

**Effects of canning on the nutritional composition and consumer acceptance of African leafy Vegetables**

**By**

**Hombisa Tozi Sigaqa**

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**School of Agricultural, Earth and Environmental Sciences (SAEES)**

**College of Agriculture, Engineering and Science**

**University of KwaZulu-Natal**

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## **PREFACE**

The work defined in this dissertation was established out in the school of Agricultural, Earth and Environmental Sciences, University of KwaZulu-Natal, from February 2014 to December 2015, under the supervision of Dr. Muthulisi Siwela, Dr.Unathi Kolanisi, and Dr Nomusa Dlamini.

Hombisa Tozi Sigaqa (Candidate)

As supervisors of the candidate, we agree to the submission of this dissertation.

Dr. Muthulisi Siwela (Supervisor)

Signed: \_\_\_\_\_

Date: \_\_\_\_\_

Dr. Unathi Kolanisi (Co-Supervisor)

Signed: \_\_\_\_\_

Date: \_\_\_\_\_

Dr. Nomusa Dlamini (Co-supervisor)

Signed: \_\_\_\_\_

Date: \_\_\_\_\_

## **DECLARATION OF ORIGINALITY**

I, Hombisa Tozi Sigaqa declare that:

1. The research reported in this dissertation, except where otherwise indicated, and is my original work.
2. This dissertation has not been submitted for any degree or examination at any other university.
3. Where other sources have been used, they have not been copied and have been acknowledged properly.
4. This dissertation does not contain text, graphics or tables copied and pasted from internet, unless specifically acknowledged, and the source being detailed in dissertation and in relevant reference section.

Signed: \_\_\_\_\_ Date: \_\_\_\_\_

Hombisa Tozi Sigaqa (Candidate)

## ABSTRACT

Several studies have reported a decline in the use of African leafy vegetables (ALVs) in sub-Saharan-African countries, including South Africa. This trend is despite the fact that the majority of ALVs are high in nutrients and health -promoting substances as well as that they are adapted to the predominantly harsh local agro-climatic conditions. In sub-Saharan Africa, preservation of vegetables by sun drying is limited to certain leafy vegetable types consequently; this significantly limits the availability of ALVs throughout the year. In South Africa, only one province (Limpopo) out of nine is actively consuming ALVs but there is a noticeable decline in the consumption of these vegetables by the younger generation. The decline seems to be largely due to modernization and its related urbanization and lack of awareness of the huge potential of ALVs to contribute to food and nutrition security and wellbeing. In the current study, which was conducted in the Limpopo Province, canning was evaluated for its potential to optimize the utilization of ALVs and entice the youth and all other population groups that are also averse to traditional and indigenous foods to consume ALVs.

The significance of ALVs as a food source for rural and urban communities in Limpopo was assessed through focus group discussions and interviews, and consumer perceptions about canning of ALVs were assessed. A total of 120 household's representatives participated in the investigation. Findings showed that the consumption of ALVs was stimulated by the perception that they were nutritious, easily accessible, chemical free and cost effective. ALVs also carried a cultural sentimental value and significantly contributed to food security, particularly among rural areas. A declining interest towards ALVs consumption amongst younger generation was reported due to limited recipes leading to monotonous flavours and limited variety.

The effects of canning on the nutritional composition and consumer acceptability were determined by standard nutritional analysis (AOAC methods) and consumer acceptability testing respectively. Canned mustard greens (*Brassica juncea*) and collards greens (*Brassica oleraceae*) and their corresponding fresh forms (controls) were used in the investigation. For sensory evaluation samples of targeted consumers were used, 30 urban residents and 30 rural residents. Canning resulted in an increased in fat and fiber content of collard greens whilst protein decreased. As for mustard greens, fiber content was not affected. Canning did affect the mineral contents of Ca, Mg, K, P and Cu which decreased, while Mn and Zn increased especially in the canned collard greens. The overall acceptability of canned ALVs was low compared to their corresponding fresh vegetable samples. Upon canning taste and aroma

acceptability decreased, whilst texture acceptability was not affected. Overall canning had no significant effect on the acceptability of the vegetables, the overall acceptability of canned vegetables; the overall acceptability of the canned vegetables was similar to that of the fresh vegetables.

The study findings indicate that canning generally has no detrimental effect on the nutritional composition of ALVs. The investigation of consumer perceptions about canning ALVs indicated that the technology would be acceptable to urban dwellers, whilst the perceptions of rural dwellers was that canning would have negative effect on the nutritional quality and safety of the vegetables as well as that canned vegetables would be too expensive. However, sensory evaluation results showed that canned vegetables would be as acceptable as the fresh (not canned). Therefore, it appears that canned ALVs would be acceptable to rural and urban dwellers of Limpopo province. However, further studies are recommended to confirm these findings.

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## **DEDICATION**

This thesis is dedicated to my son, Andile Sigaqa.

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## **ABBREVIATIONS**

<b>ALVs</b>	<b>: African leafy vegetables</b>
<b>CVD</b>	<b>: Cardiovascular Diseases</b>
<b>FAO</b>	<b>: Food and Agriculture Organisation</b>
<b>FDA</b>	<b>: Food and Drug Administration</b>
<b>GMPs</b>	<b>: Good Manufacturing Practices</b>
<b>HACCP</b>	<b>: Hazard Analysis Critical Control Points</b>
<b>PACSA</b>	<b>: Pietermaritzburg Agency for Community Social Action</b>
<b>PRA</b>	<b>: Participatory Rural Appraisal</b>
<b>RDA</b>	<b>: Recommended Daily Allowance</b>
<b>SA</b>	<b>: South Africa</b>
<b>SSA</b>	<b>: Sub-Saharan Africa</b>
<b>UKZN</b>	<b>: University of Kwa-Zulu Natal</b>
<b>USDA</b>	<b>: United States Department of Agriculture</b>
<b>WHO</b>	<b>: World Health Organisation</b>

## Chapter 1 Introduction

### 1.1. Background

In Africa, there is a wide variety of African leafy vegetables (ALVs) used for food and medicinal purposes (Jansen Van Rensburg 2007). The ALVs are cost effective and represent a quality nutritional source of food for a large segment of the population in both rural and urban areas (from children to the elderly). There is currently a significant recognition of ALVs from government and research due to the introduction of the WHO (2009) strategy to increase consumption of fruits and vegetables to improve the well-being of the population. In Kenya, there are about 210 species of ALVs that form an integral part of households' daily nutritional diets (Dansie 2008). Furthermore, ALVs in Kenya are not only used for consumption, but also as a livelihood option as 30% is sold in the market (Dagmar, Hermann 2011). A similar pattern is being noted in some sub-Saharan African (SSA) countries such as Zimbabwe where the value of the agricultural weeds as traditional vegetables was often ignored due to lack of information.

South Africa has been found to have more than 100 species of leafy vegetables, some of which are indigenous (Rose, 1983; Jansen Van Rensburg, 2007). African Leafy vegetables like pigweed (*Amaranthus cruentus* L.), Chinese cabbage (*Brassica rapa* L. subsp. *Chinensis*), Black nightshade (*Solanum retroflexum* Dun.), cowpeas (*Vigna unguiculata* (L) Walp. pumpkin leaves (*Cucurbit maxima* (Duchesne), and spider plant (*Cleome gynandra*) can flourish even in areas that have very low agricultural potential (Van der Heever 2002). When compared to other African countries, ALVs in South Africa (SA) are still being underutilised, even though about 40% of South African families live in poverty and are exposed to malnutrition (UNICEF and the South African Human Rights Commission 2011). In South Africa, micro-nutrient deficiency is also a growing problem due to limited or no dietary variety (MacKeown *et al.*, 2007). Increasing food prices, climate change and natural disasters tend to pose a serious threat to food security and aggravate the malnutrition situation.

African leafy vegetables are a cost effective alternative to combat food and malnutrition challenges due to their high micro-nutrient content, their ability to grow naturally, require less input and are drought tolerant (Osei *et al.*, 2013). However, the major challenge is that ALVs are mainly seasonal as they are mostly abundant during summer affecting their

availability throughout the year (Mepba *et al.*, 2007). As stated by Makobo *et al.*, (2010), ALVs are highly perishable food items, thus, special care should be taken during post-harvest, storage and further processing methods to extend shelf-life since there may be significant effects on the concentration of minerals, vitamins and other essential components present in the ALVs. Consumers tend to prefer exotic vegetables which are available all season in the market but less nutritious and costly when compared to the ALVs, due to limited trustworthy interventions of ensuring ALVs availability throughout the seasons. According to (Rickman *et al.*, 2007) fruits and vegetables are typical 90% water and once they are harvested they undergo a process of respiration resulting in moisture loss, quality deterioration and potential microbial spoilage. Therefore, vegetables are regarded as highly perishability products that require postharvest care and preservation interventions to maintain their sensory quality. The sensory quality of vegetables plays a significant role as they strongly influence consumers' decisions to select, consume and accept the vegetables. The sensory attributes of the vegetables should fulfil the needs and expectations of consumers to ensure continual consumption.

Previous studies have reported that consumers mainly rely on the physical appearance of the vegetable product as the determinant of quality; however, recent studies show a sudden interest of consumers on nutritional and safety aspects of such food items. Most indigenous preservation methods do not readily provide information on the nutritional and safety properties of the vegetables thus compromising the trust of consumers in the product. Consumer studies have shown that products are not only judged by their price, but also quality and safety and more certainly convenience are a fundamental influence of utilisation and consumption of the product (Solomon *et al.*, 2014). Therefore, today's consumer demand acceptable aesthetic attributes, safety, convenience and nutritious foods.

Drying has been an ancient traditional method of preventing post-harvest losses and extending shelf life of ALVs. Drying is highly preferred and widely used by resource-poor rural communities in most countries of sub-Saharan Africa, including South Africa. It is generally an appropriate indigenous system (IKS)-based preservation method for these communities. Drying remains a cheap cost effective method of preserving ALVs used by rural households. However, it has been reported in the literature that, in some cases, drying results in poor quality products, loss of micro nutrients such as vitamin A and C, loss of variable moisture content and microbial load (Prabhu and Barret 2009). On the other hand,

canning a modern method, generally ensures that a product which was previously subject to seasonality is available all year round, it is time saving (ready to eat or requires little time to prepare), and safe. Generally, canning results in the destruction of spoilage and pathogenic micro-organisms (Knechtges 2012). More so, the canned products can provide the consumer with information (written on the can), such as nutritional composition, place of origin and how it was processed. However, canning could be costly especially for rural households, further; canning could have negative effects on the sensory properties of the vegetables, especially when the consumers compare the canned vegetables with their corresponding fresh forms. Furthermore, Joubert (2010) argues that the consumers' perceptions of food processing methods are of high importance as they affect product acceptance. Therefore, this study aims to investigate the effects of canning on the nutritional and sensory properties and consumer's acceptance of ALVs.

## **1.2. Importance of the study**

African leafy vegetables are regarded as a cost-effective agricultural-based food security intervention tool because of their ability to adapt to changing agro-climatic conditions. However, the declining interest amongst the younger generation to consume these vegetables in favour of exotic types which seems to be largely due to their monotonous preparation methods, seasonality and perishability, has raised interest investigate a possible interfacing of indigenous foods with modern technology to match the needs and lifestyle of modern society. Therefore, canning of ALVs was explored as an option to lure the younger generation and assure safety and availability of the ALVs throughout the year and therefore increase food and nutrition security of the targeted communities. African leafy vegetables are known for their nutritional significance, they are known to contain several, micro nutrients, such as iron, zinc, calcium, folic acid, vitamin A and C and macro nutrients such as proteins, fat and fibre. In South Africa, the Limpopo Province is arguably leading in their consumption and other utilisation options of ALVs. Presently, there is a developing interest from research and policy on utilisation of ALVs. The findings of this study could be used to promote the utilisation of ALVs even beyond rural households and bridge the generation gap. The study findings would likely inform researchers, policy makers, and government officials involved in food and nutrition security interventions on how to attract important reference groups such as, youth and urbanised consumers to effectively utilise ALVs to reduce malnutrition.

### **1.3. Research problem**

In a South African national food consumption survey conducted in 1999, results showed that a large number of children had inadequate intake of energy, vitamins A, C, thiamine, riboflavin, niacin, vitamin B6, folic acid, and zinc (Osei et al., 2013). Vegetables are important sources of protective foods and are highly advantageous for the maintenance of good health and prevention of diseases (Nnamani 2009). Leafy vegetables are among the most nutritious and are among the world's most productive plants in terms of nutritional value. They are classified as functional foods with health benefits beyond basic nutrition (van de Walt et al., 2009). African leafy vegetables can play a significant role in alleviating hunger and malnutrition (van der Hoeven et al., 2013).

African leafy vegetables (ALVs) play a vital role in food and nutrition security, but they are highly perishable. Canning could be an effective preservation method to extend the shelf life of ALVs interfacing indigenous and modern technologies to improve household food and nutrition security. However canned ALVs may not be acceptable to rural communities who traditionally consume ALVs in fresh and dried forms.

### **1.4. General objective of the study**

The overall aim of the study was to investigate the utilization of ALVs as food by rural and urban communities in South Africa (Limpopo), assess the consumer perception towards canned ALVs. The study investigated whether canned ALVs could be used as an indigenous interfaced modern preservation alternative that could promote the ALV utilisation by all people at all times for a healthy and active life.

#### **1.4.1 Sub-problems**

1. To determine the utilisation of ALVs by rural and urban residents in Limpopo.
2. To assess consumer perceptions towards canned ALVs.

3. To evaluate the effect of canning on the nutritional composition of collard greens and mustard greens.
4. To assess the sensory acceptability of canned collard and mustard greens.

### **1.5. Hypotheses**

The nutritional composition of ALVs will change upon canning mainly due to heat-induced changes, such as nutrient decomposition.

Because ALVs are often consumed in fresh form, their canning may result in decreased consumer acceptance due to undesirable changes in their sensory properties.

### **1.6. Study limits**

This study used information and data collected only from one specific *area* (*Limpopo Province*) and cannot be generalised for the entire South African population.

The canned ALVs were imported since they were not readily available in SA markets.

### **1.7. Definition of terms**

**Safety** is defined as the assurance that food will not cause harm to the consumer when it is prepared and or eaten according to its intended use. Mensah (2014)

**Canning** Is the method of preserving food in which the food contents are processed and sealed in an airtight container (Anon).

**Perception** refers to the entire process through which an individual becomes aware of his or her environment and interprets it in such a way that it will fit into his or her frame of reference Joubert (2010).

**Attitudes** can be defined as the learned predispositions to behave in a consistently favourable or unfavourable way towards objects, events or situations, Joubert, (2010).

**Acceptability** refers to the degree of liking or disliking a food product based on the consumer's sensory perceptions in terms of the products appearance, taste, aroma and texture (White and Prescott 2007).

**African leafy vegetables** are leafy vegetables that have originally been domesticated or cultivated in Africa for the last several centuries and are found in several areas being frequently replaced by newly introduced exotic species such as cabbage, lettuce and other species (Gockowski et al.2008).

**Microbial load** is the total number of living microorganisms in a given volume or mass of microbiological media or food (Web definition).

### **1.8. Dissemination of results**

The information after the completion of this study will be shared with the Department of Agriculture, Forestry and Fisheries and other relevant stakeholders. Feedback will also be shared with the study participants. This thesis would be published in the University library and manuscripts published in accredited journals and through oral presentations at conferences.

### **1.9. Organization of dissertation**

Chapter 1 gives the introduction and background to the research problem and the objectives investigated in this study. Chapter 2 reviews the literature on the role of African leafy vegetables as an intervention to combat hidden hunger, add nutritional value, as well as consumer perceptions on canning ALVs. Chapter 3 presents the study conceptual framework and description of the study area. Chapter 4 and chapter 5 are research chapters; chapter 4 lays out outcomes on utilization of ALVs and consumers perceptions and consumer acceptance of canned ALVs. Chapter 5 presents the analysis of nutritional composition of raw and canned (collard and mustard greens) food products. Chapter 6 gives the conclusions and recommendations.

