



**Development of a sensorially acceptable food product from *Cissus quadrangularis* to create awareness among young adults**

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at the

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### **Declaration**

I, Vihara Singh, hereby declare that the research work presented by this thesis is my original work and all the materials used are appropriately acknowledged and explicitly reference. A reference list is attached to the thesis.

I also confirm that the thesis has not been submitted in any of its part or any degree in any other institution of higher learning internationally or locally.

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## **Dedication**

I dedicate this thesis to:

My parents (Ashika Lucken and Binesh Bene Singh)

My siblings (Upasana Singh and Karan Bene Singh)

For being my pillars of strength throughout my life.

## Acknowledgement

***“Put your heart, mind, and soul into even your smallest acts. This is the secret of success” - Sri Swami Sivananda***

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## ABSTRACT

**Background:** Among the main causes of food insecurity in Africa is drought which results in poor harvests for farmers. Drought tolerant plants are environmentally sustainable and show great promise in improving food security and preventing malnutrition. South Africa has a wide range of drought tolerant indigenous plants that possess both medicinal and nutritional value. However, most of these indigenous plants are used by older generations and are unfamiliar to younger generations. With the revival of indigenous knowledge systems and botanical decolonisation, the potential of indigenous plants as functional foods has come to the fore.

**Aim:** The aim of this study is to develop a sensorially acceptable food product with *Cissus quadrangularis* and to create awareness of *Cissus quadrangularis* among young adults.

**Methodology:** This food product development study was informed by key informant interviews as well as a desktop study on food and nutrition trends. Through informed consent, ten elderly community members participated in the key informant interviews and shared their knowledge, uses and perceptions of *Cissus quadrangularis*.

The developed food product underwent pilot and final sensory evaluation through a 9- point hedonic scale and a paired preference test. For the sensory evaluation, 110 participants were used, 10 for the pilot and 100 for the final sensory evaluation. The food product also underwent microbiological testing, nutrient analysis, and shelf-life testing. Once this was conducted, an awareness tool was developed. The awareness tool underwent pilot and final evaluation via a Likert scale. For the awareness tool survey, 110 young adult participants residing in KZN were used, 10 for the pilot and 100 for the final instrument.

**Results:** Analysis from the key informant interviews indicated that the participants viewed *Cissus quadrangularis* as a medicinal plant, used to treat sprains, inflammations, broken bones, cholesterol, and ulcers. The participants cooked the plant in curries, pastes or fried doughs and some participants boiled it and drank the water. The desktop study on food and nutrition trends displayed key food trends for 2019 and 2020 such as zero-waste foods, botanical beverages, alternative ingredient, sustainability, plant-based foods, and natural remedies, less sugar, health convenience items, and texture. The results from the key informant interviews and desktop study on food and nutrition trends informed the development of the food product with *Cissus quadrangularis*. Following the steps of product development, a trendy energy bite infused with *Cissus quadrangularis* was developed. The energy bite yielded 10 portions of 21.5g each.

Analysis from the microbial test indicate that the microbial count in the product was high averaging between 1000 to 5000 cfu/g which was within acceptable limit. However, the product was suitable for a short shelf-life of three days. Potassium sorbate was added to the energy bite infused with *Cissus quadrangularis* for the second microbial test. The second test results indicated that the microbial count found in the developed product was low and that there were no microorganisms present.

The *Cissus quadrangularis* infused energy bite (both samples) indicated that the product was to some extent high in sugar (4g: 3.4g / 6g: 3.48g per 21.5g). The nutrient analysis showed that the product was relatively low in fat and sodium. The energy bite carbohydrate level was relatively low as it contributed (Women: 6.72 %/ Men: 6.32%) to the Dietary Reference Intake (DRIs) of women and men aged 19-30 years old. The amount of dietary fibre present in this study; in both samples was high (4g: 4.02 / 6g: 4.16 per 21.5g), contributing well to both women and men DRIs of dietary fibre, respectively (Women: 16.08 % / Men: 10.94%). The protein value in the energy bite was significantly low only contributing Women: 3.17% / Men: 2.6% to the DRIs of women and men, respectively. The vitamins and minerals tested in the nutrient analysis were not present in notable amounts, contributing low percentages to both women and men's DRIs.

Analysis from the pilot and final sensory evaluation showed that both the 4g and 6g sample of the developed food product was liked, however, the 4g sample was preferred. The final sensory evaluation showed that 27% of participants chose "like extremely" for the 4g sample whilst 18% of participants chose "like extremely" for the 6g sample. The Wilcoxon signed ranks test indicated that there was no significant difference between the 4g and 6g sensory rating score ( $p=0.066$ ) indicating that there was a marginal preference of sample 1 (4g) over sample 2 (6g). There was no significant difference in the sensory rating of these products across gender for the 4g ( $p=0.521$ ) and 6g ( $p=0.673$ ) sample.

The last objective of the study was to develop an awareness tool using the developed food product to create awareness of *Cissus quadrangularis* among young adults. The pilot and final awareness tool survey showed that the majority of participants found the awareness tool to be informative and that the participants involved were willing to make the recipes using *Cissus quadrangularis*. The final awareness tool results indicate that a significant 93% either liked or extremely enjoyed the video ( $p<.0005$ ). Analysis with Pearson's chi-square (Fisher's exact test) of the cross-tabulation of responses with demographics shows that there was a significant relationship between gender and video rating, Fisher's exact = 11.129, ( $p=.007$ ). The results indicated that 57.1% of male participants extremely enjoyed the video whereas 59.3% of females only liked the video.

**Conclusion:** The development of a trendy and sensorially acceptable food product with *Cissus quadrangularis* as a main ingredient and the development of an awareness tool created awareness to this unfamiliar indigenous plant with various health benefits among young people. Food product development using indigenous edible plants can be seen as sustainable measure and can contribute towards food security initiatives in South Africa. Awareness tools that appeal to the youth can help educate young adults on various indigenous foods reducing the vulnerability of food and nutrition insecurity.

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## LIST OF ABBREVIATIONS

|          |  |
|----------|--|
| ANOVA    | Analysis of variance   |
| AOAC     | Association of Official Analytical Chemists                    |
| COVID-19 | Coronavirus Disease  |
| DRI      | Daily Reference Intakes  |
| DUT      | Durban University of Technology                                |
| FAO      | Food and Agriculture Organisation                              |
| KZN      | KwaZulu-Natal  |
| HSRC     | Human Sciences Research Council                                |
| IREC     | The Institutional Research Ethics Committee                    |
| NCDs     | Non-communicable diseases                                      |
| SANAS    | South African National Accreditation System                    |
| SANHANES | South African National Health and Nutrition Examination Survey |
| SDG      | Sustainable Development Goal                                   |
| SPSS     | Statistical Package for Social Sciences                        |
| SA       | South Africa   |
| STATS SA | Statistics South Africa  |

# CHAPTER ONE

## INTRODUCTION AND IMPORTANCE OF THE STUDY

### 1.1 Introduction

In this chapter, an overview of the research problem and the importance of this study which focuses on food product development with *Cissus quadrangularis* L. is presented. The significance of this study is described with regards to the nutritional and health benefits of *Cissus quadrangularis* L. as well as the development of an awareness tool on *Cissus quadrangularis* L. For the purposes of this study, *Cissus quadrangularis* L. will be referred to as *Cissus quadrangularis* hereon.

### 1.2 Importance of the Study

Food security is defined as all people having access to food at any given time, and the food accessible must be sufficient to ensure that people of any household can lead a healthy and active lifestyle (Human Sciences Research Council (HSRC) (HSRC 2013: 1). Nutrition and food security are interrelated, as nutrition security is to ensure that an individual takes in adequate micro and macronutrients to lead healthy lifestyles (Ruel 2013: 25).

The South African National Health and Nutrition Examination Survey: (SANHANES)-1 report specified that, a lack of dietary knowledge and dietary practices could lead to non-communicable diseases (NCDs) (Shisana *et al.* 2013: 201). Upon reviewing the results of SANHANES-1, the HSRC stipulated certain recommendations should be implemented to help improve the health status of South Africans (HSRC 2013:10). The recommendations were as follows: a) household income is important as it is directly linked to food accessibility and food security, b) the food fortification programme should be retained; however, it should be revised in terms of the levels of zinc and iron levels in the food products, c) knowledge of physical activity, healthy food practices and choices should be implemented at household level and in schools.

Food security is underpinned by four pillars which are the availability of food, access to food, utilisation, and food stability (Food and Agricultural Organisation (FAO) 2008:1). Among the main causes of food insecurity in Africa is drought, which results in poor harvests for farmers (Harvest help African food issues 2012:1). Drought tolerant plants are environmentally sustainable and show great promise in improving food security and preventing malnutrition (Mabhaudhi *et al.* 2019: 4). South Africa has a wide range of drought tolerant indigenous food plants that possess both medicinal

and nutritional value. However, most indigenous food plants are used by older generations and are unfamiliar to the younger generations (Inglehart and Baker 2000: 3). With the revival of indigenous knowledge systems and botanical decolonisation, the potential of indigenous food plants as functional foods has come to the fore. In support of the aforementioned, Lindow (2017: para. 6 line 1) states that in the Western Cape, people are using indigenous plants as a food source to sustain themselves.

A rarely utilised indigenous plant is *Cissus quadrangularis* (Vitaceae) (Siddiqua and Mittapally 2017: 330). *Cissus quadrangularis* grows largely in South Africa, however, it is not widely well known. Nonetheless, among some people in South Africa, especially the older Indian generation, it is quite popular and often referred to as “Hadjod” in Hindi (Translated as “Bone- Setter”); and used in a wide range of food applications and in traditional medicine. It is also known as “Hwebe kwalehra” in some African and diaspora cultures and is used primarily for medicinal purposes (Peek 2011: 170).

Medicinal plants have been widely used over centuries, and many cultures still depend on indigenous medicinal plants for their primary health care needs alone or in combination with modern medicine (Street and Prinsloo 2013). *Cissus quadrangularis* has been used in ayurvedic medicine for many years to treat diseases such as arthritis, osteoporosis and in bone healing (Malathi 2014: 3).

In terms of nutrients, *Cissus quadrangularis* has a high amount of vitamin C, vitamin A, Calcium, Potassium, Iron and Zinc (Brahmkshatriya *et al.* 2015: 169). Even though *Cissus quadrangularis* is a rich source of nutrients, there has been no research published on food product development utilising *Cissus quadrangularis* in South Africa. The development of a trendy food product enhanced with *Cissus quadrangularis* could be a suitable vehicle for South Africans to benefit from this nutritious plant. In addition, developing an awareness tool will promote the use of *Cissus quadrangularis* among the youth.

### **1.3 Problem statement**

The important role of indigenous food plants has been overshadowed through the globalisation of food systems. If promoted, indigenous food plants such as *Cissus quadrangularis* can play an important role towards a healthy food system and long-term sustainable food security in South Africa.

### **1.4 Purpose of the study**

Fundamentally, this research study involves the development of a nutritious and sensorially acceptable food product with *Cissus quadrangularis* and promotion of this edible food plant through an awareness tool which highlights various health benefits to young adults.

### 1.5 Aim of the study

This study aims to develop a sensorially acceptable food product with *Cissus quadrangularis* and create awareness of *Cissus quadrangularis* among young adults.

### 1.6 Objectives

- To determine the knowledge, use and perceptions of *Cissus quadrangularis* among elderly community members through key informant interviews.
- To develop an acceptable food product using *Cissus quadrangularis* using the steps of product development.
- To determine the amounts of macronutrients and micronutrients in the developed product by means of nutrient analysis.
- To develop an awareness tool of *Cissus quadrangularis* for young adults using the developed product.

### 1.7 Study parameters

- *Cissus quadrangularis* (Vitaceae) was the only variety of *Cissus* used in this study.
- The development of the food product was conducted at the Durban University of Technology (DUT), Department of Consumer Science: Food and Nutrition Master's Laboratory.
- The key informant interviews and sensory evaluation aspect of this study was limited to KwaZulu-Natal (KZN).
- The key informant interviews were limited to elderly Indian community members.
- The sensory evaluation of the food product was limited to young adults attending DUT, Berea, South Africa.
- For the sensory evaluation, 110 participants were used, 10 for the pilot and 100 for the final sensory evaluation
- For the awareness tool survey, 110 young adult participants were used, 10 for the pilot and 100 for the final instrument.

### 1.8 Assumptions

- The elderly Indian community have knowledge on *Cissus quadrangularis* as it is commonly used in Ayurveda and Indian home cooking.
- Young adults are not aware of *Cissus quadrangularis*.
- All the participants involved in the key informant interviews were fluent in English.
- All participants understood the questions.

- All results received from the sensory evaluation and surveys were unbiased and accurate.

## 1.9 Definition of terms

- ***Cissus quadrangularis* L:** Is part of the vitaceae family and originated in Asia and Africa (Siddiqua and Mittapally 2017: 330). *Cissus quadrangularis* is a climber plant that has four rectangular sides which are segmented, and it has simple leaves with small green or yellow flowers (Brethauer 2019: para. 1 line 3).
- **Coronavirus (COVID-19):** Is a new strain of the “Severe Acute Respiratory Syndrome Coronavirus 2” (SARS-CoV-2) (South Africa, Dept. of Health 2020: para. 1 line 1).
- **Food security:** Is defined as having access to food at any given time and the food accessible must be sufficient to ensure people of any household can lead a healthy and active lifestyle (HSRC 2013: 10).
- **Food trend:** A food trend is when a food or an ingredient rises significantly in popularity and presence in the media and the marketplace, respectively (Culinary trend tracking series 2014: 4).
- **Indigenous foods:** Are foods that are local to country or area and consist of various foods such as root vegetables, leafy vegetables, plants, and fruits (Akinola *et al.* 2020: 5).
- **Nutrition education:** Is a method of educating people and assisting them with their health and life choices (FAO 2021a: para. 1 line 2).
- **Nutrition security:** Is defined as people receiving food to sustain them on a day-to-day basis but also the food consumed should have the right amount of macro and micronutrients, along with good hygiene practices and clean water (Ruel 2013: 25).
- **Product development:** Is defined as a creative systematic method that guides the process of a new product into the market (Rouse *et al.* 2014: para. 1 line 2).
- **Sensory evaluation:** Is a rating system used to identify different attributes of a product through the five senses; taste, sight, smell, hearing, and touch (Carpenter *et al.* 2012: 14).

## 1.10 Structure of the thesis

This thesis is reported in the format described below.

### Chapter 1: Introduction and Importance of the Study

This chapter includes the importance of the research, purpose of the study, aim of the study, objectives of the study, study parameters, assumptions, and structure of the thesis.

## **Chapter 2: Literature Review**

This chapter includes an analysis of studies previously conducted related to the research topic as well as relevant information pertaining to the study.

## **Chapter 3: Methodology**

This chapter includes research methods and tools to be used in the study.

## **Chapter 4: Results and Discussion**

This chapter includes the presentation of this study's findings and discussion of results.

## **Chapter 5: Conclusion and Recommendations**

This chapter includes the deductions made on the results, limitations and strengths, and suggestions for further research into the topic.



## 1.11 Research plan



**Figure 1.1: Framework of the study**

### **1.12 Conclusion**

Chapter 1 has outlined the importance of the study and the need for research to be conducted. A framework of the stages in the study was also included as a guide to the reader on the progression of the research (Figure 1.1). Literature relating to this study will be presented in chapter 2.

### **1.13 Referencing style**

The referencing style used in this thesis is according to the guidelines used at DUT (DUT Harvard style 2019) (Mitha *et al.* 2019).

## **CHAPTER TWO**

### **LITERATURE REVIEW**

#### **2.1 Introduction**

This chapter evaluates information that was gathered and reported by various researchers who have conducted studies around key topics related food security and sensory acceptable product development of *Cissus quadrangularis* to create awareness among young adults. The information was obtained from various sources, such as journals, books, and other forms of accredited media.

#### **2.2 What is Food security?**

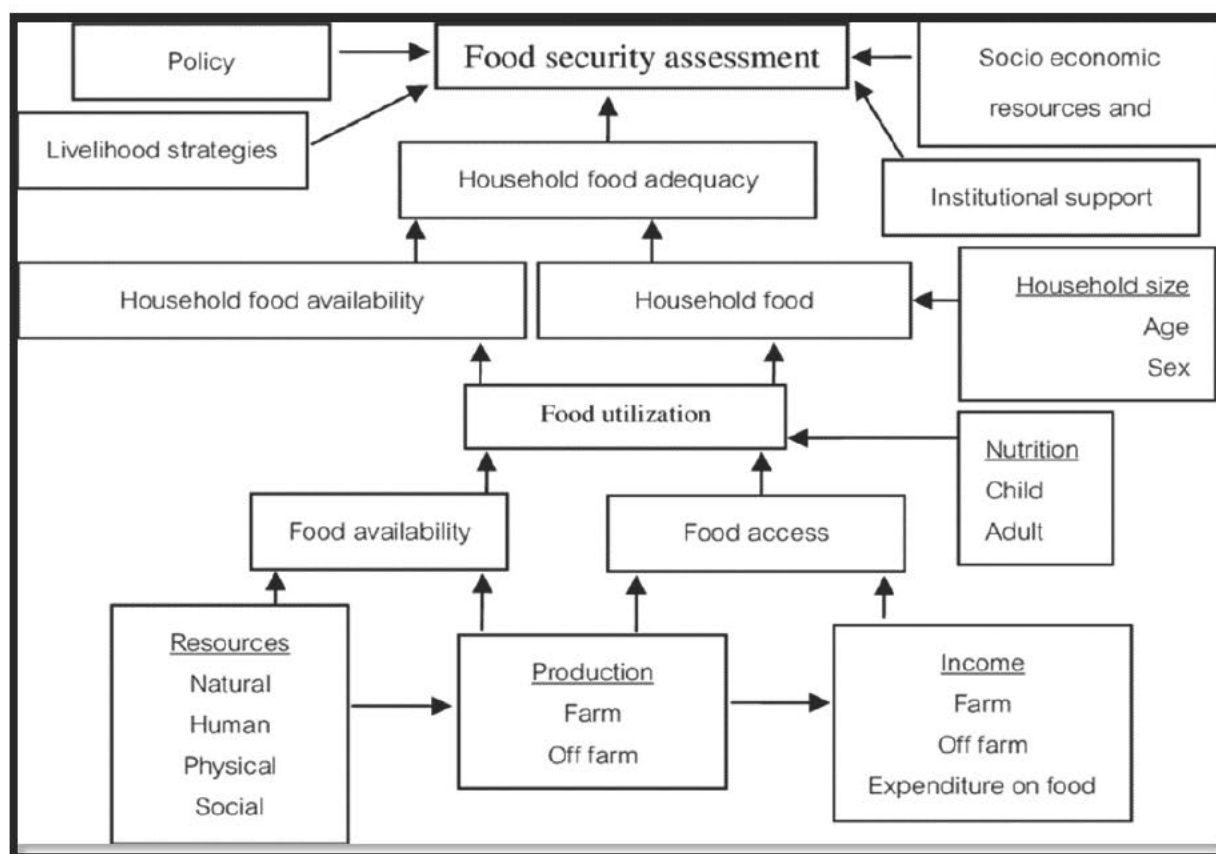
Stemming from Sustainable Development Goal 2 (SDG), emerges two important concepts: food security and nutrition security. According to the World Food Summit (1996), “Food security exists when all people, at all times, have physical and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life” (FAO 2006: 1). The HSRC (2013: 1) defines food security in the South African context, as all people of South Africa having access to food at any given time and the food accessible must be sufficient to ensure people of any household can lead a healthy and active lifestyle. Nutrition security ensures that a population does not only get food to sustain them on a day-to-day basis but are also able to consume food with the right amount of macro and micronutrients and adhere to having good hygiene practices and clean water (Ruel 2013: 25).

#### **2.3 Sustainable Development Goal 2**

In 2015, the United Nations developed the SDGs to ensure the world is a better place by the year 2030. One hundred and ninety-three countries joined the United Nations in this endeavour, and under this development, seventeen different goals were adopted (United Nations 2020: 1). Sustainable Development Goal 2 (SDG 2): Zero hunger, is the goal, which is associated with eradicating hunger, improving nutrition, agriculture and achieving food security (United Nations 2020: 1). The SDG 2 is an underlying component in all goals of the 2030 agenda (FAO 2016a :1). The SDG 2 aims to nourish people and nurture the planet by encompassing all three sectors of sustainability: economic, environmental, and social. Nutrition sensitive agriculture is based on development of nutritious foods that are rich in vitamins and minerals and are diverse. The development of these foods is aimed to assist with micronutrient deficiencies and malnutrition (FAO 2014: 19). The SDG 2 aims to end food insecurity, malnutrition as well as to assist the overall income of small-scale food producers and increase the use of sustainable genetic resources (FAO 2016a: 1).

## 2.4 Food Security framework

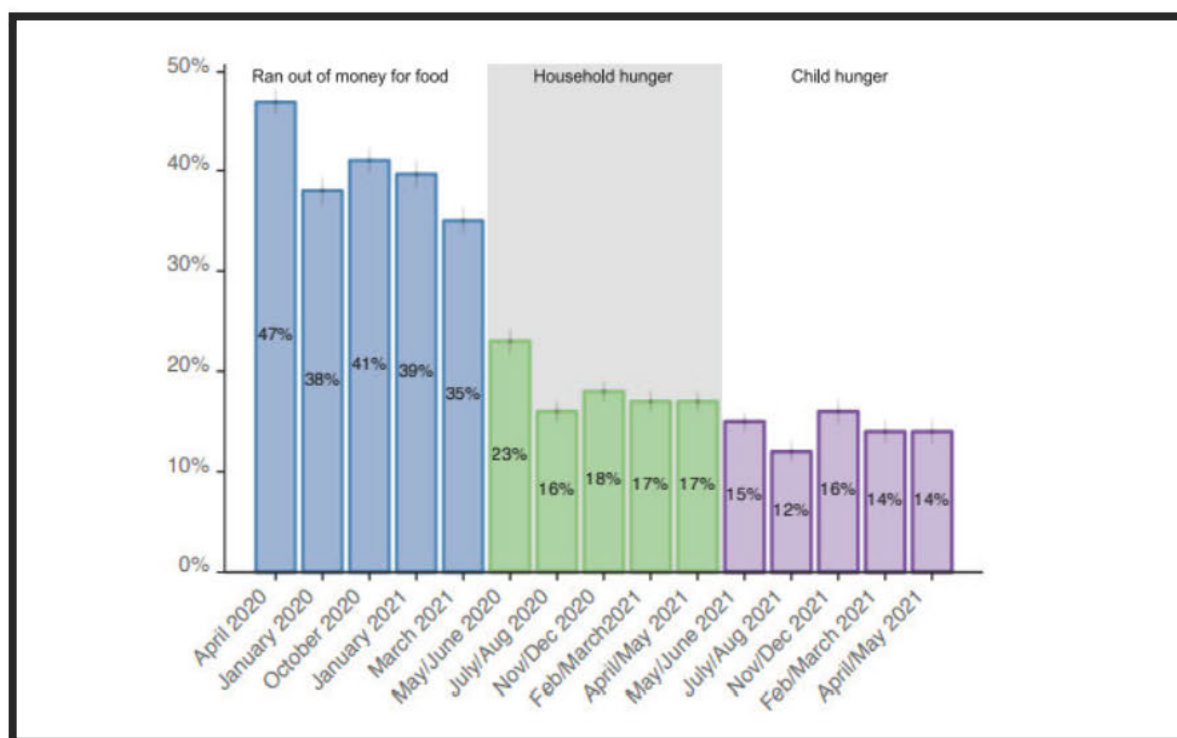
Nutrition and food security are interrelated; however, food security is grounded by four pillars namely: the availability of food, access to food, utilisation, and stability pertaining to the aforementioned sectors of food insecurity (FAO 2008:1). These four pillars are vital and have been used in food security frameworks in many studies (Gyawali and Ekasingh 2008: 216). The framework used in Nepal assesses food security by using food availability and access as a foundation to food utilisation to determine food adequacy and ultimately household food security. Gyawali and Ekasingh (2008: 216) depict the four pillars of food security in a framework along with interrelated factors such as production, income, resources, nutritional behaviour, food consumption, and food policies that are linked to household food security (Figure 2.1). Similarly, in a study by Khumalo and Sibanda (2019: 5) the conceptual framework used encompassed the four pillars of food security, to enhance household food security. A comparable food security conceptual framework was adapted and used by Maphosa *et al.* (2014: 1046) to determine food security within the study's sample population.



**Figure 2.1 Food insecurity framework depicting a food security assessment conducted in Nepal (Gyawali and Ekasingh 2008: 216)**

## 2.5 Food Security in South Africa

South Africa has a long-standing battle with food and nutrition security. Previous early research, by Lemke *et al.* (2003: 759) reported that in urban and rural areas of the Northwest province, 16% of the households were very food and nutrition insecure, 58% were insecure, 21% were relatively secure and 5% were secure. Progressively, a more recent report by Stats SA (2018: para. 1 line 65-67), showed that household hunger decreased from 24.2% to 9.7% in 2018 in South Africa. However, the food security status of individual provinces differs vastly as in the same report, households in the Northwest, Northern Cape, Mpumalanga, and Eastern Cape had a severe shortage of or inadequate access to food (Stats SA 2018 para. 1 line 4). The Coronavirus (COVID-19) pandemic has caused fluctuations in the employment and revenue sectors in South Africa. Research done by Stats SA (2020: para. 1 line 10) disclosed that individuals receiving no income increased from 5.2% before the national lockdown to 15.4%. The National Income Dynamics Study–Coronavirus Rapid Mobile (NIDS-CRAM) investigated the socioeconomic impacts of the national lockdown associated with the State of Disaster declared in South Africa in March 2020, and the social and economic consequences in South Africa of the global Coronavirus pandemic in order to inform policy using rapid reliable research on income, employment and welfare in South Africa, in the context of the global Coronavirus pandemic (NIDS 2020 para. 1 line 1). This survey explored household food insecurity, child and household hunger through 5 waves (May/ June 2020 and April/ May 2021). It was reported that in wave 1, 47% of households had run out of money whereas 35% of households ran out of money in wave 5 (Van der berg *et al.* 2021: 3). Household hunger was still prevalent as wave 1 showed 23% of households reported household hunger and wave 3 (17%), wave 4 (18%) and wave 5 (18%) of household hunger (Van der berg *et al.* 2021: 3). The report indicated that child hunger has not decreased as wave 5 showed 14% of child hunger in households (Van der berg *et al.* 2021: 3).



