Findings indicate that the rise in diseases like cancer is related to the adoption of unhealthy modern diets and the rejection of traditional foods. Chopera *et al.* (2022) also posited that changes in dietary patterns towards modern ultra-processed foods promoted the rise of diet-related diseases. The big picture coming from this theme is that indigenous root vegetable consumption among communities is tied to health and medicinal benefits, although other consumers are unaware of benefits. With regards to this, one can recommend enhancing consumer awareness to foster informed decisions as highlighted by the Quantum and Tempus theories of functional food.

5.5.4.2 Life-longevity

Longevity refers to long living. In this scenario, longevity relates to foods that contribute to a longer and healthier life. Indigenous food consumption has been linked to longevity due to the

availability of nutrients and natural properties. Research findings indicated that some consume IRVs for the sake of longevity as one of the participants from Muteweyi village said,

> *People consume these root vegetables because they know that they will help them to live long. For instance, one of the residents in this village lived up to around 98 years because she would eat Livingstone potato very often. So, I think it may have contributed to her living longer.*

The above participant confidently knows that consuming IRVs guarantees long life as evidenced by one of the village dwellers who lived up to ninety-eight years. From a phenomenological stance, the shared sentiment reflects an unshakeable belief that indigenous foods are directly linked to long life. The reference made towards "food consumed during their time" highlights an aspect of dietary changes between past and present diets. One can deduce and conclude that modern foods are potentially deemed to be inferior as compared to indigenous foods. Sentiments on longevity concur with Kuhnlein (2015), who postulated that earliest people had a longer life span due to limited exposure to modern, highly processed foods. For this reason, a certain group still holds on to their culture for the sake of longevity. Therefore, one can safely argue that consumption of IRVs can significantly contribute to longevity. Apart from longevity, enjoyment emerged as another reason for consumption.

5.5.4.3 Taste and enjoyment

Findings indicate that other people consume IRVs for the sake of enjoyment as one of the participants said, *"We used to eat these roots just for fun,"* and another one shared the same sentiment and said,

> *People consume Livingstone potatoes because they love the vegetable, especially those who will be coming from the city. People consume because they believe that these root vegetables help us health wise somewhere-somehow.*

Another old lady had this to say,

> *Although I enjoy Livingstone potato, my grandchildren spit out saying granny this is not nice, and it is very bitter. I urge them to consume it anyway because.*

The fact that one of the participants indicated that they used to consume may mean that consumption of root vegetables was not always health driven but part of enjoyment. To add on,

these sentiments also show that food choices are tied to one's preferences and sensory experiences. Livingstone potato for instance is often neglected by children due to bitter taste but findings under this theme highlighted that people have different tastes and preferences when it comes to food. These findings are in line with Bawajeeh *et al.* (2020) who indicated that several studies conducted on taste preference and dietary consumption between adults and younger individuals show that adults prefer to consume bitter-tasting vegetables as compared to younger individuals. The broader view emerging from this theme is that people have different food choices and preferences. After value addition processing issues to do with taste can be addressed so as to make these root vegetables more appealing to the younger generation. Apart from enjoyment, satiety also emerged as another theme.

5.5.4.4 Feeling of satiety

Apart from enjoyment, there is also another group of people who consume these vegetables just for the feeling of satiety as one of the participants said,

"My family eat these root vegetables just to feed a hungry stomach, so long we have eaten something". Similarly, another participant said*; "We consume yams and sweet potatoes just to feed the hungry stomach"*.

> *For me these vegetables make you feel full and that's what we need especially when going to do weeding in the garden. I like to eat yams and sweet potatoes with a big cup of tea because after this, the next meal will be seen in the afternoon or even evening.*

Taking a look using a phenomenological stance, these responses reflect just practical eating of root vegetables as a basic need to deter hunger rather than health and nutritional motive. The fact that aspects of taste, preference and other benefits are not considered in these responses may mean that IRVs are consumed as a survival strategy. The primary motive is availability rather than choice. With regards to this, one can argue that people consume IRVs to address hunger and food security issues. These results concur with Mgwenya *et al.* (2025) who stated that indigenous vegetables serve as a reliable source of sustenance during times of scarcity, mainly in rural and resource-constrained communities.

To sum up reasons for consumption, findings indicate that people consume indigenous foods for varied reasons with the main one being nutritional and health purposes. Results also indicated that the rural community still believe that native roots can mitigate ailments like blood pressure and sugar related problems. There are also people who consume for the sake of satiety not by choice and those who consume for the sake of fun without expecting more benefits. The following section unpacks contributions of IRVs to human health.

5.5.5 Contributions of IRVs to human health and wellbeing

Under this section the interviewer sought to understand the contributions of IRVs to human health. The following recurring themes were observed; medicinal value, immune system boost and disease prevention, longevity and aging, nutritional benefits and controversial views These themes resonate with the Expectancy Value Theory which states that people are motivated to eat healthy food when they know that they are going to stay healthy (expectation) and when they know that health is precious (value).

5.5.5.1 Medicinal claims

The term "medical value" herein describes the advantageous qualities of indigenous root vegetable plants that can be used to manage, prevent, or treat illnesses and ailments. Findings indicate that IRVs are not just nutrient providers but also contain medicinal properties. This was evidenced by a peasant farmer from Mugari village who said, *"You know what, these root vegetables that you're talking about are medicines on their own"*. Another widow from Kamba village shared a similar sentiment and said, *"These roots could work as medicine".*

From a phenomenological stance, these sentiments reflect that root vegetables are not ordinary foods but possess healing qualities. These findings concur with Sarkar *et al.* (2020), who stated that there is no difference between food and medicine. Participants also revealed the specific health benefits that these root vegetables are said to treat, and these will be discussed in the preceding paragraphs.

5.5.5.2 Diabetes, Cramps, and HIV remedy

Apart from general medicinal value, findings indicate that people are cognisant of specific ailments that can be ameliorated by consuming IRVs. One of the participants from Mutenure village said, "*Cassava helps people with sugar problems. Cassava porridge heals cramps (chiveve).* Another man from Kamba village said, *"I eat cassava because it will help maintain my sugar level"*.

These findings express a deeper understanding that one may have acquired through personal experience. Shared sentiments may mean that cassava is not just an ordinary crop but a beneficial root vegetable that can promote one's well-being if regularly consumed. Findings on cassava are closely related to findings by Onodu *et al.* (2018) who indicated that cassava has nutraceutical effects required for diabetes management. Although cassava is rich in potassium and magnesium which are crucial for muscle function and their deficiency leading to cramps, scholarly evidence on healing properties of cassava on cramps were not found. Although this finding may be true, there is a need to scientifically prove the claim. In support, the Quantum and Tempus theories highlighted the importance of conducting clinical trials on functional foods to protect the consumer.

Apart from cassava, an elderly woman from Mutewere village indicated the relationship between tiger-nut and people with HIV. The participant said;

> "*People always say tiger-nut is very helpful if you are HIV positive. I believe it helps because those who say so seem to be benefiting from consuming it"*

A different participant also said, *"Tiger-nut helps people with HIV".*

Shared sentiments may mean that rural communities see IRVs as a source of health and wellbeing. Literature on overall health benefits of tiger-nuts is abundant; however, no directly linked studies on tiger-nuts' healing properties on HIV patients was found. Rather this study found evidence by Ogedengbe *et al.* (2023) who tested the protective role of tiger-nut and results obtained indicated that the root vegetable helped in repairing testicular damage caused by antiretroviral drug (HAART) and improved testicular structure. Therefore, studies to prove the ability of tiger-nut in helping HIV patients are desired.

5.5.5.4 Belly button challenges (ndongorongo)

Another participant uncovered that dwarf babiana helps unborn babies from developing that green vein (*ndongorongo* in Shona) which normally develops under the belly button soon after childbirth. This green vein causes discomfort among infants and usually requires medical attention. The participant said, "*Pregnant mothers eat dwarf babiana to prevent their unborn child from developing ndongorongo".* The repeated use of this native root vegetable among pregnant mothers indicates its effectiveness. Despite this discovery, scientific evidence related to dwarf babiana and pregnant mothers could not be found. Apart from a lack of specific literature, there is a general scarcity of scientific literature on this native plant's health and wellness benefits, which is a true indicator of the need to conduct research around this root vegetable.

Although indigenous root vegetables are abundant in medicinal properties, other participants indicated that they used to consume them, unaware of health benefits, as one of the participants said,

> *These vegetables could heal us, especially dwarf babiana (ndekede) and mugwira, people would consume to sustain their health. But we used to consume not knowing these roots contain medicinal value, but as we were growing up, we ended up knowing. Yes, we can say these foods help in one's health. We used to mix a lot of foods, eating one vegetable after the other, without experiencing stomach issues. But try to mix these foods of nowadays you will see the results! Running stomachs will hit you.*

This shared sentiment indicates that specific indigenous knowledge on certain root vegetables is partially available. This may be due to the fact that indigenous knowledge is usually passed down from generation to generation using word of mouth with little or no documentation (Nyarota *et al.*, 2022). Word of mouth can be easily forgotten, highlighting the importance of documenting IKS currently possessed by our elders so as to eradicate the "indigenous knowledge erosion" mantra.

In short, findings from the study emphasize the importance of indigenous root vegetables as dependable sources of traditional medicines in helping diabetic issues, cramps, abdominal issues as well as HIV challenges. The medicinal values of native root vegetables mentioned are directly linked to indigenous knowledge passed down from one generation to the other and knowledge was discovered through experience. This knowledge and experience also indicated dependence on natural sources of medication as many rural populations are often marginalized, with minimum

access to modern health facilities. Despite rich knowledge on the contribution of IRVs, lack of scientific evidence on other root vegetables indicates a gap between traditional knowledge and modern research which could validate these claims.

5.5.5.5 Nutritional Benefits

Apart from medicinal value, research findings also indicate that IRVs contain macro and micro-nutrients that are vital for human health and wellness. One of the participants said, *"Livingstone potato have a lot of starch. I do not know the health benefits of Livingstone potato, but I believe they sustain health".* This participant highlighted an aspect of starch, and another participant also gave a similar response and said*, "We eat yams and sweet potatoes because we know that these foods sustain us especially when you want to do a hard task that needs a lot of energy".* Apart from starch, another voice was captured saying,

> *Root vegetables are abundant in fibre. 80% of IRVs are bitter and this reflects their level of toxicity, and it also means that they are beneficial to human health. All IRVs increase appetite. You will eat more.*

Another participant also gave a closer response and said;

> *Root vegetables are appetizers. They increase energy and also help those with stomach problems". There is this root which is used to increase appetite, called mungurawu (Scotland). When you or your child loses appetite, you just take it.*

These findings indicate that IRVs are a good energy source which one can rely on when doing energy demanding duties. This finding concur with Edo *et al.* (2023) and Singh (2022) who stated that root vegetables are high in starch. Anyim *et al.* (2020) also indicated that yams make up to 80% of their dry weight providing a vital energy source mainly in Sub-Saharan countries. It is also key to note that root vegetables are a good source of dietary fibre as one of the participants highlighted. This finding concur with Magbalot-Fernandez and Umar (2018) who stated that root vegetables contain dietary fibre crucial for digestion, gut health and overall human wellness. Findings also indicate that there is a relationship between indigenous root vegetable and appetite however, this study could not find supporting scientific evidence to validate the claim.

Although there are notable health and wellness contributions noted, it is also evident that there are people who are unaware of nutritional benefits of consuming IRVs. This scenario calls for an

educational awareness program that will impart knowledge to rural communities to foster informed decisions among consumers.

Apart from a lack of knowledge, there is controversy among participants, where others believe that certain root vegetables do not contribute to human health. One participant said,

> *We could consume Livingstone potato just for the sake of feeding the stomach, it's just full of water. Does it have any health benefits? It's just water! But as for yams, they have starch.*

This sentiment, from an indigenous knowledge perspective, may mean that other consumers perceive it to be less nutritious due to its high-water content. This negative view can be one of the reasons why the Livingstone potato is usually neglected. However, scientific evidence by Eleazu and Eleazu (2015) and Maroyi (2019) indicated that the Livingstone potato is highly nutritious and contains a significant amount of bioactive compounds. The negative opinion towards the Livingstone potato reflects the need for consumer awareness. According to the Expectancy Value Theory, motivation to perform a certain behaviour is determined by the value placed on the desired outcome. If the expectation is zero, then motivation becomes zero. This means that consumers' motivation to consume this indigenous root vegetable can be zero since its value is not perceived. Therefore, there is a knowledge gap among consumers on the health and wellness benefits of consuming Livingstone potato which require attention.

In short, the following nutritional value of IRVs were pointed out; fibre content, water content, and appetite-boosting properties. These attributes align with known benefits of root vegetables, which are often rich in dietary fibre, low in fat, and high in essential nutrients like potassium and antioxidants, with the exception of appetite boosting, which still desires scientific evidence to validate the claim. However, there were mixed opinions on specific vegetables, such as Livingstone potatoes. While some participants praised it for its energy-giving qualities and others described it as primarily water without significant health benefits. These varied opinions suggest that while the general nutritional value of root vegetables is acknowledged, perceptions differ depending on one's experience and knowledge. One can conclude that awareness on the health and wellness attributes of IRVs among consumers is still desired especially within Zimbabwe.

5.5.5.6 Immune system boost and disease prevention

Among participants there are others who pointed out aspects of immune health and disease prevention. Their voices are presented in the table below.

Table 5.6 Immune system boost and disease prevention

Participant	Response
R1	*"We believe that if you eat root vegetables you can resist various diseases. Even in hospitals they also encourage us to consume such crops to boost the immune system. Root vegetables are appetizers. Increase energy and also help those with stomach problems".*
R3	*"What I can say is, ancient foods helped the overall health of people. Diseases were rare, for instance people could live to the extent "yekudzururwa nendove". Nowadays people are dying at an early stage"*
R8	*"Dwarf babiana is a herb on its own, it just helps you. Our parents used to say "if you consume this, your immune system becomes strong".*
R18	*I can say IRVs contribute to one's health and wellness sustenance. Yes we could rarely go to hospital. But we used to eat without knowing that these roots were sustaining our health.*

Many participants pointed out that consumption of IRVs helps in boosting the immune system although the responses did not specify the exact species with that capacity. This confidence in IRVs reveals the traditional knowledge deeply embedded among respondents. Although this knowledge is obtained through a trial-and-error method, the method helped the majority in its time. Research findings on the immune system enhancement and boosting concur with Ojimelukwe et al., (2021) who posited that yam varieties strengthen/boost immune system and helps in wound healing. Evidence from findings shows that people could rarely go to hospitals and this could be tied to various nutrients found in root vegetables such as fibre, vitamins and minerals. However, findings also indicate that these health properties were usually discovered retrospectively indicating a historical education gap on the nutritional and medicinal value of indigenous foods, which could have led to their minimum use in modern diets. Among various responses arose an aspect of longevity.