## **1.10. Summary**

African leafy vegetables have a major role in promoting health and reducing micro-nutrients deficiency. Despite their nutritional value, ALVs are still underutilised and their availability continues to be a constraint due to their highly seasonal nature and few methods of preservation known and used to increase their shelf life. In an attempt to promote ALVs, consumer perceptions and acceptance of ALVs will be examined to determine the opportunity of canned ALVs as a way to extend the shelf life of these vegetables.

## Chapter 2 : Literature review

### 2.1. Introduction

Several nutrition interventions have failed to combat malnutrition as hidden hunger and obesity are gradually threatening the economic development of lowest income countries. As an attempt to contribute towards hunger eradication, the World Health Organisation (2009) has been promoting the utilisation of African leafy vegetables. This intervention is agricultural-based and it uses locally available and accessible resources which makes it a cost effective intervention.

African leafy vegetables have recently been attracting research attention not only because of their nutritional quality but also because of their medicinal properties (Kimiye *et al.*, 2007). The World Health Organisation in (2009) reported an increase in malnutrition that poses a threat to the health and the economy of low income countries. As a response the WHO promotes a nutrition sensitive agricultural intervention through the production of ALVs. This idea was based on the nutritional quality, availability, accessibility and easy agricultural production of ALVs in most developing countries. According to (Orech *et al.*, 2007) 54 traditional leafy vegetables studied in Kenya contained higher levels of calcium and zinc compared to varieties such as spinach (*spinaceaoleracea*), Kale (*Brassica Oleracea*) and cabbage (*brassica oleraciavar capita*). More so the sub –Saharan Africa has a great diversity of leafy vegetables providing an affordable quality nutritional food source (Dansie 2008). Despite their nutritional value these ALVs continue to be underutilized, because of how it is perceived by important groups of consumers such as the young and urban consumers. Ljbmiret al., (2010) suggests that consumer perceptions can be probed and analysed using the purchasing and consumption patterns. Furthermore, this literature review elaborates on the issues of malnutrition in the sub-Saharan Africa; the nutritional value of leafy vegetables and their potential to contribute to food security; consumer perceptions towards the utilization of ALVs; consumer perceptions and the utilization of ALVs; consumer perception towards the aesthetic and sensory attributes of ALVs; risk factors on the safety of ALVs; interventions to meet consumer needs and preferences; and consumer perceptions towards canned foods. In a South African national food consumption

survey conducted in 1999, results showed that a large number of children had an inadequate intake of energy, vitamins A, C, thiamine, riboflavin, niacin, vitamin B6, folic acid and zinc (Osei et al 2013). Vegetables are important sources of protective foods and are highly advantageous for the maintenance of good health and prevention of diseases (Nnamani 2009). Leafy vegetables are among the most nutritious and are among the world's most productive plants in terms of nutritional value, they are classified as functional foods with health benefits beyond basic nutrition (van de Walt *et al.*, 2009). African leafy vegetables can play a significant role in alleviating hunger and malnutrition (van der Hoeven *et al.*, 2013).

This section provides an overview on the literature interrogating various aspects to further elaborate on the global nutritional status, utilisation of ALVs, consumer perceptions and acceptance

## **2.2. The global malnutrition status**

According to the WHO (2009), chronic malnutrition affects over 200 million people or 42% of the population of Sub-Saharan Africa. Attempts to alleviate malnutrition and food insecurity issues have been impeded by increasing food prices, wars and natural disasters (Orech *et al.*, 2007). The leading health risk factor for low income countries is underweight; it is estimated to represent about 10% of the total disease burden in combination with childhood underweight. Food tank (2013) also reports that the global obesity rates have doubled over the past years, pushing the growth of diet-related illnesses such as diabetes, hypertension, and heart diseases. Hidden hunger (micro-nutrient deficiency) is another 'silent disease' posing to be a threat to nutrition and food security status of many countries. According to Lannotti *et al.*, 2013), the problem of micro-nutrient deficiencies is associated with poor quality diets, a condition likely to worsen in the face of rising food prices and lowered incomes. Evidence shows vitamin A to be a major problem in almost 37 countries, mostly in South East Asia and Africa, with 25000-500 000 people of which mostly children becoming partially or totally blind yearly (Kanlayanarat 2007). Also more than 2 billion people worldwide are anaemic or have insufficient iron intake. Studies have shown that green leafy vegetables are rich in both Iron and Vitamin A. A low intake of vegetables and fruits is among the top ten risk factors contributing to mortality worldwide (Faber *et al.*,

2010). Vegetables are vital to the general good of health of human beings, providing essential vitamins and minerals, dietary fibre, and phytochemicals, and reducing risk from dangerous diseases and other medicinal conditions. (Nnamani *et al.*, 2009; Dias 2010). There are more than 20 essential vitamins and minerals for human consumption, however deficiencies in folate, iodine, iron, vitamin A and zinc are having a significant impact on public health. Folate is a form of vitamin B9 and is naturally present in dark green leafy vegetables. The world health organization (WHO) recommends a daily intake of more than 400g of vegetables and fruit per capita to protect against diet related chronic diseases. More so vegetables are the cheapest sources of natural foods and can admirably supplement the main cereals of the country (AgriInfo 2011).

Malnutrition due to the nutritionally inadequate diets is one of the major concerns in developing countries Smith and Eyzaguirre (2007). South Africa is no different since the South African National Food Consumption Survey conducted in 1999, showed that a large number of children had inadequate intake of energy, vitamins A, C, B12, B6, thiamine, riboflavin, niacin, folic acid and zinc (Osei 2013). In a survey conducted in 2005, the situation of vitamin A seemed to have increased nationally when compared to the 1999 previous data, and a high prevalence of poor zinc status still exists (Steyn *et al.*, 2006).

### **2.3. The possibility of using African leafy vegetables to combat hidden hunger in sub-Saharan Africa**

Recently, Smith and Eyzaguirre (2007) have noted an increased awareness of the health protecting properties of vegetables as vital components of a daily diet. This is because Africa has a great diversity of leafy vegetables that are used for food and other purposes (Dansie 2008).

African leafy vegetables have been viewed as a cost effective intervention to reduce the micro deficiency in most parts of Africa (Kimiye *et al.*, 2007). African leafy vegetables are plant species which the leafy part, that may include young, succulent stems and very young fruits are used as a vegetable (Talen *et al.*, 2012). According to Schonfeldt and Pretorius (2011), these vegetables in the past were generally ignored and their value was underestimated.

Regardless of the ALVs nutritional value and their ability to tolerate climate change they are still underutilized. Studies conducted in various African countries have shown that

despite the growing interest in these vegetables in both research and policy circles, there is a negative perception especially among consumers, especially the youth and the urbanized affecting their acceptability and utilisation. (Masarirambi *et al.* 2010 ; Voster *et al.* 2007).

Jansen van Rensburg *et al.*, 2007 argues that in South Africa, researchers and policy makers ignored these vegetables for a long time. However, during the past two decades this has changed and traditional leafy vegetables have increasingly received attention. In South Africa the use of leafy vegetables is as old as the history of modern man, Khoisan people used to rely heavily on the gathering of plants from the wild for their survival, while the Bantu speaking tribes which started to settle in South Africa 2 000 years also used to collect leafy vegetables from the wild, with this practice continues to be widespread among African people in South Africa, even though these ALVs have now been replaced by the exotic vegetables (Jansen van Rensburg *et al.*, 2007). African people in South Africa use different concepts to refer to these plant species collectively the use of terms such as *Morogo* (Sesotho, Isipedi), or *imifino* (IsiZulu, IsiXhosa) all these are translations of ALVs, (Jan van Rensburg *et al.*, 2007). In Sub-Saharan Africa they are economical important for income generation. In South Africa, Wehmeyer and Rose (1983), reported that approximately more than 100 different species of plants are available and consumed used as leafy vegetables. In nine provinces of South Africa, these vegetables can be found, however in the Limpopo Province, they are mostly abundant local and consumed. These sometimes referred to as wild and home-grown leafy vegetables are nutrient-rich and adapted to the predominantly harsh agro-climatic conditions (Sithole *et al.*, 2011). Considering their potential as a nutritional source, African leafy vegetables awareness and strategies to promote their recognition is needed. In addition, these ALVs could contribute significantly to food security and balanced diets of many rural households, urban poor and inclusive population. the well-known Pedi proverb, 'Meat is a visitor but morogo is a daily food', captures the important role leafy vegetables have played and continue to play in the food systems of African people in South Africa (Jansen van Rensburg *et al.*, 2007).

#### **2.4. Nutritional value of African leafy vegetables and their potential to contribute to food security**

According to Chweya and Eyzaguirre (1999), there is an extremely underrated reservoir of range of ALVs that are displaced in many rural households. Yet, they are extremely important to food security, nutrition and poverty alleviation throughout Africa. There is a

decline in the production, utilization and diversity of these vegetables, Gueye and Diouf (2007) argued that these ALVs have a tremendous ecological flexibility in relation to the local environmental conditions and their organoleptic qualities are highly valued by the local people. Most of these vegetables are obtained by harvesting since they grow naturally and not by means of cultivation, they have notably been consumed by rural communities and therefore have a potential to contribute to food security by providing direct access to readily accessible nutritious foods (Vorster *et al.*,2008).

Mibei *et al.*, (2011) suggest that ALVs are important for human diets and have the ability to provide food and nutritional security to various communities in Africa therefore forming a significant part of the traditional diet. Fifty-four African leafy vegetables studied in Kenya were found to contain higher levels of calcium, zinc compared with the popular exotic varieties such as spinach (*Spinacea oleracea*), Kale (*Brassica oleracea*) and cabbage (*Brassica oleraceavar capita*), despite their nutritional value the ALVs are underutilized, due to lack of awareness of their nutritional value in favour of the exotic ones (Nnamani *et al.*, 2009). ALVs represent inexpensive but high quality nutritional source for the poor segment of the population especially where malnutrition is wide spread (Nnamani *et al.*, 2009). According to a study conducted by (Ferioli *et al.*, 2013) it was prominent that vegetables from *Brassica oleraceae* family are among the most commonly grown and consumed worldwide.

The ash content, is a measure of the mineral content of food had values ranging from 8.10-6.30%, the fibre content of these ALVs ranged from 12.50-4.50%, this indicated that the fibre (roughage) content of the ALVs studied was high, the benefit of fibre is to promote digestion and prevent constipation when consumed, also the carbohydrate level of the underutilized ALVs ranged from 58.94%, which indicated that the ALVs can act as better food supplement in providing carbohydrate (Nnamani *et al.*,2009).

ALVs are rich in vitamin C which is a highly effective antioxidant and a very small daily intake of this vitamin is said to avoid deficiency disease scurvy in an adult, even in small amounts it can protect indispensable molecules in the body such as protein, lipid (fats), carbohydrates and nucleic acid (DNA and RNA) from damage by free radicals and reactive oxygen species that can be generated during normal metabolism as well as through exposure to toxins and pollutants (e.g. smoking), (Mibei *et al.*,2011).

## 2.5 Consumers' perceptions of ALVs

Perception refers to the entire process through which an individual becomes aware of his or her environment and interprets it in such a way that it will fit into his or her frame of reference (Joubert, 2010). When trying to understand perceptions of people it is important to understand “culture” as according to the American Marketing Association it models our patterns of behaviour. Various factors affect the consumer decision making process (group and individual factors as illustrated in Figure 2.1, as revealed in this figure factors influencing consumer decision making can be influenced by the individual beliefs or group beliefs, it would therefore be important for the purpose of this study to understand various factors that influence decision making of consumers.

ALVs are highly nutritious; however, the younger generation seems to be less interested in consuming these vegetables. They are only consumed and enjoyed by the elderly, thus the consumption and utilisation of these vegetables could end with the older generation.

Consumers usually attempt to coordinate their purchase behaviour with the perception of the values of their reference groups. Joubert (2010) stated that the relevance and the importance of studying consumer behaviour are of high significance.

According to Orech et al. (2007), 54 traditional leafy vegetables studied in Kenya contained higher levels of calcium and zinc compared with varieties such as spinach (*spinacea oleracea*), Kale (*Brassica oleracea*) and cabbage (*Brassica oleraea var capita*). More so the sub-Saharan Africa has a great diversity of leafy vegetables providing an affordable quality nutritional food source (Dansie 2008). Despite their nutritional value these ALVs continue to be underutilized, because of how it is perceived by important groups of consumers such as the young and urban consumers. ALVs have been believed to be the food consumed by the poor and those who cannot afford other foods (Voster *et al.*, 2007). African leafy vegetables are moreover underutilised by consumers because of their connotation with rural poor lifestyle and are often regarded as low status foods (FAO 2013). Many leafy vegetables are obtained by collecting in the wilds since they grow natural and not by means of cultivation and are therefore regarded as wild food and unsafe (Talení 201). In Tanzania the consumption levels of ALVs has fallen from previous reported levels of 20% to approximately 11% and even at just 2% for the wealthiest households, which provides evidence that its regarded as food for the poor (Anon 2013).

However, from a positive perspective these vegetables were perceived as healthy, affordable and delicious in a study on children's sensory acceptance in South Africa (van der Hoeven et al., 2013). In a study conducted in Mtubatuba- KwaZulu-Natal, there was general a positive attitude towards ALVs, the community in this study did not perceive them as food for the poor or toxic contrary to popular notion, they considered these vegetables as nutritious and good immune boosters (Sithole *et al.*, 2011). Constant downgrading of traditional vegetables and associated knowledge by research and extension had led to the labels of 'backward knowledge' and poverty foods', as a result this led to less willingness of the youth to learn about and eat these crops, however awareness creation and interest by researchers has changed this situation in perceptions as a result there is slightly a demand for information and seed of these ALVs (Voster *et al.*, 2007, Jansen van Rensburg *et al.*, 2007). It has also been noted that the ALVs are a domain of women in many studies, differences in cultural choice in terms of taste, type of plant and method of preparation have been noted in several studies, and however the cucurbits are highly valued in all regions. Knowledge of ALVs continues to be traditional knowledge and it is better understood by knowledge transmitted from individuals of households (Misra *et al.*, 2008). In Ghana, the most preferred ALVs is indicated through the observed buying patterns of consumers and trader's perception towards *Xanthosomamafafa* (cocoyam leaves), *Corchorus* (Ayoyo), *Amaranthus spp* (Alefu), and they are mainly preferred for their nutritional value (Quaye *et al.* 2009). According to Owuor and Olaima-Anyara (2007), dietary changes taking place among the rich and poor, as well as in rural and urban population has been documented. Some African people have neglected the link between culture and cuisine, many cultures have conformed to or adopted modern cuisines and many people a leafy vegetable with a bitter taste is commonly associated with medicine while one with sour taste or mild taste associated with food.

It has been noted in several studies that those individuals eating vegetables with milder tastes are commonly associated with urban links, while those eating ALVs with a bitter taste tend to have stronger rural attachment (Owour and Olaima-Anyara 2007). Studies have shown that these vegetables are eaten as relish with starchy foods, and the excess dried and stored, (Uusiku 2010). However, Leafy vegetables are highly perishable and which affect their availability, access and utilization, Therefore, the necessity to investigate techniques that would ensure their sustainable availability for consumption even during off season. As

stated by (Mepba et al., 2007) these vegetables are abundant in summer shortly after the rainy season, but become scarce during the dry season.

Ljbomir *et al.*, (2010) suggests consumer perceptions can be probed and analysed using the purchasing and consumption patterns. Furthermore, this literature review elaborates on the issues of malnutrition in the sub-Saharan Africa; the nutritional value of leafy vegetables and their potential to contribute to food security; the consumer perceptions towards the utilization of ALVs; consumer perceptions and the utilization of ALVs; consumer perspective towards the aesthetic and sensory attributes of ALVs; risk factors on the safety of ALVs; interventions to meet consumer needs and preferences; and consumer perceptions towards canned foods.

## **2.6 Consumer consumption patterns and utilization of ALVs**

According to Kimiywe *et al.* (2007), ethnicity was found to strongly influence choices and consumption of ALVs. Those originating from the same tribe usually consume same ALVs. The convenience of finding these vegetables was another factor of their choice and consumption, because they were found in the backyards of the gardens just after rainy season. In Nairobi only a few varieties were consumed, as relish accompanying staples such as ugali (maize porridge), rice and legumes and they were consumed once a month or rarely (Kimiywe *et al.*, 2007). In Zimbabwe, although they are consumed as relish accompanied by *sadza/isitshwala*, a thick porridge made mainly from the staple food crop maize, Moroyi (2013), argues that the food value of traditional vegetables in Zimbabwe is in general often ignored and receives little recognition from government due to a lack of knowledge about their importance.