**Figure 2.2 NIDS-CRAM waves 1 to 5 survey on food insecurity and hunger (Van der berg *et al.* 2021: 3)**

## 2.6 Global perspective on food insecurity

Food and nutrition insecurity is a problem faced on a global level (FAO 2019: para. line 2). In 2018, 9.2% of the world's population experienced severe food insecurity and 1.3 billion people experienced moderate levels of food insecurity (FAO 2019: para. 1 line 4). According to FAO (2021c: 4) 720 to 811 million people faced hunger globally in 2020, this was 161 million more compared to 2019, the report also indicated that almost 2.37 billion people did not have access to food. Reports from the Global Hunger Index (2019: 1) highlighted Afghanistan, Zimbabwe, Timor- Leste, Haiti, Liberia, Zambia, Madagascar, Chad, Yemen and Central African Republic as the top ten countries experiencing severe hunger. Acute hunger is said to affect over twenty countries in the next few months if no urgent assistance is provided to them, with 34 million people already suffering from acute hunger (FAO 2021b: 1). In addition to this, the COVID-19 pandemic posed an additional threat to food and nutrition status of many people around the world due to economic instability and the disruption of food systems (FAO 2020: para. 2 line 2).

## 2.7 Causes of food insecurity

A study by Misselhorn and Hendriks (2017: 10) reflects that in South Africa the causes of food insecurity differ from place to place. However, there are many common factors such as, drought, lack of agricultural inputs, poverty and lack of income, distance from markets, lack of water, lack of

available land and lack of choice of cheap nutritious foods that contribute towards food insecurity in South Africa (Misselhorn and Hendriks 2017: 10).

Research by Misselhorn and Hendriks (2017: 10) has shown that poverty is one of the leading causes of food insecurity in South Africa. People who suffer from poverty are left with no money to buy food to sustain themselves. Claymore (2017: 1) expressed that increasing poverty levels are due to the rising unemployment rate in South Africa and the exploitation of underprivileged people. Kubik and May (2013:1), states that food prices affect more people in South Africa as poverty-stricken individuals are said to buy 15 food items from seven different food groups while the wealthier population buy 26 food items from nine different food groups.

Drought is another main cause of food insecurity (Kogan *et al.* 2018: 651). Drought is brought on by climate change which can play a huge role in weather patterns (Kubik and May 2013: 1). Research by Mulungu and Ng'ombe (2019: 48), suggests that maize crop production and other crops such as rice and potatoes and beans will decrease as a result of the drought and hotter climates. In the Western Cape, 5 billion rand was lost largely due to drought, and as the Western Cape is one of the country's biggest agricultures sectors, many jobs were lost as a result of the drought (Kalaba 2019: para. 7 line 1). This has had a spill over effect on the increased risk of food insecurity through increased food prices.

Two of the other main causes of food insecurity are the lack of affordable nutritious foods and the distance from markets to homesteads (Misselhorn and Hendrinks 2017: 10). Malnutrition occurs when diets do not contain sufficient nutrients for maintenance and growth or when one's body cannot properly utilise the nutrients it receives (Ismial and Shuffla 2013: 1). When there is no longer food, due to climate change, the problem is exacerbated as rural communities cannot afford to travel to supermarkets to buy food as supermarkets are located far away from these communities and food prices are remarkably high (Global Change System for analysis, Research and Training 2012: 6).

## **2.8 Solutions for food insecurity**

In post-Apartheid South Africa, the impetus on reducing food insecurity has gained momentum. South Africa began to develop and implement agricultural, and support policies to ensure that every South African could have access to their basic food wants and needs (Du Toit 2011: 1). However, according to Stats SA (2019: para 1 line 3), these needs are not necessarily met as South Africa is food secure at a national level; however, many households are suffering from lack of access to food and are experiencing extreme hunger.

One method endorsed by Solutions for Food Insecurity (2019: para. 1 line 5), suggests that the country needs to look at alternative ways to grow food, such as genetically modified plants and animals, which will meet the demand for the growing population as organically produced food is insufficient. Another method that is suggested is food fortification, wherein crops and food (bread, flour and maize) is enriched with essential micronutrients and minerals such as vitamin A, Iron, Folic acid and Zinc (Solutions for Food Insecurity 2019: para. 1 line 7).

Moseley *et al.* (2013: 1) suggests that a sustainable solution to reduce food insecurity is poverty alleviation, this can be done by introducing supermarkets into poverty-stricken areas, by doing this, it is believed to encourage economic growth as it will encourage job creation and improve access to food. In an initiative to combat food insecurity, the South African Medical Research Council (SAMRC) provided vegetable seeds to non-government organisations to help feed those experiencing food insecurity. This coupled, with employment opportunities and education enables food security (Naicker *et al.* 2015: 1). Short-term assistance such as social grants may be able to aid households in attaining food security by increasing household income (Naicker *et al.* 2015:1). However, social grants alone cannot be used to address food security, as research by Chakona and Shackleton (2019: 87) suggests that rising food prices stunts food security, since grants usually do not increase as frequently as food prices, leaving these individuals with insufficient money to run the household and attain food.

With drought as one of the main causes of food insecurity in Africa, drought resistant foods are vital and can be seen as part of the solution to attain food security. Many indigenous food plants in South Africa are drought resistant. Indigenous food plants can be described as plants that are native to a certain country or area (Beaulieu- Banks 2018: 13). South Africa has a wide range of indigenous plants that possess medicinal value (South African Medicinal Plants 2018: 1). In previous literature by Masekoameng and Molotja (2019: 45) indigenous foods and knowledge is recognised as being vital to the livelihood of people in many communities as it assists people within these communities to identify, cultivate and consume nutritious foods to sustain themselves, thus, reinforcing the importance of indigenous foods in attaining household food security. Indigenous foods are becoming increasingly popular in different cuisines and dishes around the world. Harding (2020: para.1 line 3) states that the usage of indigenous foods such as finger limes, lemon myrtle and Kakadu plums in Australia has heightened and moved to the mainstream. People are now interested in the use of indigenous foods not only for the diversity of different foods in the diet but also for the benefits of these superfoods. Interestingly, indigenous foods such as tamarind and moringa from West Africa



are becoming increasingly popularly for their health benefits and flavour profiles (Magoxo 2019: para. 3 line 5).

In South Africa, more people are looking at natural and indigenous foods to supplement their diets. These foods include pearl millet, grain sorghum, cow peas, bambara groundnuts, cleome (African cabbage), blackjack, umfino (Herbs), cassava, amadumbe (Taro) and marula fruit (Mngoma 2021: 1). All these foods are naturally rich with various vitamins and minerals that is said to assist with many body ailments (Mngoma 2021: 1).

Research by Thandeka *et al.* (2011: 202), reflects that households in KZN are familiar to 22 different types of indigenous traditional leafy vegetables, however, only 5 (blackjack, amaranthus, pumpkin leaves, sweet potato leaves and cucuza) are commonly used. Participants in another study pointed out that indigenous leafy vegetables are commonly prepared as an accompaniment to other foods (Masekoameng and Molotja 2019: 42). As per Akinola *et al.* (2020: 2) indigenous edible plants play an important role in the diet of many communities in Africa, however, due to globalization of the food system and food markets, indigenous foods are not being utilized and knowledge of indigenous foods is being forgotten and not being passed onto younger generations. One such rarely utilised indigenous edible plant is *Cissus quadrangularis*.

## **2.9 *Cissus quadrangularis***

*Cissus quadrangularis* is part of the vitaceae family and originated in Asia and Africa (Siddiqua and Mittapally 2017: 330). *Cissus quadrangularis* grows all over South Africa, particularly in Limpopo (Figure 2.2) (Mongalo and Makhafola 2018: 3). However, it goes unnoticed by many people. Yet, it is quite popular among the older Indian generation in South Africa and often referred to as “Hadjod” in Hindi (Translated as “Bone- Setter”); it can be used in a wide range of food applications and in Aryurvedic (Traditional) medicine. It is also used in some African and diaspora cultures as traditional medicine (Peek 2011: 170).



**Figure 2.3: Map of South African Provinces depicting Limpopo in light green (South African Provinces 2005: 1)**

### 2.9.1 Classification

*Cissus quadrangularis* is a vitaceae (Balasubramanian *et al.* 2010: 1).

**Table 2.1: Classification of *Cissus quadrangularis* L. (United States Department of Agriculture n.d: 1)**

|   |                  |
|---|------------------|
| Kingdom Plantae                         | Plants           |
| Subkingdom Tracheobionta                | Vascular plants  |
| Super division Spermatophyta            | Seed plants      |
| Division Magnoliophyta                  | Flowering plants |
| Class Magnoliopsida                     | Dicotyledons     |
| Family Vitaceae                         | Grape family     |
| Genus <i>Cissus</i> L.                  | Treebine         |
| Species <i>Cissus quadrangularis</i> L. | Veldt-grape      |

Banu *et al.* (2012a: 3082) state that *Cissus quadrangularis* is one of twelve *Cissus* genus used in medicine (Table 2.2). Previous research by Hogkiss (2016: 1), reports that the vitaceae family consists of 800 species of tropical and subtropical climbing plants. However, as per Sudmoon *et al.*

(2016: 68) although *Cissus quadrangularis* is part of the Cissus family there are some differences between *Cissus quadrangularis* and the other Cissus species (Table 2.2).

**Table 2.2: List of different Cissus Genus used in medicine (Banu *et al.* 2012a: 3082)**

| S/N | Species                  | Location  | Common Name                                    | Medicinal Property   | References  |
|-----|--------------------------|---|--|--|---|
| 1   | <i>C.araloides</i>       | Cameroon  | Kindamina                                      | Anti-microbial   | Assob <i>et al.</i> (2011)                                    |
| 2   | <i>C.assamica</i>        | China, India, Cambodia, Bhutan, Nepal, Thailand | -  | Anti-snake venom   | Yang <i>et al.</i> (1998)                                     |
| 3   | <i>C. debilis</i>        | Cameroon  | -  | Anti-cell proliferation  | Line-Edwige <i>et al.</i> (2009)                              |
| 4   | <i>C.hamaderohensis</i>  | Yemen   | -  | Anti-viral, anti ACE, NGP and APN  | Oleski <i>et al.</i> (2006)                                   |
| 5   | <i>C. hypoglauca</i>     | Australia                                       | Jungle grape, Water vine, five leaf water vine | Sore throat  | Lassack (1997)  |
| 6   | <i>C. ibuensis</i>       | Nigeria (Africa), Niger, Ghana                  | -  | Rheumatism, arthritis, Gastrointestinal tract  | Dalzeil (1958) and Irvine (1961)                              |
| 7   | <i>C. populnea</i>       | Nigeria (Africa)                                | Food gum, Ager, Okoho                          | Increase proliferation of sertoli cells  | Osibote <i>et al.</i> (2011)                                  |
| 8   | <i>C. quadrangularis</i> | India, Sri Lanka (Asia), Africa                 | Veldt grape                                    | Fracture healing, increases bone strength, protects bone from postmenopausal bone loss | Udupa and Prasad (1962; 1964)                                 |
| 9   | <i>C. rotundifolia</i>   | Africa, South America                           | Arabian wax Cissus, Peruvian grape Ivy         | Anti-parasitic, anti-diabetic  | Onyechi <i>et al.</i> (1998) and Alzoreky and Nakamura (2003) |
| 10  | <i>C. rubiginosa</i>     | Congo   | -  | Anti-dysentery, anti-diarrhoea   | Otshudi <i>et al.</i> (2000)                                  |
| 11  | <i>C. sicyoides</i>      | Brazil (South America)                          | Princess vine, curtain ivy, millionaire vine   | Anti-diabetic, diuretic, anti-inflammatory, anti-convulsant, anxiolyte                 | Salgado <i>et al.</i> (2009)                                  |
| 12  | <i>C. verticillata</i>   | Trinidad and Tobago (Caribbean)                 | -  | Anti-cholesterol, anti-diabetic  | Lans (2006)   |

### 2.9.2 Physical characteristics of *Cissus quadrangularis*

*Cissus quadrangularis* grows in dry woodland areas. Morphologically, the plants stems have a greenish tinge which are dichotomously branched, sub-angular, globous and smooth with internode measures that are 4-5 cm long and 1-2 cm thick (Sen and Dash 2012: 170). Leaves are simple or lobed and flowers are small and greenish white which produce globose fleshy berries (Sen and Dash 2012: 170).



**Figure 2.4:** *Cissus quadrangularis* with leaf (Singh 2020)

### 2.9.3 Health uses of *Cissus quadrangularis*

*Cissus quadrangularis* has been used in ayurvedic medicine to help treat diseases such as arthritis, osteoporosis and in bone healing (Malathi 2014: 3). A study by Staughton (2018: 1), indicates that *Cissus quadrangularis* is said to heal broken bones, prevent the deterioration of bone matter and aid in bone growth. In addition, *Cissus quadrangularis* is also said to possess anti-inflammatory properties, lower cholesterol levels, aid in weight loss, lessen menstrual discomfort, heal wounds, lessen the severity of respiratory disorders, or prevent them, boost immune systems as well as aid in the treatment of skin diseases, colic, epilepsy, anorexia, swelling, chronic ulcers, flatulence, dental conditions, and metabolic syndrome (Malathi 2014: 3 and Wong 2018: 1). A recent study by (Sundaran 2020: 582) shows that the intake of *Cissus quadrangularis* resulted in weight loss as participants of the study showed lower serum lipid

levels and a decreased waist circumference body mass index. The study also depicted that *Cissus quadrangularis* helps with ulcers, the central nervous system and the gastrointestinal system.

#### **2.9.4 Medicinal uses of *Cissus quadrangularis* in Africa**

Previous research conducted by Bum *et al.* (2008: 042) indicated that *Cissus quadrangularis* is used for traditional medicine in Africa, the plant was used to treat many diseases such as syphilis, sickle cells, malaria, and gonorrhoea. *Cissus quadrangularis* is also used in Cameroon for the treatment of oral dehydration (Mate *et al.* 2007: 118).

#### **2.9.5 Other uses of *Cissus quadrangularis***

The plant is available in powder and supplement form globally and in South Africa. In Australia and America, *Cissus quadrangularis* has been used as a main ingredient in supplement powders such as NutraKey™ and Bulk Nutrients™ (Nutrakeyhealth 2018: para. 1 line 2). These supplement powders promote *Cissus quadrangularis* by claiming the plant will be able to aid athletes with bone and joint strength and health as well as reducing joint pain, healing bones and by having anti-inflammatory properties (Nutrakeyhealth 2018: para. 1 line 2).

In a recent study conducted in India, *Cissus quadrangularis* powder was added to a standard bread recipe and the product was tested for nutritional analysis and sensory acceptability. Findings of this study showed that the protein content of the *Cissus quadrangularis* stem powder was higher (13.89%) than that of the control recipe (11.45% of protein) (Nawghare 2017: 4256). The findings also showed that there was a decrease of 7.79% of total carbohydrates in the baked product when 8% of *Cissus quadrangularis* stem powder was substituted for some of the wheat flour used in the recipe (Nawghare 2017: 4256).

In a study conducted by Malathi (2014: 4), *Cissus quadrangularis* stem powder was used to make rotis (Traditional Indian flat bread). The mixture was blended with *Cissus quadrangularis* and rice flour in a ratio of 1:3. The findings from this study showed that per 100g, the roti yielded 6.44g of protein, 74.36g of crude fibre, 0.73g of fat and 63.73g of carbohydrates. The researcher in this study indicated that the 1:3 ratio of *Cissus quadrangularis* and rice flour obtained the most promising results for consumer acceptability.



### 2.9.6 Nutrient value of *Cissus quadrangularis*

*Cissus quadrangularis* has a high amount of vitamin C, vitamin A, Calcium, Potassium, Iron and Sodium (Brahmkshatriya *et al.* 2015: 169 and Enechi *et al.* 2003: 66) (Table 2.3).

**Table 2.3: Mineral content in *Cissus quadrangularis* root powder (mg/100g) (Enechi *et al.* 2003: 66)**

| Mineral elements (mg) | Content (mg/100g) |
|-----------------------|-------------------|
| Potassium             | 67.5              |
| Calcium               | 39.5              |
| Zinc                  | 3.0               |
| Sodium                | 22.5              |
| Iron                  | 7.5               |
| Lead                  | 3.5               |
| Cadmium               | 0.25              |
| Copper                | 0.5               |
| Magnesium             | 1.15              |

### 2.9.7 Toxicity of *Cissus quadrangularis*

Research on the medicinal and health properties of *Cissus quadrangularis* has been conducted, however, there is limited research on the toxicity of *Cissus quadrangularis* when consumed. It has been reported that when *Cissus quadrangularis* was tested for sub chronic toxicity in a 90-day study period, with the dose of the extract as 2500mg per day, no adverse effect of the *Cissus quadrangularis* extract was noted (Kothari *et al.* 2011: 3343).

However, according to Karadbhajnev *et al.* (2014: 2266) when *Cissus quadrangularis* was baked into cookies and biscuits in their study, as the percentage of *Cissus quadrangularis* powder (10%/ 15% of *Cissus quadrangularis*) or extract (15% of *Cissus quadrangularis*) was increased in the standard recipe, it resulted in throat irritation (Table 2.4).

**Table 2.4: Percentage of *Cissus quadrangularis* powder and resulting throat irritation**

| % <i>Cissus quadrangularis</i> (Powder/Extract)         | Effect on Throat     |
|---|----------------------|
| 5% <i>Cissus quadrangularis</i> powder                  | No irritation        |
| 10% <i>Cissus quadrangularis</i> powder                 | Slight irritation    |
| 15% <i>Cissus quadrangularis</i> powder                 | Prominent irritation |
|   |                      |
| 5% <i>Cissus quadrangularis</i> powder extract in ghee  | No irritation        |
| 10% <i>Cissus quadrangularis</i> powder extract in ghee | No irritation        |
| 15% <i>Cissus quadrangularis</i> powder extract in ghee | Slight irritation    |

(Table adapted from Karadbhajnev *et al.* (2014: 2266) study on Application of *Cissus quadrangularis* Linn. (Hadjor) in nutraceutical food (bakery) products)

### **2.10 Importance of the nutrients found in *Cissus quadrangularis***

*Cissus quadrangularis* contains varying amounts of key nutrients including vitamin A, vitamin C, Calcium, Potassium, Iron and Zinc. Gilbert (2013: 65), states that vitamin A is an especially important micronutrient which the human body cannot produce. Vitamin A is important for the daily functioning and maintenance of all epithelia in the body (Arnarson 2017: para. Line 3). It improves vision, and aids in maintaining a healthy immune system. Good food sources of vitamin A include kale, sweet potato, carrot, Swiss chard and butternut (Arnarson 2017: para. Line 3).

Vitamin C is also known as L-ascorbic acid (National Institutes of Health 2020a: para. 1 line 4). Vitamin C is an important nutrient that the body needs for maintaining normal bodily functions, such as wound healing, protein metabolism, absorption of iron and the functioning of the immune system (National Institutes of Health 2020a: para.1 line 5). Good food sources of vitamin C include guavas, yellow peppers, kale, kiwis, broccoli, lemons, papaya, and oranges (Hill 2018: 8).

Calcium is an important nutrient which is essential for various functions in the human body such as bone formation and maintenance (Beto 2015: 1). If a substantial amount of calcium is consumed it can assist with osteoporosis, risk of fractures and lifelong maintenance of bones and the skeletal systems (Beto 2015: 1). Good sources of calcium come from milk, yoghurt, cheese, chia seeds, sardines, spinach and canned salmon (Jennings 2018: 1).



Potassium is an essential nutrient for normal bodily functions such as, normal cell and maintenance of intracellular fluid volume (National Institutes of Health 2020b: 1). Raman (2017: 1) states that a potassium rich diet can reduce water retention, protect against strokes, kidney stones, help reduces blood pressure and helps to prevent osteoporosis. Good food sources of potassium come from spinach, avocados, watermelon, white beans, edamame and potatoes (O'Brien 2018: 1).

Iron is vital for bodily functions such as oxygen and haemoglobin transportation (Abbaspour *et al.* 2014: 1). Morris (2014: 1) explains when there is not enough iron present in the red blood cells a person can have an iron deficiency called anaemia (Spritzler 2020: 1). This deficiency causes the red bloods cells in the body to not efficiently provide oxygen to cells and tissues. A person can receive iron from supplements or food sources such as red meat, liver and organ meat, spinach, legumes, and quinoa (Spritzler 2020: 1).

Zinc is a nutrient which the human body cannot produce or store. Zinc plays an important role in many bodily processes such as protein synthesis, immune function, gene expression, wound healing, growth, and development (Kubala 2018a: 1). Good food sources of zinc are crab, lobster, kale, mushroom, legumes, pumpkin seeds, fortified breakfast cereals, milk and yoghurt (Lawler 2020: 1). The aforementioned vitamins and minerals are present in *Cissus quadrangularis* and are essential for maintaining a healthy and active lifestyle.

### **2.11 Importance of food trends in product development**

A food trend is when the usage or awareness of a food or ingredient raises significantly in the media and the marketplace (Culinary trend tracking series 2014: 4). Companies depend on food trends to have profit making business ventures (Culinary trend tracking series 2014: 4). Food trends are constantly changing from year to year. Companies depend on the success of their new products in the markets; however, some new products seem to fail due to the ever-changing social values of consumers (Guine *et al.* 2020: 2). Making a profit and providing consumers with food products that are sensorially acceptable are a few of the challenges that food producers face, including the need make sure that consumer trends are incorporated for the product to be successful in the market (Hanus 2018: 86). Stewart-Knox and Mitchell (2003: 58) suggest that consumer knowledge is one of the reasons for product success.

### **2.12 Factors affecting young adult's food acceptance and preference**

Prior research by Hebden *et al.* (2015: 1) reported that young adults between the ages of 18-24 years tend to eat food that is processed, cheap and palatable, however, this is not the case for all young adults as their preference of food vary according to their behaviour, stress level, diet, food exposure or physical activity. Six factors that are considered when looking at the preference of food include biological factors (hunger and taste), economic factors (cost, availability and income), physical factors (education, access and time), social factors (culture, family, friends and patterns), psychological factors (stress and mood) and attitude factors (knowledge and beliefs about different kinds of food) (EUFIC 2006: 1). As per, BioMed Research International, majority of participants that took part in a study on factors affecting consumer preferences changed their eating habits due to the different emotions they were experiencing whilst 20% of participants did not (Bartkiene *et al.* 2019: 3).

### **2.13 Socio-economic status of people in South Africa**

According to Stats SA (2018: 15), socio-economic issues in South Africa centre on inequality, low standards of education, poverty, high unemployment rate and low income. As per Stats SA (2015: para 1 line 5) South Africa is an unequal country, inequality has declined at a national level from 2006 to 2015, but 60% of households are more dependent on social grants than income from labour markets. Lama (2019: 1) posited that people tend to eat junk food rather than healthier food as it is affordable, tasty, and convenient. However, South Africa has a wide range of nutritious and indigenous plants available for consumption. Most indigenous plants promise good nutrition and sustainability. However, most of these indigenous plants are used

by older generations and are unfamiliar to younger generations due to globalisation of foods (Inglehart and Baker 2000: 3).

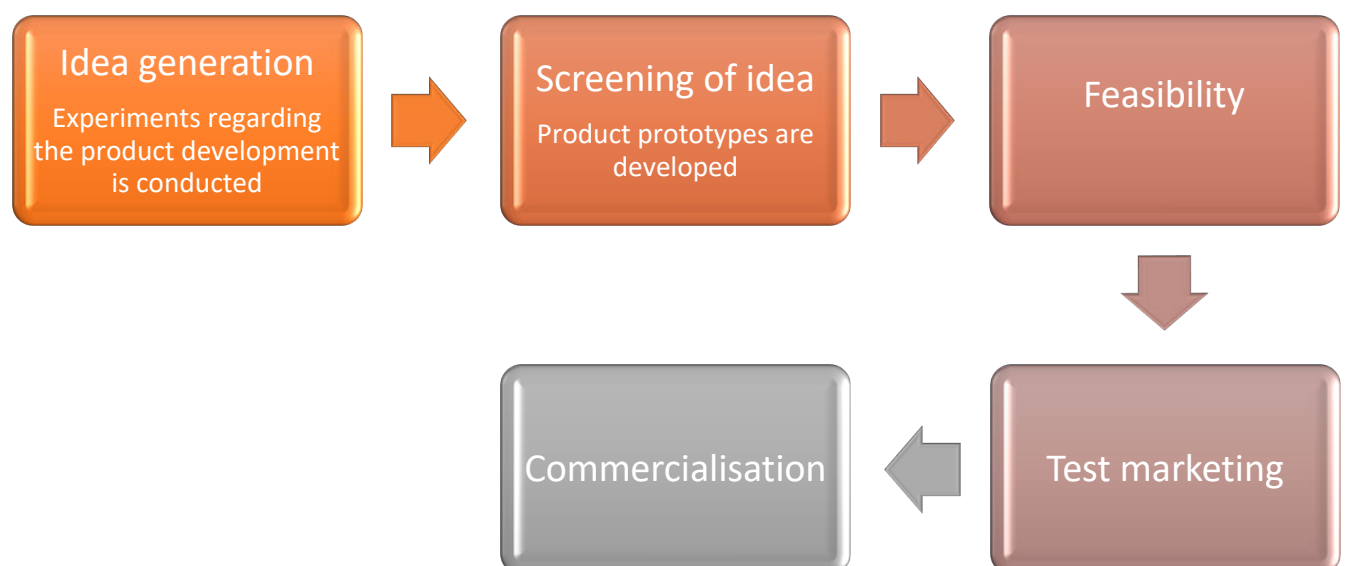
## 2.14 Product development

Product development can be defined as a creative systemic method that guides the process of a new product to the market (Rouse *et al.* 2014: 1). Companies use product development to satisfy consumer demand by increasing the company's market share (Rouse *et al.* 2014: 1).

There are many reasons why companies develop new products (Goodman 2016: 1); the reasons range from a company's need to stay ahead of the competition, and by developing new products companies can gain a competitive advantage. Innovation is also key, if a company is to come out with a creation that is the first to satisfy their consumer needs or to address a problem resulting in them being viewed as a creative and fast acting company. Improving sales and revenue is usually a driving force, as innovative products help increase sales. Consumer trends also enable a company to maintain a competitive advantage as the trends go mainstream.

### 2.14.1 Stages of product development:

The new product development process comprises of five steps which are depicted in a process flow chart (Figure 2.3). Product development is the process of designing and developing new products to meet specific consumer needs (Simons 2017: para. 1 line 3).