5.5.5.5.7 Longevity and sustenance

Research findings indicate that consumption of IRVs contributed to long life as evidenced by elders who lived to an extent of "*kudzururwa nendove"* a process where one's back will be made firm using cow dung. When old people advance in years, their bodies can be chapped as they may no longer take regular baths, their caregivers could use cow dung smear to cover those chaps. One of the participants said, *"Diseases were rare, for instance people could live to the extent "yekudzururwa nendove". Nowadays people are dying at an early stage"* and another participant also said,

> *Indigenous vegetables help you in sustaining your body, you don't grow old faster. For instance, how old do you think I am? I'm 62 but I look younger like you had observed. This present generation is growing faster because of fast foods.*

Sentiments shared indicated that indigenous foods not only promote long life but facilitate normal growth. Findings also show that rural dwellers associate fast foods with abnormalities where one's body can grow faster than the normal rate. In the same way, it is also evident that people of former times used to live long as compared to the modern-day generation. These claims concur with what is happening in this era where there is a rise in non-communicable diseases affecting almost all demographics. Ailments like hypertension, diabetes and cancers were rarely found. They were considered old age diseases but nowadays they can affect all age groups and this is attributed to modern dietary habits, according to research findings and this sentiment was scientifically proved by Singh *et al.* (2021). These claims also concur with Mbhenyane *et al.* (2015) and Kannaujia *et al.* (2019), who highlighted that modernization has extremely affected eating habits and enforced many people to consume fancy and high-calorie fast foods alternatively known as junk foods which are linked to obesity, cardiac problems, diabetes mellitus mainly in developing countries.

The bigger picture displayed here is the association of IRVs with longevity and slower aging. This conviction reflects the impression that indigenous foods are healthier than modern day processed foods. Comparisons between the older generation who mainly relied on IRVs lived longer, and the present-day generation who rely on ready-to-eat foods, experience health issues at an earlier age reflects the importance of resorting back to ancient foods

5.5.5.8 Controversial views on specific vegetables

Research findings indicate that some participants praised IRVs for their pivotal role in human health. However, some expressed scepticism. For instance, sweet potatoes were criticized for its starch content and Livingstone potato was devalued as being "just water." One of the participants stated that;

> *We could consume Livingstone potato just for the sake of feeding the stomach, it's just full of water. Does it have any health benefits?*

And another participant said,

> *Sweet potatoes are not healthy, is it not one of the crops that came with various diseases? It is full of starch which may cause BP and sugars. But cassava is good because it prevents BP, high acids.*

These different perceptions indicate the complexity of traditional food systems where indigenous vegetable plants are unequally valued. These findings reflect the necessity for more education to clarify the nutritional and medicinal importance of specific root vegetables. Greater awareness can help in eradicating misconceptions and promote the consumption of these vegetables in both traditional and modern diets

5.10 Chapter summary

This chapter focused on the first objective which sought to explore IRVs found in Rusape for health and wellness sustenance. Findings indicated that Rusape is endowed with various unique and more common IRVs. Despite this abundance, consumption in general has declined due to varied reasons. Those who consume do so because of nutritional and medicinal value, long life, taste and enjoyment as well as satiety. Findings also indicate that IRVs are associated with various nutritional and medicinal claims; however, scientific literature to prove these claims is still desired. The next chapter focuses on the second specific objective.

CHAPTER 6
VALUE ADDITION PROCESSES TOWARDS OPTIMIZING INDIGENOUS ROOT VEGETABLE CONSUMPTION

6.1 Introduction

The preceding chapter sought answers on the specific research question on the status quo concerning indigenous root vegetables consumed in Rusape, in order to inform this chapter. Chapter six (6) presents findings on value addition processes that can be used to optimize indigenous root vegetable consumption among consumers of various demographics. In this chapter, the following major themes are unpacked: transformation processes, preservation processes, effects of value addition, and lastly, other techniques to increase the consumption of IRVs. Table 6.1 below depicts the themes to be discussed in the following sections.

Table 6.1 Themes under value addition processes

Major themes	Sub-themes
Product development	➢ Maize and Cassava blend ➢ Yam flour ➢ Fermented traditional drink
Culinary innovations	➢ Sweet potato porridge ➢ Fried yams ➢ Yam/sweet potatoes in tomato and onion sauce ➢ Cassava in cowpeas
Preservation	➢ Sun-drying ➢ Solar-drying ➢ Pit storage
Processing effects	➢ Increase in nutrients ➢ Loss of nutrients ➢ Positive nutrient retention
Other techniques to increase consumption	➢ Product diversification ➢ Packaging ➢ Community education and awareness ➢ Leveraging social influence and behavioural change ➢ Promoting cultivation and establishing a ready market ➢ Targeting younger generations ➢ Coercion

6.2 Value addition processes being done in Rusape

This section sought to assess value addition processes that are used to improve quality, nutritional value, shelf life, appearance, taste and even the economic value of IRVs. The major themes that emerged from the interviews with participants are new product development, culinary innovations and preservation techniques.

6.2.1 Product development

Among participants emerged an aspect of transforming IRVs to various products by adopting innovative preparation and processing methods. This concept is essential in the modern-day era where the majority are looking for new innovative products which suit the current trends.

6.2.1.1 Maize and cassava blend

Findings indicate that farmers and consumers are developing new products out of cassava. On this, a 68-year-old lady from Mutenure village said;

> *We peel cassava and use a grater to come up with thin slices, sun-dry and mix with maize then grind into a meal then use the meal to prepare porridge. The porridge tastes very nice. The powder can also be used in cooking sadza.*

Another 62-year-old headman from Chikono village shared somewhat similar views and said,

> *We also prepare sadza using cassava. Process-sun-dry and mill then prepare your sadza. Some individuals are still cultivating it at a larger scale. They are actually deriving cassava meal out of it.*

Findings show that farmers are not only relying on primary processing but are engaging in secondary value addition processes in coming up with unique products. The aspect of blending cassava and maize to produce a meal is novelty and in line with the consumer's demand for natural food systems according to Waterschoot *et al.* (2015). The process does not only guarantee convenience but also enables one to create various baked products that are appealing to both local and international consumers. Complimenting maize with cassava enhances nutritional content and processing cassava reduces its toxicity, making it much safer to consume. However, value addition of cassava in Rusape is done using traditional methods which can be laborious and time

consuming. Given the opportunity to engage with food processors, this initiative will go a long way as far as optimizing healthy indigenous root vegetable consumption is concerned.

6.2.1.2 Yam flour

A new product can be developed using Yam. Findings unveiled that farmers and other consumers are deriving flour from yams. A 33-year-old from Mabvuwa village said,

> *My children are too choosy, when you continuously give them bread made from wheat or soya beans, they end up leaving it untouched. So sometimes I just dry my yams, pound, and sieve and derive flour. So sometimes I use yam flour and sometimes these ordinary flours. When I do that, they usually eat without complaining.*

Another 65-year-old housewife from Muteweyi village expressed her concern over the dietary habits of her children and said;

> *We remove the outer layer of the yam, use a grater in peeling it into thin slices, then sun-dry and use grindstones to mill the sliced yam to obtain the powder we use to prepare sadza. Sadza made from yam is nice, I enjoy it. I can also use it in baking bread.*

These findings show that small scale farmers and consumers are cognisant of primary and secondary value addition processes. Shared experience on pounding highlights the significance of traditional processing methods in promoting consumption especially in rural settings. Findings on pounding concur with Jeannette *et al.* (2020) who indicated that pounded yam is preferred for its elasticity, softness and texture than boiled yam. Jeannette (2020) further notes that pounding is partly a solution to challenges associated with technology adoption. This view is true, relating to the majority of Zimbabwean rural communities who often rely on traditional ways of processing foods due to lack of modern equipment. Like what is being done in Ghana and Nigeria (Boakye, Wireko-Manu *et al.*, 2018; Ferraro *et al.*, 2016), Zimbabwean communities can also upscale their production to meet the current quest for novel products. Although manual pounding plays a central role in rural settings, it is too laborious and is prone to contaminants and other foreign products that can hinder the overall benefits of consuming it as expressed in a study conducted by (Mazike *et al*., 2023). Therefore, there is a need to merge indigenous knowledge with modern ways of grinding for enhanced quality products.

6.2.1.3 Fermented traditional drink

Interestingly an aspect of fermentation, a process that obtains energy from carbohydrates in the absence of oxygen was unveiled. Fermentation is one of the olden ways of adding value that is still prominent in the present era. A 75-year-old widow from Kamba village brought up the insight and said,

> *Some of these indigenous roots work interestingly. Do you know these roots, dwarf babiana and ndekede? They are used to prepare maheu. You uproot your plant, remove the outer layer, crush the root then add the paste to your thin porridge. Those plants act as leavening agents. They work the same way as chimera. You can use them either fresh or dried.*

Another 72-year-old widow from Mutenure village shared a related sentiment and said;

> *Things have changed. Back then, we used to rely on mugwira whenever we wanted to prepare maheu. With time, things are changing, only a few still use it. No one seems to care or give attention to these methods. I think it is because generations are changing.*

Taking a closer analysis, dwarf babiana and *mugwira* function as natural fermenting agents, possessing a similar catalytic role as malt. These native roots enhance texture and taste, creating a refreshing indigenous experience. The process does not only enhance organoleptic properties but also the nutritional value as fermentation increases growth and intake of helpful micro-organisms. *Mugwira* can be used either fresh or dried, indicating its versatility in value addition. It is also worth noting that fermented products are functional foods as they offer probiotics, which are key in overall human health and wellness sustenance. Indigenous knowledge on this native root reduces dependency on commercial leavening agents that may have side effects. Therefore, encouraging local farmers to preserve and cultivate this native plant can greatly contribute to food security as well as community-based food businesses. Apart from local consumption, marketing *mugwira* based *maheu* as an authentic natural drink alternative to our usual malt with an emphasis on health and wellness benefits, can attract broader markets. Integrating discussed aspects can take indigenous food-based consumption a long way without forgetting positive results on human health and wellness sustenance. In embracing the positive attributes of this native root vegetable, benefits attached to dwarf babiana are represented in the following figure;

Figure 6.1 Benefits attached to Dwarf Babiana Traditional drink

The diagram above illustrates a range of advantages and opportunities that could arise if the idea of effectively producing dwarf babiana or *mugwira* drink is realized. Research findings indicate that rural communities possess rich indigenous knowledge that can be harnessed to meet current consumer needs. However, the identification of scientific names and evidence to validate claims about these IRVs is still necessary. Combining traditional knowledge with modern food processing can attract a wide array of consumers, enhancing consumption for health and wellness sustainability.

6.2.2 Culinary innovations

Findings evidenced that consumption of IRVs is often neglected especially by young consumers. Bearing this in mind, communities are trying to cook the same food differently so as to enhance

consumption. Under this broad theme, techniques that are currently used in adding value to root vegetables are unfolded below.

6.2.2.1 Sweet potato porridge

Apart from the ordinary methods of cooking, findings indicate that people are coming up with interesting methods of cooking that enhance the overall appeal of the often looked down upon IRVs. With respect to culinary innovations, a 55-year-old lady from Kamba village said, "*We prepare nhopi yembambaira (sweet potato porridge). We use any type, boil till tender, mash it then add peanut butter".*

Another 52-year-old farmer from Nyandowe village shared a similar response and said,

> *Eating just boiled sweet potatoes with tea can be boring so at times we prepare nhopi yembambaira (sweet potatoes in peanut butter sauce). What we do is we peel the skin then boil till it is tender and mash it the same way we do with mashed potatoes. When all lumps are broken you then add peanut butter or milk depending on what you like. You can also add both. This way I tell you, no one will reject the meal. The porridge tastes very nice, my children love it.*

Shared sentiments indicate the importance of coming up with new methods of cooking to increase consumption. Making porridge out of sweet potatoes does not only increase taste, appearance and palatability but also guarantee rich nutrients due to the incorporation of peanut butter and milk. Findings on gastronomy and culinary innovations resonates with Guiné *et al.* (2021) who postulated that the food industries that are developing new products out of indigenous foods in line with modern trends are able to conquer today's consumers, while at the same time maintaining the cultural identity of specific products that are valued as traditional. Moreover, there is great potential for producing sweet potato porridge as an instant or premix, targeting modern day. Ready-to-eat sweet potato in peanut butter porridge is an example of a product that can be packaged and commercialised. These sentiments also concur with Nayak *et al.* (2025) who posited that diversifying root vegetables creates a huge market share for food processors and increases customer possibilities. All being said, one can recommend upscaling the production and processing of sweet potato porridge targeting the modern-day generation. This goal is feasible and can be easily adopted by Zimbabwean farmers since all ingredients needed are readily available.

6.2.2.2 Fried yam

Apart from sweet potato innovations, communities are preparing yams using modern techniques to enhance consumption. In response to interviews a 33-year-old man from Mabvuwa village said,

> *To increase consumption of yams, especially by children and youngsters we peel the outer layer, boil with salt, cut into slices and fry in oil. They will like them. You can also coat with flour and fry in oil; by doing this, the children will increase their acceptance.*

Similarly, a 65-year-old lady from Mugari village said,

> *…us the elderly people are not that picky but for the sake of these children we sometimes spice up these vegetables so that they can eat. With yams, when preparing their lunchboxes I boil with salt till they are tender. I make sure not to overcook them, then set them aside to cool. After some minutes I then cut into thin round slices then coat with eggs and a little bit of flour then fry in oil. They will taste good and I also discovered that my chidren like them when fried.*

Findings indicate that the present-day generation is looking for novelty, convenience, eye catching and mouth-watering foods. From a social scientist's perspective, adapting to modern culinary techniques is a key way to catch the attention of modern-day consumers. Failure to adjust to their preferences may mean zero intake amongst the youngsters. This technique of coating increases palatability which will in turn increase the quest to eat more. Coating with eggs also enhances protein availability and other essential nutrients like riboflavin and minerals which contribute to overall health. The process also reduces the need for too much oil which is one of the food commodities that is associated with controversy when it comes to human well-being. Therefore, one can safely say that value addition of IRVs to increase consumption is actually a need especially among the current generation These findings are in tandem with Guiné et al., (2020) who posited that modern lifestyles and changes in dietary habits are increasing the demand for a year-round supply of innovative food products and indigenous foods are not an exception. With regards to this, one can recommend the incorporation of modern ways of cooking in preparing traditional foods so as to cater for current needs of consumers. Failure to adjust may result in total neglect which will then have a negative impact on consumption and one's well-being.