According to Modi (2009), consumption of traditional foods is also related to gender and location, current lifestyle and or previous exposure to a traditional food during childhood may influence a person's preference for traditional consumption. Another important factor to the consumption of ALVs is urbanization. Urban populations are becoming increasingly detached from rural food production systems and are hence unaware of the consequences of their choices that routinely occur at a considerable distance from the urban consumption

point (Ingram *et al.*, 2010). Ethnicity and gender had effect on the use and preferences of the different crops, men were observed to prefer the more bitter taste and on the other hand children preferring milder taste (Voster *et al.*, 2007).

Many people in the low income and middle income countries particularly children continue to suffer from under nutrition, they consume insufficient proteins, vitamins and minerals particularly Iron, Iodine, Vitamin A and Zinc (WHO 2009). In a study conducted in Botswana ALVs were found to have more protein and fat than those reported of the exotic vegetables (Flyman *et al.*, 2007). However, according to the S.A water commission press release (2013) the popularity of specific species depends on a variety of factors including, availability, and ease of preparation, taste consistency and appearance. Furthermore, the underutilizations of ALVs have persisted due to lack of knowledge and awareness of their nutritional values in favour of the exotic ones (Nnamani *et al.*, 2009).

## **2.7 Gender dimension in African leafy vegetables**

Globally women play an important role in small horticultural production and marketing (Mitber and Waibell, 2011). Literature has also noted gender dynamics with regards to the consumption of ALVs. Men are reported to have less preference and consumption of ALVs compared to women (Kimiye *et al.*, 2007, Jansen van Rensburg *et al.*, 2007). In a study conducted by van der Hoeven *et al.*, (2013) trying to investigate the perceptions of parents on ALVs, it was noted that group discussions were female dominated and where there were males they were hesitating to comment on issues of discussion saying cooking and the use of ALVs is the female role. Leafy vegetables are grown and adapted to a wide variety of climatic conditions. The current climate is characterised with changes and fluctuations in rainfall and therefore ALVs can be a solution for many. The harvesting of the ALVs has been seen as a female domain. Planting of exotic vegetables requires water and there is increasing competition for water due to less rainfall as a result of the climate change variation effects. In the future, climate change will have an impact on the food systems and food security outcomes especially if the negative perception about ALVs is not corrected. These foods are known to be climate resistant. However, if the climate change continues there will be a decline in wild foods as well. According to Farnworthy *et al.* (2008), the most noticeable spatial requirement that people make for their food consumption is land on which crops are grown for human consumption and animal feed.

## **2.8 Consumers' perspectives on the aesthetic and sensory attributes of ALVs**

A food product identity is perceived by its sensory characteristics, which is of great importance in consumers buying judgement (Bryne *et al.*, 2013). Food consumption and perceptions are more or less seen as the continuity of everyday habits; yet the status of ALVs may hamper their full recognition the role played in the nutrition of others. Food are perceived as important for the image and reputation in the locality, for others attractiveness is more important than culture or technological processes (Bessiere and Tibere 2013). Consumers tend to prefer exotic vegetables which are available all season in the market but at times less nutritious and costly when compared to ALVs. In Europe innovations in traditional products impacted positively on the intrinsic product quality (improving healthiness and safety), and were found to be well accepted by consumers, however innovations pertaining to new distribution systems and formats e.g. vending machines, home deliveries or ready to eat meals were less accepted and affected image of the product (Cotillon *et al.*,2013).Innovations that provide consumers with relevant benefits without producing substantially changes in a product sensory quality are general well accepted. In Nigeria ALVs were eaten as relish together with starch foods (Uuisuku 2010).

None of the ALVs requires any special processing for cooking or consumption, though removal of stings from nettle and hairs from fond of vegetable fern could be specific requirement, most all ALVs are prepared like spinach and eaten as a form of stew or cooked in oil (Misra *et al.*, 2008). Western influences have considerable modified their food consumption patterns (Modi *et al.*, 2006). The leaves and other parts of ALVs that are eaten are prepared as potherbs or as relishes primary to accompany maize porridge and sorghum, other ingredients such as tomatoes and onions may be added to add taste in South Africa (Jansen van Rensburg *et al.*, 2007). While there is a variety of preparation methods for other vegetables such as exotic counterparts there is little knowledge on varying cooking methods or recipe documented on the ALVs.

## **2.9 Risk factors for contamination and microbial safety**

Leafy vegetable may be harvested mechanically or hand harvested. Some leafy vegetables are consumed uncooked such as lettuce. Each of these human contact points represent a potential opportunity for contamination. Therefore, diligent efforts have to be taken into consideration when dealing with leafy vegetables (exotic or ALVs). According to the FDA

(2009), food borne illness due to contaminated vegetables is on the rise and investigations into outbreaks have identified issues such as agricultural water quality, the use of manure as fertilizers, the presence of animals in the fields, the health and hygiene of workers handling fresh produce, during production, packing, processing, transportation, distribution or preparation as hazards to contamination. In the last 10 years the focus of food safety efforts has been on the farms, distribution points and value added processing operation. Food and vegetable processing operations have developed sophistication of food safety programme, such as Good Manufacturing practices (GMPs).and the principle of Hazard Analysis Critical Control Point (HACCP).

According to data from the centre for diseases control and prevention in the U.S., raw vegetables can transmit many micro-organisms which may be dispersed over the plant or appear as micro colonies embedded in plant tissue. In Canada, in the year 1995 a situation where 21 people associated with a hospital in Canada became infected with E.coli 0157:H7 was noted and it was found that they had consumed vegetables. FAO-WHO (2008), reported that leafy greens are grown and exported in large volumes, and have been associated with multiple outbreaks of a high number of illnesses. Leafy vegetables grown and processed in diverse and complex ways, as well as post-harvest activities contribute to the possibility of the presence of food borne pathogens.

ALVs mostly grow in the wild and this makes them prone to faecal waste, urine and hair from live animals and carcasses of dead animals which may directly contaminate produce and therefore make it unsafe for consumption. Domestic and wild animals as well as humans are potential sources of micro-organisms that are commonly associated with illness attributed to leafy vegetables. These include non-typhoid *salmonella* and *E.coli*, which are common food borne zoonoses, *Shigella*, *hepatitis A virus*, *listeria monocytogenes* which is an environmental and also a zoonotic bacterium (WHO, 2008). In the 1998, the U.S. Food and Drug Administration issued its guidelines to minimize microbial food safety hazards on fresh fruits and vegetables. These provided general food safety guidance on critical production steps where food safety might be compromised during growing, harvesting, transportation, cooling, packing and storage of fresh produce (leafy greens guidelines, 2010).

The lack of scientific documentation about ALVs poses questions to consumers about their safety, hygiene and quality. In Nigeria ALVs are preserved using sun drying method and

are used like freshly harvested vegetables for soups (Mepba *et al.*, 2007). It has also been noted that sun-drying results in poor quality products with variable moisture content and high microbial loads thus affecting their stability (Prabhu and Barret 2009). A study conducted in Tanzania have suggested that the traditional processing practice of sun drying reduce the concentration of carotenoids (Faber *et al.*,2010).In South Africa, the marketing of leafy vegetables harvested from the wild or as weeds is limited and mostly limited to drying and dried products (Jansen van Rensburg, 2007).ALVs are mostly abundant in summer, but several drying methods are used to ensure the availability of these vegetables during winter, sun-drying is the mostly used technique, then the dried product is stored in sacks, during storage other plants e.g. beans were used as a preservatives for the plants being stored, although sun drying is often a cheap and convenient method of preserving the ALVs, it may lead to loss of essential micro nutrients such as vitamin A and C (Voster *et al.*, 2007). Mepba *et al.*, (2007), pointed out that in Nigeria ALVs are preserved by sun drying, it is also noted that sun-drying results in poor quality products with variable moisture contents and microbial loads, thus affecting stability.

Today's consumers tend to be more concerned with food safety and quality as opposed to quantity. Furthermore, the aesthetic attributes of the vegetables are more valued as the price is not key determinant of purchasing and consumption. Studies have shown that various preservation methods, including refrigeration and sun-drying have an effect on the sensory attributes of some food products. Many ALVs are obtained by collecting since they grow natural and not by means of cultivation it is therefore a necessity in this study to determine the effect of canning on the microbial quality and safety of ALVs. Based on prevalence of contamination, *Escherichia coli* in leafy greens was consistently ranked first in the study conducted in USA designed to rank the relative public health impact of pathogens, followed by *Salmonella* in tomatoes and *Salmonella* in leafy greens.

## **2.10 Interventions to meet the consumer's needs and preferences**

Despite exciting opportunities offered through ALVs their underutilization is still a challenge. One of the challenges that are overlooked in literature is the limited ALV preparation methods. Voster (2007) confirms this by saying that ethnic groups tended to prepare their ALVs in only one way, thus suggesting a need to expose them to different methods and flavours, would be an important step in increasing the popularity of these vegetables (Voster *et al.*, 2007). Maguire (2013) mentioned the top ten trends for flavours in

South Africa as presented in Table 2.1. This could serve as a guide when developing canned ALVs. Using flavours that are considerably enjoyed could improve their overall acceptability and provide willingness to buying decision making by the consumers.

**Table 2.1 Trends for flavours**

Authentic taste	<ul style="list-style-type: none"><li>• Consumers are increasingly seeking processed food that taste as though it is home cooked</li></ul>
Proven flavour profiles	<ul style="list-style-type: none"><li>• Consumers more readily accept tastes they already know</li></ul>
Sensory excitement, balance in sweetness and bitterness	<ul style="list-style-type: none"><li>• Spicy originality from emerging ethnic cuisines</li></ul>
Authentic spice blends	<ul style="list-style-type: none"><li>• Traditional spices e.g. cumin</li></ul>
Hot and hotter	<ul style="list-style-type: none"><li>• Chilli continues to be popular flavour</li></ul>
Local is lekker	<ul style="list-style-type: none"><li>• Consumers are demanding more locally grown produce; traditional foods can be re-created in convenient formats.</li></ul>

### **2.11 Consumer perceptions of canned ALVs**

In the past people obtained their food from hunting fishing and farming (Abdumumeen et al., 2012). This situation continues to exist even in this present generation. According to research many people do not have enough land or access to land competent of producing and supplying the recommended 5-13 daily servings per year. Other challenges are due to the fact that some leafy vegetables, such as ALVs grow in certain parts in particular seasons (Rickman *et al.*, 2007). Other preservation and processing technologies that have been used for ALVs are canning, freezing and drying. This method of canning is practised at industrial level; however, in South Africa it is not common to find these ALVs in retail stores. The food industry is increasingly interested in ethnic foods that satisfy the sophisticated appetite of today's consumers (Hong *et.al.* 2011). However, it is not easy to develop a new product based on ethnic cuisine because non sensory responses factors such as neophobia and openness to new culture can evoke adverse responses from the consumers. A systematic sensory approach can guide the product development by

identifying both sensory and non-sensory factors affecting consumer acceptance. Therefore, sensory evaluation of canned ALVs would be an important step to determine consumer's perceptions and attitudes towards these products. Canning is according to Brown (2011), is a two-step process, First the food is prepared by being packed into containers which are then sealed, then containers are sterilised or heated to ensure that all micro-organisms are destroyed. Knechtges, (2012) states that the heating process in canned products kills many common pathogenic micro-organisms however two unanticipated hazards to food supply were noted. Botulism, a deadly disease caused by toxins produced from a spore forming bacterium called *Clostridium botulinum*. Botulinum is said to be not new to humanity, but conditions necessary for the formation of its toxins were enhanced by the canning process, it is said to be common in vegetables and animals, but these toxins can be destroyed by using temperature above boiling point, another second hazard introduced by canning process is contamination of foods with metal lead, but several strategies to reduce the amount of lead exposure from canned foods include coating the inside of the can with enamel exist. To also ensure that foods are safely processed, food management tools such as (HACCP) are becoming mandatory. Processing provides a means of presenting the food in a more convenient way for both consumers and caterers in a form that is ready to eat or requires little time to prepare. Canned products would also ensure that a product which was previously subject to seasonality is available all year.

South Africa according to the (Water Research Commission 2014), has not done enough to promote research on indigenous food species while the rest of the world has taken note of the commercial value of indigenous species, Countries like France, New Zealand and Israel have produced their commercial Home Melons (*Cucumis metvliferus*), also in California they have produce and cultivated Dovyalis (*kei apple*) at a commercial level. During the Napoleon wars, Napoleon was having difficulty in feeding his troops, he offered a prize to the person who could discover a new method of preserving food, and the winner was Nicolas Appert who invented the canning process in the late 1790s.

Fruits and vegetables are naturally healthy but one can protect their nutritional integrity and tailor products to suits your lifestyle and taste, (Miller, 2012). However, Ingham (2008), pointed out that when preserving vegetables, it is important to select high quality vegetables and allow heat to penetrate to the centre of the food or the coldest spot in the jar.

## 2.12 Summary

African leafy vegetables are a valuable source of nutrients. In terms of food security these vegetables are likely to address the nutritional status of those households that are poor and food insecure, for the following reasons: Firstly, ALVs are considered cheaper when compared to their counterpart's exotic vegetables. Secondly, these vegetables are said to be resistant to drought and looking at the current state of climate change the rainfall levels in some cases and higher temperatures will make exotic vegetables prone to poor growth thereby reducing the quantity and quality of vegetables suitable for human consumption. ALVs can make a significant contribution to food production because of their nature to adapt in harsh conditions. Thirdly, these vegetables will serve as a livelihood option for the rural people who are isolated from the markets. However, ALVs are not only food for rural people and strategies will be required to attract urban and young consumers to these foods because the impact of eating ALVs will be associated with health benefits and a possible solution to economic challenges by means of affordability of food source.

A strong initiative is supported by both government and research institutions linkages in attempt to promote consumption of ALVs, to reduce micro-nutrient deficiency in the South African population. However, utilisation of the ALVs have been reported to decrease, and therefore a key challenge would be creating awareness in all the population groups about the high nutritional value of these vegetables and changing perceptions and negative attitudes and also promoting consumption of ALVs as a nutritious food. Research needs to invest more on seed development of these vegetables as they often grow in isolated areas so that the future generation will not lose

A very serious sensitisation among groups such as the young people is needed as they often prefer junk or non-nutritive foods merely because of their lack of exposure to these vegetables, the key informants from rural arrears to be used to gather information of those leafy vegetables that were used in history and teaching them on new ways of bringing variety in cooking methods that would promote frequent consumption. It has been noted because in many studies that respondents complain about lack of variety and flavours of the ALV dishes. There is a wealth of information that can be found among the rural women on types of ALVs and their uses that can be used and documented and be transferred to younger generation.