**Figure 2.5: Stages of new product development (Aramouni and Deschenes 2015: 2)**

The first stage of product development is idea generation and this stage centres around brainstorming a new idea or concept that the company can further develop. This process usually requires input from the marketing department or consumer. However, some companies do not use consumer input if they are driven by competition from rival companies. Idea generation stems from information regarding consumer wants and needs, trends, research articles, publications as well as the monitoring of supermarkets (Aramouni and Deschenes 2015: 2). Idea generation is generally initiated by the marketing team and then communicated to the product development team (Simons 2017: para. 2 line 3). The information used during this process is consumer needs, market research and consumer trends (Simons 2017: para. 2 line 3).

The second stage of product development includes screening; this stage involves testing of the product concepts to indicate if the product has the potential to be successful or not. Companies conducting the screening can ask themselves numerous questions such as, “who will use the product?”, “how will it be used?”, “who is the competition?”, “how will people find out about the product?”, “how much will the product cost?” and “what are the uses of the product?” (Aramouni and Deschenes 2015: 3). However, according to Agens (2020: 2) screening is the first stage of food product development and screening involves various questions such as “will the consumer benefit from this product?”, “will consumers be willing to pay for the size of the product?”. These questions help the producer to decide if the product is worth moving on to the next stages.

The third stage of product development includes feasibility; this stage involves three subsections: regulations, technology, and finances. The developers determine if the new product falls within current laws and regulations of the country. The subsection technology places emphasis on the equipment needed to manufacture the new product. The financial subsection of this stage deals with the total cost of the product including production and marketing costs. In this stage the total cost should be analysed before the manufacturing process begins. The two costs developers should consider is fixed costs and variable costs. Throughout these stages, developers need to look at the methods and items they will use regarding formulations, ingredients, processing, facilities, packaging, distribution, shelf life and safety of the product (Aramouni and Deschenes 2015: 5). However, according to Simons (2017: para.4 line 2) the third stage should also include sensory evaluation of the product; this stage should provide the production team with feedback on what modifications need to be made to the product for it to meet consumer expectations.

The fourth stage of product development includes test marketing; during this stage, developers will test the product among consumers. In this stage the product should have a final formulation and specific documentation regarding the weight of your product, ingredients, and source of ingredients. The product should also have an appealing packaging that protects the food from contamination (Aramouni and Deschenes 2015: 5). The test marketing should be applied to the target market and in a limited area. Questionnaires should be given to consumers to rate the product based on their likes and dislikes. The analysis from this stage should indicate if the product has the potential to succeed if commercialized (Aramouni and Deschenes 2015: 9). As per Agens (2020: 1) test marketing should help identify a market area to sell the product as well as an opportune time to get quality consumer feedback.

The last stage of product development is commercialization; this stage involves sending the developed product into the market. During this stage, the developers also look at the location for manufacturing of the product, consumer concerns from the test marketing stage, product promotion and product maintenance. The developers will need to keep the quality of the product at a high standard for the profits to rise. The company will use consumer reviews to determine if variations to attributes such as flavour can be made to the product (Aramouni and Deschenes 2015: 9).

### **2.15 Sensory evaluation**

Sensory evaluation can be defined as a rating system used to identify different attributes of a product through the five senses such as taste, sight, smell, hearing, and touch (Carpenter *et al.* 2012: 14). Sensory testing is important as it improves the end results of the final product (Application of sensory science to product development 2009: 1). Sensory evaluation plays a vital role in quality control and new product development providing standards and specifications for the development ensuring sensory acceptable products of good quality are consistently being developed (Reed 2012: 2).

There are two types of sensory tests: analytical tests, and affective tests. Analytical tests can be evaluated on noticeable differences and can be divided into two groups, discriminative and descriptive tests. Affective tests comprise of two groups of testing: acceptance or preference. Acceptance is based on rating the sample and preference is based on choosing the sample preferred (Choi 2008: 96).

There are many different methods that can be applied when using sensory analysis, the 9-point hedonic scale test and the paired preference test was reviewed and utilized in this study.

Hedonic testing is used to identify how much a food product is liked or disliked as well as the degree of the liking or disliking of the food product (Sensory Analysis Teachers Manual 2017: 23). Paired preference testing is used to identify which out of two food products do participants prefer (Wichchukit and O'Mahony 2010: 925).

However, certain aspects need to be controlled and monitored despite the type of testing used. The samples can be controlled by ensuring consistency in the sample size and portion. All samples should be presented in containers that are of the same shape, colour and size and the samples should always be accompanied with palate cleansers such as plain bread or room temperature water. These items will help to cleanse the palate from the different tastes of foods between samples (Choi 2008: 92).

Sensory evaluation brings about collaboration of the quality control and research and development departments to ensure high and consistent quality of products (Munoz 2002: 330). A study conducted by Fisher (2017:1) showed that sensory and quality aspects go hand in hand because when the product fails, the failure will be as a result of participant feedback from the sensory evaluation or quality of the product. Therefore, by keeping the quality and sensory acceptability of the product at a high standard there should be a limited recall of failed products. However, when an issue arises sensory evaluation allows the developer to go back to the main aspects of development and identify where the problem or misjudgement occurred. Sensory evaluation is important in the product development process as it helps to modify the developed product as well as to decipher if the product would be accepted or not by consumers once it enters the market (Pallavi 2019: 2).

## **2.16 Nutrition education**

Health conditions stemming from the lack of vitamins and minerals in one's diet or obesity and diet related chronic diseases can emanate from a lack of knowledge of correct food choices (FAO: para. 1 line 2). Nutrition education is a method of educating people and assisting them with their health and lifestyle choices (FAO 2021d: para. 3 line 3).

The SANHANES-1 report stated that lack of dietary knowledge, improper dietary behaviour and dietary practices could lead to NCDs (Shisana *et al.* 2013: 201). Upon the review of the results of SANHANES-1, the HSRC stipulated certain recommendations should be implemented to help improve the health status of South Africans (HSRC 2013: 10).

The recommendations were as follows:

- Obesity should be addressed at home, schools and in one's community.
- Knowledge of physical activity.
- Healthy food practices and choices should be implemented at homes and in schools.

A study by Kapur (2018: 1) emphasises that students should be supplied with information on nutrition knowledge for them to create and maintain a healthy lifestyle and wellbeing. Schools and places of education have been seen as the best place for nutrition education to be taught to students. According to the FAO (2007a: para. 1 line 6) creating and implementing nutrition education can help many people learn and utilise, good hand washing practices, good eating habits and suitable types of meals/snacks to prepare in their everyday life.

In South Africa, there are multiple feeding schemes that are put into place at schools and communities to assist with nutrition problems and nutrition education. However, in a study by Okeyo *et al.* (2020: 15), many teachers who were responsible for teaching nutrition education in the Eastern Cape had no formal training in nutrition education, and this showed in their responses to nutrition related questions.

To create awareness for the developed food product using *Cissus quadrangularis*, an awareness tool will be created. The awareness tool developed will be able to create awareness of *Cissus quadrangularis* and its various health benefits among young adults. Nutrition education involves people learning how to improve their nutritional status by what they eat, how they act, (FAO 2021d: para. 4 line 3). As stated by Deshpande (2003: 4164), nutrition education is the process of teaching nutrition science to groups or individual people. There are various methods that can be used for nutrition education and awareness tools. Illustrations can be used to explain how certain nutrients assist the body. When illustrations are used it makes information easier to understand (Eatrightpro 2021: para. 7 line 1). Cooking demonstrations can be held for groups of people showcasing how to cook healthy foods, balanced meals and how to use local foods (Keller 2012: 52). Brochures can be used as a form of an awareness tool. These are cost-effective, easy to distribute and can contain a lot of information (Flottman 2016: para. 2 line 1).

The awareness tool used in this study will be created and dispersed using modern methods such as social media and videography. Videos make it easier and quicker for the viewer to grasp the information being displayed (Proceed Innovative 2017: 1). Videos are more captivating than other platforms used to convey information, because people tend to prefer watching an entire video rather than reading paragraphs of information (Salswedel 2017: 1). In addition to this,

videos are exceedingly popular on all different platforms of social media (Doyle 2019: para. 6 line 1). Rai (2012: 259) stated that the use of social media has risen significantly over the past few years. In the past year, the amount of people using social media has gone up by 13%, making the total new users of social media to nearly half a billion (Kemp 2021: 1). Facebook™ is one of the largest social media platforms with 2.4 billion users, WhatsApp™ and YouTube™ have over one billion users each (Ortiz-Ospina 2019: para. 1 line1).

To produce a good video, the video should be recorded using good lighting, the background used should be clean, different angles should be used whilst filming and the video should be planned (Bedrina 2019: 1). Taking these factors into account can enhance both the quality and acceptability of the video being produced.

## **2.17 Conclusion**

It is evident that South Africa's battle with food security still stands (Abdu-Raheem *et al.* 2011: 2). However, exploring food product development using indigenous food plants may be a sustainable measure to address the current situation. *Cissus quadrangularis* has the potential to aid South Africans in receiving essential nutrients, assist with problems associated with both undernutrition and overnutrition, and other health problems such as arthritis, osteoporosis, and bone health. The development of an awareness tool of the developed food product using *Cissus quadrangularis* will be able to create awareness of the food plant and its various health benefits. The research design and methodology will be discussed in three separate phases in the next chapter.



## CHAPTER 3

### METHODOLOGY

#### 3.1 Introduction

This chapter describes the research design and methodology in three separate phases. The first phase focused on the preliminary data (key informant interviews and desktop study on food and nutrition trends); the second phase involved the development of a sensorially acceptable, nutrient-rich, food-safe, shelf-stable food product using *Cissus quadrangularis*. Lastly, the third phase involved the development of the awareness tool using the developed product.

#### 3.2 Context of research

The research was conducted in Durban, KZN (Figure 3.1). The development of a trendy food product enhanced with *Cissus quadrangularis* has the potential to provide South Africans with essential nutrients, assisting with addressing problems associated with both undernutrition and overnutrition. The intention of the awareness tool was to provide quick easy recipes using *Cissus quadrangularis* to increase consumption of the plant as a food as well as to create awareness of *Cissus quadrangularis*.



**Figure 3.1: Map of KwaZulu-Natal including Durban (SA-venues 2021)**

### 3.3 Study design

The research design for this developmental study comprised of mixed methods namely, qualitative, and quantitative research methodology (Creswell 2009: 9). The qualitative aspect of this study involved key informant interviews. The purpose of the qualitative aspect of this research was to determine South African, elderly Indian community members knowledge of *Cissus quadrangularis* and the methods they use to extract its benefits. The quantitative aspect of this study was the sensory evaluation and the development of an awareness tool. The quantitative and qualitative aspects included in this research were used to determine the guidelines used to create a food item with *Cissus quadrangularis*, to test the sensory acceptability of the food products developed and to create awareness of *Cissus quadrangularis* among young adults.

### 3.4 Plant specimen



**Figure 3.2: *Cissus quadrangularis* with leaf (Singh 2020)**

The Researcher used *Cissus quadrangularis* which was obtained from plant nurseries in South Africa to ensure the correct specimen of the plant was being used during all trials. The researcher also used a *Cissus quadrangularis* stem powder acquired from an accredited online store, Bulk Supplements™.

### 3.5 Study population

The study population for the qualitative aspect of this study comprised of 10 elderly Indian community members. The sample size was determined to ensure that the researcher had sufficient preliminary data (UCLA centre for health policy research 2004: 4). The study population for the quantitative aspect of this study compromised of 220 young adults (Table 3.1). Convenience sampling was used to determine the sample population.

**Table 3.1: Sample size for the quantitative aspect of the study**

| <b>Sensory evaluation</b>    | <b>Number of participants</b> |
|------------------------------|-------------------------------|
| Pilot sensory evaluation     | 10                            |
| Final sensory evaluation     | 100                           |
| <b>Awareness tool survey</b> | <b>Number of participants</b> |
| Pilot awareness tool survey  | 10                            |
| Final awareness tool survey  | 100                           |

### **3.5.1 Recruitment of sensory evaluation and awareness tool survey participants**

The researcher gained permission from the Gatekeeper at DUT to conduct the sensory evaluation at campus (Appendix A). Ten food and nutrition students were approached by research assistants to take part in the pilot sensory evaluation. The final sensory evaluation required a study population of 100 participants. The researcher and research assistants approached prospective participants and informed them of the nature of the study. Those who were interested in taking part in the research provided their contact details and were later provided with details of the sensory evaluation.

Regarding the awareness tool survey, ten young adults were required for the pilot survey, these young adults were sourced from DUT. The researcher and research assistants approached possible participants and asked them to participate in the survey, if they were interested, they were asked for their cell-phone numbers. The participants were then sent the pilot awareness tool via WhatsApp™. The final survey required a sample population of 100 participants who were contacted via social media (i.e.: WhatsApp™, Facebook™, and Instagram™). The researcher and research assistants used their personal social media accounts to contact participants. The final awareness tool and survey link was sent to possible participants via WhatsApp™, it was also posted on Facebook™ and Instagram™, possible participants were asked to watch the video and complete the online survey.

## **3.6 Inclusion and exclusion criteria**

### **3.6.1 Key informant interviews**

#### ***Inclusion Criteria:***

- South African Indians aged 50 years or older
- Have knowledge of *Cissus quadrangularis*
- Have used or cooked *Cissus quadrangularis*
- Both men and women

***Exclusion criteria:***

- People under the age of 50
- People who have no knowledge of *Cissus quadrangularis*
- People who have never used/cooked *Cissus quadrangularis*
- Race groups: White, African, Coloured

### **3.6.2 Sensory evaluation**

***Inclusion criteria:***

- Students including and below the age of 25
- Registered students at DUT
- All races and gender

***Exclusion criteria:***

- Students above the age of 25
- Students under the age of 18

### **3.6.3 Awareness tool survey**

***Inclusion criteria:***

- Persons below the age of 25 in SA
- All races

***Exclusion criteria:***

- Persons over the age of 25
- Persons under the age of 18

### **3.7 Research process**

#### **3.7.1 Phase one: Key informant interview and Desktop study on food and nutrition trends**

##### **3.7.1.1 Preliminary data collection (Key informant interview and Desktop study)**

The first phase of the study focused on the preliminary data. The qualitative aspect of this study involved key informant interviews. The objective of the key informant interviews was to determine the knowledge, use and perceptions of *Cissus quadrangularis* among elderly Indian community members. It has been documented that 15-25 in-depth interviews are usually adequate to capture the information needed, however, this is largely based on the type of research being conducted (UCLA centre for health policy research 2004: 4). Ten key informant interviews were conducted until data saturation was reached. According to Saunders *et al.* (2017: 6) saturation can be identified early in the process of the interviews. This can happen when the researcher realises the information being gathered is becoming redundant. Moreover, in the study by Hennink *et al.* (2017: 605) which examined 25 in-depth interviews, it was found that code saturation was reached at nine interviews, whereby a range of thematic issues were identified. A desktop study was conducted to determine current food trends which is described in depth under 3.10. 1.3

##### **3.7.1.2 Planning and administration**

The key informant interviews were conducted in KZN (Chatsworth, Durban, Queensburgh, and Shallcross), South Africa. Given that in South Africa, mainly Indians used *Cissus quadrangularis* for both medicinal and dietary purposes, it was decided that the elder Indian community will be selected for the study. Eligibility criteria for key informant interviews was that participants had to be Indian, over the age of 50, and must have used or have knowledge of *Cissus quadrangularis*. The recruitment of key informant interview participants was advertised via a session aired on a local community radio station with a frequency reach throughout KZN (Appendix B). The session was interactive where the researcher spoke on air about the research study and the listeners called through. The researcher on air explained the process of the key informant interviews and the listeners who were eligible and interested provided their contact details to the radio station. The researcher then contacted the participants and appointments were scheduled to conduct the key informant interviews at participants' convenience. Participants were given a letter of information and informed consent was sought for participation in the study (Appendix C). Prior to conducting the key informant interviews,

the researcher received training on moderating a key informant interview. A key informant interview guide with questions related to outcome measures was developed and piloted (Appendix D).

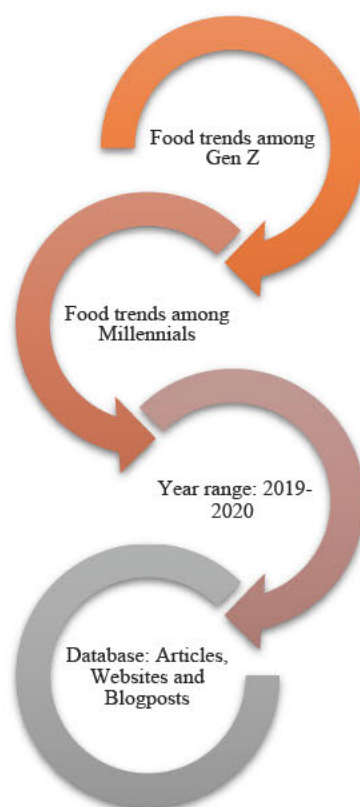
The interviews aimed to understand the participants' knowledge, views, and perceptions of *Cissus quadrangularis*. All interviews were held at the homes of the participants and were conducted in English. Participants were asked in-depth questions by the researcher and their responses were recorded by a digital recorder and notes were taken by a trained note taker. Each key informant interview took an average of 45 minutes. Prior to each interview the guidelines for the key informant interview was explained to each participant. The guidelines were as follows:

- Do not be afraid to speak freely
- There are no right or wrong answers
- Feel free to take a break from the interview if need be.

The participants were assured that even though they were being reordered their identities would remain anonymous throughout the study. The information gathered in both the interviews and the literature review aided the product development process of the study.



### 3.7.1.3 Desktop study on food and nutrition trends



**Figure 3.3: Method used for selection of information for the desktop study on food and nutrition trends**

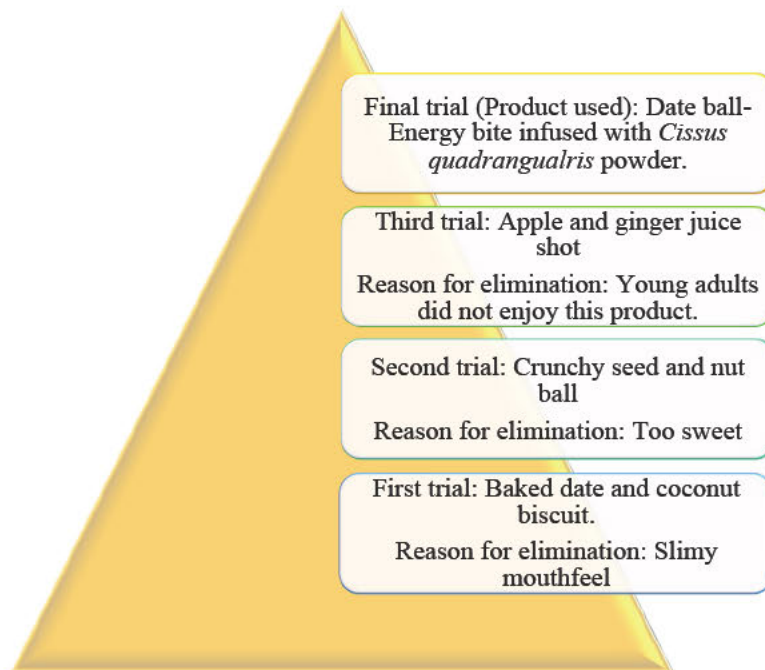
The researcher used current information based on the years 2019 to 2020. The inclusion criteria used for the desktop study was food and nutrition trends, food and nutrition trends among Gen Z and food and nutrition trends among millennials. The database used by the researcher was published articles, websites, and blogposts. Blogposts were used as the information on these sites are regularly updated and trendy, which is relevant to this study.

### 3.7.2 Phase two:

#### 3.7.2.1 Development of a food product with *Cissus quadrangularis*

The second phase consisted of the development of a sensorially acceptable product utilising *Cissus quadrangularis*. This also involved nutrient, microbial, and shelf-life analysis of the developed product. Three trials were conducted with different formulations of *Cissus quadrangularis*. Pilot sensory evaluation sessions were conducted prior to the consumer acceptance sensory evaluation (n=10). Findings from the preliminary phases influenced the food product development process.

The researcher and research supervisor experimented with three sample food products with *Cissus quadrangularis* (Figure 3.3). The final food sample was chosen by a process of elimination and with consideration from the preliminary information gathered.



**Figure 3.4: Food product trials and justification for selection**



### 3.7.2.2 Development process

The final recipe chosen was prompted by several trends that were identified in the desktop study i.e.: natural remedy, less sugar, health, convenience, texture and sustainability. The final recipe base used seven different ingredients: sunflower seeds, pumpkin seeds, almonds, oats, dried cranberries, chickpeas and dates. The recipe comprised mainly of dates, which are generally regarded as a natural sweetener and are used in healthy energy snacks. To reduce the cost of the recipe, the quantity of dates and almonds were reduced.

The researcher and the research supervisors decided to include chickpeas in the recipe to assist with binding as the quantity of dates had been reduced affecting the overall texture of the product. Chickpea flour is a popular ingredient in vegan cooking and is said to have excellent binding properties (Stockwell 2019: 16). However, the researcher used canned chickpeas in the recipe as whole chickpeas are more easily available than chickpea flour. Sunflower seeds are rich in vitamins and minerals and are regarded as healthy fats. These seeds are also said to assist with diabetes, inflammation, and heart disease (McCulloch 2018: 5).

Pumpkin seeds are high in fibre and antioxidants, and it is also said that pumpkin seeds can lower blood sugar level and improve heart health (Brown 2018: 9). Almonds contain protein, vitamin E and healthy fats and aids with weight loss as almonds can suppress feelings of hunger (Leech 2018: 12). Oats are said to be high in vitamins and minerals and are a great source of fibre and can also assist with weight loss (Palsdottir 2016: 6). Dried cranberries are said to be very vitamin rich and can also assist with urinary tract infections and heart health (Arnarson 2019: 15). All the ingredients utilised in the recipe were used to provide texture and different flavour profiles to the developed product as well as to make the energy bite as nutritious and sensorially appealing as possible. The amounts of *Cissus quadrangularis* powder used were 4g and 6g per 215g (base) of the product.

The researcher and research supervisors decided to flash bake (the use of light and heat to cook food quickly) the product at 190°C for 3minutes to reduce the microbial load and increase shelf life.

All the product trials were conducted by the researcher and research assistants at the DUT in the master's Laboratory. The samples were prepared, and sensory evaluation was conducted by the researcher, research supervisor and DUT students. The pilot sensory evaluation test aim

was to determine if the products appearance, taste, texture, and aroma were sensorially acceptable to the target population. Feedback from the sensory evaluation was then used to improve the product. The researcher and the research supervisors decided that a 4g sample and a 6g sample would be used in the pilot sensory evaluation and the final sensory evaluation. Two different amounts of *Cissus quadrangularis* powder was used in order to determine if the higher dosage of *Cissus quadrangularis* sample was sensorially accepted by the study population.



**Figure 3.5: Two variants of the developed food product with *Cissus quadrangularis* powder (from left to right, 4g and 6g)**

### **3.7.2.3 Sensory evaluation**

The researcher used a 9-point hedonic scale test in the sensory evaluation for the developed food product as well as a paired preference test (Appendix E). According to Sensory Analysis Teacher's Manual (2017: 23), hedonic testing is used to identify how much a food product is liked or disliked as well as the degree of liking or disliking the food product. Paired preference testing is used to identify which out of two food products is preferred by participants (Wichchukit and O'Mahony 2010: 925). A sample size of 10 third year Food and Nutrition students from DUT participated in the pilot sensory evaluation of the developed food product.

The researcher required a sample size of 100 DUT students for the final sensory evaluation, which were recruited through convenience sampling.

The sensory evaluation session took place in a controlled environment (Figure 3.5) with the aid of two trained research assistants. All COVID-19 protocols were observed during the sensory analysis session:

- All students had to fill in the DUT health check before entering campus. Their temperatures were also checked at campus gates.
- The sensory evaluation was divided into sessions (smaller groups) to allow for social distancing.
- Sanitiser was provided at the entrance of the venue for each participant.
- Participants were placed 1.5m apart from each other.
- Participants were asked to put their masks back on if they were done tasting the sample provided.
- Tables were sanitised in preparation for the next participant as each participant left the allocated area.
- The participants were asked to dispose of their cups, packaging, and any waste product at any of the bins provided as they were leaving the venue.



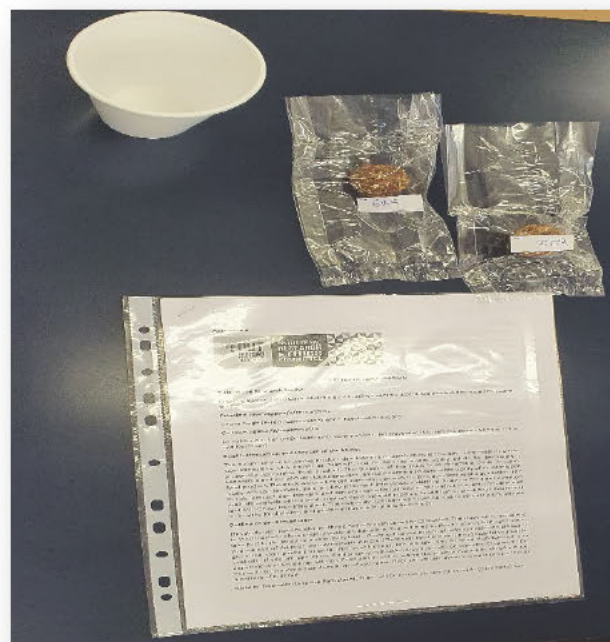
**Figure 3.6: Room used for sensory evaluation**

The study was explained to the sensory evaluation participants prior to the testing. The aims, objectives, methods, and benefits were explained in a verbal and written format with a letter of information handed to each participant (Appendix F). The participants signed a consent form agreeing to participate in the study on a voluntarily basis (Appendix G). All consenting participants were made aware that they were free to withdraw from the study at any time.

The 4g and 6g of the energy bite samples were used for the sensory evaluation. The samples were blind coded using 3-digit numbers to prevent bias. The sample containing 4g and 6g of *Cissus quadrangularis* samples were differentiated by codes and not by the quantity of *Cissus quadrangularis* present.. The participants were provided with a cup of water to cleanse their palates in between sample tasting (Figure 3.6). The participants were also given a token of appreciation at the end of the sensory evaluation session which they were not made aware of prior to the session.

The time allocated for the sensory evaluation session for each sensory evaluation session was 20-25 minutes. The participants were asked to answer as honestly as possible.

- The following instructions were given:
- Please drink water in between tasting each sample.
- Please make sure to keep enough of the sample to answer both the evaluations provided.
- Please write down the sample code on the space provided on the evaluation form.