6.2.2.3 Yam/ sweet potatoes in tomato and onion sauce

Apart from using eggs and oil, findings indicate the incorporation of tomato and onions in yams and sweet potatoes. With regards to this cooking methods, a 36-year-old commercial farmer from Mudonhi village said,

> *As you can see in rural areas people may be forced to consume these root vegetables day after day not because they like but because that is what will be available. We usually boil but eating boiled sweet potatoes day after day can be boring, so we sometimes boil then add tomatoes and onions so that the meal can look different. This recipe attracts children. You can also peel your yams, boil, then add tomatoes and onions, you will like them.*

Another 45-year-old peasant farmer from Muswere village shared a similar sentiment and said,

> *Sweet potatoes can be cooked the same way you do with potatoes. If you add tomatoes and onions these children will improve the way they eat. In the same way, yams can also be cooked by adding tomatoes and onions. If you want your children to eat then add these soups.*

Findings indicate that children and youngsters are the major groups who often under consumed IRVs when prepared using the ordinary way of boiling. With regards to that, their parents are running around trying to present the same food in a different way. The use of tomatoes and onions in cooking yams and sweet potatoes is an imitation of the traditional way of cooking potatoes. Due to the fact that children love potatoes more than what they do with sweet potatoes, parents are trying to manipulate what they have to suit their preferences. Adding tomatoes and onions do not only enhance organoleptic properties but also add the nutritional value of a meal, making it more functional or beneficial to one's well-being. The method of adding tomatoes and onions is usually used in Nigeria . Lawal *et al.*, 2012), and its continuous application may mean that it is admired. Apart from yams, cassava is also being value added.

6.2.2.4 Cassava in cowpeas

Cassava is starch based. Findings indicate the incorporation of protein-based foods in complementing other missing nutrients. One of the key informants from Chikono village who once worked under a certain non-governmental organisation that promotes value addition, health and nutrition said;

> *Cassava contains a lot of carbohydrates and very low protein. When we cook it we also need to bear the aspect of a balanced diet, especially looking at our children. We need to make sure that what they eat is beneficial, they still need to grow. Since you know that cassava is limited in terms of proteins, we usually complement it with cowpeas. We peel our cassava to remove the skin, divide it into two to remove that root found at the core of cassava, then boil together with cowpeas. This dish tastes good and it's guaranteed that the meal will be more nutritious than just boiled cassava.*

Another participant from Sabhabha village also said;

> *I prefer adding cowpeas to my cassava when cooking. This method is not so common but some of us know it. So, make sure that you peel the skin and remove that inner root found at the core of the tuber because it is poisonous. When you are done then cut into pieces of your choice, add cowpeas and sprinkle salt then boil till edible.*

From a social science perspective, these findings show the relationship between nutrition and culture. It reflects the awareness of a balanced diet, particularly on child growth and well-being. Responses also exhibit consciousness of nutritional gaps and the aspect of food pairing in enhancing nutritional value. Sentiments shared in relation to high carbohydrate and low protein are in line with Bayata (2022) who highlighted that cassava is a source of carbohydrates, protein, vitamins and minerals but its protein content could be improved by fortifying its powder with other high protein crops. Findings also unveiled the importance of removing that other root which is found at the core of the vegetable as it is deemed to be toxic. This knowledge indicates that indigenous communities are knowledgeable about the potential harm that cassava can cause if not prepared in a proper way. Toxicity in cassava resonates with findings by Ariyo *et al.* (2022). Despite this challenge, various studies indicate that proper processing such as peeling, drying and boiling, reduces this toxicity by 50% and this is considered safe for human consumption. The Quantum and Tempus theories stresses the importance of upper-tolerance-limit, a representation of maximum quantities safe for human consumption. Therefore, it is important to pay particular attention to food preparation methods to guarantee healthy eating. This being said, one can agree that consumption of cassava is not bad but excessive consumption and improper processing can impact one's wellbeing. Adding on, cassava needs to be complimented with other protein-based crops to enhance macro-nutrient availability so as to guarantee balanced diet. Innovative recipes obtained are summarized in Table 6.2 below.

Table 6.2. A summary of recipes being used in Rusape rural

Yam in tomato and onion 1. Wash yams to remove dirt 2. Peel the outer layer 3. Cut into cubes or shape of choice 4. Put to boil, Add tomatoes, onions and salt 5. Serve with tea or beverage of choice	**Fried yam** 1. Wash to remove dirt 2. Peel the skin 3. Slice into thin rings 4. Boil with salt till tender 5. Remove from stove and set aside to cool down 6. Coat with flour and eggs 7. Deep fat fry 8. Serve with protein of choice
Sweet potato chips 1. Wash to remove dirt 2. Cut into chip-sized buttons 3. Par-boil 4. Deep fat fry 5. Serve	**Sweet potato in tomato and onion** 1. Wash to remove dirt 2. Peel to remove skin 3. Add tomatoes, onions, salt and spice of choice 4. Boil till tender and edible 5. Serve
Sweet potato porridge 1. Wash to remove dirt 2. Boil till tender and remove skin 3. Cut into pieces and mash 4. Add peanut or mill or both **5.** Serve	**Cassava and cowpeas** 1. Peel the skin 2. Remove the core root (it is toxic) 3. Cut into pieces, Add cowpea, salt and boil till tender 4. Serve

6.3 Preservation techniques

Preservation of IRVs is another crucial broad theme that emerged as a value addition process. Findings indicate that people are using sun to dry cassava and sweet potatoes in coming up with flour products.

6.3.1 Sun-drying

One of the participants highlighted the importance of sun-drying IRVs in order to ensure availability throughout the year. The practice of sun-drying is rooted in cultural traditions for it has been used since ancient times to preserve and sustain food security. One of the participants said,

> "*People should be encouraged to sun-dry these vegetables so that they can get something to eat during off-season. Like we used to years ago".*

Another participant said,

"Do you know that when sweet potatoes are dried; they taste even better, they are sweeter?"

Sun-drying ensures availability all year round which in turn promotes regular consumption. It is evident that vegetables are seasonal and other people may be willing to consume them from time to time, especially the elderly, but availability can be their limiting factor. Value is added when the taste of the root vegetables changes or is enhanced as highlighted by the participant. Rural areas often encounter food shortages, relying on donor-funded food products that may not meet their requirements (Matsa *et al.*, 2023). They tend to consume not because they like because of limited choice and availability. Therefore, sun-drying can to a greater extent promote consumption especially in times of shortages.

6.3.2 Solar drying

Although traditional preservation methods still play a crucial role, some rural communities have adopted the use of contemporary drying equipment in drying vegetables. For instance, several residents who embarked on value addition initiatives are using solar dryers in drying their vegetables. Solar dryers can dry various crops, but at present, the community is mainly focusing on "leafy vegetables." This proves right the assumption that IRVs are often neglected in value addition processes as compared to their counterparts. One of the nutrition experts who worked for an NGO which promotes value addition said.

> *To preserve these vegetables, we can dry even ndekede and sweet potatoes we can dry. Now things are changing, in our ward we have a dryer that can dry a variety of vegetables. We once got engaged in value addition but we were putting much focus on leaves, the only root vegetable we looked at was beetroot.*

Since some members of the community engaged in value addition of leafy vegetables, it is also ideal to adopt the same concept in drying even wild and rarely consumed root vegetables like dwarf babiana and Livingstone potato. According to literature, solar drying not only increases shelf life but also retains and maintains nutritional and medicinal properties of vegetables. To add on, the process also maintains the colour, enhances palatability thus making it an ideal method for promoting consumption as well as health and wellness sustenance. One of the solar dryers being used by the community in drying vegetables is depicted in Figure 6.2 below.

Figure 6.2. Community solar dryer. *Primary data (March 2025)*

The adoption of solar drying in preserving and processing vegetables concurs with Tiwari (2016) who highlighted that the advancement of sun-drying is solar-drying which dries products in an enclosed system, protecting the end product from foreign objects. Taking a closer look at this assertion, it is evident that solar-drying guarantees quality, nutritious output without forgetting an aspect of medicinal value. Bearing the current generation in mind, it is ideal to adopt this technique in order to grab the attention of various consumers thus, promoting health and wellness sustenance through regular consumption. Apart from drying, pit storage is another method still practiced in preserving sweet potatoes up to the next season.

6.3.3 The pit storage

The pit method starts with digging a pit then waiting for it to dry up, lining the interior with dry ashes, putting the yield then covering with ashes again and closing the top with soil. This method is considered effective in avoiding spoilage and enhancing sweetness. However, the sweet potatoes can be affected by rainfall. One of the participants who is still practicing pit storage said,

> *To preserve sweet potatoes, you dig your pit, wait for it to dry (in winter), pour ashes, dust should rise, put your sweet potatoes and pour again ashes, close with soil and also put a metal covering on the upper surface to safeguard your sweet potatoes when people step on it. This method preserves your produce even till the next season. This method of*

preservation increases its sweetness. It may start to shoot, you just remove the shoots and put it again in the pit. However, this method can be affected if it starts to rain".

Another participant also gave a similar response and said;

To preserve sweet potatoes you dig your pit, pour ashes, put your unchipped sweet potatoes, add ashes again on top of your sweet potatoes, do not leave the pit uncovered even with a small space, close with soil. Make sure nothing steps on top of the pit. To preserve cassava, we cut into small pieces, sun-dry, mill using pestle and mortar to obtain your meal then store in a tight dry container. The drying process increases its sweetness.

Pit storage methods play a crucial role in ensuring food security across the year bearing in mind that root vegetables can easily degrade due to their high-water content. It is also key to note and applaud for the indigenous knowledge and novelty embedded within communities. Communities through trial-and-error methods, discovered this unique technique which can preserve a highly perishable commodity till the next season. The use of ashes as a preservative resembles rich cultural knowledge that can be scientifically proven. According to Mutandwa and Gadzirayi (2007) this technique is widely used in African countries. Despite its importance, this technique is heavily affected by rain and animals. These challenges limit its applicability in different climate regions hence the need to find a versatile alternative or to modernise it. Although value addition is crucial in optimizing indigenous root vegetable consumption, it was prudent to unveil its effects on nutritional and medicinal value.

6.4 Effects indigenous root vegetable value addition processes on nutritional and medicinal value

Collection of methods used to convert uncooked materials into edible substances is called food processing (Singh *et al.,* 2023) or any deliberate change in food substances that occurs before it is available for consumption (Kushwaha *et al.*, 2021). Under this section, all changes that can be made on a raw root vegetable are viewed as processing.

6.4.1 Increase of nutrients

One of the participants stated that nutrients will increase when foods are combined. The participant said,

"I believe that adding tomatoes and onions to yams increases the nutrients and is beneficial to one's health".

Another participant also said,

It depends on the level of processing and methods used. Minimum processing backed up by fortification can enhance nutrients. For instance, if you blend yam with another root vegetable it's definite that nutrients will increase.

Responses given emphasize the idea that a product's nutritional value can be increased by combining multiple ingredients. This is consistent with the idea of food interaction, which states that combining different foods improves the absorption and bioavailability of nutrients. For example, onions have many antioxidants and sulphur compounds and tomatoes are high in lycopene which play a central role in wellbeing (Pérez-Jiménez *et al.*, 2010). These combinations have the potential to enhance general health and wellness, especially in traditional diets.

6.4.2 Loss of nutrients

Although other responses were positive about value addition, some participants indicated that nutrients will be lost. One of the participants said;

"Generally unprocessed food is better than processed food. Compare processed maize meal with roller meal!"

In-line with this view, another participant also said,

Raw foods are more nutritious and have more health benefits. Indigenous uncooked root vegetables provide long-lasting energy and promote overall strength as evidenced by cattle herders who would not carry lunch-boxes knowing that they will eat from the forests.

Shared sentiments are true to a certain degree for there is a need to have a balanced view. The belief that nutrients are lost concur with studies which suggest that unprocessed foods carry more nutritive value than the processed. Likewise, some indigenous plants are heat sensitive and exposure to high temperatures can affect nutrient content (Popkin *et al.*, 2020). Nutrients like vitamins can be leached out of vegetables but other processes can reduce the toxicity level, making food safer to consume (for example the toxicity of cassava can be reduced by peeling the outer layer). Processing methods like fermenting, pasteurizing, drying, adding sugar and salt can

decrease pathogen growth and development. Heat treatments such as drying and boiling prevents food borne illnesses associated with consuming raw vegetables.

6.4.3 Nutrient retention

Although one of the participants who is a nutrition expert highlighted the negative effects of processing and said,

> "*We may not get 100% nutrients by processing but we are assured that we retain major nutrients"*

Another participant also said,

> "*If you dry well your cassava, nutrients will be maintained. Glucose increases".*

Responses show that people acknowledge that food processing can lead to some nutrient loss but proper methods can help retain or maintain key nutrients. An example given was of drying cassava appropriately and the process is said to help in maintaining nutrients as well as increasing glucose content. This sentiment concur with Leakey *et al.* (2021) who posited that sun-drying and fermentation play a pivotal role in preserving nutrients while increasing digestibility and energy content. However, it is crucial to note that too much and improper processing such as exposing food to contaminants, refining and overcooking can cause significant nutrient loss.

Generally, research findings give emphasis to the significance of raw or minimally processed vegetables in promoting health and wellness sustenance. IRVs especially those obtained from forests are valued for their ability to give energy when away from home and maintaining overall human health. These insights align with the current global promotion initiative towards sustainable, nutrient dense and plant based foods in fighting the rise in non-communicable diseases (Gur *et al*., 2018). Although participants acknowledge the fact that nutrients can be lost through processing, they emphasize that proper methods can ease these effects. This then reflects the need for training on traditional and modern food processing practices that maintain nutritional worth, safety as well as convenience.