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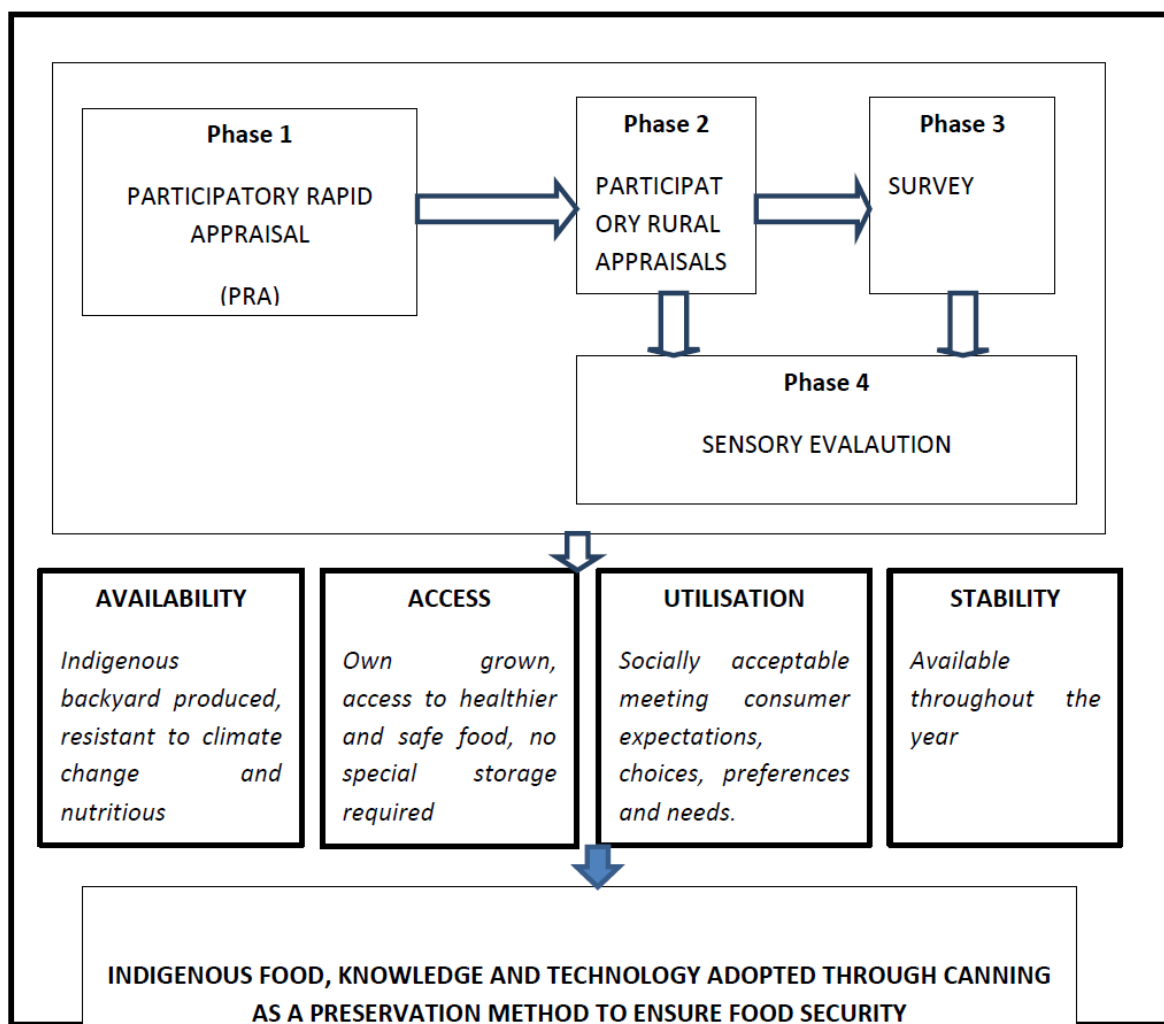
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## **Chapter 3 : Conceptual framework and methodology**

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### **3.1. Conceptual framework**

The study used a combination of qualitative and quantitative methods. The two methods were used to complement each other to provide a better insight on the effects and acceptability of canned ALVs. Qualitative methodology refers to research that produces descriptive data, (Brynard et al., 2014). Generally, the participants own written or spoken words concerning their experience and perception of ALVs were used and recorded. Quantitative approach in the form of sensory evaluation to assess the acceptability and preferences of canned traditional vegetables were also used. Quantitative methodology is associated with analytical research and its purpose is to arrive at universal statement (Brynard et al., 2014). Using the combination research methods in a form of participatory rural appraisal, surveys, and scientific experiments provided the researcher with a holistic insight of the effects as well as acceptability of canned ALVs for improved food security.



**Figure 3.1 Conceptual framework**

As presented in Figure 3.1, this study aims to interface indigenous vegetables with modern preservation technology (canning). In this study the researcher has noted that in Limpopo, collard greens and mustard greens are commonly used leafy vegetables. These vegetables are important suppliers of vitamins and minerals. The optimum health and nutrition of individuals is dependent on the regular supply of food and a balanced diet, which cannot be achieved if these vegetables are only available in certain seasons. Therefore, this study aims to introduce canned leafy vegetables and determine consumer acceptance.

The FAO (2008) definition of food security states that: food security is a situation that exist when all people, at all times, have physical, social and economic access to sufficient, safe, and nutritious food that meets their dietary needs and food preferences for an active and healthy lifestyle. The present study was carried out in four phases as discussed below. The first to third phase used a qualitative interpretive description design to determine and

describe the attitudes and perceptions of the old and youth participants from both rural and urban settings. The fourth phase which was the sensory evaluation phase used a quantitative approach to assess acceptance for canned ALVs.

### **3.1.1. Phase1: Rapid Rural Appraisal (RRA)**

Rapid rural appraisal is a systematic but semi structured activity out in the field and is designed to obtain new information and to formulate hypotheses about rural life (Crawford, 1997). It uses methods of cross checking information from different sources. In this study three local experts who are consumers of ALVs were identified. The local experts were interviewed about the techniques, processes, practises and preparations regarding ALVs. The three local experts have validated and verified each other's information on ALVs. The three most consumed ALVs were identified with which mustard greens (*Brassica juncea*) and collard greens (*Brassica oleracae*). Although these ALVs are seasonal but they are not being dried as compared to other ALVs. No particular reason was given other than that they are not dried.

Therefore, in this study the Rapid Rural Appraisal (RRA) using interviews and observation methodologies was done using triangulation where the key informants verified each other. This was done to enhance trustworthiness and validity of the data. The data collected from the local experts gave insight and informed the researcher on important aspects of preserving ALVs. Sampling of the key informants relies on the people in the community that are identified as the experts in the field of interest (Conrad and Schober (2008).

### **3.1.2. Phase 2: Survey Questionnaire**

A survey is defined as a method of gathering information from a group of individuals using identical procedures for each person (Evaluation Guide Stage 2, 2013). A survey using questionnaires was used to gather individuals' different opinions, knowledge and perceptions towards the consumption of indigenous vegetables. As stated by Fowler (2011) surveys are used for measuring the opinions, views and knowledge of a large group. Open ended questions were used, since they gave the respondents the chance of writing their own views and opinions in an open space (de Vos *et al.*, 2011). It also composed of closed questions where the respondents were only required to use the set of responses to choose one or more than one answer. According to de Vos *et al.*, (2011) in a closed questions the results of the study area being investigated can become available quickly and it can be

easier to compare responses. The responses to the statements were in a pictorial format of smiley faces. Likert scales were also used where the respondents had to indicate if they agree or disagree with a statement.

### **3.1.3. Phase 3: PRA using Focus group discussions.**

The participants in a focus group were given the opportunity to freely talk about and discuss their ideas and opinions. The thoughts and perceptions of the participants towards canned ALVs were discussed. Greenbaum (2000) noted that focus groups allow the researcher to scrutinize a whole host of perceptions, views, beliefs and attitudes about the field of study. Using word association, as a projective technique provided the researcher with the information of whether the participants would still perceive canned ALVs as traditional food

### **3.1.4 Phase 4: Sensory evaluation.**

On sensory evaluation a sample size of 60 people was used. They were divided into youth from rural areas (N=15), adults from rural area (N=15) and youth from urban (N=15), adults from urban areas (N=15). The learners were selected randomly using the class registers of Napscom secondary school and Khesethwane secondary school which listed the learners numerically in the alphabetic order. Mustard green and collard green leafy vegetables were selected for this study. Fresh leafy vegetables were used as the control and canned leafy vegetables were used as an experiment. The appropriate sitting arrangement, booth design, to minimize interactions between participants was implemented. Samples were coded with 3 random digit numbers and served in random order. Before the tasting process the participants took a sip of water and ate pieces of apples to cleanse the palate in order to reduce possible overlap of flavours. Sensory attributes such as texture, taste, aroma and appearance were used to rate the acceptability of the products. The participants were required to fill out a consent form before the tasting. A five scale facial hedonic questionnaire was used to accommodate those participants that are illiterate to be able to understand better, (1=very bad, 5= very good). Panellist to be used for sensory evaluation were selected according to the criteria as suggested by (Asensio *et al.*, 2012).

### **3.1.5 Phase 5: Nutritional analysis**

Commercial tins with canned ALVs were purchased from Glory Foods in the U.S.A. The cans were taken to Cedara Research station in Kwa-Zulu Natal for nutritional analysis. They were analysed for the macronutrients, fibre, protein fat and mineral contents of zinc, sodium, magnesium, manganese, phosphorus, calcium, potassium, copper and iron. Control samples were fresh ALVs harvested locally. All samples were analysed in duplicate.

### **3.2. Description of the study area**

The Limpopo Province of South Africa is approximately 125,754 square kilometres in area, with a highest point at 2,126m. Almost all rainfall occurs in the summer months between October and April. The average rainfall in Tzaneen where the study was conducted is 965mm per annum. The average temperature per annum in Tzaneen is 20.4. The main activity for this area is farming of fruits such as bananas, pineapples, litchis and pawpaw. This study was conducted in Mawa (representing the rural setting) and Lenyenye (representing the urban setting), Mawa is situated in the Limpopo Province of South Africa, in the Mopani district in the greater Tzaneen Municipality. It is situated 160 kilometres east of Polokwane. According to census 2011, the racial make of Lenyenye is described as 99.2% Black African, 0.2% Coloured, 0.3% Indian and Asian and Whites at 0.1%. The languages spoken are Northern Sotho at (87.8%), Sotho at (3.8%), Tsonga at (1, 7%), Zulu at (1, 4%) and other languages (5.2%). The widespread unemployment and poverty in the area is evident, (Census 2011). Schools were chosen to get the youths views as schools are closely interrelated to the community and youngest people attend schools.

### **3.3. Methodology**

The study used a combination of two methods, qualitative interpretive to explore and describe knowledge on perceptions of ALVs, qualitative methodology refers to research that produces descriptive data, (Brynard *et al.*, 2014). Generally, the participants own written or spoken words concerning their experience and perception of ALV's were used and recorded. A Quantitative approach in the form of sensory evaluation was followed to assess the acceptability and preferences of canned traditional vegetables, quantitative methodology is associated with analytical research and its purpose is to arrive at universal statement (Brynard *et al.*, 2014). The combination qualitative and quantitative methods in

this study were used to complement each other to provide a better insight on the effects and acceptability of canned ALV's.

A combination research method attempts to bring together different methodologies to gain a better understanding of a research problem and verify the methodologies. The aim was to supplement information from one source with the other by addressing issues from different data sources, or triangulate to comprehensively provide answers that could have been limited by a single approach. Triangulation means that different methods of collecting information are used to increase the validity of the study (Guion *et. al.*, 2011). Triangulation increases confidence in research data thus creating innovative ways of understanding a phenomenon, revealing unique findings and providing a clearer understanding of the problem which results from the diversity and the quantity of data used (Thurmond, 2001 in (Guion 2011). The principle of triangulation is based on the unobtrusive method by (Webb *et al.*, 2009). The essential goal of mixed methods research is to tackle research questions from any relevant angle, making use where possible of previous research and or more than one type of investigation (Anon 2014). By using a combination research in this study provided the researcher with an advantage to work with the communities to advance the traditional techniques.

### **3.3.1. Sampling technique**

A random systematic purposive sample was used in this study to generate new theories by obtaining insights of fresh perspectives about the recipe development for canning ALVs. Therefore, consumers and ALV driers formed part of this study. A total of 120 participants formed part of this study.

A quota purposive sampling was selected by segmenting the participants according to age and place of residence (rural or urban) and both genders were targeted. The quota sample defined as a type of non-probability sample in which the researcher selected people according to some fixed quota. In this study the participants were selected from community wards (*demarcation areas*) consisting of 30 urban youth, 30 rural youth, 30 urban adults and 30 rural adults who are ALV consumers. The quota sample was to form part of the focus group discussions. Focus group session normally consists of a small number of participants that are easy to handle. The focus group interviews are a valuable approach for obtaining in-depth information about perceptions, beliefs, attitude and

experiences. The different groups and location have provided different perspectives regarding the canned ALVs.

The quota sample participating in FGD later formed part of the recruits for the sensory evaluation who evaluated the canned ALVs. However, the participation was voluntarily.

In the field visit it was noted that the ALVs are consumed by all household members; however, they are most preferred by the adults compared to youth and children. The three most consumes vegetables were pumpkin leaves (Dithaka), Manawa and Lekoshe. On sensory evaluation a sample size of 60 people was used. They were divided into youth from rural areas (N=15), adults from rural area (N=15) and youth from urban (N=15), adults from urban areas (N=15). The learners were selected randomly using the class register, which listed the learners numerically in the alphabetic order.

**Table 3.1 Recipes used by local people**

<b>ALV</b>	<b>Ingredients</b>	<b>Method</b>
<b>Dithaka</b>	<ul style="list-style-type: none"> <li>• Water</li> <li>• Tomatoes</li> <li>• Salt</li> <li>• Powdered peanuts (optional)</li> </ul>	Wash vegetables and cut Boil water, pour vegetables in a saucepan, add salt Simmer and add tomatoes and simmer again.
<b>Manawa</b>	<ul style="list-style-type: none"> <li>• Salt</li> <li>• Tomatoes</li> <li>• Oil</li> </ul>	Wash vegetables, boil water and pour vegetables, stir once, put tomatoes and salt. Simmer then add oil or nuts.
<b>Lekoshe</b>	<ul style="list-style-type: none"> <li>• Water</li> <li>• Soda</li> <li>• Salt</li> <li>• Tomato</li> </ul>	Boil water, put salt, add soda or ashes, add vegetables and add tomatoes and simmer.

### 3.3.2. Data Analysis

Statically software provided an extensive and a wide range of tools that helped with data analysis and interpretation. Using the IBM Statistical Package for Social sciences (IBM SPSS), descriptive statistics, such as frequencies were done as an interpretation of the data,

Tashakkori and Teddlie (2010). Using descriptive statistics data was analysed, data validation was done to ensure survey questionnaire are complete and present consistent, response partitioning will be used as the researcher may want to compare responses from male and female respondents, youth and adult respondents on their perceptions on ALV's. Standard analysis ordinal and nominal data analysis, numerical survey data analyses using statistical equation, five-point scale (ordinal scale), chi square tests to measure relationships between nominal scale variables, percentages of responses per category were done.

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## **Chapter 4: Utilisation of African Leafy vegetables (ALVs) and consumer perceptions about canning of ALVs in the Limpopo Province.**

### **Abstract**

The utilization of ALVs as a food source for rural and urban communities in Limpopo was assessed through focus group discussions and interviews with sample of targeted consumers. Consumer perceptions about canning of ALVs were also assessed with a questionnaire. A quota purposive sample of 120 participants segmented according to age and place of residence (rural or urban) and gender integration was used in the survey. From the survey sample, willing subjects were recruited to participate in a series of six focus group discussions. The main findings indicated that ALVs are perceived as nutritious. Ninety-nine percent of the survey participants were consumers of ALVs. The consumption of ALVs was influenced by the belief that they were nutritious, easily accessible, chemical free and cost-effective.

Moreso, the ALVs had a sentimental value as they formed part of the African cultural heritage. There was no significant difference in preference for ALVs according to consumer geographical locations in urban and rural areas, respectively. Yet, there was a significant difference ( $P < 0.05$ ) in the preference for ALVs between the urban and rural dwellers as influenced by perceived ease of preparation and availability of a variety of preparation methods. The youth were less interested in the ALV consumption due to their perceptions of ALVs as having monotonous flavors and limited recipes compared to exotic vegetables (EVs). There was uncertainty about canning ALVs; this was an abstract concept to the consumers. The concerns about canning the ALVs were mainly related to their anticipated negative effects on sensory properties (taste 92%; colour 78%); nutritional value (87.4%); and price (56.7%), respectively. The participants (74%) were concerned that canning would introduce chemicals that would result in unfamiliar taste and compromise the nutritional content. The colour of ALVs was the most important quality attribute for the participants; a bright green colour was perceived as an indicator of high nutrient content. However, some consumers showed keenness on canning ALVs. Sixty-five percent of the participants (urban dwellers and youths) believed that canned ALVs would be convenient (time saving),

increase the availability of the ALVs, enhance their safety, and perhaps introduce some new flavors. Methods of preservation are required so that they are available throughout the year. The study showed that these vegetables are key to food and nutrition security of these communities; however, interventions are needed, as these vegetables are perishable. Canning could be used.