### Figure 3.7: Set-up for final sensory evaluation

The set-up for the final sensory evaluation consisted of two energy bites infused with *Cissus quadrangularis* samples: 4g and 6g and a cup of water. The researcher had planned to provide pens to the participants, however, due to the COVID-19 pandemic the researcher asked the participants to use their own writing equipment to limit the potential of possible cross-contamination.

#### 3.7.2.4 Microbiological testing

The tests used for the microbiological testing was total plate count (TPC), coliforms and yeast and mould tests. The aim of these tests is to determine if there are harmful microorganisms present in the product (Heredia *et al.* 2009: 264) as well as if the developed product is safe for human consumption and commercialization.

#### 3.7.2.5 Nutritional analysis

The final food product developed was sent for nutrient analysis. Nutrient testing was conducted in an accredited South African National Accreditation System (SANAS) laboratory using Association of Official Analytical Chemists (AOAC) methods. The nutrient analysis of the developed product was also compared against the South African Dietary Reference Intakes (DRIs). The tests conducted on the product are tabled below:

**Table 3.2 Test and methods conducted during the nutrient analysis**

| Test                   | Methods                                       |
|------------------------|---|
| Moisture               | Air oven method                               |
| Protein                | Buchi app. Note no. 3xxOO1en- Kjeldahl method |
| Ash                    | AOAC 942.05                                   |
| Fat by acid hydrolysis | AOAC 922.06                                   |
| Fatty acid composition | Gas chromatography                            |
| Dietary fibre          | AOAC 991.43                                   |
| Total sugars           | HPLC methods                                  |
| Energy                 | Atwater system by calculation                 |
| Total carbohydrates    | Atwater system by calculation                 |
| Sodium                 | Flame photometry                              |

| Test                                 | Methods   |
|--------------------------------------|-----------|
| Vitamin C                            | Titration |
| Calcium<br>Iron<br>Zinc<br>Potassium | ICP- MS   |

The amount of fat by acid hydrolysis in the sample was calculated by AOAC 922.06 which entails the process of manual acid digestion using a Mojonnier tube for extraction in acid hydrolysis (Bench *et al.* n.d: 1). The Atwater system by calculation was used to determine the total amount of carbohydrates and energy in the product, this system utilizes pre-determined energy values for different macronutrients to test the energy value in food products (Novotny *et al.* 2012: 296). The amount of protein present in the product was tested using the Kjeldahl method which utilises three steps: digestion, distillation, and titration to determine the quantity of protein found in developed products (Goulding *et al.* 2020: 21). High performance liquid chromatography (HPLC) method was used to determine total sugars in the product, this method entails breaking down and analysing carbohydrates to determine the amount of sugar present in them (Xu *et al.* 2013: 248). HPLC was also utilised to test for vitamin A present in the product. Flame photometry was used to determine the total sodium in the product, this method involves introducing flames to the sample solution, the flame, dissolves and vaporises the solution, the remaining solution is then measured (Sanchez *et al.* 2019: 160). The vitamin C content in the product was determined by titration, this involved using Iodine to determine the amount of vitamin C present in the product (Helmenstine 2019: 2). Inductively Coupled Plasma- mass spectrometry method (IPC-MS) was used to analysis the amount of calcium, iron, zinc and potassium present in the product, this method involves the use of liquified samples and a plasma torch, once torched the sample was then examined to determine the number of elements present in it (Element 2021: para. 2 line 3).

### 3.7.2.6 Shelf-life testing

Shelf-life testing was conducted, to determine how long the developed food item can be stored and distributed until the product begins to deteriorate (Microchem n.d.: 1). The shelf-life test was conducted by storing the product in a constant climate chamber, TH3-E (Jeio Tech). Six samples (3×4g of *Cissus quadrangularis* powder and 3×6g of *Cissus quadrangularis* powder)

of the product was placed in the constant climate chamber. The product was stored at refrigeration temperature of 5°C. The product was reviewed by the researcher at three intervals whilst in the constant climate chamber (4 days, 7 days, and 14 days). Organoleptic factors: appearance, aroma, taste and texture were assessed by the researcher at each interval. The samples were evaluated at refrigeration temperature.

### **3.7.3 Phase three**

#### **3.7.3.1 Development of an awareness tool**

The third and last phase consisted of the development of an awareness tool. According to (FAO 2007b: 6), creating and implementing nutrition education tools can help many people learn and utilise essential skills such as good hand washing practices, good eating habits, and types of meals/snacks to prepare in their everyday life. Once the food product was developed and the sensory evaluation was conducted, an awareness tool was developed depicting the product developed and information on *Cissus quadrangularis* using videography. Two recipes were displayed in the video, the energy bite infused with *Cissus quadrangularis* using the plants powder and a juice shot using fresh *Cissus quadrangularis*. The video displayed an ingredient list and a step-by-step tutorial on how to make the recipes mentioned above. The researcher filmed and edited the awareness tool video. The video was developed using the camera on a S21 Samsung galaxy smart phone. A tripod stand was used to assist with the filming of the video. The researcher utilised natural lighting. The video contained nutritional and geographical information on *Cissus quadrangularis*. The awareness tool was aimed at young adults (Appendix H).

The awareness tool created underwent pilot screening by ten young adults. The pilot screening of the awareness tool was tested by the means of a Likert test. This method was used to decipher the effectiveness of the tool. Responses were collected using an online survey via Microsoft™ forms (Appendix I). Once this was conducted, the awareness tool was altered according to the data collected from the pilot test. The final awareness tool was sent to 100 participants and was evaluated using a Likert test, administered through an online survey via Microsoft™ forms (Appendix J). The awareness tool was then posted on social media platforms (WhatsApp™,

Facebook™ and Instagram™) along with the link to the survey including the information letter and consent form to ensure ethically sound protocol was observed.

The surveys created on Microsoft™ Forms displayed a letter of information on the study. The information sheet clearly explained what *Cissus quadrangularis* is and how the persons participation would aid the study. The participants were made aware that their answers would be anonymous and that they were free to withdraw from the survey at any time if they so desired. The participants had to tick a required tick box to indicate consent in order to continue with the survey.

### **3.8 Data analysis**

All data was captured on a Microsoft™ Excel spreadsheet. The data collected from key informant interviews was transcribed verbatim. Thematic analysis was used to identify key themes. De-identified textual data was managed and coded using ATLAS ti. Deductive coding was used by developing a set of codes corresponding to the topics of interest and coding data.

The sensory evaluation and awareness tool data was analysed using the Statistical Package for Social Sciences (SPSS®) version 22.0. Statistical techniques included descriptive statistics for demographic variables and one-way analysis of variance (ANOVA). The Wilcoxon Signed Ranks Test and Mann-Whitney test were used to test the two independent samples for dependency in sensory evaluation. The Mann-Whitney test was used to determine differences among gender for the sensory evaluation results. The Wilcoxon Signed Ranks Test was used to determine which product was preferred during the sensory evaluation paired preference test. The awareness tool survey was analysed through the Binomial test, Chi-square goodness-of-fit test and Pearson's chi-square (Fisher's exact test). The Binomial test was used to determine proportion of the results in awareness tool survey. The Chi-square goodness-of-fit test was used to determine the significance of the results in comparison to the other results. The Pearson's chi-square (Fisher's exact test) was used to determine the comparison of results among gender, age and race in the awareness tool survey.

### **3.9 Quality assurance and reduction of bias**

The paired preference sensory evaluation form was piloted by the researcher. A validated 9-point hedonic scale was used. During the pilot and final sensory evaluation, the following standard items were presented to each participant: information letter, consent form, sensory evaluation sheet (all forms were placed individually into plastic sleeves), product samples and



a glass of water. The participants were instructed to drink a sip of water between tasting of both samples. COVID-19 protocols were followed throughout the sensory evaluation session which included wearing a facemask, using a 70% alcohol-based sanitiser, and temperature checks before entering the sensory evaluation room, maintaining a 1.5m distance between participants and sanitising the area before each participant arrived. A calibrated analytical balance was used to weigh the ingredients for each recipe trial. Blind labelled Energy bites weighing 21.5g were presented to the sensory panellists at all sensory evaluation sessions. The pilot and final surveys used to determine the effectiveness of the awareness tool was piloted by the researcher. Data collection for the sensory evaluation and surveys were collected by the researcher and trained research assistants.

### **3.10 Data quality management**

The researcher and the research assistants checked that the participants completed all fields in the sensory evaluation forms. Data from the sensory evaluation and online surveys were captured on a Microsoft<sup>TM</sup> excel spreadsheet by the researcher. The data entry was crosschecked for accuracy by the supervisor and the statistician. Data quality was maintained by ensuring that all the data was captured in a systematic manner and coded appropriately. Coding of themes was done independently and reviewed by the research team for agreement. Electronic data was password protected and only the researcher, supervisors and the statistician had access to the data.

### **3.11 Validity**

Validity can be defined as the extent to which the concept of the study is accurately measured quantitatively (Heale *et al.* 2015: 66). Reliability in research can be defined as consistency of the measuring instruments and results obtained from the study conducted (Sürücü *et al.* 2020: 2694). A validated 9-point Hedonic scale (FAO 2016b :1) was used for sensory evaluation sessions. The awareness tool survey and the paired preference sensory evaluation tool was piloted before administration.

### **3.12 Ethical Considerations**

This study was granted approval by the DUT Institutional Research Ethics Committee (IREC): IREC Number 076/19 (Appendix K). The researcher was granted Gatekeeper permission from the DUT to conduct the research at the institution. For the sensory evaluation, the aims, objectives, methods, and benefits were explained verbally by the researcher and research assistants and in a written format with a letter of information handed to each participant. The

participants signed a consent form agreeing to take part in the study on a voluntarily basis and that they were free to withdraw at any time without any penalties or repercussions. Participants with common food allergies were excluded from the study to mitigate risk. Anonymity was maintained during every phase using the coding system as opposed to names of the participants. Field workers were trained by the researcher. Research assistants involved in the preparing of samples were dressed in full chefs' uniform to avoid any possible cross contamination. Research assistants who assisted with food product development and sensory evaluation during the COVID-19 pandemic, always wore masks and shields during food preparation and whilst setting up for the sensory analysis.

### **3.13 Conclusion**

Chapter 3 has outlined and described in detail the methods used in this research study. Chapter 4 will report on and discuss the results that emerged from the tests conducted in the various phases of the study.

## CHAPTER 4

### RESULTS AND DISCUSSION

#### 4.1 Introduction

This chapter contains the results, findings and discussion obtained from the qualitative and quantitative data captured in this study. The data collected from the key informant interviews were coded and grouped into themes to determine elderly community members' knowledge, use and perceptions of *Cissus quadrangularis*, whilst the sensory evaluation of the developed product, and awareness tool survey data were analysed quantitatively. In this chapter, the results of the study according to the objectives outlined in chapter one will be presented followed by a detailed discussion of the results.

#### 4.2 Key informant interviews

The key informant interviews cover the first objective of this study which was to determine the knowledge, use and perceptions of *Cissus quadrangularis* among elderly community members. The key informant interviews were grouped into themes and the information produced was coded using Atlas ti. The key informant interview group consisted of 10 participants all of whom were Indian. Eighty percent of the participants were women while 20% were men. The results revealed that half of the participants were between the ages of 70 and 80, 40% were between the ages of 60 and 70, and 10% were aged 80 and above. Table 4.1 outlines the characteristics of the key informant interviews.

**Table 4.1: Characteristics of key informant interview participants**

| Age (years)  | % (n)  |
|--------------|--------|
| 50-59        | 0 (0)  |
| 60-69        | 40 (4) |
| 70-79        | 50 (5) |
| 80 and above | 10 (1) |
| Gender       |        |
| Women        | 80 (8) |
| Men          | 20 (2) |

Several themes and sub-themes emerged from the key informant interviews including knowledge, uses, food preparation and toxicity of *Cissus quadrangularis* (Table 4.2)

**Table 4.2: Key informant interviews conducted with elderly community members (n=10)**

| Key informant interview question  | Theme     | Sub- theme                                  | Discussion   | Direct quote   |
|---|-----------|---|--|--|
| What is <i>Cissus quadrangularis</i> ?                                    | Knowledge | Plant identification                        | The participants explained that <i>Cissus quadrangularis</i> is a Cactus plant/ Creeper with great medicinal and healing properties.   | “Hadjod is a creeper plant”. “Hadjod is part of the cactus family”.<br><br>“Hadjod is a medicinal plant”.  |
| Do you know of any medicinal properties of <i>Cissus quadrangularis</i> ? |           | Medicinal                                   | “I have heard that Hadjod aids with ulcers”. “Hadjod can be used for stomach sores and broken/fractured bones”.  | “I have heard that Hadjod aids with ulcers”. “Hadjod can be used for stomach sores and broken/fractured bones”.  |
| What do you use <i>Cissus quadrangularis</i> for?                         | Uses      | Treatment for ailments                      | Most participants explained that they had used <i>Cissus quadrangularis</i> for sprains, other inflammations, rib fractures, shoulder injuries, rashes and body pain.        | “I used Hadjod for a sprain in my ankle and pain I had from a should injury, I applied a paste I made on the injured area for 3-4 days. I also used Hadjod for rashes”.  |
| Do you know of any health benefits of <i>Cissus quadrangularis</i> ?      |           | Health benefits<br><br>Nutritional benefits | One participant believed that ever since they have been consuming <i>Cissus quadrangularis</i> they do not have to take cholesterol medication. Another participant explains | “I started drinking Hadjod in the morning and evening and did not have to take any cholesterol tablets”.<br><br>“Cooking and eating the Hadjod will help with making your bones stronger especially when you get older, like a calcium tablet”.<br><br>“I fry Hadjod with onion, green chilli” |

| Key informant interview question   | Theme            | Sub- theme                   | Discussion   | Direct quote  |
|--|------------------|------------------------------|--|---|
|  |                  | Food source                  | <p>that consuming <i>Cissus quadrangularis</i> makes your bones stronger and that the plant has a similar effect as taking a calcium tablet.</p> <p>Many participants used <i>Cissus quadrangularis</i> in food applications to receive its health benefits.</p> | "I cook Hadjod as a curry" .  |
| Have you cooked <i>Cissus quadrangularis</i> before?                               | Food preparation | Cooking methods              | Ninety percent of the participants had cooked <i>Cissus quadrangularis</i> .   | <p>"Yes, I have cooked it with onion and Hurdee (turmeric powder),"</p> <p>"Yes, I have added it to my bhajia mixture"</p> <p>(Indian savoury deep-fried snack/ chili bite)</p> |
| What are some methods (fry, simmer, add to curries) you have use to cook it?       |                  | Recipes                      | Most participants made pastes, chutneys and added blended or small pieces of <i>Cissus quadrangularis</i> to chilli bite mixture then fried the mixture.   | <p>"I cooked it in a chutney".</p> <p>"I added it to my bhajia mix".</p> <p>"I made a paste with Hurdee (turmeric powder) and Hadjod".</p>                                      |
| Are there any recipes using <i>Cissus quadrangularis</i> you are willing to share? |                  | Food application suggestions | Many participants said they have not tried it any other way than they have already mentioned, however, a few participants suggested ways to use the plant in food development. The suggestions are   | "You can bake it into a scone" .  |



| Key informant interview question  | Theme    | Sub- theme          | Discussion   | Direct quote  |
|---|----------|---------------------|--|---|
|   |          |                     | as follows: roast, juice and add to baked items such as bread/scone/sweet doughs.  |   |
| How do you prepare the <i>Cissus quadrangularis</i> ?                   |          | Preparation methods | Some of the participants explained that you must wash the plant first as it gets very sticky if washed after it is cut. The participants explained that when preparing <i>Cissus quadrangularis</i> you must remove the thorns and a thin layer of the outer skin. Once this process is done you may chop the plant into small pieces or blend into a paste. | <p>"I wash the hadjod before cutting the plant otherwise it becomes too sticky to peel and cut".</p> <p>"I remove the thorns from the hadjod and peel out a thin layer of, once I finish cleaning the hadjod I cut it into pieces".</p> |
| Were there any side effects when you ate <i>Cissus quadrangularis</i> ? | Toxicity | Side-effects        | All participants said that they did not experience any side effects after eating the plant.  | "No side-effects".  |

### 4.3 Food and Nutrition trends

A desktop study on food and nutrition trends was conducted to aid the researcher in the development of a sensorially acceptable food product with *Cissus quadrangularis*.

**Table 4.3: Food and Nutrition trends in 2019 and 2020**

| Food trend             | Description   | Reference   |
|------------------------|---|---|
| Zero-waste foods       | Foods that can be composted after use. Foods should be eaten or incorporated in dishes before the expiry date. There should be ways to use up surplus food.   | National Geographic (2019: 1) and Williams (2019: 1)        |
| Botanical beverages    | Describe the use of botanical ingredients such as plants and citrus. These beverages are noted to be healthy and authentic.   | The Institute of Food Technology (IFT) (2019: 1)            |
| Alternative ingredient | Focuses on shift from processed foods to fresh foods as consumers are more centred on healthy clean eating.   | (IFT 2019: 1) and (Sloan 2021: 1)                           |
| Sustainability         | Refers to the use of foods and ingredients that are sourced using sustainable and healthy procedures.   | (IFT 2019: 1) and (National Geographic 2019: 1)             |
| Plant-based foods      | Refers to introduction of more plant derived foods into one's diet. Food such as: berries, kale, rolled oats, avocados, chickpeas, lentils, almonds, sunflower seeds, pumpkin seeds, coconut milk, quinoa, sweet potato, spinach, pineapple, and peaches. | Williams (2019: 1), Ohr (2019: 1), Kuhn (2019: 1) and       |
| Natural remedies       | Refers to the use of food to help treat conditions instead of modern medication.  | Williams (2019: 1)  |
| Less sugar             | Indicates that consumers are now on the lookout for products that contain low amounts of sugar or sugar substitutes.  | Williams (2019: 1) and Askew (2020: 1)<br>CPKelco (2019: 4) |
| Health                 | Refers to the consumption/ usage of products that are good for the body.  | Turow-Paul (2021: 1)  |
| Convenience items      | Describe dishes that are easy to prepare or eat while also being healthy as people have less time to prepare home cooked meals. Young adults prefer healthy convenience items.  | (IFT 2019: 1) and Morrison (2020: 1)                        |
| Texture                | Consumers are more likely to try out and enjoy foods that provide texture.  | Food ingredients (2019: 1) and CPKelco (2019: 2)            |

Table 4.3 outlines the review of key food and nutrition trends from 2019 and 2020 which forms part of objective two of this study for the purposes of idea generation for product development. The main food trends identified for 2019 and 2020 were zero-waste foods, botanical beverages,

alternative ingredient, sustainability, plant-based foods, natural remedies, less sugar, health convenience items, and texture.

#### 4.4 Development of a food product with *Cissus quadrangularis*

Objective two was to develop an acceptable food product using *Cissus quadrangularis*. Using the food trend reviews from 2019 and 2020, four trials were conducted. The final product was an energy bite infused with *Cissus quadrangularis*.

**Table 4.4: Food and nutrition trends that informed food product development trials**

| Food trial  | Food and nutrition trend   | Reasons for further development   |
|---|--|---|
| First trial: Baked date and coconut biscuit. This trial was developed with dried <i>Cissus quadrangularis</i> . | Texture, less sugar, health, convenience items and natural remedies.   | This product was not developed any further as it presented a slimy mouthfeel.                                     |
| Second trial: Crunchy seed and nut ball. This trial was developed with <i>Cissus quadrangularis</i> powder.     | Texture, less sugar, health, convenience items and natural remedies.   | This product was not developed any further as it was too sweet. The recipe used an excess amount of honey.        |
| Third trial: Apple and ginger juice shot. This trial was made with fresh <i>Cissus quadrangularis</i> .         | Less sugar, health, convenience items and natural remedies, botanical beverages, zero waste food, sustainability, and alternative ingredients. | This product was not developed any further as it was not liked by young adults during a tasting session.          |
| Final trial (Product used): Date ball - Energy bite infused with <i>Cissus quadrangularis</i> powder.           | Natural remedy, less sugar, health, convenience, texture, and sustainability and alternative ingredients.                                      | This product was chosen to be further developed as the results were favoured during the pilot sensory evaluation. |



**Table 4.5: Energy bite infused with *Cissus quadrangularis* recipe**


| <b>Picture: Final Recipe</b>   |       |              |   |  |
|--|-------|--------------|---|--|
| <b>Name of dish:</b> Energy bite infused with <i>Cissus quadrangularis</i> . |       |              | <b>Recipe yield:</b><br><b>Formulation 1 (F1):</b> 380g<br><b>Formulation 2 (F2):</b> 220g<br><b>Final Recipe:</b> 215g (21.5g per ball × 10) | <b>Preparation time:</b> 10 Minutes<br><b>Cooking time:</b> 3 Minutes at 200°C             |
| F1   | F2    | Final Recipe | Ingredients   | Method   |
| 10g  | 10g   | 10g          | Sunflower seeds, whole (Raw)  | Blend dry ingredients until a chunky crumb is formed.                                      |
| 15g  | 10g   | 10g          | Pumpkin seeds, whole (Raw)  |  |
| 70g  | 15g   | 30g          | Almonds, whole (Raw)  |  |
| -  | 15g   | 35g          | Rolled Oats   |  |
| 50g  | -     | -            | Coconut (Desiccated)  |  |
| 4g/6g  | 4g/6g | 4g/6g        | <i>Cissus quadrangularis</i> stem powder  | Mix <i>Cissus quadrangularis</i> powder into the mixture and set aside.                    |
| 90g  | 30g   | 50g          | Cranberries (Dried)   | Blend remainder ingredients until well combined. Mix the dry and wet ingredients together. |
| -  | 80g   | 20g          | Chickpeas, Canned (Drained)   |  |
| 145g   | 50g   | 60g          | Dates ( whole, pitted)  |  |
|  |       |              |   | Form into balls (21.5g each) and flash bake for 3 minutes at 200°C.                        |
|  |       |              |   | Store in an airtight container and keep refrigerated.                                      |

Table 4.5 Depicts the food product developed with *Cissus quadrangularis* (Energy-bite infused with *Cissus quadrangularis*) as well as the different recipe formulations tested until the final recipe was formulated.

**Table 4.6: Costing of the final *Cissus quadrangularis* infused energy bite**

| Ingredient                          | Quantity required | Calculation   | Cost per amount needed |
|-------------------------------------|-------------------|---------------|------------------------|
| Sunflower seeds                     | 10g               | R52.99/500g   | R1.06                  |
| Pumpkin seeds                       | 10g               | R17.99/100g   | R1.80                  |
| Almonds                             | 30g               | R194.99/1000g | R5.85                  |
| Oats                                | 35g               | R39.99/1000g  | R1.40                  |
| Cranberries (Dried)                 | 50g               | R22.99/100g   | R11.50                 |
| Chickpeas (Canned)                  | 20g               | R13.99/400g   | R0.70                  |
| Dates                               | 60g               | R32.99/400g   | R4.95                  |
| <i>Cissus quadrangularis</i> powder | 4g                | R303.74/250g  | R4.85                  |
|                                     | 6g                | R303.74/250g  | R7.23                  |
| Total                               |                   |               |                        |
| 4g Sample                           |                   |               | R32.11                 |
| 6g Sample                           |                   |               | R34.49                 |
| Total cost per unit                 |                   |               |                        |
| 4g Sample                           |                   |               | R3.21                  |
| 6g Sample                           |                   |               | R3.45                  |

Table 4.6 depict the costing for the final developed recipe. Using online food prices of large food retail stores, the ingredients of the *Cissus quadrangularis* infused energy bite was costed. The cost for the 4g sample was R32.11 per 215g and R34.49 per 215g for the 6g sample.

#### 4.5 Microbiological testing

Microbiological testing for energy bite infused with *Cissus quadrangularis* recipe was conducted in a SANAS accredited laboratory using AOAC methods. An aerobic plate count and yeast and mould test was used to determine if there are harmful micro-organisms present in the product. The samples were tested in triplicate.

The first set of results indicated that the microbial count in the product was high, averaging between 1000 to 5000 cfu per gram within the acceptable limit. However, the product was suitable for a short shelf life of three days. Expert advice from the laboratory technician suggested the addition of potassium sorbate (6000mg/kg) to the product to reduce the microbial count and to further preserve the product (Table 4.7 and Table 4.8).