6.5 Other techniques to increase indigenous root vegetable consumption

The quest to know what can be done to optimize indigenous root vegetable consumption prompted this study to search for more answers. This section presents findings on what the community thinks can promote consumption leading to better health and wellness sustenance.

6.5.1 Product diversification

Participants suggested product innovation as a way to increase the consumption of IRVs like *dwarf babiana* and tiger nut. One of the participants said,

> "*For example, we can have dwarf babiana drink, consumers will now consume it in the form of a drink. For instance, ginger has been infused in some beers so we can do the same with dwarf babiana".*

Another responded gave a similar response and said,

> "*To increase consumption, you can process these native root vegetables"*.

These foods can reach a wider market by developing innovative products like drinks or processed substitutes, especially for younger consumers and those unfamiliar with native foods. In order to satisfy changing consumer preferences, traditional ingredients are being reformulated into contemporary, convenient products, which is in line with global trends in food innovation and transformation (Kennedy *et al.*, 2021). For instance, transforming root vegetables into beverages and snacks can increase their availability, and appeal to contemporary markets. The gap between traditional and modern diets can be closed with the aid of product innovation. Native vegetables can draw in younger and health-conscious customers by being reimagined as functional foods. For instance, fortified dwarf babiana drinks could satisfy consumers' convenience-driven needs while simultaneously providing vital nutrients. This strategy is in line with the rising demand for functional foods that go beyond simple nourishment to support health (Singh *et al.*, 2021). To add on, gastronomic evolution emphasizes the need to preserve culinary heritage while embracing innovation and sustainability (Rajan, 2023). Creation of indigenous based drinks highlights the significance of tradition and innovation coexisting in the development of a diverse and vibrant gastronomic world.

6.5.2 Packaging

Packaging plays a crucial role in attracting consumers. One of the participants said,

> "*We can package these vegetables. For example, these days you can find packaged Livingstone potato*.

Apart from packaging, another participant said,

> "*I think it will work if these foods can be found in supermarkets. This way a lot of people can have access".*

Key elements that can boost consumption include better packaging and the availability of local root vegetables in retail establishments like supermarkets. In addition to maintaining freshness, packaging increases marketability and convenience. Vegetables that are vacuum-sealed or pre-washed, for instance, appeal more to urban consumers who value convenience. In addition to packaging, the availability of supermarkets which sell IRVs makes these vegetables more accessible, particularly to populations that might not cultivate them. Appropriate packaging and distribution methods can have a big impact on dietary choices, increasing accessibility and consumption of indigenous foods (Monteiro et al 2019). The concept of packaging also resonates with the tenth step on the Quantum and Tempus Theory which emphasize packaging and branding to inform consumers on the most effective way to consume the product. However, a study by van Herpen *et al.* (2016) in the Netherlands revealed that consumers prefer unpacked organic vegetables over the packaged ones. This indicates differences in consumer choice, hence the need to do market research, unveiling the needs of different consumers.

6.5.3 Community education and awareness

Awareness plays a crucial role in dietary behaviours. One of the participants said,

> "*I think it will help us if you educate the community on the importance of consuming root vegetables".*

Another participant who is also a nutrition expert said,

> *I think if you inform the consumers on medicinal and other benefits of root vegetables then they will consume". Some of our children do not even know these plants so if you educate them, some of them will actually appreciate it. What you're doing you're researching. Yes you're*

learning but you're also reminding us and teaching us the importance of resorting back to our ancient foods. So, imagine if you spread this knowledge to this whole community, you will definitely find 5 people who will decide and say I now want to resort back to such foods. Yes, some may take time to adjust but when they see that their peers are actually benefiting from consuming these roots then they will follow suit. I think that what you're doing, the data that you're collecting …. if documented and implemented, can help raise awareness. Do your research and come back to the community and educate them.

Research findings indicate the necessity of community education. Participants believe that IRVs can restore their value and attention back by educating the community, especially the younger generation on health and wellness benefits that can be derived from regular consumption. One of the responses indicated that some children do not even know these vegetables. This shared sentiment concur with studies which pointed out an issue of indigenous knowledge erosion among younger generations (Sur et *al.*, 2015; Shelembe *et al.*, 2024). This knowledge can be restored back by documenting what is known and having awareness campaigns as proposed by one of the participants.

Optimizing the consumption of IRVs requires education campaigns that highlight their nutritional and therapeutic advantages. Both urban and rural populations should be the target of these campaigns, with an emphasis on younger generations who might not have had as much exposure to these foods. Information can be effectively distributed through media outlets, community gatherings, and schools as posited in the Quantum and Tempus theories. A study by Fanzo *et al.* (2021) have demonstrated that nutrition education that is culturally can result in long-lasting dietary modifications and better health outcomes. Fuhrman (2018) postulated that if consumers have no access to good information on healthy eating, they will eat whatever they feel like eating. The more knowledge they get, the more they become willing to adopt better decisions. This shows the importance of imparting consumers with knowledge in making informed decisions.

6.5.4 Leveraging social influence and behaviour change

According to the Theory of Planned Behaviour, dietary behaviour can be influenced by those who are around us. People can learn to eat healthy if their peers are doing the same. Among participants, one of them said,

> *"If documented and implemented, the research that you are doing can help raise awareness... Some may take time to adjust, but when they see that their peers are benefiting, they will follow suit."*

Social proof plays an important role in dietary decisions, as evidenced by the notion that people can pay attention to eating IRVs when they see favourable results among their peers. It has been validated that community-based interventions and peer influence are effective ways to encourage healthier eating habits (Cruwys *et al.*, 2015). Demand may be further increased by campaigns involving influencers, community leaders, or testimonies from people who have benefited from eating traditional vegetables, as supported by the Health Belief Model. Peer pressure and social proof are powerful tools for promoting dietary changes. Broader adoption may be sparked by community-based initiatives that highlight the advantages of eating traditional vegetables, such as increased energy or a lower risk of illness. This is in line with behaviour change theories, which stress the significance of social norms and observational learning in shaping personal decisions.

6.5.5 Promoting Cultivation and establishing a ready market

Participants pointed out the aspect promoting the cultivation of IRVs among rural dwellers. The rate at which people used to cultivate and the current scenario are now different. With the availability of substitutes like bread and pasta, consumers are no longer investing much into farming, and this has also affected consumption patterns. Apart from cultivation, participants feel that marketing and promoting native root vegetables can bring these foods closer to consumers and increase their intake. One of the key informants who embarked on indigenous tree planting emphasized the need to promote native root vegetables and said,

> *People might be willing to cultivate IRVs but the challenge is that these crops seem to lack support as well as a ready market. It becomes easy and motivating if a farmer knows that soon after harvesting a hectare of Livingstone potato, Company A or B will buy all my produce. But currently, you may struggle to sell your produce if you put a huge investment on that.*

Although this participant is not cultivating any root vegetable at present, an indigenous tree planting initiative has been embarked on. The initiative is presented in Figure. 6.3

Figure. 6.3. Indigenous fruit tree growing initiative by the village head. *Photo*

It is evident that currently, there are no markets that are effectively advertising and promoting IRVs. In Zimbabwe the common root vegetables found on markets are sweet potatoes, yams and at times cassava in small quantities. Livingstone potato can be found once in a while and the rest of the unmentioned vegetables are not present in the market. This scenario reveals a gap that needs to be bridged, bringing native foods close to consumers. For instance, tiger nuts in Zimbabwe are considered as weeds to a greater extent and farmers are actually running around trying to find the best methods to eliminate it. Although its value is not yet appreciated by the majority, other countries are actually cultivating it at a commercial level to produce flour, flour products, pharmaceutical products and beverages. Therefore, encouraging cultivation and increasing awareness on the benefits of using these IRVs is essential for behaviour change. FAO (2021) stresses the importance of community-based interventions, such as in endorsing indigenous crop cultivation and consumption.

6.5.6 Targeting younger generations and knowledge transmission

Concerns about younger generations losing knowledge of indigenous foods indicate the risk of cultural degradation. Participants emphasized the significance of educating youngsters about these vegetables, including their nutritional value and traditional preparation methods. This implies that awareness campaigns or school-based programs may play a role in restoring indigenous food culture. One of the participants said,

> *"We need to expose these vegetables to the younger generation because some do not even know. Knowledge is diminishing among them".*

Another participant also said,

> *The present-day generation does not know native root vegetables. They are much more aware of sweet potatoes, cassava and yams because people cultivate and consume them better than other species. If you ask this child to show you tiger-nuts or other root vegetables that grow naturally, haaa; they will not be able to do so. I think it's because we are no longer teaching or showing them. What we used to do is slowly fading away.*

Sentiments shared reflect the importance of educating the younger generation about indigenous food knowledge. This observation is key as various scholars concur that indigenous knowledge among the younger generation is on the decline in various countries (Shukla & Ramchandra, 2021; Sur *et al.*, 2015). With regards to this, it is vital to disseminate indigenous knowledge to the present generation using both word of mouth and documentation. However, other participants indicate the need to use coercion.

6.5.7 Coercion

Other participants suggest that parents need to enforce consumption by providing limited food choices, the voice was captured saying, *"To increase acceptance and consumption, parents especially mothers need to be helped. Children should not be selective, they should eat that which is available"* and another participant also said,

> *To increase consumption among the children, haa. you force them. You just cook that whatever is available. If the child doesn't want to eat then he/she will spend the whole day with a hungry stomach. The following day he/she will eat.*

The shared sentiments on food choices can be proven by Haines *et al.* (2019) who postulated that children worldwide learn eating habits from their parents, caregivers and peers. The author added that parents usually struggle to establish healthy eating habits in their children due to modern life pressures. Developing a habit of healthy eating among children can both educate them on its advantages and increase consumption.

6.6 Chapter summary

This chapter presented and analysed findings on value addition processes being done in Rusape, Makoni District. Findings indicated main reliance on traditional value addition processes, which are sun-drying, pit storage (to extend shelf life), pounding, milling, and fermentation. Although traditional methods are dominant, the use of solar drying was also observed, indicating a slight

adaptation to current trends. However, at present, solar dryers are being used to dry leafy vegetables. Culinary innovations and their respective recipes were observed. Findings also indicated mixed opinions on vegetable processing, where others are in favour of unprocessed vegetables, and others prefer processed vegetables for health reasons. The chapter lastly looked at other techniques that can be adopted to increase indigenous root vegetable consumption. The next chapter is on factors affecting value addition

CHAPTER 7
CHALLENGES AND OPPORTUNITIES FOR INDIGENOUS ROOT VEGETABLE VALUE ADDITION PROCESSES IN RUSAPE

7.1 Introduction

The preceding chapter presented findings on value addition processes that can be used to optimize indigenous root vegetable consumption for health and wellness sustenance. The main objective of this study was to explore value addition processes to optimize indigenous root vegetable consumption for sustaining health and wellness in Zimbabwe. Specifically, the study sought to: Explore indigenous root vegetables that are consumed for health and wellness sustenance in Rusape; Determine value addition processes for optimizing indigenous root vegetables consumption in Rusape; Evaluate challenges and opportunities for value addition processes of indigenous root vegetables in Rusape and lastly to recommend value addition processes to optimize indigenous root vegetable consumption for health and wellness sustenance in Rusape. This section evaluates factors affecting value addition processes for IRVs in Rusape. Research findings reveal several interrelated factors that are presented in Table 7.1 below.

Table7.1. Themes that emerged under challenges and opportunities

Major themes	Sub-themes
Challenges	➢ Economic and market-related ➢ Technological ➢ Environmental
Opportunities	➢ Untapped market ➢ The quest for healthier diets ➢ The rise of gastronomy initiatives ➢ The demand for gluten-free products

7.2 Challenges affecting value addition processes

Value addition of IRVs is key in optimizing consumption for health and wellness sustenance; however, there are challenges along the way. This section presents market and economic-related challenges, technological, environmental and cultural challenges.

7.2.1 Economic and market related challenges

Participants highlighted the impact of the current economy on value addition and agronomic activities. One of the farmers said,

"The industry is dead, there is no ready market for IRVs".

Another participant expressed serious concern and said,

> *I wish these vegetables were given the same value as what happens with potatoes. If you invest in potato farming, companies will certainly buy from you, plus they pay better than selling in vegetable markets like Mbare. Maybe it is because these companies will later use these potatoes in manufacturing products like crisps. The challenge comes with our IRVs; when you intensively invest in them, you may not get much profit. Plus, you will be selling your produce directly to customers. They buy in small quantities, and they normally pay less.*

These shared sentiments show the importance of having industries that process IRVs, like what happens with potato farmers. Potato farmers have an established value chain, they know that they can distribute their produce to companies like Cairns Foods and Hanawa Super Foods at a better price. Unlike the indigenous root vegetable market, companies that can buy seem to be paying attention or showing interest. Aspects of constrained value chains concur with Elolu *et al.* (2023), who indicated that African indigenous vegetable (AIV) value chains are limited and require development. Establishing an effective value chain will promote cultivation, production, value addition, consumption, employment creation, and even have a positive impact on human well-being. The big picture emerging is the limited industry that buys IRVs for further processing, like what happens with exotic species. This limitation then imposes the burden to small scale farmers as they rely on low capital to run their operations.

In an effort to have a balanced view, an expert in food processing from a certain company said;

> *Yes, apparently nothing is being done using IRVs. But we have embarked on value addition of sorghum to produce cereals. The research and development department has not been looking at this area but rather investigating what they already have and ways to improve what the company is already processing. However, the rising government initiative to incorporate indigenous foods is now pushing us to adjust.*

Another expert in food processing from a different company said;

> *At this company we do not produce anything from IRVs because this is a white owned company. Our basic ingredient in this factory is flour but we only use flour derived from wheat. We actually import the wheat that we use from countries like South Africa, Canada, Latvia, Lithuania, Australia, and Russia because that which is produced in Zimbabwe does not conform to the required standard. This is because wheat is a cool-season crop,*

Zimbabwean temperatures are usually high so this affects its quality. Given these quality checks, the use of flours made from IRVs is far from reality but it can be feasible if a multi-disciplinary approach is considered. However, I know of a certain company that just started commercializing sweet potato flour.