Key words: African leafy vegetables, Canning, Consumption, Perceptions

#### 4.1. Introduction

Under nutrition has been an underlying cause of child deaths estimated at about one third although a decline has been prominent from 25% in (1990) to 18% in (2005) but still according to the World Health organisation (WHO 2010), children under the age of 5years worldwide have stunted growth. There is an increased awareness of the health protecting properties of non-nutrient bio active components found in fruits and vegetables (Smith and Eyzaguirre 2007). Vegetables are considered to be vital components of daily diets. Although South Africa is a developing country with a good reasonably priced standing, it has challenges of economic inequalities and is faced with malnutrition, under- and over-nutrition. According to Faber and Wenhold (2007), malnutrition is a reality for rural households in South Africa. Taleni *et al.* (2012) indicated that consumption of African leafy vegetables is found to be the most sustainable way of adding variety to the diet and controlling micronutrient deficiencies. African leafy vegetables play an important role in alleviating hunger and malnutrition (van der Hoeven *et al.* 2013). Vegetables are vital to the general good health of human beings, providing essential vitamins and minerals, dietary fibre, and phytochemicals, and reducing the risk of dangerous diseases and other medicinal conditions. (Dias, 2010; Nnamani *et al.*, 2009). According to (van Rensburg *et al.*2007) collecting and cultivating green leafy vegetables continues to be prevalent among African people. Global attempts to alleviate malnutrition and food insecurity issues have been impeded by increasing food prices, wars and natural disasters (Orech *et al.*, 2007). According to the World Health Organization (2009), the leading health risk factor for low income countries is underweight; it is estimated to represent about 10% of the total disease burden and in combination with childhood underweight.

Food insecurity is defined as the lack of economic and physical access to food which is nutritious and socially acceptable in order to meet dietary requirements (McDonalds 2010). Food access is a major determinant of adequate dietary intake; it is a major challenge in South Africa. Statistics South Africa (SSA) (2011) indicated almost all South Africans had inadequate access to food and that the KwaZulu-Natal Province was the second highest with regard to food access constraints. A low intake of vegetables and fruits is among the top ten risk factors contributing to mortality worldwide (Faber *et al.*, 2010). There is currently a high recognition of ALVs from government and research due to the introduction

of WHO (2009) strategy to increase the consumption of fruits and vegetables to improve the well-being of the population. More so vegetables are the cheapest sources of natural foods and can admirably supplement the main cereals of the country (AgriInfo 2011). The World Health Organization (WHO) recommends a daily intake of more than 400g of vegetables and fruit per capita to protect against diet related chronic diseases. According to FAO (2010) nutritional status of each family member of the household depends on numerous conditions being met, food available, variety, quality and safety of food consumed.

## **4.2. Materials and methods**

### **4.2.1. Research technique**

A mixed research methodology was used for the study, i.e. both quantitative and qualitative methods were used. According to Teddlie and Tashokkori (2009), a mixed research methodology is used to answer research questions, which a single methodology cannot answer. It is intended to supplement information from one source with the other by addressing issues from different data sources, or triangulate to comprehensively provide answers that can be limited by a single approach. Triangulation means that different methods of collecting information are used to increase the validity of the study (Guion *et al.*, 2011).

### **4.2.2. Sampling technique**

The study was conducted in the Limpopo Province of South Africa, in the Mopani district in greater Tzaneen Municipality, Mawa block 8 representing a rural setting and Lenyenye representing the urban setting. Key informants were identified through a participatory rural appraisal. 120 respondents were used, whom included 30 rural adults, 30 rural youth, 30 urban adults and 30 urban youth. Schoolchildren above the age of 14 were used from Khesethwane secondary school and Napscom secondary school. For focus group discussions (FDG) and sensory evaluation, purposive sampling and quota sampling were used. From the survey participants, a purposeful quota sample of 20 adult women and 20 youths participated in a series of four focus group discussions (FDGs) and 60 subjects were randomly selected to participate in sensory evaluation. 30 from a rural setting and 30 from the urban setting.

### **4.2.3. Research procedure**

#### **4.2.3.1. Survey**

A newly compiled survey questionnaire was used (Appendix B). Questions were written in English and interpreted into *Isipedi*. In the survey questionnaire, graphical rating in the form of smiley faces were used where participants were required to rate their responses by means of pictures. A 5-point scale rating from very bad to very good was used. The questionnaire written in English and translated in *Isipedi* was administered to 120 respondents. The participants were requested to sit apart from each other and were given a questionnaire. Trained field workers assisted illiterate participants to fill out the questionnaire. The questionnaire was made up of 43 questions, which investigated consumption of vegetables, utilization of ALVs, perceptions on ALVs and ALVs selection criteria.

#### **4.2.3.2. Focus group discussion**

A series of focus group discussions were carried out on the perceptions of consumers about canned African leafy vegetables for the rural and urban populations. On average each focus group discussion took 45-50 minutes per group. The focus group discussion guide was formulated in English (Appendix A). The questions however were asked in *IsiPedi*.

### **4.3. Validity, reliability and trustworthiness of methods**

A pre visit was done to familiarize the researcher with the area and key informants were identified. The identified experts were also crosschecked to validate each other's information. For the survey, skilled field workers were used to oversee the questionnaire, which was translated from English to *IsiPedi* by two field workers who were proficient in both English and *IsiPedi* (local language). A qualified facilitator who was fluent in *IsiPedi* conducted focus group discussions. A research assistant was available to explain where the respondents needed clarity.

### **4.4. Data analysis**

Using the IBM Statistical Package for Social sciences (IBM SPSS), descriptive and frequencies were used as an interpretation of the data. Focus group discussions were analyzed by associating themes, concepts, patterns, and quotes that appeared from the

discussions with the applicable literature.

## 4.5. Results and discussions

### 4.5.1. Demographics

In total 120 respondents, (n=120), participated in the survey questionnaire. It was expected that the majority of the respondents would be females in the focus group discussions and survey but the Table 3 indicates that more males participated. On average about 51.7 % of the respondents were males. The socio- demographic data also indicates that these participants had a low educational background and with very high rate of unemployment. However, the rate of employment was revealed higher in urban area with 20.8%. The pensioners were also mostly found in the rural area. In addition, 65% of the rural participants had lower literacy levels as compared to urban areas. Most of the respondents in both areas were single (70.8%) and unemployed (78%).

**Table 3 Socio demographic statistics of the respondents**

		Study area		Total
		Mawa – khesethwane	Lenyenye	
Gender	Female	25 (20.8%)	33 (27.5%)	58 (48.3%)
	Male	30 (25.0%)	32 (26.7%)	62 (51.7%)
<b>Total</b>		<b>55 (45.8%)</b>	<b>65 (54.2%)</b>	<b>120 (100.0%)</b>
educational level	no formal education	65.0%	0 (0%)	6 (5%)
	Primary	7 (5.8%)	1 (0.8)	8 (6.7%)
	Secondary	41 (34.2%)	37 (30.8%)	78 (65%)
	Tertiary	1 (0.8)	27 (22.5%)	28 (23.3%)
	<b>Total</b>	<b>55 (45.8%)</b>	<b>65 (54.2%)</b>	<b>120 (100%)</b>
marital status	Single	38(31.7%)	47(39.2%)	85(70.8%)
	Married	16 (13.3%)	14 (11.7%)	30% (25.0%)
	Divorced	0 (.0%)	3 (2.5%)	3 (2.5%)
	Widowed	0 (.0%)	1 (.8%)	1 (.8%)
	Separated	1 (.8%)	0 (.0%)	1 (.8%)
	<b>Total</b>	<b>55 (45.8%)</b>	<b>65 (54.2%)</b>	<b>120 (100.0%)</b>
Employment	employed full time	1 (.8%)	25 (20.8%)	26 (21.7%)
	employed part time	5 (4.2%)	4 (3.3%)	9 (7.5%)
	Unemployed	42 (35.0%)	36 (30.0%)	78 (65.0%)
	Pensioner	7 (5.8%)	0 (.0%)	7 (5.8%)
<b>Total</b>	<b>55 (45.8%)</b>	<b>65 (54.2%)</b>	<b>120 (100.0%)</b>	

#### 4.5.2. Consumption of ALVs by respondents

When the participants were asked if they consumed ALVs, most (99.2%) indicated that they consume ALVs while only 0.8% revealed they do not consume them. This was a very positive response and eating of these ALVs were associated with the benefits of their nutritional value.

#### Preference for African leafy vegetables

As specified in Table 4.1, descriptive analysis for the survey shows that overall the respondents had a positive preference for ALVs. For instance, 30.8% suggest that the preference for ALVs was good and 54.2% was very good. Only 2.5% recorded these ALVs as preferred very bad.

A chi square test was performed to show if there were differences in their preference on the consumption for ALV. The result for chi square test shows that there was no significant difference ( $p=0.145$ ) in preference between the two study areas Mawa and Lenyenye.

**Table 3.1 : African leafy vegetables preference**

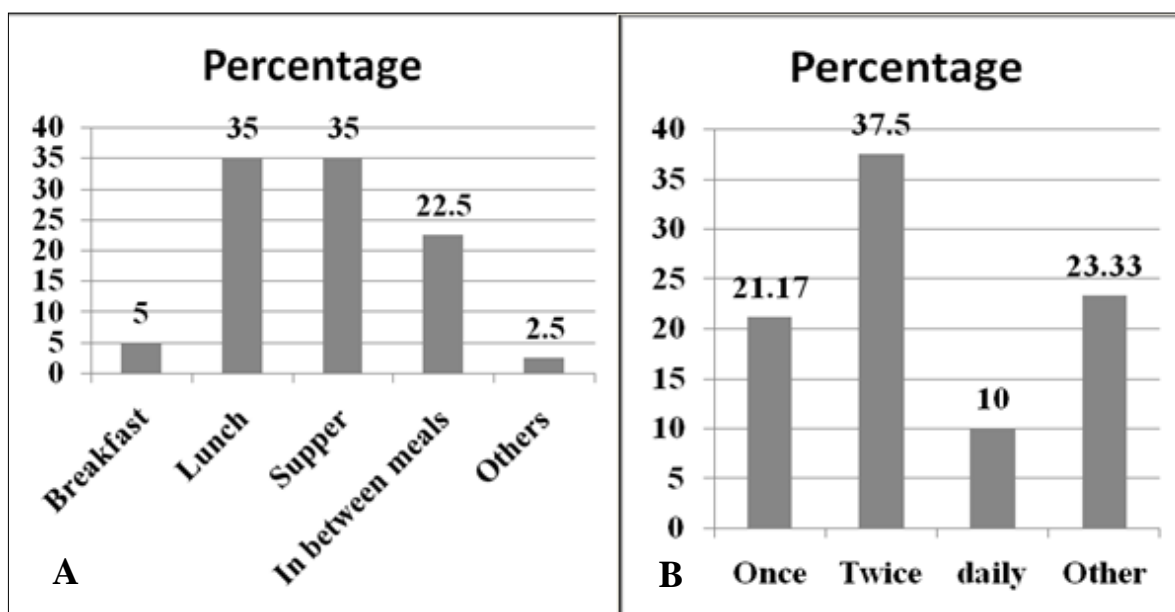
		Very bad	Bad	Average	Good	Very good
Study area	Mawa –khesethwane	0.8%	0.8%	2.5%	12.5%	29.2%
	Lenyenye	1.7%		9.2%	18.3%	25.0%
Total		2.5%	0.8%	11.7%	30.8%	54.2%

When the two study areas were analysed in terms of their preference for exotic vegetables it was shown that Lenyenye representing an urban setting had a high preference for exotic vegetables,  $P=0.817$ . It is revealed in many studies that urbanisation has been linked with loss of familiarity with ALVs and their use.

**Table 4.2 Preference for exotic vegetables in two study areas**

		Very bad	Bad	Average	Good	Very good
Study area	Rural	0.8%	2.5%	5.0%	19.2%	18.3%
	Urban	0%	2.5%	5.0%	25.8%	20.8%
Total		0.8%	5.0%	10.0%	45.0%	39.2%

The most important findings of focus group discussions are on participants for focus group preference on ALVs. The ALVs were consumed almost on a daily basis with an average of twice per day mainly during lunch and supper (Figure 4.1). The focus group discussions showed that this particular consumption pattern was mainly common in rural areas as compared to urban areas. From the focus group discussions, it was found that they were mainly consumed as a relish accompanying maize meal. These leafy vegetables in Africa have been uses as a relish, accompanying staple based cereal diets, and are generally reported to be rich in micro-nutrients (Mavengahana et al., 2013, Ovlai et al., 2014).



**Figure 4.1: (A) Meal time consumption of ALVs (B) ALV consumption per week**

As shown in Table 4.3 ALVs are mostly valued for their nutritional benefit in both the views of young and adult people and also in both rural and urban areas. Cost effectiveness of these vegetables was not the greatest motive for consuming these ALVs. The second greatest motive for consuming ALVs was that they are easily available. A similar finding was found in a study conducted by Faber *et al.*, (2010) in Limpopo and KZN, these vegetables were consumed for their benefit as a nutritional source. Literature has confirmed that these African vegetables grow wild and are freely available in the field as they do not involve any formal cultivation (Odhav *et al.*, 2007). During focus group discussions the respondents also reported that they consume these vegetables for health and medicinal benefits. Certain African leafy vegetables are categorized as functional foods since that they have health benefits in addition to basic nutrition (van de Walt *et al.*, 2009)

**Table 4.3 Motivation for consuming ALVs**

	%				
	Strongly agree	Agree	Average	Disagree	Strongly disagree
Nutritional value	84.2	5.8	9.2	0	0.8
Chemical free	71.7	6.7	15.8	4.2	1.7
Cost effective	61.7	12.5	15.0	2.5	8.3
Easily available	73.3	6.7	12.5	3.3	4.2

Table 4.4 shows that ALVs were perceived to be the most valued food items within households. It mainly played a key role as a food security buffer, represented cultural heritage and they are medicinal. As stated by World Bank (2005) African leafy vegetables are known for their importance in providing food security to millions of Africans both in the rural and urban areas. African leafy vegetables are now contributing to the diet of the people furthermore still continues to be associated with health benefits. According to a study conducted in the United States in 2007, diabetes is considered the seventh leading cause of death, and participants in the present study have shown the role the ALVs can help in controlling blood glucose levels and reduce complications (Lee 2007). There are certain types of ALVs that are perceived to be more health beneficial to the elderly “ALVs are eaten by everyone in the household but Nku is mostly preferred by old people because it is believed to reduce high blood pressure and helps control diabetes”.

**Table 4.4 Focus group discussion regarding traditional vegetable**

<b>Theme</b>	<b>Concepts</b>	<b>Quotes</b>	<b>Discussion</b>
Local production	Livelihood task	“you can find it at home”	South Africa is known to have varieties of these wild plants which are remarkable nutritious. And even though they are neglected they still offer numerous opportunities in alleviating hunger and food security.
Natural		“You do not have to plant it; they grow on their own” “They are seasonal”	These African leafy vegetables are considered natural foods as they can appear in the backyards after heavy rains.
Use indigenous knowledge to prepare it		“we cook it in our traditional way, it requires less ingredients”	Little information is available on cooking instructions of these vegetables
Generation heritage		“It was eaten in the olden days” “They have been utilized for decades by Africans”	Communities in Africa have a long history of using these vegetables.
Medicinal	Healing properties	“we use it for medicinal purposes” “We consume ALVs because they give our body nutrients” “We consume ALVs to reduce high blood pressure” ”you do not age quickly and you do not gain weight if you consume ALVs”	The contribution that these resources make to maintaining health and preventing diseases is general unrecognised.

When asked who consumes African leafy vegetables (ALVs) participants revealed that: “everyone eats ALVs at home but children get tired of ALVs because they are consumed almost every day”. According to (Talení *et al.*, 2011, Voster *et al.*, 2007) the poor preparation methods used when cooking ALVs could be a setback to their consumption especially because the children and the youth consider taste to be an important factor in food. The younger generation is more interested in taste and texture of the fattier foods popularised by the media. There is a limited variation in methods of preparation or recipes for most of the priority ALVs, with main ingredients being water, salt and bicarbonate of

soda. This was noted when participants were probed on ingredients used for preparing these vegetables.

### 4.5.3. Participants' perception on the consumption of ALVs

Table 4.5 discusses the general participant's perception on ALVs. African leafy vegetables have been found to be affordable source of several micro-nutrients. However, the use is deteriorating and their familiarity over the years would be lost if the younger generations are not being educated on the significance of these vegetables. The attitudes and perceptions of people towards these vegetables are not entirely understood. The contribution of African leafy vegetables to the livelihood of the poor in rural areas is widely acknowledged (Kepe 2008.).