The second set of results with the potassium sorbate showed that the microbial count found in the developed product was low. The mould count found in the product is acceptable as it is less than 1000cfu. (Table 4.7 and Table 4.8)

**Table 4.7: Microbial results for *Cissus quadrangularis* infused energy bites (4g)**

| <b>Results: 1</b>                   | <b>Total variable count</b>      | <b>Total Coliforms</b>   | <b>Yeast and Mould</b>     |                            |
|-------------------------------------|----------------------------------|--------------------------|----------------------------|----------------------------|
| Sample 1                            | TNTC                             | 0                        | 5 cfu's                    |                            |
| Sample 2                            | TNTC                             | 0                        | 2 cfu's                    |                            |
| Sample 3                            | 5 cfu's                          | 0                        | 1 cfu                      |                            |
| <b>Results 2:</b>                   | <b>Total plate count (CFU/g)</b> | <b>Coliforms (CFU/g)</b> | <b>Yeast count (CFU/g)</b> | <b>Mould count (CFU/g)</b> |
| Sample containing potassium sorbate | 3.0 x 10 <sup>2</sup>            | <10                      | <10                        | 15                         |

\*CFU: Colony forming unit

**Table 4.8: Microbial results: *Cissus quadrangularis* infused energy bites (6g)**

| <b>Results: 1</b>                   | <b>Total variable count</b>      | <b>Total Coliforms</b>   | <b>Yeast and Mould</b>     |                            |
|-------------------------------------|----------------------------------|--------------------------|----------------------------|----------------------------|
| Sample 1                            | TNTC                             | 0                        | 0                          |                            |
| Sample 2                            | TNTC                             | 0                        | 0                          |                            |
| Sample 3                            | 1 cfu                            | 0                        | 0                          |                            |
| <b>Results: 2</b>                   | <b>Total plate count (CFU/g)</b> | <b>Coliforms (CFU/g)</b> | <b>Yeast count (CFU/g)</b> | <b>Mould count (CFU/g)</b> |
| Sample containing potassium sorbate | 2.1x10 <sup>2</sup>              | <10                      | <10                        | 65                         |

\*CFU: Colony forming unit

## 4.6 Nutrient analysis

**Table 4.9: Nutrient analysis of the energy bite**

| Nutrient                             | Quantity(grams)   |  |   |  |
|--------------------------------------|---|--|---|--|
|                                      | Energy bite<br>infused with <i>C.<br/>quadrangularis</i><br>(4g)<br>[ Per 100g] | Energy bite<br>infused with <i>C.<br/>quadrangularis</i><br>(4g)<br>[Per 21.5g-<br>serving size] | Energy bite<br>infused with <i>C.<br/>quadrangularis</i><br>(6g)<br>[ Per 100g] | Energy bite<br>infused with <i>C.<br/>quadrangularis</i><br>(6g)<br>[Per 21.5g-<br>Serving size] |
| Energy (kJ)                          | 1034.2  | 206.84   | 1000.0  | 200  |
| Protein (g)                          | 7.30  | 1.46   | 7.30  | 1.46   |
| Total Carbohydrates of which:<br>(g) | 43.7  | 8.74   | 41.1  | 8.22   |
| Total Sugars (g)                     | 17.0  | 3.40   | 17.4  | 3.48   |
| Fat by Acid hydrolysis (g)           | 5.70  | 1.14   | 5.90  | 1.18   |
| Of which: Saturated Fats             | 0.73  | 0.15   | 0.73  | 0.15   |
| Monounsaturated<br>Fats (g)          | 3.44  | 0.69   | 3.58  | 0.72   |
| Polyunsaturated<br>Fats (g)          | 1.53  | 0.31   | 1.59  | 0.32   |
| Trans Fats(g)                        | 0.00  | 0.00   | 0.00  | 0.00   |
| Dietary Fibre (g)                    | 20.1  | 4.02   | 20.8  | 4.16   |
| Moisture (g)                         | 20.9  | 4.18   | 22.6  | 4.52   |
| Ash (g)                              | 2.30  | 0.46   | 2.30  | 0.46   |
| Sodium (mg)                          | <10   | 2  | <10   | 2  |
| Vitamin C (mg)                       | 4.0   | 0.8  | 4.0   | 0.8  |
| Vitamin A (µg)                       | <1.2  | <0.258   | <1.2  | <0.258   |
| Calcium (mg)                         | 0.96933   | 0.19   | 0.96935   | 0.19   |

|                |         |        |         |        |
|----------------|---------|--------|---------|--------|
| Zinc (mg)      | 0.02171 | 0.0043 | 0.02172 | 0.0043 |
| Iron (mg)      | 0.036   | 0.0072 | 0.036   | 0.0072 |
| Potassium (mg) | 5.43966 | 1.09   | 5.4397  | 1.08   |

Table 4.9 reflects the nutrient composition of the energy bite infused with *C. quadrangularis* sample containing 4g and 6g of *C. quadrangularis* powder in every 21.5g of the product. Each of the tests conducted used 100g of the energy bite sample. The energy value reflected to be slighter higher in the 4g sample (1034.2 kJ). The protein in both samples were consistent at (7.3g/100g). For total carbohydrates (4g: 43.7g/ 6g: 41.1g) there was a slight increase in the 4g sample compared to the 6g sample however, the total sugar (4g: 17.0g/ 6g: 17.4g) and dietary fibre (4g: 20.1/ 6g: 20.8) increased in the 6g sample. The total fat content was higher in the 6g sample (5.9g) as compared to the 4g sample (5,7g). The results reflect that the sodium (<10mg), vitamin A (<1.2 µg ), vitamin C (4.0mg) and iron (0.036mg) were the same among both samples, however, there was slight increase in the amount of potassium (4g: 5.43966mg / 6g: 5.4397mg), calcium (4g: 0.96933mg/ 6g: 0.96935mg) and zinc (4g: 0.02171mg/ 6g: 0.02172mg) in the 6g sample.

**Table 4.10: Nutrient comparison against DRIs**

| Nutrient                              | Quantity(grams)  |  | Recommended Dietary Intake |                       | Percentage of DRI (%)    |                       |
|---------------------------------------|--|--|----------------------------|-----------------------|--------------------------|-----------------------|
|                                       | Energy bite infused with <i>C. quadrangularis</i> (4g)<br>[Per 21.5g-serving size] | Energy bite infused with <i>C. quadrangularis</i> (6g)<br>[Per 21.5g-Serving size] | Women (19- 30 years old)   | Men (19-30 years old) | Women (19- 30 years old) | Men (19-30 years old) |
| Protein (g/d)                         | 1.46   | 1.46   | 46                         | 56                    | 3.17                     | 2.6                   |
| Total Carbohydrates(g/d)<br>of which: | 8.74   | 8.22   | 130                        | 130                   | 6.72                     | 6.32                  |
| Total Sugars (g/d)                    | 3.4  | 3.48   |                            |                       |                          |                       |
| Fat by Acid hydrolysis (g/d)          | 1.14   | 1.18   | ND*                        | ND*                   | -                        | -                     |
| Dietary Fibre (g/d)                   | 4.02   | 4.16   | 25                         | 38                    | 16.08                    | 10.94                 |
| Sodium (mg/d)                         | 2  | 2  | 1500                       | 1500                  | 0.133                    | 0.133                 |
| Vitamin C (mg/d)                      | 0.8  | 0.8  | 75                         | 90                    | 1.06                     | 0.88                  |
| Vitamin A (µg /d)                     | <0.258   | <0.258   | 700                        | 900                   | 0.037                    | 0.029                 |
| Calcium (mg/d)                        | 0.19   | 0.19   | 1000                       | 1000                  | 0.019                    | 0.019                 |
| Zinc (mg/d)                           | 0.0043   | 0.004344   | 8                          | 11                    | 0.053                    | 0.039                 |
| Iron (mg/d)                           | 0.036  | 0.036  | 18                         | 8                     | 0.2                      | 0.45                  |
| Potassium (mg/d)                      | 1.09   | 1.08   | 2600                       | 3400                  | 0.042                    | 0.032                 |

\*ND: Not determined \*DRI value (National Institute of Health 2019.)

Table 4.10 reflects the DRIs of the energy bite compared to the DRIs of women and men aged from 19-30 years old.



#### 4.7 Shelf-life testing

**Table 4.11: Table depicting the results from the shelf-life test**

| Review day: | Fresh product   |   | Day 4   |  | Day 7   |  | Day 14  |  |
|-------------|---|---|---|--|---|--|---|--|
| Sample      | 1: 4g <i>Cissus quadrangularis</i>  | 2: 6g <i>Cissus quadrangularis</i>  | 1: 4g <i>Cissus quadrangularis</i>  | 2: 6g <i>Cissus quadrangularis</i>   | 1: 4g <i>Cissus quadrangularis</i>  | 2: 6g <i>Cissus quadrangularis</i>   | 1: 4g <i>Cissus quadrangularis</i>  | 2: 6g <i>Cissus quadrangularis</i>   |
| Appearance  | Round. Pieces of the ingredients were visible were on the outer surface of the product. | Round. Pieces of the ingredients were visible were on the outer surface of the product. | Round. Pieces of the ingredients were visible were on the outer surface of the product.                           | Round. Pieces of the ingredients were visible were on the outer surface of the product.                        | Round. Pieces of the ingredients were visible were on the outer surface of the product.                           | Round. Pieces of the ingredients were visible were on the outer surface of the product.                        | Round. Pieces of the ingredients were visible were on the outer surface of the product.                           | Round. Pieces of the ingredients were visible were on the outer surface of the product.                        |
| Aroma       | A prominent date aroma was detected.  | A prominent date aroma was detected.  | A prominent date aroma was detected.  | A prominent date aroma was detected.   | A prominent date aroma was detected.  | A prominent date aroma was detected.   | A prominent date aroma was detected.  | A prominent date aroma was detected.   |
| Taste       | A tangy and tart flavour was detected.  | A tangy and tart flavour was detected.  | A tangy and tart flavour was detected; however, the flavour appears to be stronger compared to the fresh product. | A tangy and tart flavour was detected; however, the flavour appears to be stronger compared to the 4g product. | A tangy and tart flavour was detected; however, the flavour appears to be stronger compared to the day 4 product. | A tangy and tart flavour was detected; however, the flavour appears to be stronger compared to the 4g product. | A tangy and tart flavour was detected; however, the flavour appears to be stronger compared to the day 7 product. | A tangy and tart flavour was detected; however, the flavour appears to be stronger compared to the 4g product. |
| Texture     | Smooth texture with a slight crunch.  | Smooth texture with a slight crunch.  | Smooth texture with a slight crunch.  | Smooth texture with a slight crunch.   | Smooth texture with a slight crunch.  | Smooth texture with a slight crunch.   | Smooth texture with a slight crunch.  | Smooth texture with a slight crunch.   |

Table 4.11 represents the results from the shelf-life tests. The samples were individual packed and heat-sealed in 5×5cm plastic polyethylene bags. The results indicate that the appearance, aroma, and texture of the sample stayed the same over 14 days in the constant climate chamber at 5°C (Refrigeration temperature). However, the taste flavour profile of the product seemed to develop and get stronger as it was stored. The results show that the taste of the product containing 6g of *Cissus*

*quadrangularis* powder was stronger compared to the product containing 4g of *Cissus quadrangularis* powder. The results depict that the product was sensorially acceptable and safe to consume after being stored for 14 days at 5°C.

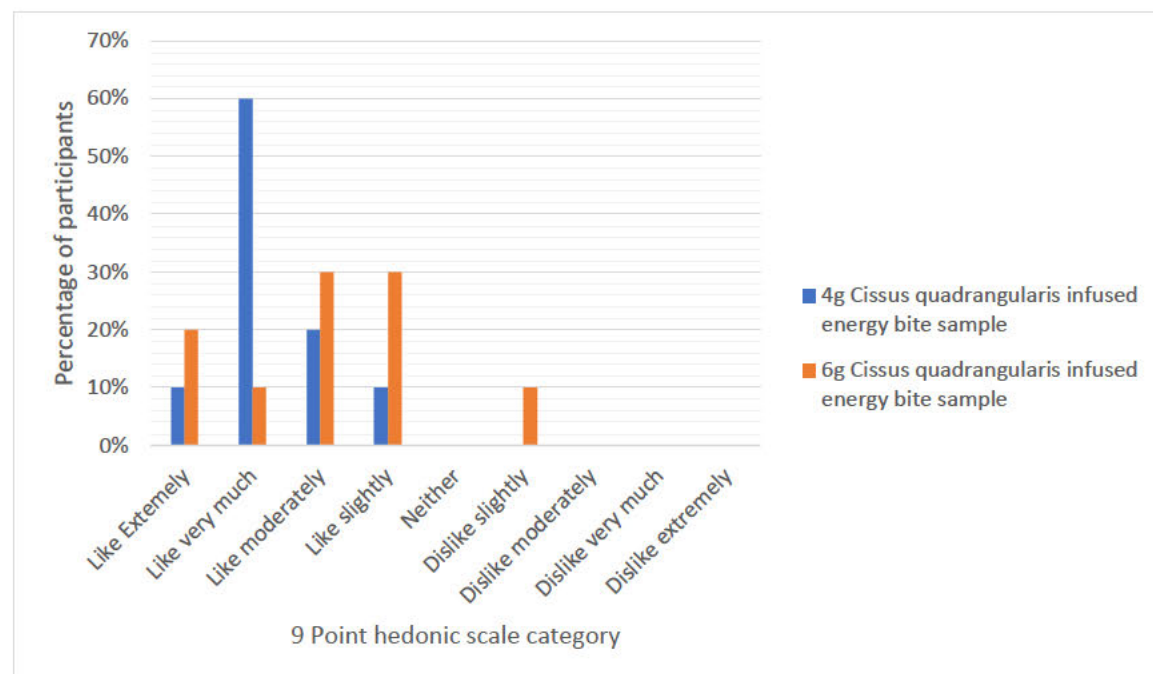
#### 4.8 Pilot sensory evaluation results

Pilot sensory evaluation of the energy bite infused with *Cissus quadrangularis* was conducted to determine if the product was sensory acceptable and if it had the potential to be liked by young adults. The researcher used a validated 9-point hedonic scale as well as a paired preference test. A sample population of ten third year Food and Nutrition students were recruited for the pilot sensory evaluation of the energy bite infused with *Cissus quadrangularis*.

**Table 4.12: Gender of participants from the pilot sensory analysis**

| Gender | % (n)  |
|--------|--------|
| Women  | 90 (9) |
| Men    | 10 (1) |

Table 4.12 reflects that majority of the participants 90 % for the pilot sensory evaluation were women and one person, 10% was a man.



**Figure 4.1: Sensory responses of the 9-point hedonic scale test (pilot sensory analysis) for the 4g and 6g sample of the *Cissus quadrangularis* infused energy bite**

Figure 4.1 reflects the findings of the 9-point hedonic scale pertaining to the 4g and 6g samples of the *Cissus quadrangularis* infused energy bites. The data collected for the 4g sample showed



that 60% of participants chose “like very much”, 20% participants chose “like moderately”, “slightly dislike” and “like extremely” was chosen by one participant, respectively. The data collected for the 6g sample showed that 30% of the participants chose “like moderately”, 30% participants chose “like slightly”, 20% participant chose “like extremely”, an equal number of participants chose ‘like very much’ and dislike slightly’ (n=1).

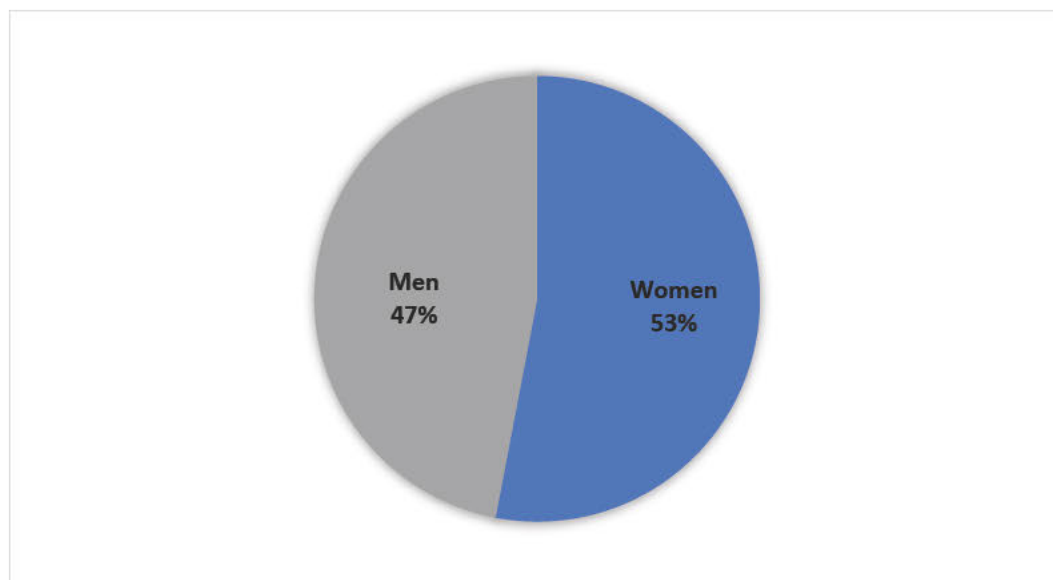
**Table 4.13: Results of the paired preference test (pilot sensory analysis) (4g and 6g of *Cissus quadrangularis* powder used in each sample)**

| Sample | % (n)  |
|--------|--------|
| 4g     | 70 (7) |
| 6g     | 30 (3) |

Table 4.13 the pilot paired preference test showed that majority of the participants (70%) preferred the 4g sample as compared to 6g (30%).

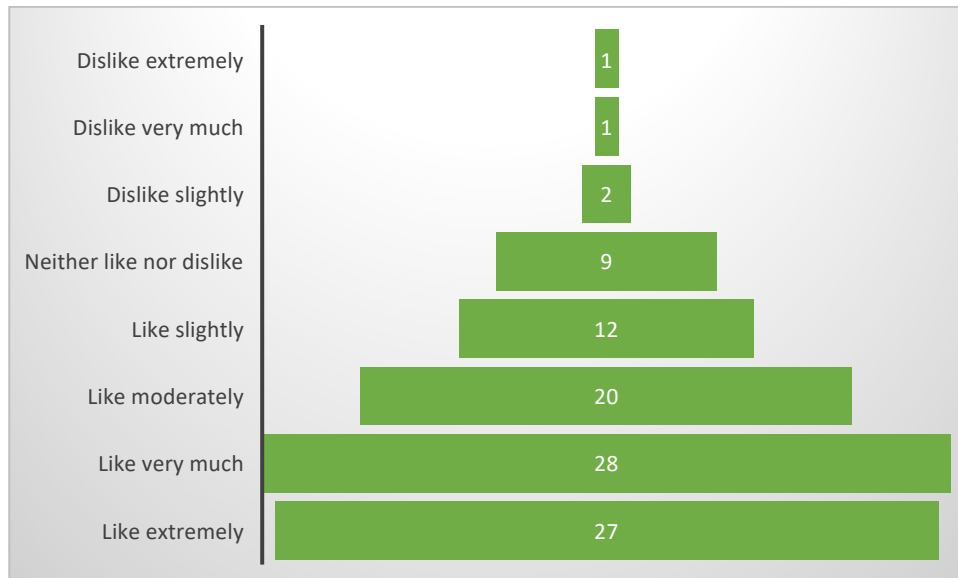
#### 4.9 Final sensory evaluation results

The final sensory evaluation was conducted to determine if the products were sensory acceptable and to determine which sample was preferred among the participants.



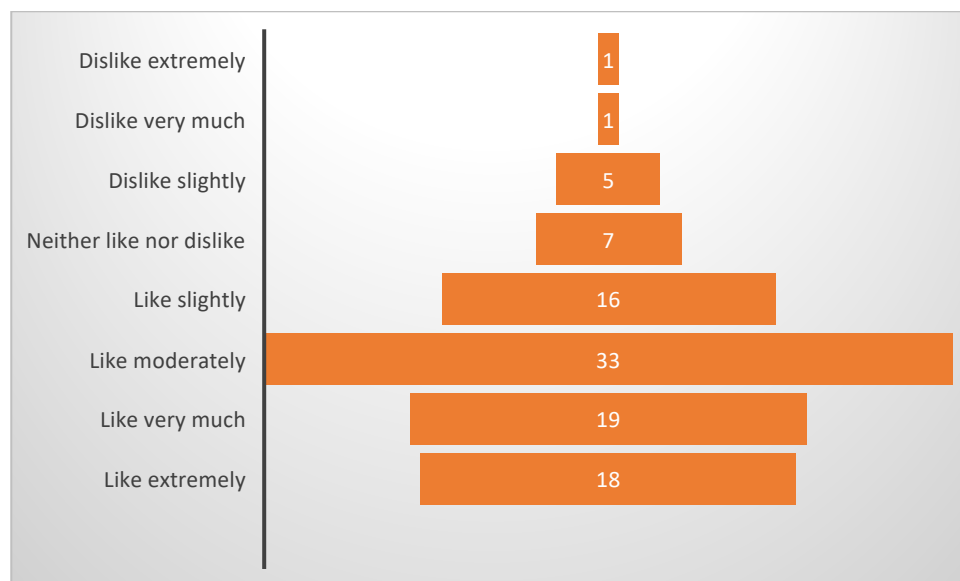
**Figure 4.2: Gender of participants in the final sensory analysis**

Figure 4.2 indicates that 53% participants were women and 47% were men. There is no significant difference in the sensory rating of these products across gender for the 4g ( $p=0.521$ ) and 6g ( $p=0.673$ ) sample.



**Figure 4.3: Funnel chart depicting the responses given by the participants during the 9-point hedonic scale test (final sensory analysis) for the 4g sample of the energy bite infused with *Cissus quadrangularis* (n=100)**

Figure 4.3 reflects that 27% participants chose “like extremely”, 28% participants chose “like very much”, 20% participants chose “like moderately”, 12% participants chose “like slightly”, 9% participants chose “neither like nor dislike”, 2% participants chose “dislike slightly”, 1% (n=1) participant chose “dislike very much” and 1% participant chose “dislike extremely”. This indicates that majority of the participants enjoyed the energy bite infused with *Cissus quadrangularis*.



**Figure 4.4: Funnel chart depicting the responses given by the participants during the 9-point hedonic scale test (final sensory analysis) for the 6g sample of the energy bite infused with *Cissus quadrangularis* (n=100)**

Figure 4.4 reflects that 18% of the participants chose “like extremely”, 19% of the participants chose “like very much”, 33% chose “like moderately”, 16% of the participants chose “like slightly”, 7% of the participants chose “neither like nor dislike”, 5% of the participants chose “dislike slightly”, 1% of the participants chose “dislike moderately” and “dislike extremely” respectively. The results depict that most of the participants (68%) collectively liked the energy bite infused with *Cissus quadrangularis*.

**Table 4.14: Table depicting the mean sensory rating score of the 4g sample and 6g sample**

|              | Sensory rating (Sample 1: 4g) | Sensory rating (Sample 2: 6g) |
|--------------|-------------------------------|-------------------------------|
| Participants | 100                           | 100                           |
| Mean (SD)    | 7.35 (1.591)                  | 7.01 (1.494)                  |

Table 4.14 depicts that the mean sensory rating score for final sensory analysis for the 4g (7.35) and for the 6g (7.01) on the 9-point hedonic scale. Using the Wilcoxon signed ranks test there was no significant difference between the 4g and 6g sensory rating score ( $p=0.066$ ) which is not far above  $p=0.05$ , indicating that there was a marginal preference of sample 1 (4g) over sample 2.

#### 4.10 Pilot awareness tool results

The pilot awareness tool survey was conducted to meet objective 4 (to develop an awareness tool for *Cissus quadrangularis* using the energy bite infused with *Cissus quadrangularis* recipe developed for young adults). The pilot awareness tool was used to decipher if the awareness tool was effective. The results of the pilot test allowed the researcher to alter the awareness tool, thereby increasing its acceptability among the sample population.

**Table 4.15: Participant characteristics**

| Age (years) | % (n)    |
|-------------|----------|
| 20-22       | 50 (5)   |
| 23-25       | 50 (5)   |
| Gender      | % (n)    |
| Women       | 100 (10) |
| Men         | 0 (0)    |
| Race        | % (n)    |
| Indian      | 40 (4)   |
| Black       | 60 (6)   |
| Coloured    | 0 (0)    |
| White       | 0 (0)    |

Table 4.15 reflects that the participants for the pilot testing of the awareness tool were all women. Majority being black (60%) with 40% comprising of Indian participants. The age distribution ranged from 50% being between 20-22 years old, and 50% aged between 23-25.

**Table 4.16: Participants' responses to the pilot awareness tool survey (n=10)**

| Question                                     | Answer | Percentage (n) |
|--|--------|----------------|
| “Was this video informative?”                | Yes    | 90 (9)         |
|  | No     | 10 (1)         |
| “Were the recipes easy to follow?”           | Yes    | 90 (9)         |
|  | No     | 10 (1)         |
| “Will you make the recipes from this video?” | Yes    | 80 (8)         |
|  | No     | 20 (2)         |

|   |     |        |
|---|-----|--------|
| “Did you know about <i>Cissus quadrangularis</i> before watching this video?” | Yes | 20 (2) |
|   | No  | 80 (8) |

Table 4.16 reflects the responses given by participants during the pilot survey of the awareness tool. The results indicate that 90% of the participants thought that the video was informative, whereas 10% of the participants did not. The results convey that 90% of the participants thought that the recipes in the video were easy to follow, however, 10% of the participants did not. In addition, the results also reflect that 80% of the participants said they would make the recipes from the video, whereas 20% of the participants said that they would not. This reflects that 20% of the participants knew about *Cissus quadrangularis* before watching the awareness tool video, and 80% of the participants did not.

**Table 4.17: Responses by participants during the pilot awareness tool survey. “On a scale from 1-10, how much did you enjoy the video?” (0- Not at all / 10- Extremely) (n=10).**

| “On a scale from 1-10, how much did you enjoy the video?” | Percentage (n) |
|---|----------------|
| 10  | 10 (1)         |
| 9   | 20 (2)         |
| 8   | 40 (4)         |
| 7   | 20 (2)         |
| 6   | 10 (1)         |
| 5   | 0              |
| 4   | 0              |
| 3   | 0              |
| 2   | 0              |
| 1   | 0              |
| 0   | 0              |

Table 4.17 reflects that 10% of the participants chose 10; 20% of the participants chose 9; 40% chose 8; 20% chose 7 and 10% of participants chose 6.

#### 4.11 Final awareness tool survey results

The final awareness tool survey was conducted to meet objective 4 which was to develop an awareness tool for *Cissus quadrangularis* using the energy bite infused with *Cissus quadrangularis* developed for young adults. The results indicate that the participants enjoyed the video and found the information displayed on the video informative.

**Table 4.18: Participant profile of the final awareness tool survey (n=100)**

| Age (years) | %  |
|-------------|----|
| 18-20       | 24 |
| 20-22       | 33 |
| 23-25       | 43 |
| Gender      | %  |
| Women       | 86 |
| Men         | 14 |
| Race        | %  |
| Indian      | 89 |
| Black       | 10 |
| Coloured    | 1  |
| White       | 0  |
| Asian       | 0  |

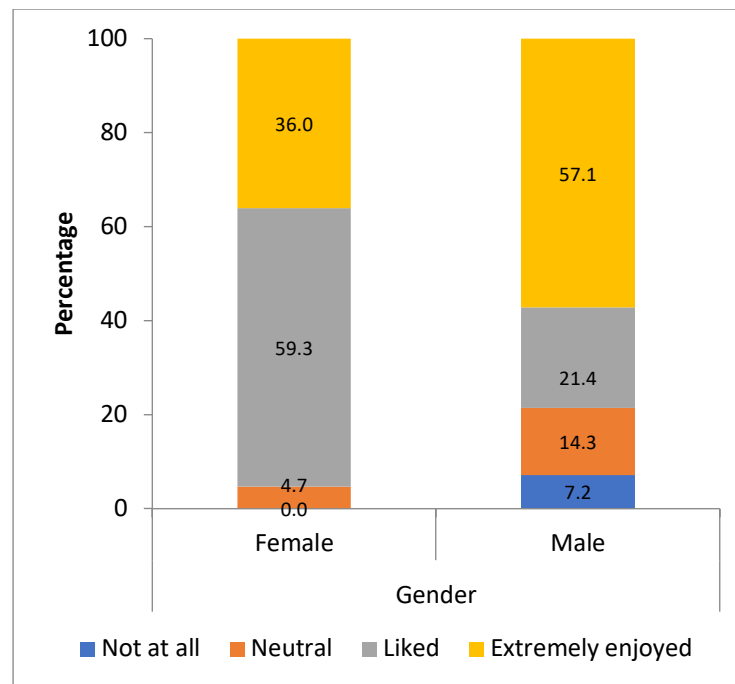
Table 4.18 reflects that 86% of the participants for the final awareness tool survey were women and 14% of the participants were men. The information reflects that majority of the participants (89%) participants were Indian; 10% of the participants were black and one participant was coloured. In addition, the results depict that 24% of the participants were from the age range of 18-20, 33% of participants were from the age range of 20-22 and 43% of participants were from the age range of 23-25.