Findings from food processing experts indicate that little is being done with IRVs as far as value addition is concerned. Evidence shows that IRVs are often ignored in favour of other vegetable plant parts, proving right the assumption that they are often neglected. These findings resonate with Nayak *et al.* (2025), who indicated that root crops globally are facing low production, insufficient value addition, weak market access, insufficient market research, and minimal marketing efforts. Nayak *et al.* (2025) added that a comprehensive manufacturing, processing, and marketing plan is required to increase consumption. The big picture emerging from the findings is limited value addition of IRVs by food processing companies due to adherence to certain company standards, as well as limited research by the research and development departments. Therefore, more needs to be done to encourage food processors to consider IRVs in their production lines.

7.2.2 Technological challenges

Technology can cover up challenges that can be encountered when using traditional methods. Under this broad theme emerged lack of specialised equipment as well as the use of fertilizers.

7.2.2.1 Lack of specialised equipment

The need for specialised equipment to facilitate value addition processes is critical.

One of the small-scale farmers from Sabhabha village said,

It is expensive to process these vegetables. You need special equipment and knowledge on how to use the equipment. The methods we use here are demanding. They take time plus they require many conditions.

Another participant from Mutenure village also said,

We sometimes face challenges when trying to sun-dry. There is a lot of work here in the countryside, we cultivate a lot of crops and sometimes we find it challenging to devote time to sun drying. At times when you want to sun-dry you will find out that it will start to rain. However, it is very hard to keep root vegetables for longer duration, they easily go bad. It is not easy to sell IRVs to commercial markets, they do not buy from us. What they buy is garlic.

The view that value addition requires many conditions imply that processing attracts costs associated with labour, energy, packaging and distribution. Investing in specialised equipment also

adds to the financial burden. More so, small scale farmers often lack access to loans and other financial aids, which in turn force them to rely on traditional methods of processing. Findings show that rural farmers grow several crops that require their attention. Due to limited resources, they often rely on sun-drying, a value addition method that requires dedicated time and effort. Apart from time constraints, unpredictable weather usually disrupts their efforts, and lack of alternative technologies makes the drying process complicated. In rural settings, cold storages are very limited and this leads to high post-harvest losses due to the high perishability of vegetables. Singh *et al.* (2021) acknowledged the need for better processing methods, highlighting how technology may lower post-harvest losses and increase the longevity and marketability of locally grown produce. To add on, commercial markets often favour farm products with a stable supply chain, which makes it harder for smallholder farmers to participate in the value chain.

To improve an impartial standpoint, participants' voices from food processing companies were sought. One of the participants said;

> *Mechanisation is a huge factor that affects several farmers. Yes, at present this company is not using IRVs in its production lines, maybe in later times. Our products are derived from potatoes and even with these potatoes, we don't just buy. We have our suppliers who have specialised harvesting equipment that maintain the integrity of the crop. We do not compromise our standards, so we make sure that the raw materials we use are up to scratch. So, with small-scale farmers, consistency is quite challenging because they often rely on traditional methods that may affect quality at the end.*

Another respondent from a different food processing company said,

> *Machines that we use here are specifically for potatoes. Sweet potatoes will require its own machinery and this can be costly considering the start-up costs and the rate of return. So, diversification will require intensive research to do feasibility analysis before investing.*

Findings indicate that big companies pay particular attention to established standards. It is partially incorrect that companies do not want to buy produce from small scale farmers but the major issue is on quality assurance. Small scale farmers may not be able to uphold the demands of big food processing companies as they mainly rely on traditional methods of farming. In light of this, it is crucial for collaborative effort between small scale farmers and food processors. Food processors can assist farmers with mechanised inputs to ensure seamless production.

7.2.2.2The use of non-organic fertilizers

The shift away from traditional organic practices has eroded cultural heritage and local knowledge. Traditionally, farmers used to cultivate their crops using organic manures but globalisation exposed farmers to non-organic fertilizers. The quest for quick money also triggered the use of fertilizers which are deemed to be affecting the quality and cultivation of IRVs.

One of the concerned elderly farmers from Mudonhi village said,

> *The love for money has promoted the use of fertilizers (people want to commercialize). During our time, our parents could teach us not to throw away ashes but to reserve it for use when cultivating sweet potatoes. You could also find that sweet potatoes of that time were different from those that you obtain when using non-organic fertilizer. Our old ways of farming are slowly dying, farmers now need quick things so they will not have patience for the long process of using ashes. Non-organic fertilizers are not good for the soil.*

Findings indicate that traditional farming methods like growing indigenous crops using ashes, organic manure, and composts have become less common as a result of the need to commercialise within a short period. Findings also highlighted negative impacts of non-organic fertilizers on both the soil and the yield. Moreover, Manzoor *et al*. (2018) indicated that inorganic fertilizers are associated with an increased risk of cancerous outcomes. In the same vein, Ahmed *et al*. (2019) stated that prolonged application of non-organic fertilizers may speed the depletion of soil organic matter. These findings reflect the importance and need to resort to sustainable farming practices like the use of non-organic fertilizers in maintaining soil integrity and as well as guaranteeing health food outcomes (Knez *et al*., 2022). Although farmers may be interested in quick income, the use of non-organic fertilizers in cultivating organic crops seems promising in the modern day as consumers are seeking healthy foods (Gur *et al*., 2018). By adopting organic farming, farmers can tap into this niche but lucrative market. This will not only increase their earnings but maintain cultural integrity, conserve soil and guarantee healthy eating. Therefore, this study recommends farmers to resort to the use of organic fertilizers.

7.2.3 Environmental challenges

Apart from economic challenges, participants also lamented environmental hardships that they are experiencing. One of the participants from Kamba village said,

> *We used to cultivate Livingstone potato in wetlands, but now we no longer have such. Yes, we want to cultivate but due to changes in climate, we are receiving limited rains as compared to years back. But those who still have wetlands are cultivating.*

Another participant from Mutenure village said,

> *We used to cultivate these root vegetables in wetlands but right now people have built structures there. We no longer have adequate space for cultivation. Another challenge is that in this area, there is moles (nhuta) which affects the yield. The use of chemicals has affected the cultivation of root vegetables, for example tobacco farming…it uses a lot of chemicals that can affect root crops if you happen to do crop rotation.*

Environmental challenges are a recurring issue with farmers citing climate change and land use issues. Findings indicate that the conversion of wetlands to residential structures has significantly reduced the land available for cultivating root vegetables, which traditionally thrive in wetlands. The construction of structures in wetlands was also observed by Magure, Gumindoga, Makurira and Rwasoka, (2022). Moreover, the use of fertilizers and chemicals in commercial farming such as tobacco farming has degraded soil quality and reduced the nutritional value of root vegetables like sweet potatoes. Findings on the negative impacts of prolonged use of non-organic fertilizers are in line with Knez et al. (2022) and Manzoor *et al*. (2018). This being said, there is an urgent need to resort to sustainable farming practices as necessitated by the Zimbabwean government.

To sum up all negative factors affecting value addition processes, challenges in cultivation, processing, and preservation result in reduced availability and quality of these vegetables. Limited access to these nutrient-dense foods worsens malnutrition and diet-related health diseases mainly among vulnerable populations. To add on, the dilapidation of wetlands and excessive use of chemical fertilizers compromise not only value the chain of IRVs but also health and wellness sustenance and sustainable farming. Organic methods of farming and restoration of wetlands are essential elements for effective preservation of IRVs and ensuring long-term health and wellness of consumers. Addressing economic limitations to value addition is key in empowering small-scale farmers and promoting seamless access to nutritious foodstuffs. Investing in indigenous vegetable processing infrastructure or companies, training, and market access can increase farmer's disposable income and on the other hand improve the availability of IRVs for both local consumption and exportation. Reviving traditional farming and processing methods can support both cultural heritage and health outcomes.

7.3 Opportunities to Promote Value Addition Processes

Although there are quite a number of challenges along the way, other participants indicated opportunities along the value chain.

7.3.1 Untapped market

Generally, an established market for indigenous value-added products seems to be missing in Zimbabwe. One of the key informants who is an expert in nutrition said;

> *Value addition seems to be more inclined to exotic root vegetables than these indigenous varieties. Maybe I am wrong but I'm not sure if there are companies that process yams or our very own Livingstone Potato into enhanced products. If I had resources, I would start that project.*

Similarly, another headman from Mudonhi village said,

> *Children, these days are looking for convenient foods. These root vegetables take a longer time to cook so if one finds a way to minimize all that I believe we will make money. For instance, someone is earning a lot out of Kambucha drink made from ginger. Can't we do the same with these roots? I think we can also make a lot of money plus it will be a new market with no competition.*

From a business perspective, findings indicate that there is an opportunity to start businesses that process value added products made from IRVs because of demand (Kannaujia *et al*., 2019). Shared sentiments are insightful and very practical if implemented effectively. Apparently, it is true that indigenous vegetable value chains are highly constrained (Elolu *et al.*, 2023) and companies involved are more inclined to 'leafy vegetables' and other parts of the vegetable plant. It is also true that at present, companies that are processing IRVs seem to be missing. This is indeed an untapped opportunity that producers can tap into in producing unique products. The big picture emerging under this theme is the absence of indigenous root vegetable processing companies in Zimbabwe. Apart from this opportunity, the quest for healthier diets was unveiled.

7.3.2 The Quest for Healthier Diets

Indeed, consumption of IRVs at present cannot be compared to the days before the Green Revolution. Participants indicated that people are currently looking for healthier diets. With regards to this, a 58-year-old man from Mugari village said,

> *Our children like these fancy fast foods, but us grown-ups we know their impacts on our health. Nowadays, diseases like diabetes, BP, and cancer are topical and people are dying at an alarming rate. Even the youngsters are dying. So, people are running around trying*

to find ways to fight these diseases. On the radio, people are being encouraged to eat traditional foods.

In line with the previous voice, another participant said;

I love traditional food, but it's just that sometimes you will not find these foods when you need them. I prefer yam to bread because I know that if I cook them nicely and complement with my avocado, I will spend the whole day working in my field. Plus, naturally you just feel okay but with bread it's a different story. I am not saying bread is bad but I think yams are superior to bread.

Findings indicate the role of indigenous foods in the present era. Participants indicated that people are looking for healthier lifestyles to combat the rise of non-communicable diseases. The quest for healthier diets is in tandem with Rajan, (2023) who stated that consumers are gradually becoming concerned about their health and they are now paying attention to their dietary lifestyle. If consumers become aware of the health benefits of consuming a particular food, they are likely to shift their diets towards super foods as indicated by the Health Belief Model. Given that IRVs contain various bioactive compounds, they can play a huge role in combating these diseases if regularly consumed (Edo *et al*., 2023). However, the major challenge is with the younger generation which often neglect and overlook indigenous foods as inferior. This aspect then needs the adoption of contemporary cooking methods to enhance appearance, texture and even the taste. The broad picture emerging under this theme is an opportunity to invest in IRVs targeting the health-conscious consumers. This opportunity seems lucrative. Proper implementation of this idea will not only benefit those involved in production and processing but also consumers' health and wellbeing. Apart from the quest for healthier diets, the rise of gastronomy initiatives unfolded.

7.3.3 The rise in gastronomy initiatives

There is a rise in programmes that promote culinary traditions, food culture and sustainable practices. Gastronomy entails the use of modern culinary skills on traditional means in creating innovative dishes that still resemble our ethnicity. The main focus being the preservation of local cuisines, supporting small scale farmers, communities and promoting food tourism. With regards to this a 65-year lady from one village said,

What you are currently doing is close to what Amai Mnangagwa is doing. This coming week we might go for traditional cook-outs. This is my second time participating in this event. We will be showcasing our cooking skills and this is indeed helping us in reviving methods that we had left behind in favour of modern ways. These events enable you to learn

a lot from others, you also gain exposure to a lot of things that we had not known in our lives. You also travel places especially when you are outstanding in what you do.

Another respondent from Kamba village said,

These days' people are coming up with nice food made from traditional foods. People used to neglect mawuyu (Baobab) but this company processed it in a way that people now love it (Baobab juice). Kambucha and Ginger maheu are now on the market. People are modifying these indigenous foods and they are being loved by our children and even adults.

Findings indicate that the rise of gastronomy initiatives is an opportunity to embark on value addition. This is a new but very promising initiative that is currently reviving culinary skills that were about to die. The innovation part works hand in hand with value addition. These initiatives do not only promote local dishes but also promote food tourism as postulated by Rajan, (2023). This being said, one can agree that investing in the value addition of IRVs can attract gastronomy tourists and other interested stakeholders willing to taste new foods.

7.3.4 The Demand for Gluten-Free Products

At present, consumer demand for gluten free products is on the rise. This indicates an opportunity one can exploit using IRVs. An expert in food processing from a renowned company said;

Root crops like sweet potatoes, yams and cassava are gluten free. We sometimes receive consumer concerns requesting gluten-free products but it is unfortunate that we never met these demands. So yes, producing flour and flour products from these crops can take us somewhere. Consumers are willing to do anything to safeguard their health so the price may not matter to such consumers. It's a niche market which one can make a lot out of it.

Another participant from a different food processing company said,

We sometimes receive requests on gluten-free products but it is so unfortunate that this production line only uses wheat and synthetic products.

Findings indicate that the demand for gluten free products is on the rise. However, empirical evidence indicates that currently the market is failing to meet the rising demand for gluten-free products. This shows that Zimbabwean food processors need to invest in indigenous root vegetable processing as it is one of the niche promising markets that will promote regular consumption. More so, health-conscious consumers are willing to go an extra mile when it comes to what they consume. This may also mean that price changes may not affect their buying behaviour. IRVs like cassava, sweet potatoes, yam and Livingstone potato are all gluten free (Boakye *et al*., 2018; Ferdaus *et al*., 2023). According to Alla *et al*. (2024), the significance of gluten-free products goes

beyond the medical aspect; and the growing interest in healthy lifestyles and nutrition is increasing the demand for gluten-free alternatives even by consumers with no direct medical indications. Worse with people with celiac disease, they can suffer severe health challenges from consuming even small amounts of gluten. Therefore, food processing companies need to recognise the potential of investing in these IRVs, targeting consumers who are gluten-intolerant.