**Table 4.5: General participant's perception on ALVs**

		Rural	Urban	<i>P</i> = value
ALV are food for rural people	Yes	3.3%	7.5%	0.248
	No	42.5%	46.7%	
ALV are for the elderly	Yes	3.3%	2.5%	0.536
	No	42.5%	51.7%	
ALV should not be consumed by the youth	Yes	0.8%	6.7%	<b>0.030</b>
	No	45.0%	47.5%	
ALV are food for low income class	Yes	5.8%	3.3%	0.214
	No	40.0%	50.8%	
ALV are backwards	Yes	6.7%	5.0%	0.366
	No	39.2%	49.2%	
ALV are more nutritious than exotic vegetables	Yes	45.0%	42.5%	<b>0.001</b>
	No	.8%	11.7%	

Focus group discussion as shown in Table 4.5 revealed that the ALVs are not regarded as food for the poor, neither as food for the low income class and are considered to be more nutritious than the exotic counter parts.

In South Africa there has been a great shift, people moving from rural to urban areas and this has led to great changes in socio-cultural and natural environment (Vorster *et al.* 2008). However, findings from this study indicated that even the highly educated with better incomes residing in urban areas still do not approve to the fact that these vegetables are for the low income class. The need to promote consumption of ALVs need to consider the different settings, taking into account the rural and urban differences (Faber *et al.*, 2010). In most parts of the developed world these vegetables are regarded as ‘weeds’ but in Africa other and other developing counties, these plants form of the daily diets of many rural households (Senyolo *et al.*, 2014). The potential value for food security of these plants is also recognised by the FAO together with Biodiversity International (WHO 2009). Even though socio- economic changes that have taken place in Africa, have changed the eating habits in both rural and urban set ups, people in Africa still value these ALVs (Orech *et al.*, 2007). There was a significant difference ( $p < 0.05$ ) between the views of whether ALVs should be eaten by the youth with members originating from rural areas and urban households. There was also a significant difference in the views of participants, with more urban consumers agreeing on whether these vegetables are more nutritious than the exotic counter parts. Among the consumers the popularity of these vegetables in the diet is as a result of factors including their, taste, preference and ease of preparation (Vorster *et al.*, 2007). A positive shift has been noted as the respondents were confident that these vegetables are not backward foods or low class foods, contrary to studies conducted previously where these vegetables were regarded as ‘backward’ foods (Weinberger 2004), it is evident from the findings that there is future for these vegetables if enough effort is put to promote their consumption.

In tropical Africa leafy vegetables are traditionally cooked and eaten as a relish together with the staple food of that particular region (Olvai *et al.*, 2014). Despite the fact that these vegetables have been in decades cooked traditional using ingredients such as salt and water, findings from this study indicates that the respondents were eager to have them prepared in different methods including addition of different flavours to make them more delicious, however participants felt that addition of spices would not be appealing with a total of 89% saying spices are not important in ALVs (Table 4.6). In a study conducted by (Faber *et al.*, 2010), nearly all respondents used the same ingredients during preparation of ALVs. In this study it was also discovered that only the same ingredients are used in preparation of ALVs, and that there is a lack of variety. Taste preferences of the youth have a negative influence

on the utilisation of ALVs; therefore, a new paradigm of introducing flavours to ALVs has to be reached. More urban consumers want it chemical free.

**Table 4.6: Participants' perception on the flavour of ALVs**

		Study area		Total	P= Value
		Rural	Urban		
I would enjoy if ALVs have a variety of flavours	Yes	33.3%	44.2%	77.5%	0.249
	No	12.5%	10.0%	22.5%	
ALVs would be very exiting with the taste of tanginess	Yes	34.2%	35.8%	70.0%	0.318
	No	11.7%	18.3%	30.0%	
ALVs would be very exiting with sweet and sour taste	Yes	27.5%	29.2%	56.7%	0.498
	No	18.3%	25.0%	43.3%	
ALVs would be exiting with bitter sweet taste	Yes	21.8%	19.3%	41.2%	0.210
	No	24.4%	34.5%	58.8%	
Spices are important in flavouring ALVs	Yes	6.7%	3.4%	10.1%	0.134
	No	39.5%	50.4%	89.9%	
Local produced food is good	Yes	42.5%	50.8%	93.3%	0.807
	No	3.3%	3.3%	6.7%	
ALVs should be chemical free	Yes	28.3%	45.8%	74.2%	<b>0.004</b>
	No	17.5%	8.3%	25.8%	

**Table 4.7: Findings from focus group discussion on the consumption of ALVs by younger generation**

Question	Theme	Concepts	Quotes	Discussion
ALVs consumption by younger generation	Limited consumption	Stigmatisation	“most people think morogo is for poor people”	Variation in diets through increase utilisation and consumption would help improve the status of these vegetables, Major constraint in consumption of ALVs by younger generation is associated with lack of diversity in cooking methods.
		Preferences	“They like meat a lot” “A meal without meat is not a meal”	Youth usually prefer the junk and unhealthy food
		Lack of variety in preparation methods	“lack of variety, that is why they do not like it” “they like it but it depends on the way it is prepared” “Morogo must not be served with meat because leave morogo and eat the meat”	The most commonly used method for preparation of these vegetables is boiling. Therefore there is a need to develop new recipes on cooking these vegetables to appeal to the youth.
		Lack of flavour	“we do consume morogo but it does not have flavour, as a result we prefer junk food”	Taste sensory attribute is very important to young people, and most of the ALVs have a bitter taste.

As indicated in Table 4.7 the lower level of consumption by the younger generation is as a result of lack of awareness these vegetables have in contributing to a balance diet and their nutritional status. In a study conducted in Nigeria it was noted that these plants are potentially capable to provide in essential nutrients needed for good health (Nnamani 2009). According to the FAO (2006) fruits and vegetables when eaten in daily in sufficient amounts they assist in the prevention of chronic diseases such as diabetes, stroke, heart failure and reduce the deficiencies in micro-nutrients and vitamins.

Parents in the urban area also indicated that they work during the day and therefore they do not have time to cook but buy take away food, and urban youth alluded to this “*we do consume morogo but it does not have flavour, as a result we prefer junk food*”. Good nutrition is required for cells of the immune system and all the supporting tissues so that they can be built, grow strengthen and carry out their jobs in the body (Maczulak 2012). Junk food is an informal term applied to some foods which are perceived to have little or no nutritional value (Abdulmumeen *et al.*, 2012). According to Alexanndra (2010) food is fuel and therefore eating junk food is not the best option as most of these foods contain no or little nutritional value. Junk food are best known to contain salt, sugar, fat and even chemicals. Vegetables are good food for the young and old as they contain vitamins, proteins and fibre.

#### **4.5.4. Participants’ perception on the selection criteria for ALVs**

Participants were asked on the criteria they use during ALVs selection. A Likert type scale questionnaire was employed where 5, means they strongly agreed that the entity is important as a selection criteria and 1 denotes they strongly disagree on the importance of the entity in question as selection criteria. Table 4.8 depicts the participant’s perception on different criteria used for ALVs, selection. A total of 92.5% of the respondents strongly agreed that taste was the main reason for selecting ALVs for consumption, nutritional value of ALVs was ranked as second reason for selection at 87.4%, whilst 78.3% of the respondents indicated that colour was the main selection criteria for ALVs, and about 75.8% believed appearance was the main selection criteria. About 65% of the respondents said convenience of these vegetables is considered as a selection criterion, and the price of the ALVs as a selection criteria was ranked lowest at 56.7%. Generally, respondents suggested that canned ALVs would change the colour of ALVs, these are some of the quotes: “*cooking before canning would change the colour and taste because they might not*

*use the ingredients that we use*". Another possible reason why canned ALVs cannot be easily acceptable by other people as they already believe colour will change. According to (Rickman *et al.*, 2007), most people do not have enough planting spaces capable of supplying the recommended 5-13 daily serving of fruit and vegetables year round. It is notable that these vegetables are only available in specific seasons such as summer, therefore canning can improve the nature of these vegetables to products that can be consumed throughout the year, while respondents have believed that canned ALVs will be less nutritious than fresh ALVs, studies have shown that this not the case. The findings of this study also revealed that price is another selection criterion for these vegetables, they are inexpensive. However, according to Chelang *et al.* (2013), ALVs would fetch a higher price at the retail stores than in open markets. However, this would increase the possibility of attracting clientele with higher incomes and attaching more importance to the more anxious with nutritional value of foods. Mild or minimal processing and preservation treatments lead to high convenience advantages to consumers (Habwe *et al.*, 2012), in this study 65% of the respondents agree that convenience would be criteria for selecting ALVs, however concerns on canning exist.

**Table 4.8 : Selection criteria for ALVs**

		Strongly agree	Agree	Average	Disagree	Strongly disagree	Total
<b>Color</b>	Rural	53 (44.2%)	0 (0%)	1 (0.8%)	0 (0%)	1 (0.8%)	55 (45.8%)
	Urban	41 (34.2%)	3 (2.5%)	15 (12.5%)	0 (0%)	5 (4.2%)	65 (54.2%)
	Total	94 (78.3%)	3 (2.5%)	16 (13.3)	0 (0%)	6 (5.0%)	120 (100%)
<b>Appearance</b>	Rural	51 (42.5%)	1 (0.8%)	2 9 (1.7%)	0 (0%)	1 (0.8%)	55 (45.8%)
	Urban	40 (33.3%)	3 (2.5%)	17 (14.2%)	2 (1.7%)	3 (2.5%)	65 (54.2%)
	Total	91 (75.8%)	4 (3.3%)	19 (15.8%)	2 (1.7%)	4 (3.3%)	120 (100%)
<b>Taste</b>	Rural	55 (45.8%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	55 (45.8%)
	Urban	56 (46.7%)	3 (2.5%)	6 (5%)	0 (0%)	0 (0%)	65 (54.2%)
	Total	111 (92.5%)	3 (2.5%)	6 (5%)	0 (0%)	0 (0%)	120 (100%)
<b>Nutritional value</b>	Rural	53 (44.5)	1 (0.8%)	0 (0%)	0 (0%)	0 (0%)	55 (45.8%)
	Urban	51 (42.9)	1 (0.8%)	11 (9.2%)	1 (0.8%)	1 (0.8%)	65 (54.2%)
	Total	104 (87.4)	2 (1.7%)	11 (9.2%)	1 (0.8%)	1 (0.8%)	120 (100%)
<b>Price</b>	Rural	43 (35.8%)	6 (5%)	1 (0.8%)	1 (0.8%)	4 (3.3%)	55 (45.8%)
	Urban	25 (20.8%)	6 (5%)	24 (20%)	4 (3.3%)	6 (5%)	65 (54.2%)
	Total	68 (56.7%)	12 (10%)	25 (20.8%)	5 (4.2%)	10 (8.3%)	120 (100%)
<b>Convenience</b>	Rural	45 (37.5%)	2 (1.7%)	4 (3.3%)	2 (1.7%)	2 (1.7%)	55 (45.8%)
	Urban	33 (27.5%)	2 (1.7%)	26 (21.7)	1 (0.8%)	3 (2.5%)	65 (54.2%)
	Total	78 (65%)	4 (3.3%)	30 (25.0)	3 (2.5%)	5 (4.2%)	120 (100%)

Table 4.9: summarises the findings of focus group discussion on participants concerning canned food. Participants were asked about their perception towards the possibility of ALVs canning and its implication towards the food safety. The easy of perishability of ALVs poses an extreme hazard to their marketing and distribution, as they often go to waste during off seasons (Shiundu and Oniango 2007). The results showed that the respondents felt that trustworthiness of canning a concern and there was no significant difference in views of participants from the rural and the urban study areas ( $p < 0.05$ ).

**Table 4.9: Perception on canning**

		<b>Rural</b>	<b>Urban</b>	<b>P = value</b>
ALV have a shelf life of more than a year when preserved	Yes	40.8%	45.0%	0.347
	No	5.0%	9.2%	
I trust the people who dry ALV	Yes	40.8%	46.7%	0.628
	No	5.0%	7.5%	
ALV cannot be canned	Yes	22.5%	20.8%	0.242
	No	23.3%	33.3%	
the expiry date are not important for ALV	Yes	22.5%	33.3%	0.171
	No	23.3%	20.8%	

The focus groups showed that there were concerns about canned ALVs Table 4.10. When participants were asked if they would still regard canned ALVs as traditional the participants revealed that they would not trust it, and that they believe that it would be now unnatural as preservatives and chemicals will be added. “No, because the moment I think of canning I remember canned baked beans, they taste like they have sugar”. However, there were conflicting views especially from the urban and youth, some youth respondents said: “Yes, it would still be traditional morogo but the problem will be added chemicals”. What was observed is that there is a rising concern about food safety from both rural and urban people both of all age groups. The incidence of some inherent anti nutrients and toxic substances in vegetables has been a major hindrance in hitching their nutritional benefit (Musa *et al.*, 2012). Therefore, canned vegetables could be a possible solution for the future since canning destroys toxic substances.

Participants perceived that canned ALVs will have detrimental effects on their health due to the poison associated with preservatives that will be used during the canning process. However according to Maczulak (2012), food toxicities occurs when microbes growing in food secrete a toxin that causes illness when eaten.

Furthermore, chemical preservatives are used to allow food to be stored without spoiling for several months or years. Chemicals that are safe for consumption are used according to the GRAS list such as Ascorbic acid, benzoic acid, butylatedhydroxynisole (BHA), butylatedhydroxytoluene (BHT), methylparaben, propylparaben, propionic acid, sodium benzoate, ascorbic acid and sulphur dioxide. Canning involves cooking food sealing it in a sterile cans or jars and boiling the containers to kill or weaken any remaining bacteria;

therefore, people can still contribute their recipes on how they cook their ALVs. At present the majority of the food consumed by the world population is supplied by the food industry (Abdulmumeen *et al.*, 2012).

Trustworthiness of canning to maintain adequate levels of nutrients was in question. Sensory properties such as aroma, texture, and colour was expected to change due to canning. Although participants in the study indicated concerns about the nutritional value of canned ALVs, research reveals that despite the fact that canned products are regarded to have smaller amounts of nutrients than fresh or frozen products this not always true (Rickman *et al.*,2007).

Studies have confirmed that various preservation methods have an effect on sensory attributes of some food products (Mepba *et al.*, 2007, Anjana *et al.*, 2007). Nevertheless, other studies have shown that the loss of dietary antioxidants is caused by the cooking method, cooking time and amount of water added (Cartea *et al.*, 2010). Therefore, by merging information gained from these studies concerning how nutrients are lost in vegetables, it might be possible to successfully use the canning technique to result in a product with even better health properties. One technique that has not received attention in the literature is canning of ALVs. Canning is currently practised at industry level, however in South Africa it has not been tried to preserve ALVs. Nearly half of the respondents reported more concerns on canned ALVs as it is indicated in the table above. Collard greens (*Brassica oleracea*) have proved beneficial in reducing the risk associated with cardiovascular diseases (CVD) development and progression (Johnson *et al.*, 2013). This article study therefore proposes the use of collard greens and mustard greens for the purpose of sensory evaluation.

**Table 4.10: Concerns and benefits of canning**

Theme	Concepts	Quotes	Discussion
Cost	Expensive limiting purchasing power/afford ability	“we get our morogo for free at home but canning would be costly”	ALVs are naturally available in specified seasons and if there is no post-harvest technique applied, this would mean that there are insufficient vegetables consumed by households and this can impact their nutritional status.
Sensory characteristics	Unfamiliar taste	“ <i>cooking before canning would change the taste because they might not use the ingredients that we use</i> ”	<i>ALVs are believed to have a pleasant taste and most favourite dish therefore canning would influence their sensory characteristics.</i>
	Nutritional content	“nutritional value will not be maintained	Studies have shown that canning of leafy vegetables does not have a negative effect on their nutritional quality.
Shelf life extension		“Gradually <i>morogo</i> is decreasing because of a weed which kills <i>morogo</i> , canning is the best option” “insects and bacteria will be killed during the process of canning”	Even though there were no benefits of canning mention by the rural old but the youth felt slightly that canning would increase their shelf life.
Lower food toxicity	Microbes reduction		Fruit and vegetables are natural contaminated with microorganisms and many of these microorganisms possess pectin degrading enzymes, therefore canning would be a best.