**Table 4.19: Participants' responses to the final awareness tool survey (n=100)**

| Question   | Answer            | %    |
|--|-------------------|------|
| “Was this video informative?”                      | Yes               | 100  |
|  | No                | 0    |
| “Will you make the recipes from this video?”       | Yes               | 91 * |
|  | No                | 9    |
| On a scale of 1-5 how much did you enjoy the video | Not at all        | 1    |
|  | Neutral           | 6    |
|  | Liked             | 54   |
|  | Slightly enjoyed  | 0    |
|  | Extremely enjoyed | 39   |

\* $p < 0.0005$

Figure 4.19 reflects that 100% of the participants thought that the video was informative. Significantly, 91% of the participants said they would make the recipes from the video ( $p < .0005$ ). Results from a binominal test show that there are no differences in these responses across gender, race, or age. 39% of participants “extremely enjoyed” the video, 54% of participants “liked” the video, 6% of participants felt neutral about the video, 1% of participants did not enjoy the video at all and 0% of participants “slightly liked the video. The Chi-square goodness-of-fit test) showed that a significant 93% either liked or extremely enjoyed the video ( $p < .0005$ ).



**Figure 4.5: Responses produced by men and women during the final awareness tool survey. “On a scale from 1-5, how much did you enjoy the video?”**

Analysis with Pearson’s chi-square (Fisher’s exact test) of the cross-tabulation of responses with demographics shows that there was a significant relationship between gender and video rating, Fisher’s exact = 11.129, ( $p=.007$ ). Compared to women, significantly more men either did not like it at all, were neutral, or extremely enjoyed it (Figure 4.5). No differences were found between age and race.

## 4.12 Discussion

### 4.12.1 Key informant interviews

The key informant interview participants from this study thoroughly shared their knowledge on the uses and perceptions of *Cissus quadrangularis*. *Cissus quadrangularis* is part of the vitaceae family and is also known as the veldt grape, however, two participants in this study described *Cissus quadrangularis* as a medicinal cactus plant which is also a creeper (Siddiqua and Mittapally 2017: 330). A possible reason for aligning *Cissus quadrangularis* to the Cactaceae family is that morphologically it looks remarkably like the dragon fruit plant, *Hylocereus undatus* which also grows widely in KZN (Joubert 2012: 1).

It has been well documented that *Cissus quadrangularis* is used in traditional medicine (Malathi, 2014, Justin and Baby 2011, Goli *et al.* 2018). Likewise, this study confirms that



the participants use *Cissus quadrangularis* for many medicinal purposes such as arthritis, fractures, body pain, rashes, and ulcers and for its anti-inflammatory properties. In a study by Joseph *et al.* (2013: 601) *Cissus quadrangularis* is described as effectively treating different bone disorders and can be used as preventive treatment for low bone density. Banu *et al.* (2012b: 3) indicates that *Cissus quadrangularis* can be a good supplement for postmenopausal bone loss. *Cissus quadrangularis* is also said to possess anti-inflammatory properties, lower cholesterol levels and aid with chronic ulcers (Staughton, 2018: 1). In addition, Jainu *et al.* (2010: 225) stated *Cissus quadrangularis* is effective in suppressing chronic ulcers. A participant from the key informant interviews indicated that she began to drink *Cissus quadrangularis* in the morning and evening and this resulted in her stopping her cholesterol medication prescribed for high cholesterol levels. A study conducted in Yaounde, Cameroon was conducted to determine if participants who were consuming *Cissus quadrangularis* in capsule form, without any changes to their diet or exercise, would lower their fasting blood glucose levels, total cholesterol levels, and contribute towards weight loss (Oben *et al.* 2007: 4).

The results of a previous study found that the daily intake of *Cissus quadrangularis* was effective in lowering some of the participants blood glucose levels by 14.6%, cholesterol by 18% and Body Mass Index by 5.4% (Oben *et al.* 2007: 4). In this study, participants used *Cissus quadrangularis* as a food source in their diet. There are various studies that indicate that *Cissus quadrangularis* has been used in food product development for its nutrient properties in other countries outside of South Africa (Nawghare 2017: 4256; Malathi, 2014: 3). *Cissus quadrangularis* has a high amount of vitamin C, vitamin A, Calcium, Potassium, Iron and Zinc (Brahmkshatriya *et al.* 2015: 169). Research by Oben *et al.* (2007:2) report that *Cissus quadrangularis* has high amounts of calcium, ascorbic acid, and carotene. Moreover, according to a study conducted in Nigeria, it was found that *Cissus quadrangularis* powder has a high amount of sodium, (22.5mg/100g), potassium (67.5mg/100g) and calcium (39.5mg/100g) (Enechi *et al.* 2003:66).

The participants for the key informant interviews expressed confidence in preparing *Cissus quadrangularis*. Washing the plant prior to cutting was emphasised, if not done in this manner the plant would become too sticky to use. The anatomical characteristics of *Cissus quadrangularis* indicates that the plant has large size mucilage cells (25-48µ) which is

frequently observed in the cortex (Austin *et al.* 2004: 34). Hence, the treatment of the plant during preparation as described by the participants is in line with methods used to reduce the secretions by the mucilage cells of the plant when chopped. The participants cooked the *Cissus quadrangularis* into a chutney, paste and fritters.

Although the study participants indicated no side effects when they consumed the plant, care needs to be practised when using any plant in terms of safety for human consumption. Even though the participants indicated no side effects when consuming *Cissus quadrangularis* products, a study by Goli *et al.* (2018: 99) reported that *Cissus quadrangularis* was soaked in tamarind to reduce the itching sensation to the oral cavity and the throat. In the study conducted by Karadbhajne *et al.* (2014: 2266) *Cissus quadrangularis* was processed in dry form and baked into cookies and biscuits, the baked products were tested for sensory acceptability, the findings of this study indicated that when a ratio of 10% of *Cissus quadrangularis* powder was added to the biscuit, a slight throat irritation was recorded as compared to when a 15% ratio of the powder was added, where the irritation was prominent.

#### **4.12.2 Food and nutrition trends**

The food product developed for this research study was informed by the results from the desktop review on food trends for 2019-2020. Natural remedy, less sugar, health, convenience, texture, and sustainability and plant-based foods were the key trends used in the food product development. These key trends are important and vital in creating a trendy product that is accepted by young adults. Natural remedies refer to substances which are derived from natural sources such as plants (Youngson 2005: 1). Less sugar indicates that consumers want more foods that have less or no sugar (sugar substitutes) in them, health refers to the consumption of food products that are good for your body, convenience refers to foods that are quick and easy to eat, texture indicates that consumers are more likely to try out and enjoy foods that provide texture, sustainability refers to the use of foods and ingredients that are sourced using sustainable and healthy procedures, plant-based foods refer to the use and consumption of plant derived foods such as; berries, kale, rolled oats, avocados, chickpeas, lentils, almonds, sunflower seeds, pumpkin seeds, coconut milk. Three product development trials were conducted before a final recipe was chosen (Table 4.4). The final recipe used seven different ingredients that were identified in the trends mentioned above: sunflower seeds, pumpkin

seeds, almonds, oats, dried cranberries, chickpeas and dates, all of which are readily available in South African supermarkets.

#### **4.12.3 Consumer acceptance and preference of Energy bite infused with *Cissus quadrangularis***

The second objective of the study was to develop an acceptable food product using *Cissus quadrangularis* by the means of test trials conducted in the Consumer Sciences: Food and Nutrition laboratories. Once the test trials were conducted on the food products developed (Figure 3.3) the final food product with *Cissus quadrangularis* was developed and chosen for sensory evaluation. Pilot sensory evaluation was conducted to determine the potential of the final food product being sensorially acceptable among young adults. A 9-point hedonic scale test and a paired preference test were used for the pilot sensory analysis. Kalva (2009: 31) states that the 9-point hedonic scale is an easy test to use to determine participants' preference of food attributes. Lawless and Heymann (1999: 431) posited that paired preference testing is used to find out the preference over two products. The results indicates that 90% of woman and 10% men participated in the study. According to Moosa (2017: 1) there are more women students enrolled in South African universities than male students. The results reflect that 60% of participants chose 'like very much' for the 4g sample whereas 30% of participants chose "like moderately" and "like slightly" for the 6g sample. These results suggest that the 4g sample was favoured over the 6g sample of the energy bite infused with *Cissus quadrangularis*, a possible reason for this is that the 4g sample had less prominent tart and tangy flavour.

Once the pilot sensory analysis was conducted, the results showed that both the product variations were sensorially accepted and liked by the participants. This was followed by the final sensory evaluation using the 9-point hedonic scale test and a paired preference test. In terms of gender, 53% of the participants were women and 47% were men. The results from the 9-point hedonic scale test indicated that that 27% of participants chose "like extremely", 28% participants chose "like very much" whereas, 12% participants chose "like slightly", for the 4g sample, however, for the 6g sample 18% participants chose "like extremely", 19% participants chose "like very much", 16% participants chose "like slightly". The results indicate that most participants responded to the "like extremely", "like very much" and "like slightly" category for the both the 4g and 6g sample. This suggests that both samples were mostly enjoyed by the study's sample population. Given that the developed food product was a snack item, a study by Potter *et al.* (2018: 88) suggested that most people, both male and women spend most of the

day snacking and snack foods were seen as foods that were convenient and easy to prepare. Research by Schlinkert *et al.* (2020:7) showed that health repeatedly appeared when participants were asked factors that constituted an ideal snack. This information suggests that because the energy bite infused with *Cissus quadrangularis* was convenient, healthy and a snack item, it was well liked and accepted by participants of this study.

The results show that the mean for the 4g sample was 7.35 and 7.01 for 6g. Analysis showed that there was a marginal preference of sample 1 (4g) over sample 2 (6g). These results show that both products were accepted and enjoyed by the study's sample population. A mean of 7 on the 9-point hedonic scale depicts that the recipe is of a high sensory acceptable quality as stated by Everitt (2009: 117).

The pilot sensory evaluation paired preference test results indicated that 70% of the participants preferred the 4g sample over the 6g sample. The result for the final sensory evaluation indicates that the 4g sample was enjoyed by majority of the participants, however, the results reflect that most of the participants (33%) collectively liked the 6g sample moderately. The results show that the 4g sample was preferred in both the pilot sensory evaluation and the final sensory evaluation. A study conducted by Karadhajne *et al.* (2014:2266) where *Cissus quadrangularis* was baked into biscuits, revealed that when the ratio of *Cissus quadrangularis* powder was increased, the baked product had a significant herb taste. Another study by Talreja *et al.* (2017: 146) expressed that *Cissus quadrangularis* developed products were not accepted by participants due to a bitter taste.

#### **4.12.4 Microbial load and safety of Energy bite infused with *Cissus quadrangularis***

Microbiological testing is a process of identifying any pathogens or bacteria that may be present in the developed food product to determine if the product is safe for consumption (ARBRO 2021:1). The results indicated that the microbial count in the product was high averaging between 1000 to 5000 cfu per gram within the acceptable limit. However, the product was suitable for a short shelf life of three days. Potassium sorbate was added to the energy bite infused with *Cissus quadrangularis* for the second microbial test. Potassium Sorbate is a commonly known and safe food preservative used in the food industry (Jorge 2003: 5356). The second test results indicated that the microbial count found in the developed product was low and that there are no microorganisms present.

#### 4.12.5 Nutritional composition of Energy bite infused with *Cissus quadrangularis*

Nutrient analysis is an important aspect in food product development as it provides vital nutritional information on the developed product. Objective 3 of this study was to determine the amounts of macronutrients and micronutrients in the final developed product.

Both samples of the developed product showed that the sugar content was relatively high (4g: 3.4g / 6g: 3.48g per 21.5g). However, the high amount of sugar can be attributed to use of dates in the recipe, dates are considered as natural sweeteners. According to Olsen (2021: para. 2 line 3) dates are great alternative sources of sugar as they have the ability to add sweetness to food, limiting the need for refined sugars.

In 2016, South Africa implemented compulsory legislation regarding sodium limits in foodstuffs (Peters *et al.* 2017: 1). According to Spires *et al.* (2016: 35) excessive salt, fat, sugar intake is the cause of many NCDs in South Africa. Reducing the amount of sodium used in food is vital in preventing or reducing the occurrences of many NCDs such as hypertension in South Africa. The sodium levels in both the samples of the developed product were low, contributing only 0.133% to the DRIs of both women and men. Noteworthy, globally majority of snacks are high in sugar and fat, leading to obesity, and weight gain (Cleobury *et al.* 2013: 333). According to Hess *et al.* (2018: 284) snacks often are nutrient poor foods which are high in sugar, saturated fat and sodium. The nutrient analysis results reflected that both samples were low in fat (4g: 1.14 / 6g: 1.18 per 21.5g). Carbohydrates and fat are essential and play a vital role in a diet as they provide the body with energy, however a high fat diet can have many side effects such as coronary heart disease (Meksawan *et al.* 2013: 131). According to Shai *et al.* (2008: 229) low fat diets can aid in weight loss and can lower cholesterol levels. The protein value in the energy bite was significantly low only contributing (Women: 3.17% / Men: 2.6%) to the DRIs of women and men, respectively.

The energy bite carbohydrate level was relatively low as it contributed (Women: 6.72 %/ Men: 6.32%) to the DRIs of women and men, respectively. The amount of dietary fibre present in this study; in both samples were high (4g: 4.02 / 6g: 4.16 per 21.5g), contributing well to both women and men's DRIs of dietary fibre, respectively (Women: 16.08% / Men: 10.94%). Dietary fibre plays a vital role in the diet as they are said to aid in reducing the risk of diabetes (assisting with glycaemic response), assisting with inflammation, aiding with weight loss, the risk of cardiovascular disease and lowering blood pressure (Maćkowiak *et al.* 2016: 105). Good sources of dietary fibre include fruits, vegetables, nuts and cereals (Dhingra *et al.* 2012: 255).

However, according to (Mchiza *et al.* 2015: 8243) as South Africans are currently consuming less fruit and vegetables in their diet, this leads to lack of micronutrients and fibre present in their diet. Mbogori and Mucherah (n.d. 1) stated that African countries are consuming less cereals, fruits and vegetables due to the westernisation of their diet. Dietary fibre helps humans and animals meet their energy levels whilst contributing no calories to one's diet (Turner *et al.* 2011: 151).

The vitamins and minerals tested in the nutrient analysis were not present in notable amounts, contributing low percentages to both women and men's DRIs. However, the daily intake of the energy bite can help contribute to women and men meeting certain vitamin and mineral DRIs.

#### **4. 12.6 Shelf-life testing**

The samples were tested by looking at organoleptic factors such as appearance, aroma, and texture of product during the shelf-life test. According to Carter (2021: para.6 line 2) odour, texture, flavour, and appearance is tested to determine if a product is safe to eat during the shelf-life test. The results indicate that the appearance, aroma, and texture of the sample stayed the same over 14 days in constant climate chamber. A possible reason for the product remaining the same over the 14 days in the constant climate chamber could be attributed to the usage of potassium sorbate in the recipe. Potassium sorbate is used as a food preservative in drinks and food, it is a tasteless and odourless chemical additive (Hecht 2017: para. 1 line 4). The results showed that the product was still safe to eat, however, the overall flavour of the product seemed to develop and became stronger as it was stored at refrigeration temperature. Prior research by Porzio (2007: 23) suggests that the temperature of a food product plays a vital role in the aromatics of the product. This has a direct link to the taste and flavour of the overall food product. However, as the product seemed to have a long shelf life in refrigeration temperature, it is suggested that the product be kept at 5°C.

#### **4.12.4 Awareness tool survey**

The fourth objective of this study was to develop an awareness tool for *Cissus quadrangularis* using the developed food product for young adults. The pilot awareness tool was used as test to decipher if the awareness tool is effective. The awareness tool was tested via an online survey via Microsoft™ forms and a Likert scale test. A Likert scale is used to understand the perception or preference of the participant which in turn will assist the study (Joshi *et al.* 2015:398). Microsoft™ forms an easy platform to create surveys, collect and share data (Singh 2017: 1).

The pilot awareness tool survey reflects that 100% of the participants were women. Similarly, in a study by Hawkins (2014: 2), more women than men participated in this study. The results revealed that 60% of participants were Indian and 40% were black. The results indicated that 50% of the participants were between the age 20-22 and 50% of the participants were between the ages of 22-25 years.

The results also reflected that 90% of participants found the video informative and 10% of the participants did not. In addition, 90% of the participants found the video easy to follow, whereas 10% of the participants did not. The participants of the pilot awareness tool also found the video easy to comprehend as well as informative.

The pilot awareness tool results depicted that most participants enjoyed the short awareness tool video as the responses from the Likert scale (“On a scale from 1-10, how much did you enjoy the video?” ‘0- Not at all/ 10- Extremely’) did not fall below a 6. The results indicated that 80% of participants did not know about *Cissus quadrangularis* before watching the awareness tool whereas 20% of the participants were already aware of the Vitaceae. *Cissus quadrangularis* grows in tropical Africa (Brethauer 2019:1). However, it is not widely well known of among young adults. The results indicated that 80% of the participants reported that they would make the recipes from the awareness tool whereas, 20% reported that they would not. A possible reason for this is that several people have food neophobia; this presents itself in individuals not wanting to try or experience unfamiliar foods and tastes (Johnson *et al.* 2018: 22 and Pilner *et al.* 2006: 75). Another possible reason is that the diet for young adults especially university students consist of fast foods, sweets, cool drinks and snacks, suggesting that healthy snacks may not necessarily be the first preference (Bernardo *et al.* 2017: 860).

Once the pilot awareness tool survey was conducted, the researcher used the results from pilot awareness tool to streamline the survey. This was done by eliminating some of the irrelevant questions from the pilot survey as well as changing the 10-point Likert scale to a more precise 5-point Likert scale. The final awareness tool was tested via an online survey using Microsoft™ forms and a Likert scale test. The final awareness tool results depicted 86% of the participants were women and 14% of the participants were men. According to Genovese (2020:1) women are more likely to participate in online surveys than men. In addition, 89% of the participants were Indian. The final awareness tool results reflect that 24% of the participants were from the age range of 18-20, 33% of participants were from the age range of 20-22 and 43% of participants were from the age range of 22-25. The results indicate that all the participants



found the awareness tool to be informative. In addition, 91% of participants were willing to make the recipes depicted in the awareness tool. This information suggests that the participants were intrigued by the awareness tool and were willing to try out the recipes presented to them. As stated by Ingredient solutions (2019: 1) Gen Z are self-sufficient in the kitchen and are willing to try new recipes by watching YouTube™ videos. According to Judkis (2018: 1) millennial's watch cooking videos online and get their recipes from the internet. The results from the Likert survey reflect that 39% participants "extremely enjoyed" the video, 54% participants "liked" the video. This data suggests that most of the participants liked the video. The results indicate that 93% either liked or extremely enjoyed the video (chi-square goodness-of-fit test). This information suggests that majority of the sample population of the study enjoyed the video and found it informative. The results show that compared to women, significantly more men either did not like it at all, were neutral, or extremely enjoyed it (Fisher's exact test). This indicates that more men did not like the video at all or were neutral, indicating that more women were fond of the video. Research by Wardle *et al.* (2004: 107) posited that women are more likely to consume healthy food such as fibre, fruit as well as limiting their salt and fat intake than men. This information suggests that more women are likely to take interest in health awareness than men. No differences were found between age and race. According to Delgado *et al.* (2014:1) all young adults including millennials enjoy food videos.

#### **4.13 Conclusion**

Chapter 4 incorporates the results and discussion of the study. The food product developed by the researcher was well liked by the sample population of the study. The awareness tool participants found the video on *Cissus quadrangularis* informative and displayed general enthusiasm in trying out the recipes presented to them using *Cissus quadrangularis*. The next chapter (Chapter 5) will comprise of the conclusion and recommendations of this study.

## CHAPTER 5

### CONCLUSION AND RECOMMENDATIONS

#### 5.1 Introduction

This chapter entails the conclusions of this study based on the results discussed in the previous chapter. Recommendations, limitations, and strengths of the study will also be dealt with. The aim of this study was to develop a sensorially acceptable food product with *Cissus quadrangularis* to create awareness of this plant among young adults.

#### 5.2 Main findings

*Objective 1: To determine the knowledge, use and perceptions of Cissus quadrangularis among elder community members*

Several themes and sub-themes emerged from the key informant interviews including knowledge, uses, food preparation and toxicity of *Cissus quadrangularis*. The findings from the key informant interviews specified the uses and perceptions of *Cissus quadrangularis* among the elderly Indian community in KZN. The participants from the key informant interviews indicated that *Cissus quadrangularis* was used as a medicinal plant, used to treat sprains, inflammations, broken bones, cholesterol, and ulcers. The participants cooked the plant in curries, pastes or fried doughs and some participants boiled it and drank the water with minimum to no toxicity level noted.

*Objective 2: To develop an acceptable food product using Cissus quadrangularis by the means of test trials conducted in the Consumer Science: Food and Nutrition laboratories*

The findings of the key informant interviews and the desktop study on food and nutrition trends were used to inform the ideation of the food product to be developed and challenges to expect when using *Cissus quadrangularis* in the product development process. The desktop study on food and nutrition trends displayed key food trends for 2019 and 2020 such as zero-waste foods, botanical beverages, alternative ingredient, sustainability, plant-based foods, natural remedies, less sugar, health convenience items, and texture.

Following the systemic steps of product development, a trendy sensorially acceptable food product was developed to create awareness of *Cissus quadrangularis* amongst young adults. The energy bite infused with *Cissus quadrangularis* yielded 10 portions (21.5g each). The product developed used two variations of *Cissus quadrangularis* powder (4g and 6g). The

microbial analysis indicated that the product was safe for consumption. The sensory evaluation of the product clearly indicated that although both samples were liked, the 4g variation was preferred.

*Objective 3: To determine the amounts of macronutrients and micronutrients in the product by means of nutrient analysis.*

The nutritional analysis of the product reflected that the energy infused *Cissus quadrangularis* bite is low in sodium and fat. The energy bite reflected high sugar values, however, most of the sugar content in the product can be attribute to the usage of dates in the recipe. The amount of dietary fibre in both samples were high, and this can be attributed to the core ingredients in the recipe formulation. Vitamins and minerals in the product were not present in notable amounts.

*Objective 4: To develop an awareness tool for Cissus quadrangularis using the developed food product for young adults.*

The awareness tool created showed that the sample population found the video on *Cissus quadrangularis* informative and that they were willing to make the recipes presented to them.

Noteworthy, the findings of the study indicate that *Cissus quadrangularis* can be adapted into a food product and is sensorially acceptable. Vitamins and minerals in the product were not present in notable amounts, however, the daily intake of the energy bite can help contribute to women and men meeting certain vitamin and mineral DRIs. Therefore, if promoted, indigenous food plants such as *Cissus quadrangularis* can play an important role towards a healthy food system and long-term sustainable food security in South Africa.

### **5.3 Limitations of the study**

- The major limitation of the study was due to the COVID-19 pandemic. The study was delayed due to lockdown and other contributing factors.
- The budget for the study was insufficient to conduct the nutrient analysis tests in triplicate, which is generally a scientific guideline.
- The key informant interviews were limited to KZN.
- Some prospective key informant interview participants confused *Cissus quadrangularis* with the dragon fruit plant (*Hylocereus*) as both the plants look remarkably similar. This led to a lot of personal calls and messages being sent to the researcher for clarification.

- Recruitment for the key informant interviews was challenging as it was one on one interviews and many participants cancelled and rescheduled at different times. This prolonged the data collection.
- The sensory evaluation participants for the study were limited to DUT students.
- There was difficulty in the recruitment for the sensory evaluation as many participants were also not on campus because of the COVID-19 lockdown regulations.
- The product contained tree nuts (Almonds), which is a common food allergy.
- Due to a high microbial count, the first batch of the product had a shelf- life of 3 days to extend the products shelf-life and lower the microbial count, potassium sorbate was added to the product.

#### **5.4 Strengths of the study**

- According to the researcher's knowledge, this study is the first food product development with *Cissus quadrangularis* in South Africa.
- Product development steps of the study were followed, and the study was informed by consumer acceptance (sensory evaluation).
- The products were prepared in a food safe environment and all COVID-19 protocols were followed during food preparation and sensory evaluation.
- The food product developed with *Cissus quadrangularis* was sensorially accepted by the sample population.
- The results of the awareness tool of the study depicted that the young adults involved found the awareness tool informative and were willing to try out the recipes presented to them. This indicates that awareness regarding *Cissus quadrangularis* has risen.

#### **5.5 Recommendations of the study**

- Further development of this study is recommended. The study should be extended to include other groups of young adults (outside of DUT) for sensory evaluation.
- Higher dosages of *Cissus quadrangularis* powder should be added to the developed product to test for its sensory acceptability.
- The study testing the sensory acceptability of *Cissus quadrangularis* snacks should include elderly community members in South Africa.
- Different variants of food products should be made with *Cissus quadrangularis*.

- A study should be conducted with *Cissus quadrangularis* to determine if it can aid with health outcomes relating to both undernutrition and overnutrition by testing participants blood before and after; through a timed consumption of *Cissus quadrangularis*.
- Medicinal properties of *Cissus quadrangularis* can be assessed.
- The promotion of the planting and processing (such as drying/ Capsule form) of *Cissus quadrangularis* should be promoted in South Africa.
- Recipe books and infographics on the revival of indigenous foods should be produced.

## 5.6 Conclusion

The study focused on creating a sensory acceptable food product with *Cissus quadrangularis* as well as to raise awareness of *Cissus quadrangularis* among young adults. Food product development using indigenous edible plants can be seen as sustainable measure and can contribute towards food security initiatives in South Africa. Awareness tools that appeal to the youth can help educate young adults on various indigenous foods reducing the vulnerability of food and nutrition insecurity. The researcher followed the food product development stages as well as microbiological testing, nutrient analysis, shelf-life testing, and sensory evaluation in producing an acceptable food product with *Cissus quadrangularis* (Energy bite infused with *Cissus quadrangularis*). The study hopes to raise awareness of this food plant and its various health benefits.

## 6. References

Abbaspour, N., Hurrell, R. and Kelishadi, R. 2014. Review on iron and its importance for human health. *Journal of Research in Medical Sciences: the official Journal of Isfahan University of Medical Sciences*, 19(2): 164-174.