7.4 Chapter Summary

This chapter presented and analysed findings on factors affecting value addition. Findings indicate that processing is being impeded by various economic, technological, environmental and cultural factors. However, the untapped niche market, the quest for healthier diets and the rise of gastronomy initiatives seems promising in creating opportunities for value added products. Findings also indicated that little is being done by renowned food processing companies, indicating a gap that needs to be bridged. The next chapter sought to recommend value addition processes that can be adopted to increase indigenous root vegetable consumption for health and wellness sustenance.

CHAPTER 8
RECOMMENDATIONS ON VALUE ADDITION PROCESSES TO OPTIMIZE INDIGENOUS ROOT VEGETABLE CONSUMPTION FOR HEALTH AND WELLNESS SUSTENANCE

8.1 Introduction

The preceding chapter assessed the challenges and opportunities affecting indigenous root vegetable value addition processes. The main objective of this study was to explore value addition processes to optimize indigenous root vegetable consumption for sustaining health and wellness in Zimbabwe. Specifically, the study sought to: Explore indigenous root vegetables that are consumed for health and wellness sustenance in Rusape; Determine value addition processes for optimizing indigenous root vegetables consumption in Rusape; Evaluate challenges and opportunities for value addition processes of indigenous root vegetables in Rusape and lastly to recommend value addition processes to optimize indigenous root vegetable consumption for health and wellness sustenance in Rusape. This chapter recommends value addition processes based on research findings and literature on objectives one (1) to three (3). The implementation of value addition processes can change IRVs from being under-consumed foods to widely consumed healthy promoting meals.

8.2 Recommended value addition processes

In this section, the following things emerged; fermentation milling, , chips and crisps processing

8.3.2 Fermentation

Fermentation is one of the oldest and economical methods of producing new foods that is being practiced in Rusape. Participants shared very insightful and interesting facts about dwarf babiana and *mugwira* in coming up with fermented beverages.

In an interview one of the participants said;

> *Mugwira and dwarf babiana (hwenya) is used to ferment traditional drinks. People used to do it but long back and it was helpful however these days it's now rare.*

An expert in food processing said;

> *Turning local root veggies into fermented foods? Yah It's a great idea for healthy eating! It makes them easier to digest, adds good bacteria, and fits right in with how people have always eaten. If it's done in a proper way, products can be sold in stores. With a bit more study and telling people the health benefits, Zimbabwe could become known for awesome, healthy foods based on our old traditions. I would love to bring back old memories in the current era!*

Considering the fact that the fermentation process is associated with improved food safety, enhanced nutritional value and enhanced organoleptic properties, (Knez *et al*., 2025) it is one of the ideal techniques one can recommend for both small-scale and commercial production to increase consumption. In relation to this technique, sweet potato fermentation has been practiced in East Asian cultures to make drinks, pastes, or pickles (Sheikha & Ray, 2017). Therefore, the same technique can be adopted in Zimbabwean context. Findings also indicate that fermentation using IRVs is a method that was once used by communities but had been declining. Since its efficacy has been noted through experience, it can be recommended to use lab based approaches in coming up with beverages of the same nature. Fermented products have an array of healthy advantages including promotion of gut health, immune system boost, minimizing heart diseases, type 2 diabetes, development of colon cancer, osteoporosis, obesity, allergies, atherosclerosis and infections (Siddiqui *et al.*, 2023). It is also evident that a number of consumers are becoming health conscious, seeking healthy plant-based-diets (Gur *et al*., 2018), fermented traditional drinks can be widely accepted.

8.3.3 Milling flour products

Findings indicate the aspect of milling flour products from IRVs such as sweet potatoes, cassava and yams.

In an interview, one of the respondents who was a small-scale farmer said;

> *Turning sweet potatoes and cassava into flour has been helpful. Now, it's not just boiling or roasting; we're baking bread, making porridge that children love. The flour lasts longer, which really helps when fresh roots are hard to find in the dry season. More training and better equipment? That could really lift up families, both financially and health-wise.*

Another respondent who was a food processing expert shared a similar opinion and said;

Drying and milling yams, sweet potatoes and cassava into flour is a game-changer for handling IRVs after harvest. It opens up a bunch of new ways to these crops - think bread, porridge, and even adding extra nutrients to baked products. Plus, it helps them last longer and cuts down on post-harvest loses. Looking at the bigger food picture, using flour offers simple answers for improving nutrition, especially where it doesn't rain much. Investing in local milling and training people to process the crops could kick-start small businesses in the country and make sure societies have a better variety of food to eat all over Zimbabwe.

Findings indicate the possibility of drying various IRVs in coming up with flour products. In countries like Nigeria and Ghana, flour and flour products are being produced (Nanbol & Namo, 2019). Milling is one of the processes that is widely used in rural settings, but mainly on grains. The same concept that is applied in coming up with maize meal and sorghum meal can also be adopted in coming up with cassava and yam or Livingstone potato meal. Flour obtained can be used in cooking various dishes. Milling equipment is common and can be afforded by smallholder farmers, making the production process easy. The availability of nutrition experts in the community is a stepping stone when it comes to health and safe food production. Flour products are easy to transport and sell to commercial markets, thus enhancing convenience and availability all year round. This process can also encourage farmers to intensively engage in large commercial farming due to the establishment of a ready market, thus upholding living standards. Since milling of IRVs in Rusape is currently practiced at household level, investing small-scale businesses that process IRVs can be recommended.

8.3.4 Chips and crisps processing

The quest for ready-to-eat foods among the young generation requires attention. It is better for children to consume IRVs in the form of a snack than not consuming at all.

One of the participants who was a farmer said;

I like the idea of making chips. It's an easy one, my children likes eating yams in form of chips as compared to the boiled

A food processing expert said;

Making snack foods, like sweet potato or Livingstone potato chips is a good way to get into the snack market that's growing fast. These kinds of snacks are not too hard to make. If people are taught how add flavours and packaging well, they can make snacks that people in cities will like, while also promoting local farmers. This is also a good chance to grow this minimally tapped market. I think ready-to-eat snack products made from Zimbabwe's IRVs can be recommended.

At present, commercial processors that derive snacks from IRVs seem to be missing in Zimbabwe. With regards to this, findings indicated that farmers and food processors can integrate and produce value-added chips and crisps out of Livingstone potato, yam and cassava. The production of chips has been noted in India (Thirumdasu, 2018). Therefore, value addition stakeholders can be recommend to adopt the same technique using IRVs in Zimbabwe. This initiative will not only attract young consumers but also uphold IRVs by bringing them to the map where local and international markets can appreciate Cereda *et al*. (2024). More so, communities will take pride in their traditional foods, encouraging them to embark on increased production to meet a rise in demand for local foods. This process can also have a direct positive impact on lifestyles, disposable income and the economy at large.

8.3.5 Flaking

Flaking is another value addition process that emerged among respondents. In line with this, one of the food processing expert had this to say;

To increase IRV intake and market viability of yam, cassava, and sweet potatoes, I do recommend the development of flake-based products. This process do not only increases shelf life but also reduces post-harvest losses. IRVs have high water content, they easily go bad because of that. Production of flakes can help in meeting consumer demand for convenient but healthy foods. Flakes derived can be used as porridge or in baking mixes.

In line with flacking, another respondent said;

From a value addition perspective, flakes can offer practical solution especially for children who often like ready-to-eat foods. This initiative can open up opportunities for IRV product diversification. Think of instant Livingstone potato flakes or a blend of yam and sweet potato. What is needed is to support food processor with needed equipment and training. The good thing about flaking of IRVs is that it is not just about convenience it's also about preserving cultural heritage, promoting healthy eating and income generation. With the right investment, indigenous root vegetables can move from underutilized and under consumed to increased demand.

Findings indicate that flaking emerged as a highly recommended value addition process for yam, cassava, and sweet potatoes offering both nutritional and economic benefits. Respondents also pointed out that flaking not only increase product life but also minimize post-harvest losses as due to their high water activity which is closed linked to spoilage. Findings on high water content and spoilage resonates with Thirumdasu (2018) who indicated that underground plant species have a short life span due to their high water content, hence they can easily rot and decay if not properly handled, preserved and processed for future use. Findings also indicated the growing consumer demand for convenient and healthy foods. Moreover, flakes are seen as particularly impactful for the children who favour ready-to-eat products (Mironeasa *et al*, 2023). As a gateway to product innovation, the concept of blending different IRVs was also raised. Findings emphasize the need to invest required equipment, training as well as policy support. In other countries value added products like yam and sweet potato flakes are on the market. Considering that Zimbabwe is also endowed with the same IRVs, considering this production can be recommended.

8.3.6 Instant porridge processing

Research findings indicate that communities are currently making porridge from sweet potato. However, this process is currently done at household level.

One of the commercial farmer said;

> *My family usually prepare porridge from sweet potatoes with peanut butter. I can advise one to try it. It's loved by the majority.*

A food processing expert said;

> *Porridge formulations using orange-fleshed sweet potatoes seem to be a promising initiative both nutritionally and when commercialising. Its production can be more suitable for school feeding programs, gluten-intolerant consumers and those who seek quick, convenient but healthy foodstuffs. Sweet potatoes are rich in beta-carotene, so the porridge supports vitamin A intake, which is critical in human wellbeing. Another crucial thing after processing is the right packaging and consumer awareness. I believe its production if effectively implemented can go far. Considering that sweet potatoes are easily accessible, I do recommend it.*

Findings indicate that sweet potato porridge with peanut butter is given strong cultural acceptance in Zimbabwean households, potential to build on this tradition using contemporary food processing

techniques is feasible. Insights from one of the food processing experts affirm that orange-fleshed sweet potatoes have health promoting properties (Moore, 2006), because of their high vitamin A content. At present, instant porridges in the market are mainly made of corn, bran and wheat. Therefore, considering the production of instant porridge from IRVs can be recommended both nutritional and market-wise. Findings also recommended the aspect of proper packaging and consumer education to foster consumption in line with findings by Monteiro *et al* (2019). Therefore, these findings mean that aligning preferences for an indigenous touch and nutritional aspects, instant sweet potato porridge with peanut butter can serve as a culturally relevant as well as commercially viable product that supports public health and agro-industrial development of locally found produce.

8.3.7 Solar drying

Solar drying also emerged as one of the value addition processes that can be used for upscaling. In line with this, one of the commercial farmer said;

> *Things are changing; the community has a solar dryer although it is currently being used to dry leafy vegetables. It can also be used to dry IRVs. Solar drying is more effective as compared to sun-drying. When it is cloudy, sun-drying can be challenging.*

One of the food processors said,

> *In my opinion and what I have seen so far solar-drying is one of the practical and cost-effective methods for drying and preserving vegetables. IRVs have high water content which increases their rate of perishability once harvested especially in areas were cold storages are not available. The use of solar dryers can reduce post-harvest losses to a greater extent while retaining or maintaining nutritional value. Dried roots can be milled into flours which can be used in producing flour based products. Access to affordable dryers, the initiative can be recommended to small-scale processors. Drying at a larger scale can also be done on the likes of yam and sweet potatoes as they can be cultivated in huge quantities.*

Findings indicate the presence of a solar dryer in the community. This shows a shift towards better advanced food preservation technique. Although solar-dryers are currently being used mainly to dry leafy vegetables, its potential application to IRVs can be recommended due to its practicality. Findings also highlighted limitations with the use of traditional sun-drying during cloudy weather, solar-dyers minimize this challenge. Shared sentiments are in tandem with findings by Skåra *et*

al. (2023) who postulated that solar dryers overcome challenges faced by sun-drying. As noted by one of the food processing experts, solar dryers extend shelf life and facilitate value addition through particularly flour production. Findings also indicate that enhanced access to affordable solar dryers can facilitate large scale production and processing. Although sun-drying facilitates storage and year-round availability, it is more prone to micro-organisms, dust, insects, rodents and other contaminants hence the need to adopt safer processes. Therefore, the use of solar dryers on IRVs is recommendable.

8.3.8 Branding and packaging

Branding and packaging emerged as priorities when adding value. In line with this, one of the commercial farmer said;

> *Relating with my experience with customers, branding and packaging are equally important as the product itself. Customers are lured by what they see first. If your product is smartly packaged, containing information that they may require, they buy. For instance processed yams or sweet potato with a great label that speaks out nutritional benefits and preparation methods can sell itself on the market. Good branding can easily help in positing IRV products in urban and export markets.*

Another respondent also said;

> *Branding and packaging are more than just aesthetics, they help in selling a product. The packaging needs to show the product's worth, like its nutrition and how easy it is to use. Good branding and clear labels can change how people see these local crops, making them feel more special. This matters a lot when trying to sell in stores. By investing in product design, labelling, and packaging, appearance can help these crops to be noticed and do well in the food market.*

Findings indicate that branding and packaging are key in the value addition of IRVs mainly in fostering product visibility and consumer engagement. Responses given emphasized that good packaging which contains nutritional information and preparation methods can greatly have a positive impact on consumer buying behaviour. Respondents noted that branding is not only about visual appeal but serves as a tool for communicating a product worth. The importance of branding in the value chain is in line with Mihu *et al*. (2024). Therefore, investing in branding and packaging is recommended to support commercialization efforts in promoting the integration of IRVs into formal food systems.

8.4 Recommended innovative products

Since the consumption of IRVs has declined, there are various value addition processes that can be infused in coming up with more innovative products. This study recommends the following innovative products for large scale production;

- Sweet potato and peanut butter porridge (instant)
- Livingstone potato noodles/chips/crisps
- Tiger nut and yam flakes
- Tiger nut fortified products
- *Mugwira* or Dwarf babiana traditional drink
- Composite flours

8.5 Chapter summary

This chapter recommended value addition processes that can be adopted in optimizing indigenous root vegetable consumption. In the Zimbabwean context, the following value addition techniques were recommended: healthier cooking, fermentation, milling, chip and crisp processing, flaking, instant porridge processing, solar drying, packaging and branding. The chapter also recommended various value-added products that can be made using readily available resources. The next chapter provides conclusions and recommendations for the entire study.