#### **4.6. Conclusion**

African leafy vegetables are a valuable source of nutrients and have the ability to contribute to food security. The findings of this study indicated that African leafy vegetables are valued for their nutritional value. The status of these crops has improved, negative perceptions referring to them as poverty foods have diminished. However, there is a need for improved variation in preparation methods to attract the youth to these products. Strategies to attract the youth to utilize ALVs needs attention as they often prefer junk foods, which in most cases are less nutritious and detrimental to human health.

There is an opportunity for the acceptance of canned ALVs, especially by the younger generation from both rural and urban communities. However, local recipes would have to be integrated, be locally produced (traditional identity), use less or no chemicals and try to retain the original colour. In addition, awareness creation and education about the canning process would be beneficial in changing consumer negative perceptions towards the canning of ALVs.

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## **Chapter 5: Effect of canning on the nutritional composition and consumer acceptability of African leafy vegetables (collard and mustard greens).**

### **Abstract**

The effect of canning on the nutritional composition of African leafy vegetables was determined by comparing the nutritional composition of samples of canned ALVs (Collard greens (*Brassica oleraceae*) and mustard greens (*Brassica juncea*), with their corresponding fresh forms. The standard AOC methods for nutritional analysis were used. Canning resulted in increased fat content, whilst crude protein of both canned collard greens and mustard greens was lower than that of their fresh forms. Content of fibre for canned collard green were higher, as mustard greens fibre decreased. Mineral contents of the minerals such as, Ca, Mg, K, P, and Cu decreased with canning. Samples of canned ALVs were found to be best providers of Mn and Zn. Canned collard greens were best providers of iron. The effect of canning on consumer acceptability was assessed through sensory evaluation. A sample of 30 urban residents and 30 rural residents evaluated the consumer acceptability of mustard and collard greens, using a five pictorial hedonic scale. Overall canned ALVs had a lesser taste compared to their corresponding fresh forms. Generally, most of the nutrients analysed were not highly affected by canning except for protein and fat. Investigation shows that the taste of canned ALVs is not ideal. Therefore, there is a need to improve taste of canned vegetables for consumer acceptability.

**Key Words:** African leafy vegetables, nutritional composition and consumer acceptability.

## 5.1. Introduction

The beneficial of fruits and vegetables as antioxidants have been acknowledged (Rico *et al.*, 2007). The daily African are dominated by starchy staple foods (Kwenin and Dzomeku 2011). Plant -based diets could act as a first line management for chronic illnesses (Tuso *et al.*, 2013). In Africa there are an excessive variety of traditional leafy vegetables (ALVs) used for food and medicinal purposes Jansen Van Rensburg (2007). Inhabitants in Africa have a lengthy history of using African leafy vegetables to supplement their diets (Odhav *et al.*, 2007). In South Africa, a nutritional dilemma is found with many children and adults suffering from micronutrients deficiencies (Schönfeldt and Pretorius 2011). African leafy vegetables are the cheapest and readily accessible source of proteins, vitamins minerals and essential amino acids (Mepba *et al.*, 2007). Deficiencies in protein, vitamin A, zinc and iron are highly ranked among children and adults in sub-Saharan Africa and other developing countries (Tathiah *et al.*, 2013). However, the biggest challenge is that these ALVs are underutilised when compared to their exotic equivalents regardless of their nutritional value (Smith and Eyzaguire2007).

There are various challenges that hinder the consumption of these vegetables. These ALVs have been labelled as 'food for the poor'. This has constantly downgraded the utilisation of ALVs, especially among the youth and urbanised (Voster *et al.*, 2007). Despite the consumption of the exotic vegetables some ALVs have been reported to be more nutritious than exotic ones (Ndlovu and Afolayan 2008). Another challenge is that these vegetables are highly seasonal, being mostly abundant in summer. This suggest that in other seasons they might not be available. Therefore, the development of preserved products would play a major role in increasing awareness on the potential of ALVs and in extending their shelf life. Preservation adds variety to the form in which food is taken, it guarantees availability and could open income generating opportunities, thus improving food security (Kapinga *et al.*, 2007). Consumers nowadays want both nutritional and nontoxic foods (Lesschaeve and Noble 2005). The expected challenge is that canned ALVs would be expensive. However, in recent times consumers have been surviving in a society where convenience foods and high quality products are available at a high price premium (Ragaert 2007). Furthermore, increased demand for fruits and vegetables, and high convenience foods is causing an

expansion in the market share for minimally processed vegetables (Froder *et al.*, 2007; Cagno 2009).

In this study the most consumed local ALVs, (collard greens and mustard greens), were prepared and compared with their commercially purchased canned counterparts. Collard green stands to be one of the best worlds healthiest vegetable (Lewu and Kambizi 2014). Mustard greens require well drained sandy loam soil (Shekhawat *et al.*, 2012).

The objectives of this study were to determine the effects of canning on the nutritional composition of collard greens and mustard greens.

## **5.2. Materials and Methods**

### **5.2.1. Research technique**

In this study a combination research methodology was used to collect both quantitative and qualitative data. The qualitative data was collected using laboratory experiments. Focus group discussions were used to collect data on perceptions towards canned ALVs.

### **5.2.2. Sampling technique**

The study was conducted in the Limpopo Province of South Africa, in the Mopani district in greater Tzaneen Municipality, Mawa block 8 representing a rural setting and Lenyenye representing the urban setting. Key informants were identified through a participatory rural appraisal. 60 respondents were used for sensory evaluation, whom included 30 rural adults and rural youth, 30 urban adults and urban youth. School children above the age of 14 were used from Khesethwane secondary school and Napscom secondary school.

### **5.2.3. Research procedure**

#### *Preparation of African leafy vegetables samples for nutritional analysis*

Two types of canned ALVs were used, Collard greens and Mustard greens. The canned AVLs, which were used as the experimental samples, were purchased in USA, at Glory Foods and Walmart. The control, which were the fresh ALVs (Mustard and Collard greens) were harvested at the local farms in Tzaneen. The ALVs were taken to Cedara Research station, KwaZulu-Natal. Samples were analysed in duplicate.

### *Nutritional analysis*

Samples of African leafy vegetables both the fresh and the canned were analysed for their Fat, NDF (Neutral Detergent Fibre), protein, total mineral (Ash) and individual mineral contents of calcium, magnesium, manganese, zinc, iron, copper, phosphorus and sodium were analysed.

#### *Protein*

The protein content was determined by the methods as described in AOAC (1990). Estimated using Kjeldahl method.

#### *Fat*

The fat content was analysed using the AOAC official method (AOAC 1990).

#### *NDF*

The fibre content of the samples was determined as the neutral detergent fibre (NDF). The NDF was determined following AOAC official method 2002.04 (AOAC 2002)

#### *Total mineral content*

The ash was measured according to the AOAC official method 942.05 (AOAC 2003).

#### *Individual minerals*

The calcium, magnesium, manganese, zinc, iron, sodium, potassium, copper and phosphorus were analysed following the AOAC Method Number 6.1.2 (AOAC 1984).

### **5.2.3.1 Sensory evaluation**

#### *Sensory evaluation panellists*

A total of 60 panellists from rural two study areas participated in the sensory evaluation. Participation in the sensory evaluation was on a voluntary basis and the sensory evaluation participants were recruited from the survey participants who were youth and adults in both rural and urban areas. The individuals who were willing to participate were randomly selected from the list of volunteers by field workers.

#### *Preparation of the African leafy vegetables (ALVs) samples*

Commercially canned ALVs, Collard green and Mustard green and locally- harvested fresh ALVs (the control) were used to prepare two types of African leafy vegetables dishes which were mostly preferred by rural and urban households of Lenyenye and Mawa, mainly as a relish with tomato added. The ALVs dishes were prepared using recipes which were obtained from the community. To ensure that the dishes were culturally acceptable to the participants, the dishes were prepared in the research site by two women from the community with experience of preparing the recipes. The women were trained on how to wash the leafy vegetables in order to remove any soil residues to maintain high levels of hygiene.

#### *Sample coding, serving order and sensory evaluation set-up*

To reduce bias associated with the labelling of samples, a table of random numbers was used. For each sample a unique three-digit code was used. The samples were served in randomised order from left to right. Randomisation of the serving order was done using a Table of Random Permutations of Nine. To prevent the panellists from influencing each other's responses, the sensory evaluation panellists were made to sit far apart. All participants were provided with a glass of water, plastic teaspoon, serviette, small dish containing approximately 5 g of each ALV dish and the sensory evaluation questionnaire written in English (Appendix C). Before the tasting, the sensory evaluation questionnaire was explained in iSepedi for panellist to understand.

The sensory evaluation questionnaire was in the form of a five-point facial hedonic scale (1=very good; 5=very bad) in order to accommodate illiterate individuals.

Before starting the sensory evaluation, participants were required to fill out a consent form. The consent form was formulated in English and explained in iSipedi. The researcher provided an explanation of the consent form in iSipedi to ensure that participants understood everything before signing the form. After the consent form was signed, field workers provided an explanation of the sensory evaluation questionnaire. The panellists were asked to rate the acceptability of each sensory attribute of the ALVs samples by marking an 'X' on the face which best suited the sensory acceptability of the attributes of each sample. Illiterate participants were further assisted by field workers if they required more assistance to fill out the questionnaire.

#### 5.2.4. Statistical analysis

The statistical package for social sciences (IBM SPSS), version 21 was used. The t test was used to determine whether there was a statistically significant difference in the nutritional composition of canned and fresh forms of each of the two ALVs types. Means and standard deviations were calculated from the duplicate nutrient values. Statistical significance was considered at  $p < 0.05$ .

#### 5.3. Results and discussion

**Table 5.1 Vegetables analysed.**

English name	IsiPedi name	Scientific name	Family
Collard greens	Phophorokha	<i>Brassica oleracea</i>	Brassicaceae
Mustard greens	Mokhwaripa	<i>Brassica juncea</i>	Brassicaceae

Table 5.2 shows that canning resulted in about 50% increase in the fat and fibre content of collard greens, whereas protein content decreased by about 50%.

The total mineral (ash) content of the collard greens decreased by about 50% due to canning. In terms of individual minerals analysed, the results indicate that some minerals increased, whilst others decreased. Zn, Mn and Fe increased when the vegetables were canned, whilst Ca, Mg K, Na, P and Cu decreased.

The results of Van Jaarsveld *et al.*, (2014) also revealed that canning caused a reduction in the potassium, phosphorus, calcium contents of vegetables. In addition, in a study conducted by Mepba *et al.*, (2007), the raw African leafy vegetables had a higher concentration of minerals; therefore, a similar pattern was noted in this study. However, the percentage of protein increased with canning in a study conducted by (Rasmussen and Morissey 2007). Similar to the present study, the study done by Schönfeldt and Pretorius (2011), showed that protein content was highest in the raw leaves in Cats whiskers. Collard greens are generally rich in protein (Jackson *et al.*, 2000). Fat content increased with canning which may be due to additional ingredients added such as peanuts. Iron contents of canned collard green were significantly higher when compared to their levels in the fresh ALVs. This could be advantageous to address iron deficiencies in sub-Saharan as indicated by (Thathiah *et al.*, 2013). Different from the results of this study, species studied in Odhav *et al.*, (2007), resulted in higher amounts of calcium. Rickman *et al.*, (2007) suggest that

canning can increase calcium levels due to uptake from hard water used in processing. Increased fibre content added advantage of canning in foods prevents digestion problems, constipation piles and colon cancer. Results of Nnamani (2009) displayed the complete absence of zinc and lead, different to the results observed in this study. Zinc is essential for growth and development (Maret and Sandstead 2006).

**Table 5.2: Effect of canning on the nutrient content of Collard greens**

	Nutrients	Mean		<i>P</i> Value
		FCG	CCG	
Macro nutrients	Fat (g/ 100 g)	3.55 ± 0.17	5.87 ± 0.30	0.011
	NDF (g/ 100 g)	20.83 ± 0.84	40.33 ± 0.64	0.001
	Protein (g/ 100 g)	41.26 ± 0.01	22.46 ± 0.31	0.000
Micronutrients	Ash (g/ 100 g)	19.19 ± 0.01	9.19 ± 0.23	0.000
	Ca (g/ 100 g)	2.83 ± 0.01	1.57 ± 0.06	0.001
	Mg (g/ 100 g)	0.76 ± 0.00	0.26 ± 0.01	0.000
	K (g/ 100 g)	4.72 ± 0.01	1.93 ± 0.02	0.000
	Na (g/ 100 g)	0.51 ± 0.02	0.16 ± 0.01	0.003
	P (g/ 100 g)	0.55 ± 0.07	0.36 ± 0.00	0.063
	Zn (mg/kg)	46.44 ± 0.18	55.03 ± 0.85	0.005
	Cu (mg/kg)	8.76 ± 0.11	3.18 ± 0.05	0.000
	Mn (mg/kg)	40.11 ± 0.16	118.50 ± 1.17	0.000
	Fe (mg/kg)	91.82 ± 1.12	172.42 ± 7.83	0.005

Note: NDF=Neutral Detergent Fibre; FCG=Fresh collard green; CGC=canned collard green

Table 5.3 reveals that canning resulted in increased fat content in mustard green, whilst protein content decreased by 45% there was no significant difference in fibre content. The total mineral content (Ash) of the mustard greens decreased by 5% due to canning. In terms of the individual minerals analysed results show that some minerals increased whilst

others decreased. Sodium, zinc and manganese increased when the vegetables were canned whilst calcium, magnesium, potassium, phosphorus, copper and iron decreased.

The fat increase in mustard green could be attributed to addition ingredients such as bacon fat, pork broth and ham broth as it was noted on the package of the canned Mustard greens

As reviewed in section two, results of Lewu and Kambizi (2014), sodium levels increased in samples studied. Sodium could increase with canning as it is often added to enhance flavour (Rickman *et al.*, 2007). Low calcium levels in food could be detrimental to health as calcium aids in strong bones and teeth by (Nnamani 2009).

When vegetables are boiled there is some loss of sodium. This study suggests that there are fewer studies on the nutritional composition of mustard green.

**Table 5.3: Effect of canning on the nutrient content of Mustard greens**

	Nutrients	Mean		P value
		FMG	CMG	
Macro nutrients	Fat (g/ 100g)	3.44 ± 0.17	7.89 ± 0.25	0.002
	ADF (g/ 100g)	17.22 ± 0.69	13.37 ± 0.88	0.039
	NDF (g/ 100g)	22.00 ± 0.24	22.17 ± 0.26	0.579
	Protein (g/ 100g)	34.53 ± 0.25	20.00 ± 0.08	0.000
Micronutrients (Minerals)	Ash (g/ 100g)	20.02 ± 0.01	15.13 ± 0.12	0.000
	Ca (g/ 100g)	2.51 ± 0.02	0.64 ± 0.01	0.000
	Mg (g/ 100g)	0.65 ± 0.01	0.13 ± 0.01	0.000
	K (g/ 100g)	5.56 ± 0.11	2.38 ± 0.13	0.001
	Na (g/ 100g)	0.73 ± 0.01	2.46 ± 0.02	0.000
	P (g/ 100 g)	0.37 ± 0.00	0.27 ± 0.01	0.002
	Zn (mg/kg)	31.86 ± 0.18	106.05 ± 0.44	0.000
	Cu (mg/kg)	5.95 ± 0.04	3.58 ± 1.52	0.158
	Mn(mg/kg)	23.36 ± 0.13	147.02 ± 1.45	0.000
	Fe (mg/kg)	152.89 ± 0.86	88.20 ± 2.10	0.001

Note: NDF=Neutral Detergent Fibre; FMG=fresh mustard green; CMC=canned mustard green

## **5.4 Sensory evaluation of African leafy vegetables**

### **5.4.1 Taste**

The results of the sensory evaluation of both the canned and Raw African leafy vegetables are shown in Table 5.5. According to the findings, there was a significant difference in taste acceptability of the raw and canned African leafy vegetables; the raw African leafy vegetables were rated higher than those of canned African leafy vegetables. Generally, the overall acceptability of the raw (fresh) African leafy vegetables was higher than the corresponding canned African leafy vegetables. High preference for fresh ALVs was noted in both study areas; nonetheless the urban respondents liked canned vegetables more than rural respondents, previous research on ALVs suggest that these vegetables (in fresh form) are highly preferred for their health promoting and protecting properties (Smith and Eyzaguirre 2007). As shown in Table 4.10, there were concerns about canning, quotes revealed that: “cooking before canning would change the taste because they might not use the ingredients that we use”. The results of Ofori *et al.*, (2009) when assessing varieties of sweet potato indicated that incorporation of local ingredients in food preparation could be an important step in improving acceptability.