Agens, N. 2020. The process of food product development from concept to market for restaurants and food industries. Available: [https://issuu.com/foodresearchlab/docs/process\\_of\\_food\\_product\\_development\\_from\\_concept](https://issuu.com/foodresearchlab/docs/process_of_food_product_development_from_concept) (Accessed 21 April 2021).

Akinola, R., Pereira, L.M., Mabhaudhi, T., de Bruin, F.M. and Rusch, L. 2020. A review of indigenous food crops in Africa and the implications for more sustainable and healthy food systems. *Sustainability*, 12(8): 2-24.

AOAC International. 2017. Official Methods of Analysis. Available: <http://www.eoma.aoac.org/> (Accessed 4 March 2017).

Application of sensory science to product development. 2009. Application of sensory science to product development. Available: <http://functions.safeshop.co.za/View.asp?ID=114917/> (Accessed 29 June 2019).

Aramouni, F. and Deschenes, K. 2015. *Methods for developing new food products An Instructional Guide*. Available: <https://www.destechpub.com/wp-content/uploads/2015/01/Methods-for-Developing-New-Food-Products-preview.pdf> (Accessed June 2019).

Arnarson, A. 2017. 20 Foods That Are High in Vitamin A. Available: <https://www.healthline.com/nutrition/foods-high-in-vitamin-a> (Accessed 10 October 2020).

Arnarson, A. 2019. Cranberries 101: Nutrition Facts and Health Benefits. Available: <https://www.healthline.com/nutrition/foods/cranberries> (Accessed 29 April 2021).

Askew, K. 2020. Shifting away from sugar: what's the outlook in 2020? Available: <https://www.foodnavigator.com/Article/2020/01/15/Shifting-away-from-sugar-What-s-the-outlook-in-2020> (Accessed 19 April 2021).

Austin, A., Kannan, R. and Jegadeesan, M. 2004. Pharmacognostical studies on *Cissus quadrangularis* L. variant I & II. *Ancient Science of Life*, 23(4): 33-47.

Balasubramanian, P., Jayalakshmi, K., Vidhya, N., Prasad, R., Sheriff, A.K., Kathiravan, G., Rajagopal, K. and Sureban, S.M. 2010. Antiviral activity of ancient system of ayurvedic medicinal plant *Cissus quadrangularis* L. (Vitaceae). *Journal of Basic and Clinical Pharmacy*, 1(1).1

Banu, J. 2012a. Medicinal properties of plants from the genus *Cissus*: A review. *Journal of Medicinal Plants Research*, 6(16): 3080-3086.

Banu, J., Varela, E., Bahadur, A.N., Soomro, R., Kazi, N. and Fernandes, G. 2012b. Inhibition of bone loss by *Cissus quadrangularis* in mice: a preliminary report. *Journal of Osteoporosis*, 2012: 9-10.

Bartkiene, E., Steibliene, V., Adomaitiene, V., Juodeikiene, G., Cernauskas, D., Lele, V., Klupsaite, D., Zadeike, D., Jarutiene, L. and Guiné, R.P. 2019. Factors affecting consumer food preferences: Food taste and depression-based evoked emotional expressions with the use of face reading technology. *BioMed Research International*, 1-10.

Beaulieu-Banks, R., Sundeen, K. and Christopherson, K. 2018. American Indian Perspectives on Healing from Historical Trauma: An Indigenous Inquiry. Masters. St. Catherine University.

Bedrina, O. 2019. 12 Simple Tips for Making Your Videos Look More Professional. Available: <https://wave.video/blog/12-simple-tips-for-making-your-videos-look-more-professional/> (Accessed 12 February 2021).

Bernardo, G.L., Jomori, M.M., Fernandes, A.C. and Proença, R.P.D.C. 2017. Food intake of university students. *Revista de Nutrição*, 30(6): 847-865.

Bench, B, J. Whittington, W. Kranz, M., Guerrero, F. n.d. Determining Total Fat Content by Automated Acid Hydrolysis. Available: <https://www.oico.com/File%20Library/Resource%20Library/Application%20Notes/Determining-total-fat-content-by-acid-hydrolysis.pdf> ( Accessed date: 5 October 2021).

Beto, J.A. 2015. The role of calcium in human aging. *Clinical Nutrition Research*, 4(1):1-8.

Brahmkshatriya, H.R., Shah, K.A., Ananthkumar, G.B. and Brahmkshatriya, M.H. 2015. Clinical evaluation of *Cissus quadrangularis* as osteogenic agent in maxillofacial fracture: A pilot study. *Ayu*, 36(2):169-173.



Brethauer, B. 2019. Cissus quadrangularis. Available: <http://www.columbuscactusclub.com/cissus-quadrangularis.html> (Accessed date: 20 April 2021).

Brown, M.J. 2018. Top 11 Science-Based Health Benefits of Pumpkin Seeds. Available: <https://www.healthline.com/nutrition/11-benefits-of-pumpkin-seeds> (Accessed 29 April 2021).

Bum, E.N., Ngoupaye, G.T., Talla, E., Dimo, T., Nkantchoua, G.N., Pelanken, M.M. and Taiwe, G.S. 2008. The anticonvulsant and sedative properties of stems of Cissus quadrangularis in mice. *African Journal of Pharmacy and Pharmacology*, 2(3): 042-047.

Carpenter, R.P., Lyon, D.H. and Hasdell, T.A. 2012. Guidelines for sensory analysis in food product development and quality control. Springer science & business media. Available: [https://books.google.co.za/books?id=yGcECAAQBAJ&dq=sensory+analysis+in+product+development&lr=&source=gbs\\_navlinks\\_s/](https://books.google.co.za/books?id=yGcECAAQBAJ&dq=sensory+analysis+in+product+development&lr=&source=gbs_navlinks_s/) (Accessed 29 June 2019).

Carter, A. 2021. A guide to shelf-life testing for your product. Available: <https://foodconsulting.co.za/a-guide-to-shelf-life-testing-for-your-product/> (Date: 21 May 2021).

Chakona, G. and Shackleton, C.M., 2019. Food insecurity in South Africa: To what extent can social grants and consumption of wild foods eradicate hunger?. *World Development Perspectives*, 13:87-94.

Choi, S. E. 2008. Sensory evaluation. Available: [http://samples.jbpub.com/9781449694777/9781449603441\\_CH03.pdf](http://samples.jbpub.com/9781449694777/9781449603441_CH03.pdf) (Accessed 20 September 2020).

Corey, E. 2011. World Health Organisation. Formative Research: What, Why and How. Available: <https://www.gfmer.ch/SRH-Course-2010/Geneva-Workshop/pdf/Formative-research-Corey-2011.pdf> (Accessed 14 March 2020).

Cleobury, L. and Tapper, K. 2014. Reasons for eating ‘unhealthy’ snacks in overweight and obese males and females. *Journal of Human Nutrition and Dietetics*, 27(4): 333-341.

CPKelco. 2019. Top 10 texture trends. Available: <https://www.cpkelco.com/texture/> (Accessed date: 20 October 2020).

Creswell, J.W. 2009. Mapping the field of mixed methods research. Available: [https://scholar.google.com/scholar?hl=en&as\\_sdt=0%2C5&q=qualitative%2C+and+quantitative+research+methodology+%28Creswell+2008%3A+9%29.++&btnG=](https://scholar.google.com/scholar?hl=en&as_sdt=0%2C5&q=qualitative%2C+and+quantitative+research+methodology+%28Creswell+2008%3A+9%29.++&btnG=) (Accessed 20 June 2019).

Culinary trend tracking series. 2014. How to identify food trends. Availability: [https://cdn2.hubspot.net/hub/209482/file-799265167-pdf/docs/White+Papers/How\\_to\\_Identify\\_Food\\_Trends\\_White\\_Paper.pdf](https://cdn2.hubspot.net/hub/209482/file-799265167-pdf/docs/White+Papers/How_to_Identify_Food_Trends_White_Paper.pdf) (Accessed 21 April 2020).

Delgado, J., Johnsmeyer, B. and Balanovskiy, S. 2014. Millennials Eat Up YouTube Food Videos. Available: [https://www.thinkwithgoogle.com/marketing-strategies/video/millennials-eat-up-youtube-food-videos/amp/#aoh=16194711521272&referrer=https%3A%2F%2Fwww.google.com&amp\\_tf=From%20%251%24s](https://www.thinkwithgoogle.com/marketing-strategies/video/millennials-eat-up-youtube-food-videos/amp/#aoh=16194711521272&referrer=https%3A%2F%2Fwww.google.com&amp_tf=From%20%251%24s) (Accessed date: 26 April 2020).

Dhingra, D., Michael, M., Rajput, H. and Patil, R.T. 2012. Dietary fibre in foods: a review. *Journal of Food Science and Technology*, 49(3):255-266.

Deshpande, S.S. 2003. *Nutrition education: Encyclopaedia of Food Sciences and Nutrition*. Massachusetts: Academic Press.

Doyle, L. 2019. The importance of video on social media. Available: <https://trust.guidestar.org/the-importance-of-video-on-social-media> (Accessed 15 October 2020).

Du Toit, D.C. 2011. Department of Agriculture Foresters and Fisheries (DAFF): Republic of South. Food security. Available: <http://www.nda.agric.za/docs/genreports/foodsecurity.pdf> (Accessed 18 May 2019).

Eatrightpro. 2021. How to explain basic nutrition concepts. Available: <https://www.eatrightpro.org/practice/practice-resources/international-nutrition-pilot-project/how-to-explain-basic-nutrition-concepts> (Accessed 10 October 2021).

Element. 2021. ICP Analysis Laboratories– ICP-MS, ICP-AES, ICP-OES. Available: <https://www.element.com/materials-testing-services/chemical-analysis-labs/icp-analysis-laboratories%E2%80%93icp-ms,-icp-aes,-icp-oes> (Accessed 12 October 2021).

Enechi, O.C. and Odonwodo, I. 2003. An assessment of the phytochemical and nutrient composition of the pulverized root of *Cissus quadrangularis*. *Bioresearch*, 1(1): 63-68.

Eufic. 2006. The Factors That Influence Our Food Choices. Available: <https://www.eufic.org/en/healthy-living/article/the-determinants-of-food-choice> ( Accessed August 2020).

Everitt, M., 2009. *Consumer-targeted sensory quality*. In *Global issues in food science and technology*. Massachusetts: Academic Press.

FAO. 2021a. Food and Nutrition education. Available: [Education | Nutrition | Food and Agriculture Organization of the United Nations \(fao.org\)](#) (Accessed 10 October 2021).

FAO. 2021b. Acute hunger set to soar in over 20 countries, warn FAO and WFP. Available: <http://www.fao.org/news/story/en/item/1382490/icode/> (Accessed 20 February 2021).

FAO. 2021c. The state of food security and nutrition in the world. <http://www.fao.org/3/cb4474en/cb4474en.pdf> (Accessed 18 May 2021).

FAO. 2021d. Nutrition. Available: <https://www.fao.org/nutrition/education/en/> ( Accessed 18 May 2021).

FAO. 2020. Impacts of COVID-19 on food security and nutrition: developing effective policy responses to address the hunger and malnutrition pandemic. Available: <http://www.fao.org/3/cb1000en/cb1000en.pdf> (Accessed 24 January 2021).

FAO. 2019. The state of food security and nutrition in the world. Available: <http://www.fao.org/3/ca5162en/ca5162en.pdf> (Accessed 24 January 2021).

FAO. 2016a. Achieving SDG2 - End hunger, achieve food security and improved nutrition and promote sustainable agriculture. Available: <http://www.fao.org/sustainable-development-goals/news/detail-news/en/c/424259/> (Accessed 12 February 2021).

FAO. 2016b. Simple test methods for meat products. Available: <http://www.fao.org/docrep/010/ai407e/AI407E24.htm> (Accessed 5 July 2017).

FAO. 2014. Nutrition-sensitive agriculture. Available: <http://www.fao.org/about/meetings/icn2/preparations/document-detail/en/c/238665/> (Accessed 11 February 2021).

FAO. 2008. An Introduction to the Basic Concepts of Food Security. Available: <http://www.fao.org/3/al936e/al936e.pdf> (Accessed April 2019).

FAO. 2007a. Nutrition, education and awareness raising for the right to adequate food. Available: <http://www.fao.org/3/i3895e/i3895e.pdf> (Accessed 10 October 2020).

FAO. 2007b. Why education matters. Available: [http://www.fao.org/fileadmin/user\\_upload/red-icean/docs/Nutrition%20Education\\_FAO\\_Concept%20note.pdf](http://www.fao.org/fileadmin/user_upload/red-icean/docs/Nutrition%20Education_FAO_Concept%20note.pdf) (Accessed June 2020).

FAO. 2006. Food security. Available: [http://www.fao.org/fileadmin/templates/faoitaly/documents/pdf/pdf\\_Food\\_Security\\_Concept\\_Note.pdf](http://www.fao.org/fileadmin/templates/faoitaly/documents/pdf/pdf_Food_Security_Concept_Note.pdf) (Accessed 12 February 2021).

Fisher, T. 2017. *The role of sensory evaluation in food quality control, food research and development: a case of coffee study*. Available: [www.researchnet.net/publication.com](http://www.researchnet.net/publication.com) (Accessed 7 July 2019).

Flottman. 2016. 6 Benefits of Using Brochures. Available: <https://www.flottmanco.com/6-benefits-of-using-brochures/> (Accessed 10 October 2021).

Food ingredients. 2019. Texture trends and innovation: Modifying mouthfeel, engaging the senses and making visual statements. Available: <https://www.foodingredientsfirst.com/news/texture-trends-and-innovation-modifying-mouthfeel-engaging-the-senses-and-making-visual-statements.html> (Accessed date: 20 October 2020).

Hess, J.M. and Slavin, J.L. 2018. The benefits of defining “snacks”. *Physiology & Behavior*, 193: 284-287.

Gacalar, M. and Retunbeck, S. 2006. Sample size in consumer test and descriptive analysis. *Journal of Sensory Studies*, 21: 129-145. Available: <https://onlinelibrary.wiley.com/doi/full/10.1111/j.1745-459X.2006.00055.x#:~:text=Books%20and%20articles%20on%20sensory,Sidel%201993%3B%20Moskowitz%20et%20al> (Accessed 12 February 2021).

Genovese, K. 2020. A woman's perspective - a look at gender and survey participation. Available: <https://culturecounts.cc/blog/a-womans-perspective-a-look-at-gender-and-survey-participation/> (Accessed date: 20 April 2020).

Gilbert, C. 2013. What is vitamin A and why do we need it? Community eye health. Available: <https://www.healthline.com/nutrition/foods-high-in-vitamin-a> (Accessed 23 October 2020).

Global Change System for analysis, Research and Training (START). 2012. The Impact of Climate Change on Food Security among Coastal Communities of Kaskamma, in the Eastern Cape, South Africa. South Africa: START. Available: <http://www.start.org> (Accessed 23 May 2019).

Global Hunger Index. 2019. Global hunger index the challenge of hunger and climate change. Available: <https://reliefweb.int/sites/reliefweb.int/files/resources/2019%20Global%20Hunger%20Index.pdf> (Accessed April 2020).

Goli, P.P., Vaddi, M, Pal., P.K and Srikanth, N. 2018. Ethnomedicinal and Dietary Uses of *Cissus quadrangularis* L. (Asthisrinkhala) from the Tribes, Rural People and Traditional Healers of Andhra Pradesh, India. *Journal of Drug Research in Ayurvedic Sciences*, (2):96-105.

Goulding, D.A., Fox, P.F. and O'Mahony, J.A., 2020. *Milk proteins: an overview*. 3<sup>rd</sup> ed. Massachusetts: Academic Press.

Guiné, R.P., Florença, S.G., Barroca, M.J. and Anjos, O. 2020. The link between the consumer and the innovations in food product development. *Foods*, 9(9):1-22.

Gyawali, S, and Ekasingh, B. 2008. Livelihood and Food Security Assessment of Tharu Ethnic People, Dang District, Nepal: 1-10

Hanus, G. 2018. The influence of the trends in consumers' food behavior contributing to the formulation of marketing strategies for food companies. Available: <http://www.worldscientificnews.com/wp-content/uploads/2018/09/WSN-112-2018-85-95-1.pdf> (Accessed 21 April 2021).

Harding, K. 2020. Native superfoods: How bush tucker is becoming Australia's new fusion food trend. Available: <https://www.sbs.com.au/language/english/native-superfoods-how-bush-tucker-is-becoming-australia-s-new-fusion-food-trend> (Accessed 02 February 2021).

Harvest help African food issues. 2012. Causes of Food Insecurity in African and Other Third World Countries. Available: <http://www.harvesthelp.org.uk/causes-of-food-insecurity-in-african-and-other-third-world-countries.html> (Accessed 30 January 2019).

Hawkins, J., Kieffer, E.C., Sinco, B., Spencer, M., Anderson, M. and Rosland, A.M. 2013. Does gender influence participation? Predictors of participation in a community health worker

diabetes management intervention with African American and Latino adults. *The Diabetes Educator*, 39(5): 647-654.

Heale, R. and Twycross, A. 2015. Validity and reliability in quantitative studies. *Evidence-based Nursing*, 18(3): 66-67.

Hebden, L., Chan, H.N., Louie, J.C., Rangan, A. and Allman-Farinelli, M. 2015. You are what you choose to eat: factors influencing young adults' food selection behaviour. *Journal of Human Nutrition and Dietetics*, 28(4):401-408.

Hecht, M. 2017. Everything You Should Know About Potassium Sorbate. Available: <https://www.healthline.com/health/potassium-sorbate> (Date: 20 May 2021).

Hennink, M.M., Kaiser, B.N. and Marconi, V.C. 2017. Code Saturation Versus Meaning Saturation: How Many Interviews Are Enough? *Qualitative Health Research*, 27(4): 591-608.

Helmenstine, A. 2019. Vitamin C Determination by Iodine Titration. Available: <https://www.thoughtco.com/vitamin-c-determination-by-iodine-titration-606322> (Accessed 5 October 2021).

Heredia, N., Wesley, I. and Garcia, S. 2009. Microbiologically Safe Foods. New Jersey: John Wiley & Sons, inc.

Hill, C. 2018. 20 Foods That Are High in Vitamin C. Available: <https://www.healthline.com/nutrition/vitamin-c-foods#section20> (Accessed 15 June 2020).

Hogkiss, R.J. 2016. Vitaceae grape family. Available: <https://succulent-plant.com/families/vitaceae.html> (Accessed 15 June 2020).

Human Sciences Research Council (HSRC). 2013. Food security in SA declining. Available: <http://www.news24.com/SouthAfrica/News/Food-security-in-SA-declining-study-20130806> (Accessed 26 February 2019).

IBM Corp. Released 2017. IBM SPSS Statistics for Windows, Version 25.0. Armonk, NY: IBM Corp.

Inglehart, R. and Baker, W.E., 2000. Modernization, cultural change, and the persistence of traditional values. *American Sociological Review*, 65: 19-51.

Ingredient Solutions. 2019. DFA Dairy farmers of America Gen Z eating habits & food trends you need to know (2020). Available: <https://dfaingredients.com/trends/gen-z-eating-habits/> (Accessed 20 April 2021).

Ismial, G. and Shuffla, S. 2013. *Child safety, peace and health promotion child malnutrition*. Available: <https://www.samrc.ac.za/sites/default/files/attachments/2016-07-15/ChildMalnutrition.pdf> (Accessed 20 April 2021).

Jainu, M., Vijaimohan, K. and Kannan, K. 2010. Cissus quadrangularis L. extract attenuates chronic ulcer by possible involvement of polyamines and proliferating cell nuclear antigen. *Pharmacogn Mag*, 6(23): 225-233.

Jennings, K. 2018. Top 15 Calcium-Rich Foods (Many Are Non-Dairy). Available: <https://www.healthline.com/nutrition/15-calcium-rich-foods> (Accessed 23 October 2020).

Johnson, S.L., Moding, K.J., Maloney, K. and Bellows, L.L. 2018. A preschooler self-assessment of willingness to try new foods. *Appetite. Development of the Trying New Foods Scale*, 128: 21-31.

Jorge, K., Caballero, B. 2003. *Soft drinks Chemical Composition. Encyclopaedia of Food Sciences and Nutrition*. Massachusetts: Academic Press.

Joseph, B., George, J. and Mohan, J. 2013. Cissus quadrangularis in the treatment of osteoporosis. *World Journal of Pharmaceutical Research*, 2(3): 596-605.

Joshi, A., Kale, S., Chandel, S. and Pal, D.K.. 2015. Likert scale: Explored and explained. *Current Journal of Applied Science and Technology*: 396-403.

Joubert, R. 2012. Dragon fruit farming in South Africa. Available: <https://www.farmersweekly.co.za/crops/field-crops/dragon-fruit/> (Accessed 12 April 2020).

Judkis, M. 2018. Reporter covering culture, food and the arts. Available: <https://www.washingtonpost.com/news/voraciously/wp/2018/04/12/do-millennials-really-not-know-how-cook-with-technology-they-dont-really-have-to/> (Accessed 18 April 2021).

Justin, S. and Baby, J. Pharmacognostic and traditional properties of Cissus quadrangularis Linn – An overview. *International Journal Pharma and Bio Sciences*, 2:131-139.



Kalaba, M. 2019. How droughts will affect South Africa's broader economy. Available: <https://theconversation.com/how-droughts-will-affect-south-africas-broader-economy-111378> (Accessed December 2019).

Kalva, J.J. 2009. Comparison of the hedonic general labelled magnitude scale to the hedonic 9-point scale. Masters. University of Florida. 31.

Kapur, R. 2018. The Significance of Nutrition Education. Available: [https://www.researchgate.net/publication/323770755\\_The\\_Significance\\_of\\_Nutrition\\_Education](https://www.researchgate.net/publication/323770755_The_Significance_of_Nutrition_Education) (Accessed 10 January 2020).

Karadbhajnev, S.V., Kumbhare, V. and Bombaywala, M.A. 2014. Application of *Cissus quadrangularis* Linn. (Hadjor) in nutraceutical food (bakery) products. *International Journal of ChemTech Research*, 6(4): 2263-2270.

Keller, H. 2012. 1 Adapted from "Understanding Nutrition" in Nutrition Family Community. *International in Bangladesh and Save the Children*, USA: 51-53.

Kemp, S. 2021. WhatsApp is the World's Favorite Social Platform (And Other Facts). Available: <https://blog.hootsuite.com/simonkempsocialmedia/#:~:text=Social%20media%3A%20there%20are%20now,of%20the%20world's%20total%20population> (Accessed 12 February 2021).

Khumalo, N.Z. and Sibanda, M. 2019. Does urban and peri-urban agriculture contribute to household food security? An assessment of the food security status of households in Tongaat, eThekweni Municipality. *Sustainability*, 11(4): 1-24.

Kogan, F., Guo, W. and Yang, W. 2019. Drought and food security prediction from NOAA new generation of operational satellites. *Geomatics, Natural Hazards and Risk*, 10(1): 651-666.

Kothari, S.C., Shivarudraiah, P., Venkataramaiah, S.B., Koppolu, K.P., Gavara, S., Jairam, R., Krishna, S., Chandrappa, R.K. and Soni, M.G. 2011. Safety assessment of *Cissus quadrangularis* extract (CQR-300): Subchronic toxicity and mutagenicity studies. *Food and Chemical Toxicology*, 49(12): 3343-3357.

Kubala, J. 2018. Whole-Foods, Plant-Based Diet: A Detailed Beginner's Guide. Available: <https://www.healthline.com/nutrition/plant-based-diet-guide> (Accessed 23 October 2020).

Kubala, J. 2018a. Zinc: Everything You Need to Know. Available: <https://www.healthline.com/nutrition/zinc> (Accessed 23 October 2020).



Kubik, Z. and May, J. 2013. Drought, Food prices and Food security. Available: <https://www.uwc.ac.za/News/Pages/Drought,-Food-Prices-and-Food-Security.aspx> (Accessed 04 September 2020).

Lama, S.C. 2019. 4 Reasons People Choose Junk Food Over Healthy Food. Available: <https://www.livestrong.com/article/392358-reasons-why-people-eat-junk-food-over-healthy-food/> (Accessed June 2020).

Lawler, M. 2020. 10 best food sources of Zinc. Available: <https://www.everydayhealth.com/pictures/best-food-sources-zinc/> (Accessed 23 October 2020).

Lawless, H.T. and Heymann, H. 1999. *Acceptance and preference testing. In Sensory Evaluation of Food Springer*. Boston: Springer.

Leech, J. 2018. 9 Evidence-Based Health Benefits of Almonds. Available: <https://www.healthline.com/nutrition/9-proven-benefits-of-almonds> (Accessed 29 April 2021).

Lemke, S. 2005. Nutrition security, livelihoods and HIV/AIDS: implications for research among farm worker households in South Africa. *Public Health Nutrition*, 8(7): 844-852.

Lindow, M. 2017. Feature/Rediscovering local wild food in South Africa's Western Cape. Available: <https://rethink.earth/rediscovering-local-wild-food-in-south-africas-western-cape/> (Accessed 10 February 2019).

Maćkowiak, K., Torlińska-Walkowiak, N. and Torlińska, B. 2016. Dietary fibre as an important constituent of the diet. *Postępy Higieny i Medycyny Doświadczalnej (Advances in Hygiene and Experimental Medicine)*, 70: 104-109.

Mabhaudhi, T., Chibarabada, T.P., Chimonyo, V.G.P., Murugani, V.G., Pereira, L.M., Sobratee, N., Govender, L., Slotow, R. and Modi, A.T. 2019. Mainstreaming Underutilized Indigenous and Traditional Crops into Food Systems: A South African Perspective. *Sustainability*, 11: 1-22.

Mchiza, Z.J., Steyn, N.P., Hill, J., Kruger, A., Schönfeldt, H., Nel, J. and Wentzel-Viljoen, E. 2015. A review of dietary surveys in the adult South African population from 2000 to 2015. *Nutrients*, 7(9):8227-8250.

Magoxo, S. 2020. Top 10 health food trends for 2020. Available: [Top 10 health food trends for 2020 - Africa's Big 7 \(africabig7.com\)](https://africabig7.com/top-10-health-food-trends-for-2020/) (Accessed 10 February 2021).

Malathi, A.N. 2014. Nutritive value of Mangoravalli (*Cissus quadrangularis*) powder and its value addition. *Current Trends in Technology and Science*, 3(3): 41-44.

Maphosa, M., Dube, T., Dube, Z.L., Ncube, G. and Tshuma, N. 2014. Enhancing food security through micro-irrigation: Evaluating the contribution of treadle pumps to household food security in Umzingwane district of Zimbabwe. *International Journal of Development and Sustainability*, 3(5): 1043-1059.