CHAPTER 9
CONCLUSIONS AND RECOMMENDATIONS

9.1 Introduction

The foregoing study explored value addition processes towards optimizing indigenous root vegetable consumption for health and wellness sustenance. Chapter one served as the foundation of the entire study by introducing the research topic, establishing the relevance as well as objectives. Chapter two is based on how this research fits into already established ideas and a traditional literature stance was adopted. Literature review assisted in highlighting areas that need attention as well as justifying the need to conduct this study. Chapter four focused on the methodology aspect which helped in navigating the whole data collection, analysis and presentation processes. Chapter three also helped in introducing key theories that support this research. Chapters' five (5) to eight (8) synthesizes major findings gained throughout the study and reflects on their broader significance. By revisiting the research objectives, summarizing key findings, and acknowledging limitations, this chapter (Chapter 9) aims to provide a comprehensive closure to the study. Through this conclusion, the study aims to demonstrate how value addition processes influence consumption for health and wellness sustenance. This chapter also offers directions for future studies as well as practical implications to various stakeholders in the value chain. Summaries herein are presented using objective by objective-by-objective approach.

9.2 Summary of Findings

9.2.1 IRVs that are consumed in Makoni District for health and wellness sustenance.

Research findings on the first objective indicated the availability of the following IRVs: Livingstone potato *(tsenza),* sweet potato *(mbambaira),* yam *(madhumbe/magogoya),* tiger nut *(pfende),* okra (derere rechijonga), *mugwira* and *hwenene*. IRVs like yam and sweet potatoes are favoured as compared to Livingstone potato. Results indicated generational differences in acceptance where children, young adults and young parents tend to side-line IRVs due to taste, dietary changes, lack of exposure and globalization. However, consumption among the elderly is relatively better as compared to the younger generation. Generally, consumption of IRVs has declined. Those who consume IRVs do so for health and medicinal benefits, longevity, satiety, taste as well as the sake of enjoyment. Since consumption is on the decline, findings highlighted that preservation, culinary innovation, knowledge transmission, promoting cultivation and community awareness can help in increasing consumption. Results also indicated that IRVs help

in boosting the immune system, prevent diseases, promote longevity as well as the availability of medicinal properties. Other findings indicated controversial opinions on nutritional properties and this reflected the need to increase consumer knowledge through awareness programs so as to facilitate informed decisions. Generally, Makoni District is endowed with various indigenous root vegetables that are consumed for varied reasons with the dominance of Livingstone potato and yams. However, more work needs to be done to increase their consumption across all ages as consumptions continues to decline.

9.2.2 An assessment of value addition processes for optimizing IRVs consumption.

Findings on the second objective indicated that rural communities are mainly using traditional value addition processes, including fermentation, milling, sun-drying and pit storage at household level. Traditional processes are playing a crucial role however, they are labour intensive, prone to contamination and are also heavily affected by changes in weather. Available traditional value addition processes need to be enhanced to meet the requirements of the present-day consumers. The use of solar drying was observed however, it is being used to value-add indigenous "leafy" vegetables, proving right the assumption that IRVs are often neglected in value addition. Despite this neglect, there is a great potential to dry IRVs using solar dryers, coming up with novel and nutrient dense products since communities already know how to use it. The most prevalent value addition being used in Rusape is sun-drying.

9.2.3 Factors affecting indigenous value addition processes for IRVs.

Findings on the third objective indicated that farmers are willing to engage in value addition however, there are challenges along the way. Economically, small scale farmers have limited access to adequate finance to facilitate seamless production and processing. Environmentally, climate change and limited availability of wetlands have affected cultivation, as many IRVs thrive in swampy areas. The use of non-organic fertilizers and chemicals in tobacco farming has degraded soil fertility, impacting indigenous root vegetable farming. Reliance on sun-drying and pit storage is affected by unpredictable rainfall. To add on, very little to no attention towards indigenous root vegetable processing by renowned companies was indicated. Although there are quite a number of challenges, there are opportunities to invest in value addition as there is an increase in demand for healthier diets, the rise of gastronomy initiatives, the demand for gluten-free products, and the opportunity to invest in an untapped market. This being said, there is a need to facilitate IRV

farmers with capital to cultivate, promote the use of organic fertilizers, and invest in solar dryers. There is also a need for food processing companies and IRV farmers to integrate and establish a seamless value chain.

9.2.4 Recommendations of appropriate value addition processes to optimize indigenous root vegetable consumption for health and wellness sustenance

Based on literature and research findings, the study recommends fermentation at both small-scale and commercial levels, milling flour products, chip and crisp processing, flaking, instant porridge production, solar drying, packaging and branding. These processes, if used at an industrial level can bring back IRVs on the map and increase appearance, taste, texture, nutritional and medicinal value. A combination of these properties can increase consumption, which in turn has a direct link with health and wellness sustenance. The study also recommended various value-added products that can be made using readily available resources.

9.3 Conclusion

The main objective of this study was to explore value addition processes to optimize indigenous root vegetable consumption in sustaining health and wellness in Zimbabwe. Solar drying, fermentation and milling processes can be adopted a large scale to optimize indigenous root vegetable consumption for health and wellness sustenance. However, value addition processes being used are mainly traditional in nature, they have limitations that deter effective consumption for health and wellness sustenance.

9.4 Implications of the Study

The following sections discuss the significance or impact of this study's findings in the real world.

9.4.1 Policy formulation

Stakeholders need specific policy that support the IRV value chain. Support can be in form of subsidies or grants for farmers who grow IRVs to encourage production. The government through the health sector can incorporate IRVs into nutrition programs to improve countrywide dietary habits. Food producers can engage with regulatory bodies in establishing quality standards for processing IRVs to maintain the nutritional and medicinal integrity of these species. Land use and

environmental policies that protect and support sustainable farming practices and preservation of wetlands can be accentuated.

9.4.2 Agro processing

In real-world settings, farmers can adopt improved processing techniques to suit current food trends, bearing in mind the aspect of nutritional and medicinal value. These processes can also reduce post-harvest losses and enhance the market visibility of IRVs. The food industry can develop diverse unique nutrient dense products using locally found ingredients. This initiative will create more opportunities for food innovation and opportunities for stakeholders along the value chain. Apart from farmers and food processors, the nutritionists and dietitians can incorporate indigenous vegetable value added products into dietary recommendations putting more emphasis on communities that are prone to malnutrition and diet related diseases.

9.4.3 Knowledge generation

This research highlighted gaps and new perspectives that still need attention. This study also revealed less popular IRVs that have gained minimum research attention. Little has been done on value addition processes of IRVs in Zimbabwean context, this study explored these processes. This study can act as a stepping stone for interdisciplinary research integrating food science, nutrition, gastronomy, agriculture and the supply chain.

9.5 Suggestions/Recommendations for Future Research

This study recommends research on IRVs that require plant profiling (c.f. 2.2.3 & 5.5.3.3). Experimental research can also be conducted to validate medicinal claims that were discovered through trial-and-error methods (c.f. 6.2.1.3). There is a need for lab based approaches to experiment the feasibility of merging indigenous knowledge and contemporary value addition processes in coming up with novel products (c.f.8.3.2)

9.9 Limitations

Due to the scarcity of information, particularly on indigenous root vegetable value addition, this study mainly used related literature. In the field, participants predominantly used vernacular and this necessitated the translation of an English research instrument to Shona language. Some participants lost their relatives the same week the researcher was collecting data. This mishap forced the researcher to find other participants who were not close to where mourners were gathered.

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APPENDICES

APPENDIX 1: RESEARCH INSTRUMENT

INTERVIEW GUIDE

Section A: Demographics

Village/ward name (**Dunhu/Wadhi)**

Age (**Makore/Zera**) (20 years and above)

Marital status (**Mamiriro ewanano**)

Occupation (**Basa**)

Section B: To establish IRVs that are consumed in Rusape for health and wellness sustenance. (**Kuburitsa pachena zvirimwa zvinoberekera muvhu zvinodyiwa (midzi) zvinowanika munzvimbo yemaRusape zvichibatsira kuvaka utano hwemunhu)**

1. Which types of indigenous vegetables are found in your area?
   (Ndezvipi zvirimwa kana kukura zvega zvechivanhu zvinowanika munharaunda yenyu?)
2. Among the indigenous vegetables that you know, which ones are regarded as IRVs?
   (Pazvirimwa zvechivanhu zvinowanika muno, ndezvipi zvinopinda muboka rezvirimwa zvinoberekera muvhu?)
3. How often are the IRVs consumed within this community? How often do you consume IRVs?
   (**Munowanzodya zvirimwa zvinoberekera muvhu kakawanda sei pavhiki kana pamwedzi**?)
4. What are the reasons why people in your community consume IRVs?
   (Ndezipi zvikonzero zvinoita kuti vanhu vemunharaunda ino vadye zvirimwa zvinoberekera muvhu?)
5. What are the contributions of IRVs to one's wellbeing?
   (Zvirimwa zvinoberekera muvhu zvinobatsira sei mukuvandudza hutano hwevanhu?)
6. What do you think can be done to optimise the consumption of IRVs in communities?
   (Ndedzipi nzira dzamunofunga kuti dzinogona kushandiswa pakuwedzera kwekufarirwa kwezvirimwa zvinoberekera muvhu?)

Section C: To assess value addition processes towards optimizing IRVs consumption **(Kuongorora nzira dziri kushandiswa kuwedzera hukoshi hwezvirimwa zvinoberekera muvhu?)**

7. In what state are the IRVs consumed?
   (Zvirimwa izvi munowanzozvidya zvakaita sei, zvakabikwa kana kuti zviri zvimbishi?)
8. What do people do to improve
   a) The taste, b) texture c) appearance and d) aroma of the IRVs?
   (Ndedzipi dzira dzamunoshandisa kuvandudza (a) manakiro (b) maumbirwo (c) maonerwo (d) manhuwiriro?)
9. Which methods are used to make a) prepare/cook, b) serve, c) preserve and d) to conserve their nutritional value?
   (Ndedzipi nzira dzamunoshandisa (a) kugadzira/kubika, (b) kupakura, (c) kuchengetedzeka kwenguva refu isina kushata (d) uye kuti isarase utano?)
10. In what ways do these processes alter or affect the nutritional value of these vegetables?
    (Inzira dzipi dzekuvandudza hukoshi dzinogona kuwedzera kana kutapudza hutano hwezvirimwa zvinoberekera muvhu?)
11. How do these processes help increase the overall consumption of IRVs?
    (Hwaro hwekuvandudza zvirimwa zvinoberekera muvhu hwurikubatsira sei mukudyiwa kwazvo)
12. Which other new ideas or techniques can be infused in the processes that are already in existence to make IRVs more palatable.
    (Ndehupi humwe hunyanzvi hungashandiswa pakuvandudza zvirimwa izvi kuti zvive zvinodyika zvakanaka?)
13. What else can be done to increase the consumption of these vegetables for sustaining health (innovative techniques)?
    (Ndedzipi dzimwe dzira dzingashandiswa kukurudzira vanhu kuti vafarire kudya zvirimwa zvinoberekwa muvhu?)

Section D: To evaluate the factors affecting indigenous root vegetable value addition processes in Rusape (Kuongorora zvinhu zvinobatsira kana kuvhiringa kuvandudzwa kwezvirimwa zvinoberekera muvhu?)

14. What challenges do you think most people face when trying to improve the methods that are currently used to process IRVs? (Economic/Cultural/Environmental)
    (Zvipingaidzo zvipi zvamurikusangana nazvo pakuzama kuvandudza zvikwanisiro zvamunoshandisa mukuvandudza zvirimwa izvi)
15. Which opportunities do you think can promote value addition processes for sustaining the health and wellness of consumers?
    (Ndeipi mikana yamunofunga kuti ingabatsira kuvandudza zvikwanisiro vamunoshandisa?)

Section E: To recommend value addition processes to optimize indigenous root vegetable consumption for health and wellness sustenance. **Kukurudzira nzira dzakakodzera kuvandudza nadzo zvirimwa zvinoberekera muvhu.**

16. Which processes do you recommend when adding value to IRVs?
    (Ndedzipi nzira dzamunokurudzira kushandisa mukuvandudza zvirimwa zvinoberekera muvhu?)
17. What new initiatives or ideas do you think can be embraced to help sustain lives through the consumption of IRVs in communities?
    (Ndedzipi nzira itsva dzamunofunga kuti dzingabatsira mukuwedzera nekuumba hutano hwevanhu kuburikidza nezvirimwa zvinoberekera muvhu?
18. How can the local community be involved in promoting value addition and consumption of IRVs for health and wellness sustenance?
    Vagari vemunharaunda yedu vanogona kubatsirawo sei mukukurudzira kudyiwa nekuvandudzwa kwezvirimwa zvinoberekera muvhu?

…The end…

APPENDIX 2: RESEARCH ETHICS CLEARANCE LETTER

ANNEX 19 Form GRSD 17 SHT/ 02/2025
CHINHOYI UNIVERSITY OF TECHNOLOGY

RESEARCH ETHICS CLEARANCE LETTER

NAME OF RESERCHER: - Patience Chitupa

STUDENT ID NUMBER: C24160082M_ **ID Number**: 63-1571579W43

SCHOOL OF HOSPITLITY AND TOURISM

APPROVED RESEARCH TITLE: An exploration of value addition processes towards optimizing indigenous root vegetable consumption for health and wellness sustenance in Zimbabwe.

I hereby confirm that the above mentioned Researcher is a Postgraduate Researcher at Chinhoyi University of Technology. The proposed study met all the requirements as stipulated in the University Policies and Guidelines and has been approved by the relevant committees.
The proposal adheres to ethical principles as outlined by the University. Permission is hereby granted to carry out the research as described in the attached approved proposal.

The main objective of the research is: To explore value addition processes to optimize indigenous root vegetable consumption in sustaining health and wellness in Zimbabwe

Expected Outcome:-The research intends to present and recommend value addition processes that adopted to optimize consumption of indigenous root vegetables for health and wellness sustenance

In addition, the Researcher is urged to adhere to international and national ethical guidelines and all requirements by Chinhoyi University of Technology.