### **5.4.2 Texture**

There was no significant difference in the texture of ALVs. Both urban and rural respondents did not detect a significant difference in texture of canned mustard green and fresh mustard green. The findings of this study suggest that canning has a likelihood of not affecting the texture of the ALVs, which could mean a possibility for a canning technique to be explored as a way of extending shelf life of ALVs.

### **5.4.3 Aroma**

The aroma of fresh African leafy vegetables was found to be the most desirable; the potential of using local recipes for the cooking of canned African leafy vegetables could be a resolution in improving the aroma of canned ALVs. Generally, these results show that aroma of fresh ALVs is highly treasured by respondents, therefore could highly influence overall acceptability. According to (Mepba *et al.*, 2007 the most important attributes of a food are its sensory characteristics.

#### 5.4.4 Overall acceptability

The findings of this study suggest that canned ALVs are generally more acceptable by the urban respondents, considering that this segment group has high need for convenience foods as they are mostly working class and have little or no time to prepare foods. There appears to be future for canning as a preservation technique for extending shelf life of ALVs, relatively moderate acceptability by rural respondents may be due to the fact that these vegetables grow local in their home gardens and they may fear that once they are canned they would be a little more expensive compared to their normal way of picking them up at their back gardens. It is clear that among both the views of the rural and urban respondents ALVs are regarded as nutritious and flavoursome. During focus group discussion the respondents thought canning was an abstract concept however the sensory evaluation results reveal that there is general acceptability of canned ALVs.

**Table 5.5.:** Effect of canning on consumer acceptability of African leafy vegetables

Samples	Sensory attributes	Mean $\pm$ SD		P value
		Canned	Raw	
<b>Mustard Green</b>	Taste	3.17 $\pm$ 1.11	2.23 $\pm$ 1.24	0.000
	Texture	2.72 $\pm$ 0.87	2.22 $\pm$ 1.17	0.009
	Aroma	3.02 $\pm$ 1.00	2.02 $\pm$ 1.00	0.000
	Colour	2.45 $\pm$ 1.03	2.05 $\pm$ 1.05	0.037
	Overall acceptability	2.67 $\pm$ 1.17	1.85 $\pm$ 1.12	0.000
<b>Collard Green</b>	Taste	3.42 $\pm$ 1.00	2.70 $\pm$ 0.81	0.000
	Texture	3.15 $\pm$ 1.02	2.88 $\pm$ 0.96	0.143
	Aroma	3.20 $\pm$ 0.94	2.42 $\pm$ 0.91	0.000
	Colour	3.14 $\pm$ 1.00	2.45 $\pm$ 0.96	0.000
	Overall acceptability	3.28 $\pm$ 1.01	2.53 $\pm$ 0.95	0.000

Sample had a significant effect on overall acceptability as illustrated in Table 5.6. In Both the views of urban and rural areas.

**Table 5.6: Overall acceptability, comparison between Mustard green and Collard Green Samples**

Type of African leafy vegetable	Overall acceptability (Mean $\pm$ SD)	P value
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	Urban	Rural	
Mustard Green	2.13 ± 1.16	2.38 ± 1.26	0.261
Collard Green	2.93 ± 2.88	1.15 ± 0.94	0.795

Age had no significant effect on the overall acceptability of canned mustard green and fresh mustard greens. Generally, canned ALVs were satisfactory; therefore, there is a progressive opportunity to introduction of canning as a preservation technique for ALVs. In a study conducted by Pillay et al., (2014) age had a significant effect on overall acceptability of phuthu and samp, which is different from this study. Age had a significant effect on the overall acceptability of the sample, fresh collard green was better preferred than canned collard green as indicated in Table .5.8

**Table 5.7: Overall acceptability Mustard Green**

Age	Overall acceptability (Mean ± SD )			P value		
	CMG	FMG	Total	Sample	Age	Sample × Age
Younger than 25	2.68 ± 1.30	2.13 ± 1.28	2.40 ± 1.31	0.017	0.291	0.081
Between 25 to 55	2.80 ± 1.00	1.48 ± 0.71	2.14 ± 1.09			
Older than 55	1.75 ± 0.96	2.00 ± 1.41	1.88 ± 1.13			
Total	2.67 ± 1.17	1.85 ± 1.12	2.26 ± 1.21			

**Table 5.8: Overall acceptability Collard Green**

Age	Overall acceptability (Mean $\pm$ SD)			P value		
	CCG	FCG	Total	Sample	Age	S $\times$ A
Younger than 25	3.26 $\pm$ 1.12	2.50 $\pm$ 0.80	2.87 $\pm$ 1.04	0.021	0.492	0.893
Between 25 to 55	3.40 $\pm$ 0.76	2.60 $\pm$ 1.15	3.00 $\pm$ 1.05			
Older than 55	2.75 $\pm$ 1.50	2.33 $\pm$ 0.58	2.57 $\pm$ 1.13			
Total	3.28 $\pm$ 1.01	2.53 $\pm$ 0.95	2.91 $\pm$ 1.05			

## 5.5 Conclusion

The results obtained suggest there is a unique opportunity with regard to the introduction of canning as a preservation technique. Canned collard greens had higher levels of iron, therefore can be used to combat iron deficiency, which is prevalent in sub-Saharan Africa. Both canned African leafy vegetables have adequate levels of fibre. The study demonstrates that the taste and aroma of ALVs are most valuable sensory attributes for overall acceptability of canned ALVs. Most urban people have limited land to use for gardening, canned ALVs could serve as a solution to make sure that these vegetables are available and benefit even those who do not have access to land enough to have these vegetables planted. The respondent did not observe any major colour changes because of canned ALVs; however, it was somewhat noticeable with canned collard greens. When the focus group discussions were held to assess consumer perception about canning there was a heavy 'no'. However, after conducted sensory evaluation it was clear that there is future for canned ALVs, as they were not highly disliked after tasting, it seemed that canning was really an abstract concept to them before sensory evaluation had been conducted.

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## Chapter 6: Conclusion and recommendations

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### 6.1. Conclusion

The objectives of this study were (i) to determine the utilization of ALVs, (ii) To assess consumer perceptions towards canned ALVs, (iii) To determine the effect of canning on the nutritional composition of canned ALVs and determine consumer acceptability of ALVs (collard greens and mustard greens). The main conclusions and recommendations of the study are presented in this chapter.

Results of the current study indicated that people in the Limpopo Province of South Africa perceived ALVs as a valuable food source, particularly as good sources of nutrients. In terms of food security, these vegetables are likely to address the nutritional status of those households that are poor and food insecure, for the following reasons: ALVs are considered cheaper when compared to their counterpart's exotic vegetables. The consumption of ALVs was influenced by the belief that they were nutritious, easily accessible, chemical free and cost-effective. More so, ALVs had a sentimental value as they formed part of the African cultural heritage. Strategies to attract youth to utilize ALVs needs serious attention as they often prefer junk foods which in most cases are less nutritious and detrimental to human health.

There is an opportunity for acceptance of canned ALVs, especially by the younger generation from both rural and urban communities. However, local recipes would have to be integrated, be locally produced (traditional identity), use less or no chemicals and try to retain the original colour. Also awareness creation and education about the canning process would be beneficial in changing consumer negative perceptions towards the canning of ALVs. It was apparent that canned leafy vegetables were mostly acceptable by urban consumers. However, sample had a significant effect on overall acceptability. Age does not affect the overall acceptability of mustard green and collard. The study also found out that fresh African leafy vegetables were most preferred than canned African leafy vegetables.

However, there was no significant difference in colour between the canned and fresh African leafy vegetables. The study concludes that taste and flavour play a significant role in overall acceptability of a product. There is also future for canned African leafy vegetables to be acceptable among different segments of settings and age categories, and canning would mean expanded season of availability. The nutritional analysis showed that some nutrients and minerals increase while others decreased

## **6.2. Recommendations**

### **6.2.1. Recommendations for improvement of the study**

The recommendations from this study are:

- a) This study was conducted only in Tzaneen, Limpopo Province of South Africa targeting only a few segment of the population; this limits general findings of this study.
- b) The study only evaluated the nutritional quality of purchased canned ALVs. Further research should be conducted exploring with canning of the locally produced products and incorporating local recipes for canning.

### **6.2.2. Recommendations for policy makers**

- There is a need to promote consumption of these vegetables as a result of better understanding by community members that these ALVs could improve nutritional well-being, and shift has been noted that they are no longer considered as foods for the poor.
- Relevant government departments and researchers need to develop a specific national food policy with defined targets to preserve the leafy vegetables as a food and nutrition endeavour.
- Fund research and development at national level on how country can continue to find and implement methods of canning leafy vegetables and take advantage of the readily available leafy vegetables to educate locals on canning leafy vegetables by availing capacity building on nutrition.

- Incorporate into the national curriculum specific subjects which teach from primary level and develop an organized work- plan to teach and raise awareness on the importance of leafy vegetables.
- Identify stakeholders who should include the health, nutrition, local government and other sectors who are relevant to the national food and nutrition policy that will then work to promote the canning of leafy vegetables. Involve the private sectors working closely with the people in designing strategies of canning leafy vegetables.
- Due to the fact that most of these leafy vegetables occur in remote rural locations, there is need to identify target areas where they are and conscientize the populace on the importance of harvesting the crops for preservation.
- Establish caning factories for the local people and involve major food producers in the process. Develop technologies of canning leafy vegetables using simple easy to operate machinery which can be deployed even at village level.
- Involve external development partners such as the Food and Agriculture Organization (FAO) in the project in order to get expertise and capacity building support.

## APPENDICES

### Appendix A: Focus group discussions

1. What vegetables are consumed in your household? (*Rank them according to order of importance*)
  - a. *Investigate the reasons why/what value do vegetables bring to your household?*
  - b. *How are these utilised or consumed?*
  - c. *In what forms?*
  - d. *Who consumes what vegetables?*
  - e. *What purposes do these vegetables play?*
2. Is there a difference in the preparation of the vegetables?
  - a. *Probe on ingredients*
  - b. *Probe on colour retaining ingredients (ash & soda)*
3. Why do you think younger generation is not interested in consuming African leafy vegetables?
  - a. *What could be done to encourage them to consume them?*
4. What do you regard as traditional vegetables?
5. What are your thoughts about canned vegetables?
6. Do you think African leafy vegetables can be canned?
  - a. *Perceptions*
  - b. *Concerns*
  - c. *Beliefs*

## Appendix B: Survey questionnaire in English

University of KwaZulu-Natal

### Questionnaire

All the information provided here will be treated as **STRICTLY CONFIDENTIAL**.

**Date:** .....

**Area:** .....

#### Socio-Demographics

1. Gender

Female		Male	
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2. Age

18-25		26-35		36-60	
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3. Date of Birth

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4. Education level:

No formal education		Primary		Secondary		Tertiary	
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5. Marital status:

Single		Married		Divorced		Widowed		Separated	
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6. Employment:

Employed full time		Employed part time		Unemployed		Pensioner	
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7. Income bracket:

R0-R1000	R1001-R3500	R3500 and above	
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8. Are you a farmer?

Yes		No	
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If **yes** indicate the type of farmer, you are

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9. How many are you in the household?

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10. How many children are in the household?

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***Consumption of vegetables***

11. Do you eat vegetables?

Yes		No	
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Indicate the vegetables you prefer the most

12. *ALVs*



Very bad

Bad

Average

Good

Very good

13. *Exotic*



Very bad      Bad      Average      Good      Very good

14. How many times do you consume ALVs per week?

Once		Twice		Daily		Other	
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15. What meal times do you consume ALVs?

Breakfast		Lunch		Supper		In between meals		Other	
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Why do you consume ALVs, rank the following according to order of importance?

16. For nutritional value

Strongly agree		Agree		Average		Disagree		Strongly disagree	
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17. Chemical free

Strongly agree		Agree		Average		Disagree		Strongly disagree	
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18. Cost effective

Strongly agree		Agree		Average		Disagree		Strongly disagree	
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19. Easily available

Strongly agree		Agree		Average		Disagree		Strongly disagree	
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## Utilisation

20. What dishes are prepared with ALVs?

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21. How important is using ALVs in your diet?

Not important at all		Not very important		Important		Very important		I do not know	
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22. Why are ALVs consumed in your household?

Nutritional value		Flavour		Easily available	
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## Perceptions

23. ALVs are food for rural people?

Yes		No	
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24. ALVs are for the elderly?

Yes		No	
-----	--	----	--

25. ALVs should not be consumed by youth?

Yes		No	
-----	--	----	--

26. ALVs are food for low income class?

Yes		No	
-----	--	----	--

27. ALVs are backwards?

Yes		No	
-----	--	----	--

28. ALVs are more nutritious than exotic vegetables?

Yes		No	
-----	--	----	--

29. ALVs have a shelf-life of more than a year when preserved?

Yes		No	
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30. I trust the people who dry ALVs?

Yes		No	
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31. ALVs cannot be canned?

Yes		No	
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32. Expiry dates are not important for ALVs?

Yes		No	
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**ALVs selection criteria indicators; rank according to the order of importance**

33. Colour

Strongly agree		Agree		Average		Disagree		Strongly disagree	
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Appearance

Strongly agree		Agree		Average		Disagree		Strongly disagree	
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Taste

Strongly agree		Agree		Average		Disagree		Strongly disagree	
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Nutritional value

Strongly agree		Agree		Average		Disagree		Strongly disagree	
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Price

Strongly agree		Agree		Undecided		Disagree		Strongly disagree	
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Convenience

Strongly agree		Agree		Average		Disagree		Strongly disagree	
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I would enjoy if ALVs could have variety of flavours.

Yes		No	
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ALVs would be very exciting with a taste of tanginess.

Yes		No	
-----	--	----	--

41. ALVs would be very exciting with sweet and sour taste.

Yes		No	
-----	--	----	--

42. ALVs would be very exciting with a bitter sweet taste.

Yes		No	
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43. Spices are important in flavouring ALVs.

Yes		No	
-----	--	----	--

44. Local produced food is good.

Yes		No	
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### **Appendix C: consent form in English**

My name is Hombisa Tozi Sigaqa and I am a full-time student at the University of KwaZulu-Natal registered for Masters in agriculture (food security). I would like you to participate in a study evaluating the acceptance of African leafy vegetables. Therefore you will be required to taste food products and further rate each samples using a simple picture scale indicating your views on the taste, texture, smell, colour and overall acceptability.

It is essential to know that:

- Participation in this study is voluntary, participants are free to leave the study any time they wish.
- There will be no form of payment for participating in the study
- All information will be kept confidentially and will only be used for the purpose of this study.
- All information will be destroyed when it is no longer needed.
- For any further information with the study, you may contact Dr Kolanisi who is the supervisor of the study at 033 260 6342 or [kolanisi@ukzn.ac.za](mailto:kolanisi@ukzn.ac.za)

Declaration:

I \_\_\_\_\_ (full name and surname) hereby confirm my understanding of the questionnaire and I understand that there will be no risks from the study and I may withdraw if I desire since the study is voluntary.

\_\_\_\_\_

Signature

\_\_\_\_\_

Date

## Appendix D: Five-point pictorial hedonic scale

### Sensory evaluation questionnaire

Gender:  Male  Female

Age: \_\_\_\_\_

Number: \_\_\_\_\_

Sample number: \_\_\_\_\_

#### TASTE



Very bad

Bad

Average

Good

Very good

#### TEXTURE



Very bad

Bad

Average

Good

Very good

#### AROMA



Very bad

Bad

Average

Good

Very good

#### COLOUR



Very bad

Bad

Average

Good

Very good

**OVERALL ACCEPTABILITY**



Very bad

Bad

Average

Good

Very good