Best Regards

Yours Faithfully

CHINHOYI UNIVERSITY OF TECHNOLOGY
DIRECTORATE OF RESEARCH
AND GRADUATE STUDIES
12 MAR 2025
PRIVATE BAG 7724
CHINHOYI ZIMBABWE

Dr. M. C. Mwando
Chairperson, University Research Committee - Research Ethics
Tel: +263 6721 22203-5
E-mail: - researchandgraduatestudies@cut.ac.zw

Date: 12/03/2025

APPENDIX 3: REQUEST FOR RESEARCH PERMIT

Patience Chitupa
352 Gadzema, Chinhoyi
0779654612
pchitupa@cut.ac.zw/chitupapatience@gmail.com

25 November 2024

Makoni Rural District Council
396 Stockton Street
P .O. Box 255 Rusape
+263 0225 2051470/205265
makonirdc@gmail.com

Dear Sir/Madam

My name is Patience Chitupa and I am a Master of Philosophy student at Chinhoyi University of Technology in the School of Hospitality and Tourism. I am kindly writing to request permission to conduct research in Rusape rural (Makoni District) as part of my study on indigenous vegetable (IV) value addition processes for health and wellness sustenance in Zimbabwe.

The main objective of my research is to explore indigenous vegetable value addition processes done in Rusape as well as indigenous vegetables that are found there. I believe that Rusape rural is essential for my study because of availability of a number of wetlands. The research will involve the vegetable consumers, farmers and the community at large and I anticipate it will take approximately one (1) year to complete.

I assure you that all research activities will adhere to the highest ethical standards. Participant confidentiality and data protection will be strictly maintained throughout the research process.

Your approval to conduct this research would be greatly appreciated. I am more than willing to adhere to any specific protocols or requirements you may have. Please feel free to contact me on 0779654612 or chitupapatience@gmail.com/pchitupa@cut.ac.zw if you have any questions or need further information.

Sincerely

Patience Chitupa

MPhil Student (Chinhoyi University of Technology)

School of Hospitality and Tourism

Signature.....

APPENDIX 4: RESPONSE FROM THE RDC

535

MAKONI RURAL DISTRICT COUNCIL

All Communication to
be addressed to the
Chief Executive Officer

Our Ref: ADM-19

Your Ref:

P.O. Box 255
RUSAPE
TEL: 025-2052851
025-2051470
Fax: 025-2052566
RUSAPE
ZIMBABWE
Email: makonirdc@gmail.com
Website: www.makonirdc.co.zw

Patience Chitupa 0779654612
pchitupa@cut.ac.zw

Dear Madam

RE: REQUEST FOR A RESEARCH PERMIT PATIENCE CHITUPA A M PHIL STUDENT AT CHINHOYI UNIVERSITY

We acknowledge receipt of your email of 18 November 2024 concerning the above mentioned subject.

Can you submit a letter from Chinhoyi University stating that you need to conduct a research in Makoni District.

Yours faithfully

A Murigwa
FOR ACTING CHIEF EXECUTIVE OFFICER

VISION: EMERGE A VIBRANT ECONOMIC HUB IN LOCAL DEVELOPMENT BY 2025

APPENDIX 5: LETTER FROM CUT TO MAKONI RDC

CHINHOYI UNIVERSITY OF TECHNOLOGY

SCHOOL OF HOSPITALITY AND TOURISM

DEPARTMENT OF HOSPITALITY AND TOURISM

To whom it may concern

This communication serves to notify you that PATIENCE CHITUPA Registration Number: C24160082M is a Master of Philosophy (MPhil degree) student at Chinhoyi University of Technology in the Department of Hospitality and Tourism. It is mandatory for MPhil students to undertake research in line with their study.

The research is expected to benefit the academia, the student, the tourism and hospitality industry, and the nation at large. May you please assist her with information that she may require from your organization and Rusape Rural (Makoni District). Please note that information obtained by the student will be used strictly for academic purposes.

For any queries you can contact the under signed. We would like to thank you for your support towards our training

..... Date 25/11/24

Kazembe. C. (Dr)

Research Supervisor – Department of Hospitality and Tourism

Chinhoyi University of Technology

School of Hospitality and Tourism

P. Bag 7724 Chinhoyi

Tel: 06721-22203-5 ext. 2207

Cell: 0772 225 7961

E-mail: ckazembe@cut.ac.zw

CHINHOYI UNIVERSITY OF TECHNOLOGY
SCHOOL OF HOSPITALITY AND TOURISM
DEPT OF HOSPITALITY AND TOURISM
DATE 25 / 11 / 24

APPENDIX 6: RESEARCH PERMIT FROM RDC

MAKONI RURAL DISTRICT COUNCIL

All Communication to
be addressed to the
Chief Executive Officer

Our Ref.

Your Ref. **ADM – 19**

P.O. Box 255
RUSAPE
TEL: 025-2052851
025-2051470
Fax: 025-2052596
RUSAPE
ZIMBABWE
Email: makonirdc@gmail.com
Website: www.makonirdc.co.zw

26 November 2024

Patience Chitupa
Cell: 0779 654 612
Email: pchitupa@cut.ac.zw

Dear Madam

RE: REQUEST FOR A RESEARCH PERMIT: PATIENCE CHITUPA, A MPHIL STUDENT AT CHINHOYI UNIVERSITY OF TECHNOLOGY

Our correspondence to you of 22 November 2024 concerning the research permit in Makoni District refers.

Thank you for submitting the letter from Chinhoyi University of Technology.

Authority has been granted to you to conduct the research in Makoni District.

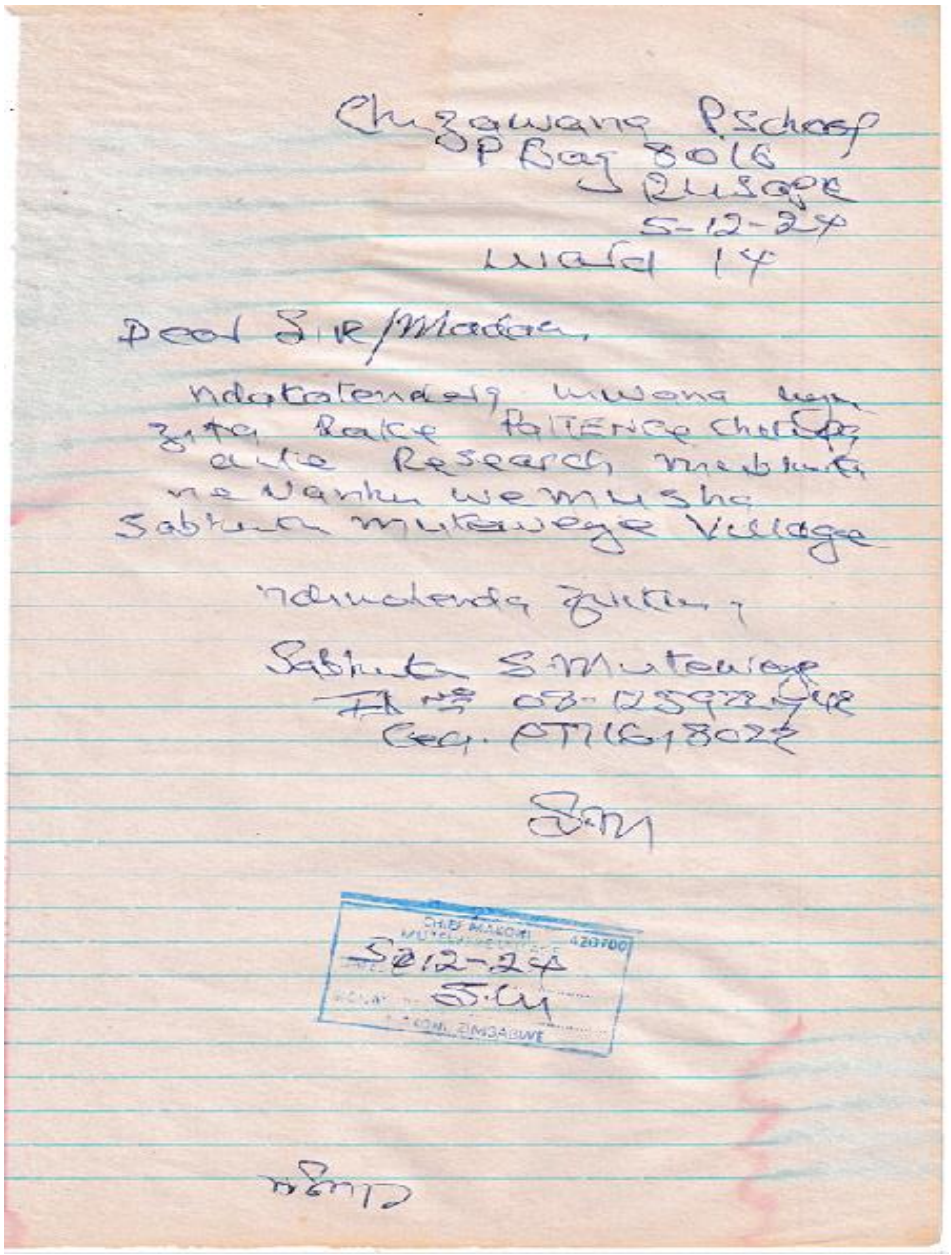
However, may you submit your findings to council to enable us to learn from the research project.

Yours faithfully

A. Murigwa
FOR: ACTING CHIEF EXECUTIVE OFFICER

VISION: EMERGE A VIBRANT ECONOMIC HUB IN LOCAL DEVELOPMENT BY 2025

APPENDIX 7: PERMIT FROM ONE OF THE VILLAGE HEADS



Chegawana Pschool
P Bag 8016
Rusape
5-12-24
Ward 14

Dear Sir/Madam,

Ndatatenda kuwana kuti
zita Rake FAITENCE Chirisa
ave Research mubukuti
ne Vanhu weMusha
Sabhuku Mutawepe Village

Ndinotenda zvikuru,

Sabhuku S. Mutawepe
ID no 08-125922 Q08
Cell. 0711618022

5/12/24

5/12/24

APPENDIX 8: CONSENT FORM

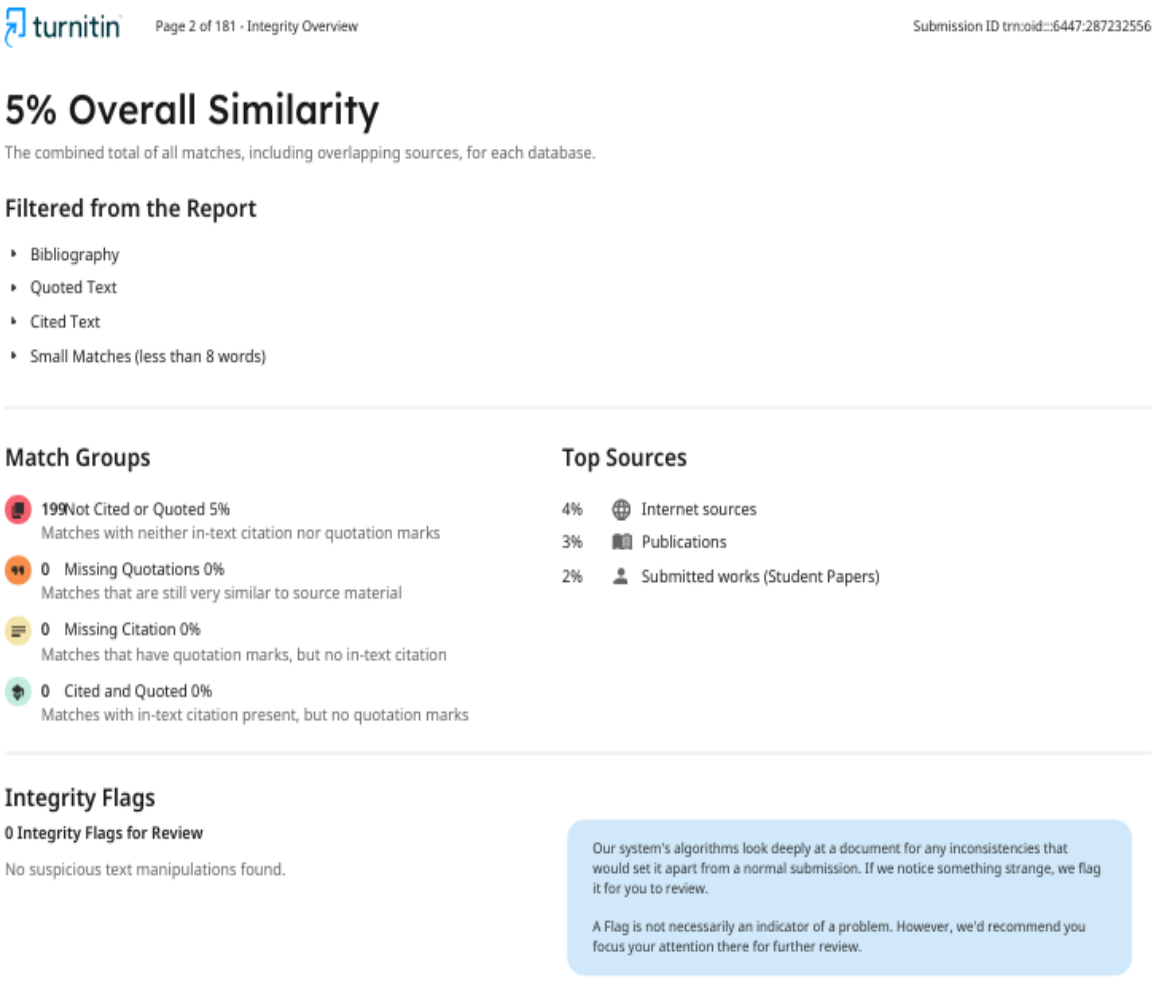
CONSENT FORM

Name: Patience Chitupa
Institution: Chinhoyi University of Technology
Contact Details: 0779654612 (pchitupa@cut.ac.zw)
Tittle of the study: An exploration of indigenous vegetable (IV) value addition processes for health and wellness-sustenance in Zimbabwe

The purpose of this study is to explore indigenous root vegetables found in Rusape, examine methods used to add value and health benefits found in these vegetables. This research will be carried out in 1 year. There are no potential risks associated with this study. Results obtained will benefit the local community and the nation at large. Information collected will be used solely for the purpose of this study. Names and related information will be kept confidential. The participant has the right to discontinue or decline the participation in the research anytime. By signing below, you indicate that you have read and understood the information provided above, and you agree to participate in this study.

Participant's name. [illegible] Signature.....	Participant's name. M. Chaseka Signature.....
Participant's name. Stephen Makoni Signature.....	Participant's name..... Signature. Euzodia.....
Participant's name..... Signature. P. Makoni.....	Participant's name..... Signature.....

APPENDIX 9: SIMILARITY REPORT



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