Masekoameng, M.R. and Molotja, M.C. 2019. The role of indigenous foods and indigenous knowledge systems for rural households' food security in Sekhukhune district, Limpopo province, South Africa. *Journal of Consumer Sciences*, 4: 34-38

Mate, G.S., Naikwade, N.S., Magdum, C.S., Chowki, A.A. and Patil, S.B. 2008. Evaluation of anti-nociceptive activity of *Cissus quadrangularis* on albino mice. *International Journal of Green Pharmacy*, 2(2): 118- 121

Mbhenyane, X.G. 2017. Indigenous foods and their contribution to nutrient requirements. *South African Journal of Clinical Nutrition*, 30(4):5-7.

Mbogori, T. and Mucherah, W. n.d. Westernization of Traditional African Diets and the Development of Chronic Diseases in Africa:1-10

McCulloch, M. 2018. Are Sunflower Seeds Good for You? Nutrition, Benefits and More. Available: <https://www.healthline.com/nutrition/sunflower-seeds> (Accessed 29 April 2021).

Meksawan, K., Pendergast, D.R., Leddy, J.J., Mason, M., Horvath, P.J. and Awad, A.B. 2004. Effect of low and high fat diets on nutrient intakes and selected cardiovascular risk factors in sedentary men and women. *Journal of the American College of Nutrition*, 23(2): 131-140.

Microchem. n.d. shelf-life analyses. Available: <http://www.microchem.co.za/news/shelf-life-analyses/#:~:text=Reasons%20for%20the%20Determination%20of,Physical> (Accessed: 03 May 2021).

Misselhorn, A. and Hendriks, S.L. 2017. A systematic review of sub-national food insecurity research in South Africa: Missed opportunities for policy insights. *PloS ONE*, 12(8). 1-32

Mitha, S., Naidoo, S., Thomas, D. 2019. Referencing guide DUT Harvard referencing style. Available: <https://library.dut.ac.za/wp-content/uploads/2017/08/Referencing-Guide.pdf> (Accessed 19 April 2021).

Mngoma, S. 2021. Let's get back to eating some traditional veggies. Available: <https://www.foodformzansi.co.za/why-little-understood-indigenous-foods-are-great-for-your-health/> (Accessed 10 April 2021).

Moosa, F. 2017. Why do SA universities have more female graduates but fewer academics?. Available: <https://www.thedailyvox.co.za/sa-universities-female-graduates-fewer-academics-fatima-moosa/> (Accessed 26 April 2020).

Mongalo, N.I. and Makhafola, T.J. 2018. Ethnobotanical knowledge of the lay people of Blouberg area (Pedi tribe), Limpopo Province, South Africa. *Journal of Ethnobiology and Ethnomedicine*, 14(1): 1-23.

Morris, S.Y. 2014. 10 Reasons Why You Might Need Iron Supplements. Available: <https://www.healthline.com/health/10-reasons-iron-supplements> (Accessed 23 October 2020).

Morrison, K. 2020. Feeding Gen Z During Quarantine and Beyond. Available: <https://foodindustryexecutive.com/2020/07/feeding-gen-z-during-quarantine-and-beyond/> (Accessed 20 April 2021).

Moseley, W., Schnurr, M. and Bezner Kerr, R. 2015. Interrogating the technocratic (neoliberal) agenda for agricultural development and hunger alleviation in Africa. *African Geographical Review*, 34(1):1-7.

Mulungu, K. and Ng'ombe, J.N., 2019. Climate change impacts on sustainable maize production in Sub-Saharan Africa: a review. *Maize Prod.* 47-53.

Naicker, N., Mathee, A. and Teare, J. 2015. Food insecurity in households in informal settlements in urban South Africa. *South African Medical Journal*, 105(4):268-270.

National Institutes of Health. 2020a. Vitamin C. Available: [Vitamin C - Health Professional Fact Sheet \(nih.gov\)](#) (Accessed 23 October 2020).

National Institutes of Health. 2020b. Potassium. Available: [Potassium - Health Professional Fact Sheet \(nih.gov\)](#) (Accessed 23 October 2020).

National Institutes of Health. 2019. Nutrient Recommendations: Dietary Reference Intakes (DRI). Available: [https://ods.od.nih.gov/HealthInformation/Dietary\\_Reference\\_Intakes.aspx](https://ods.od.nih.gov/HealthInformation/Dietary_Reference_Intakes.aspx) ( 5 October 2021).

Nawghare, C.G. Studies on utilization of hadjod (*cissus quadrangularis*) stem powder as a nutraceutical in bread. Doctoral dissertation. Collage of food technology Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani. Available: <https://krishikosh.egranth.ac.in/displaybitstream?handle=1/5810033248> (Accessed 10 March 2020).

National Income Dynamics Study (NIDS). 2020. About. Available: <http://www.nids.uct.ac.za/about/nids-cram/nids-cram> (Accessed July 2021).

Nutrakeyhealth. 2018. Cissus Quadrangularis. Available: <https://nutrakeyhealth.com/products/cissus-quadrangularis> (Accessed 31 March 2020).

Novotny, J.A., Gebauer, S.K. and Baer, D.J. 2012. Discrepancy between the Atwater factor predicted and empirically measured energy values of almonds in human diets. *The American Journal of Clinical Nutrition*, 96(2): 296-301.

O'Brien, S. 2018. 15 Foods That Pack More Potassium than a Banana. Available: <https://www.healthline.com/nutrition/foods-loaded-with-potassium> (Accessed 23 October 2020).

Oben, J.E., Enyegue, D.M., Fomekong, G.I., Soukontoua, Y.B. and Agbor, G.A., 2007. The effect of *Cissus quadrangularis* (CQR-300) and a *Cissus* formulation (CORE) on obesity and obesity-induced oxidative stress. *Lipids in Health and Disease*, 6(1): 1-8.

Okeyo, A.P., Seekoe, E., de Villiers, A., Faber, M., Nel, J.H. and Steyn, N.P. 2020. The Food and Nutrition Environment at Secondary Schools in the Eastern Cape, South Africa as Reported by Learners. *International Journal of Environmental Research and Public Health*, 17(11): 1-18.

Olsen, A. 2021. Are dates healthful. Available: <https://www.medicalnewstoday.com/articles/322548#five-benefits> (Accessed 6 October 2021).

Ortiz-Ospina, E. 2019. The rise of social media. Available: <https://ourworldindata.org/rise-of-social-media> (Accessed 12 February 2021).

Pallavi, B.S. 2019. Sensory evaluation and requirements, and importance in food industry. Available: <https://www.slideshare.net/pallaviBS4/sensory-evaluation-and-requirements-and-importance-in-food-industry> (Accessed 21 April 2021).

- Palsdottir, H. 2016. 9 Health Benefits of Eating Oats and Oatmeal. Available: <https://www.healthline.com/nutrition/9-benefits-oats-oatmeal> (Accessed 29 April 2021).
- Peek, M.H. 2011. *Twins in African and Disapora cultures: Double trouble, twice blessed*. 1<sup>st</sup> ed. Bloomington, Indiana: Indiana University Press.
- Peters, S.A., Dunford, E., Ware, L.J., Harris, T., Walker, A., Wicks, M., Van Zyl, T., Swanepoel, B., Charlton, K.E., Woodward, M. and Webster, J. 2017. The sodium content of processed foods in South Africa during the introduction of mandatory sodium limits. *Nutrients*, 9(4): 1-15
- Pilner, P. and Salvy, S., 2006. *Food neophobia in humans. Frontiers in nutritional science*. London: CAB International.
- Proceed Innovative. 2017. 7 Major benefits of video marketing. Available: <https://www.proceedinnovative.com/blog/7-major-benefits-video-marketing/#:~:text=Video%20Advertising%20Improves%20Brand%20Trust,get%20repeat%20customers%20or%20clients> (Accessed 10 October 2020).
- Porzio, M.A., 2007. Flavor delivery and product development. *Food technology (Chicago)*, 61(1): 22-29.
- Potter, M., Vlassopoulos, A. and Lehmann, U. 2018. Snacking recommendations worldwide: a scoping review. *Advances in Nutrition*, 9(2): 86-98.
- Rai, S. 2012. Engaging young employees (Gen Y) in a social media dominated world–Review and Retrospection. *Procedia-Social and Behavioral Sciences*, 37:257-266.
- Raman, R. 2017. What Does Potassium Do for Your Body? A Detailed Review. Available: <https://www.healthline.com/nutrition/what-does-potassium-do> (Accessed 23 October 2020).
- Reed, W. 2012. Sensory analysis data is vital for quality control and NPD. Available: [mobile.Foodnavigator.com](https://www.foodnavigator.com) (Accessed 12 February 2019).
- Rouse, M., Shiao, D. and Koski, A. 2014. Product development (new product development - NPD). Available: <https://searchcio.techtarget.com/definition/product-development-or-new-product-development-NPD> (Accessed June 2020).
- Ruel, M. 2013. Food Security and Nutrition: Linkages and complementarities. Washington DC: Research institute (IFPRI).

Salswedel, E. 2017. 7 Powerful Benefits of Video Content Marketing. Available: <https://synecticsmedia.com/7-powerful-benefits-of-video-content-marketing> (Accessed 10 October 2020).

Saunders, B., Sim, J., Kingstone, T., Baker, S., Waterfield, J., Bartlam, B., Burroughs, H. and Jinks, C. 2018. Saturation in qualitative research: exploring its conceptualization and operationalization. *Quality & Quantity*, 52(4):1893-1907.

Schlinkert, C., Gillebaart, M., Benjamins, J., Poelman, M. and de Ridder, D., 2020. The snack that has it all: People's associations with ideal snacks. *Appetite*, 152: 1-7.

Sen, M. and Dash, B.K. 2012. A review on phytochemical and pharmacological aspects of *Cissus quadrangularis* L. *International Journal of Green Pharmacy*, 6: 169-173.

Sensory Analysis Teachers Manual: Home Economics Support Service 2004. 2017.Dublin: Professional Development Services for Teachers.

Shai, I., Schwarzfuchs, D., Henkin, Y., Shahar, D.R., Witkow, S., Greenberg, I., Golan, R., Fraser, D., Bolotin, A., Vardi, H. and Tangi-Rozental, O. 2008. Weight loss with a low-carbohydrate, Mediterranean, or low-fat diet. *New England Journal of Medicine*, 359(3): 229-241.

Shisana, O., Labadarios, D., Rehle, T., Simbayi, L., Zuma, K., Dhansay, A., Reddy, P., Parker, W., Hoosain, E., Naidoo, P., Hongoro, C., Mchiza, Z., Steyn, NP., Dwane, N., Makoe, M., Maluleke, T., Ramlagan, S., Zungu, N., Evans, MG., Jacobs, L., Faber, M., & SANHANES-1 Team. (2013). South African National Health and Nutrition Examination Survey (SANHANES-1). Cape Town: HSRC Press, /201. Available: [http://www.hsrc.ac.za/uploads/pageNews/72/SANHANES-launch%20edition%20\(online%20version\).pdf](http://www.hsrc.ac.za/uploads/pageNews/72/SANHANES-launch%20edition%20(online%20version).pdf) (Accessed 10 February 2019).

Siddiqua, A. and Mittapally, S. 2017. A review on *Cissus quadrangularis*. *The Pharma Innovation*, 6(7):329-334.

Simons, C. 2017. Steps in food product development. Available: <https://cwsimons.com/steps-in-food-product-development/> (Accessed 21 April 2021).

Singh, D. 2017. [The Ultimate Guide to Microsoft Forms](https://collab365.com/ultimate-guide-microsoft-forms/). Available: <https://collab365.com/ultimate-guide-microsoft-forms/> (Accessed 20 April 2020).

Singh, V. 2020. *Cissus quadrangularis* image. Durban.

Sloan, E. 2021. Top 10 Food Trends of 2021. Available: <https://www.ift.org/news-and-publications/food-technology-magazine/issues/2021/april/features/top-10-food-trends-of-2021> (18 April 2021).

Solutions to food insecurity. 2019. Food security in South Africa. Available: <http://southafrica.co.za/solutions-food-insecurity.html> (Accessed 03 September 2020).

South Africa, Dept. Health. 2020. About COVID 19 (coronavirus). Available: <https://sacoronavirus.co.za/information-about-the-virus-2/> (Accessed 20 April 2021).

South African Medicinal Plants. 2018. South African Medicinal plants. Available: <http://southafrica.co.za/medicinal-plants.html> (Accessed 30 January 2019).

Spires, M., Delobelle, P., Sanders, D., Puoane, T., Hoelzel, P. and Swart, R. 2016. Diet-related non-communicable diseases in South Africa: determinants and policy responses. *South African Health Review*, 2016(1): 35-42.

Spritzler, F. 2020. 12 Healthy Foods That Are High in Iron. Available: <https://www.healthline.com/nutrition/healthy-iron-rich-foods> (Accessed 23 October 2020).

Staughton, J. 2018. 10 Amazing benefits of Cissus Quadrangularis. Available: <https://www.organicfacts.net/health-benefits/other/cissus-quadrangularis.html> (Accessed 10 September 2018).

STATS SA. 2020. Loss of income resulting from the COVID-19 pandemic may lead to higher levels of food insecurity SA. Available: <http://www.statssa.gov.za/?p=13327> (Accessed 24 January 2021).

STATS SA. 2019. The Extent of Food Security in South Africa. Available: <http://www.statssa.gov.za/?p=12135> (Accessed 20 February 2021).

STATS SA. 2018. General Household Survey. Available: <http://www.statssa.gov.za/publications/P0318/P03182018.pdf> (Accessed 13 February 2021).

STATS SA. 2018. Overcoming poverty and inequality in South Africa. Available: [https://www.statssa.gov.za/wp-content/themes/umkhanyakude/documents/South\\_Africa\\_Poverty\\_and\\_Inequality\\_Assessment\\_Report\\_2018.pdf](https://www.statssa.gov.za/wp-content/themes/umkhanyakude/documents/South_Africa_Poverty_and_Inequality_Assessment_Report_2018.pdf) (Accessed June 2019).



STATS SA. 2017. Poverty trends in South Africa: An examination of absolute poverty between 2006 and 2015. *Pretoria: statistics south. Africa*. Available: [http://www.statssa.gov.za/?p=10341#:~:text=between%202006%20%26%202015-.Poverty%20Trends%20in%20South%20Africa%3A%20An%20examination,absolute%20poverty%20between%202006%20%26%202015&text=The%20proportion%20of%20the%20population,%2C4%20million\)%20in%202015](http://www.statssa.gov.za/?p=10341#:~:text=between%202006%20%26%202015-.Poverty%20Trends%20in%20South%20Africa%3A%20An%20examination,absolute%20poverty%20between%202006%20%26%202015&text=The%20proportion%20of%20the%20population,%2C4%20million)%20in%202015) (Accessed 03 May 2021).

STATS SA. 2015. How unequal is South Africa? Available: <http://www.statssa.gov.za/?p=12930> (Accessed 03 May 2021).

Stewart-Knox, B. and Mitchell, P. 2003. What separates the winners from the losers in new food product development? *Trends in Food Science & Technology*, 14(1-2):58-64.

Stockwell, A. 2019. Why You Should Buy a Bag of Chickpea Flour. Available: <https://www.epicurious.com/ingredients/how-to-cook-and-bake-with-chickpea-flour-article> (Accessed 25 April 2021).

Street, R. and Prinsloo, G. 2013. Commercially Important Medicinal Plants of South Africa: A Review. *Journal of Chemistry*, 1-16.

Sürücü, L. and Maslakçi, A., 2020. Validity and reliability in quantitative research. *Business & Management Studies: An International Journal*, 8(3):2694-2726.

Sundaran, J., 2020. A short review on pharmacological activity of *Cissus quadrangularis*. *Bioinformation*, 16(8): 579-585.

Sudmoon, R., Chaveerach, A. and Tanee, T. 2016. Analysis of genetics and chemical contents relation compared to commonly used *Cissus quadrangularis* L. and barcode markers of some Thailand *Cissus* species. *Pakistan Journal of Pharmaceutical Sciences*, 29(1): 65-75.

Talreja, T., Kumar, M., Sirohi, P. and Sharma, T. 2017. Preparation and use of *Cissus quadrangularis* and *Achyranthes aspera* formulation in the management of weight loss. *The Pharma Innovation Journal*, 6(3): 143-15 (Available: <https://www.thepharmajournal.com/archives/2017/vol6issue3/PartC/6-3-25-950.pdf>) (Accessed 19 April 2021).

Thandeka, N., Sithole, N., Thamaga-Chitja, J.M. and Makanda, I. 2011. The role of traditional leafy vegetables in household food security in rural KwaZulu-Natal. *Indilinga African Journal of Indigenous Knowledge systems*, 10(2):195-209.



- Turner, N.D. and Lupton, J.R. 2011. Dietary fiber. *Advances in Nutrition*, 2(2): 151-152.
- Turow- Paul, E. 2021. 7 Food And Lifestyle Trends That Will Define 2021. Available: <https://www.forbes.com/sites/eveturowpaul/2021/01/05/7-food-and-lifestyle-trends-that-will-define-2021/?sh=16d2305c6c6b> (Accessed 18 April 2021).
- UCLA centre for health policy research. 2004. Health DATA Train the Trainer Project. Available: [https://healthpolicy.ucla.edu/programs/health-data/trainings/Documents/tw\\_cba4.pdf](https://healthpolicy.ucla.edu/programs/health-data/trainings/Documents/tw_cba4.pdf) (Accessed date: 20 June 2019).
- United Nations.2020. Sustainable development goals officially adopted by 193 countries. Available: <http://www.un.org.cn/info/6/620.html#:~:text=Sustainable%20Development%20Goals%20Officially%20Adopted%20by%20193%20Countries,-Sustainable%20Development%20Goals> (Accessed date: October 2020).
- United Nations. 2020. Goal 2: Zero Hunger. Available: [Goal 2: Zero Hunger – United Nations Sustainable Development](#) (Accessed 12 February 2021).
- United States Department of Agriculture. n.d. *Cissus quadrangularis* L. Available: <https://www.plants.usda.gov/java/ClassificationServlet?source=profile&symbol=CISSU&display=31> (Accessed 30 April 2021).
- Van der berg, S., Patel, L. and Bridgman, G. 2021. Food insecurity in South Africa: Evidence from NIDS-CRAM Wave 5. Available: [13.-Van-der-Berg-S.-Patel-L-and-Bridgeman-G.-2021-Food-insecurity-in-South-Africa---Evidence-from-NIDS-CRAM-Wave-5.pdf \(cramsurvey.org\)](#) (Accessed 18 October 2021)
- Wardle, J., Haase, A.M. and Steptoe, A. 2004. Gender differences in food choice: The contribution of health beliefs and dieting. *Annals of Behavioral Medicine*, 27: 107-116.
- Wichchukit, S. and O'Mahony, M. 2010. Paired preference tests: 'Liking', 'Buying' and 'Take Away' preferences. *Food Quality and Preference*, 21(8):925-929.
- Williams, C. 2019. These will be the biggest food and health trends of 2020. Available: <https://www.cookinglight.com/healthy-living/health/top-food-health-trends-2020> (Accessed 26 March 2020)
- Wong, C. 2018. The benefits of *Cissus Quadrangularis*. Available: <https://www.verywellhealth.com/the-benefits-of-cissus-quadrangularis-88623> (Accessed 14 February 2019).

Wustefeld, M. 2013. Food and Nutrition Security. Available: [http://www.unscn.org/files/Annual\\_Sessions/UNSCN\\_Meetings\\_2013/Wustefeld\\_Final\\_MoM\\_FNS\\_concept.pdf](http://www.unscn.org/files/Annual_Sessions/UNSCN_Meetings_2013/Wustefeld_Final_MoM_FNS_concept.pdf) (Accessed 10 February 2019).

Xu, W., Liang, L and Zhu, M. 2015. Determination of sugars in molasses by HPLC following solid-phase extraction. *International Journal of Food Properties*, 18(3): 547-557.

Youngson, R. 2005. Natural remedies. Available: <https://medical-dictionary.thefreedictionary.com/natural+remedies> (Accessed 18 October 2021)

## Appendix A – Gatekeeper approval letter



Directorate for Research and Postgraduate Support  
Durban University of Technology  
Tromso Annexe, Steve Biko Campus  
P.O. Box 1334, Durban 4000  
Tel.: 031-3732576/7  
Fax: 031-3732946

23rd July 2019

Ms Vihara Singh  
c/o Department of Consumer Science: Food and Nutrition  
Faculty of Applied Sciences  
Durban University of Technology

Dear Ms Singh

### **PERMISSION TO CONDUCT RESEARCH AT THE DUT**

Your email correspondence in respect of the above refers. I am pleased to inform you that the Institutional Research and Innovation Committee (IRIC) has granted full permission for you to conduct your research "Sensory acceptable product development of *Cissus quadrangularis* to create awareness among young adults" at the Durban University of Technology.

The DUT may impose any other condition it deems appropriate in the circumstances having regard to nature and extent of access to and use of information requested.

We would be grateful if a summary of your key research findings can be submitted to the IRIC on completion of your studies.

Kindest regards  
Yours sincerely

A handwritten signature in black ink, appearing to read 'Duffy'.

---

PROF KEVIN DUFFY  
ACTING DIRECTOR: RESEARCH AND POSTGRADUATE SUPPORT DIRECORATE

## Appendix B – Radio announcement



Vihara Singh

Contact Number: 0782389341

Email Address: [viharasingh06@gmail.com](mailto:viharasingh06@gmail.com)

Radio announcement:

I am a Durban University of Technology (DUT) master's student, doing research on Harjod most commonly known as Harjod. The research I am doing entails the development of a trendy food product with Harjod.

I am currently seeking volunteers to share their knowledge of Harjod by taking part in an interview. The interview stipulations are as follows:

Participants must be over the age of 50

Have knowledge of Harjod

Have used/cooked Harjod

The interview will be conducted by the researcher at the nearest location to you. The interview will be of no expense to you.

Thank you. I hope you are willing to share your expertise and help me on this exciting journey in creating a tasty new food product.

Kindly contact me, Vihara on 0782389341.

You may also WhatsApp or SMS me and I will call you back with further details.

## Appendix C – Letter of information and consent form for key informant interviews



### LETTER OF INFORMATION

#### **Title of the Research Study:**

Creating awareness of Cissus Quadrangularis using a sensory acceptable product developed for young adults.

#### **Principal Investigator/s/researcher:**

Vihara Singh (B-Tech Consumer Science: Food and Nutrition)

#### **Co-Investigator/s/supervisor/s:**

Dr Ashika Naicker (PhD: Nutrition)/ Co-supervisor: Ms Govender (Masters Consumer Science: Food and Nutrition)

#### **Brief Introduction and Purpose of the Study:**

The nature of this upcoming product development research study is to create awareness of Cissus Quadrangularis, also known as “Harjod”, and its benefits among young adults by developing a sensorially acceptable food product. The purpose of the study is to determine South African’s knowledge and use of Cissus Quadrangularis; and to determine sensory acceptability of the developed food product. The study will use a mixed methods approach, i.e. both quantitative and qualitative. The study will use methods such as, key informant interviews, a desktop study on food and nutrition trends, product development and sensory evaluation as well as to conduct nutrient, microbial and shelf life analysis will be conducted on the developed product, in addition to creating an awareness tool with Cissus Quadrangularis. The awareness tool developed will be able to educate young people on healthy food choices and practices that use local and fresh foods.

#### **Outline of the Procedures:**

This study uses non-invasive methods. Key informant interviews will be conducted. The study will be explained in detail to you before the key informant interviews takes place. You must sign a consent form agreeing to take part in the study on a voluntarily basis. Key informant interviews will take place at your comfort; as you will be visited by the researcher dependent on your availability. You will then be asked questions surrounding the use and knowledge of Cissus Quadrangularis, these interviews should not take up more than 1hour. You will be recorded via the use of a tape recorder for recollection purposes only.

**Risks or Discomforts to the Participant:** There will be no risk or discomfort made to the Participant.

#### **Benefits:**

#### **Intellectual property rights:**

The academic property rights will belong to the Durban University of Technology (DUT) where the publication will be kept and made available to the public.

**Relevance and outcomes:**

The outcome of this study can lead to an affordable, sensory acceptable and nutrient dense food product available to the market. The development of a food product with *Cissus Quadrangularis* will help South Africans receive its vast variety of benefits that aid in both under and over malnutrition as well as many other health issues.

**Scientific Outcomes:**

The submission of this study will result in a Master of Applied Science qualification in Food and Nutrition for the researcher. The results will be scientifically measured and published in publications and presented at conferences.

**Community capacity building:**

The community will be involved in sharing their knowledge on *Cissus Quadrangularis*. The results from this study will be shared with participants. A final copy will be given to DUT where it will be made available to the public.

An awareness tool will be developed in the form of a short video clip. Which aims to raise awareness on *Cissus Quadrangularis* and its benefits as well as to show easy steps on how to make the developed product. This will aid the public's knowledge on what *Cissus Quadrangularis* is and how it can be used.

**Capacity building:**

Food and Nutrition students will assist in gathering the information, which will contribute to the student's level of understanding in research and fieldwork. Food and Nutrition students will also assist in the pilot sensory evaluation. This will aid students' knowledge and experience in sensory evaluation and its procedures.

**Reason/s why the Participant May Be Withdrawn from the Study:** If the participant does not wish to comply to the procedures of the study, the researcher has full right to withdraw the participant. Should the participant have an adverse reaction to the study the researcher can withdraw the participant. Should the participant wish to withdraw from the study, there will be no adverse consequence to him/her.

**Remuneration:** The participant will not receive any remuneration. However, the participants will receive a fruit as a gesture of gratitude.

**Costs of the Study:** There will be no cost incurred to the participant.

**Confidentiality:** Raw data on paper will be stored in a locked cupboard at the Durban University of Technology: Department of Consumer Sciences: Food and Nutrition. This information will only be available to the researcher and supervisor and will be shredded after a retention period of 5 years. Electronic data that is collected will be password protected.

**Research-related Injury:** The study is of such, where there is no room for any possible injury.

**Persons to Contact in the Event of Any Problems or Queries:**

Please contact the researcher Vihara Singh ( 0782389341), my Supervisor Dr Ashika Naicker (0822009726) or the Institutional Research Ethics Administrator on 031 373 2375. Complaints can be reported to the Director: Research and Postgraduate Support, Prof S Moyo on 031 373 2577 or moyos@dut.ac.za



## CONSENT

### Statement of Agreement to Participate in the Research Study:

- I hereby confirm that I have been informed by the researcher, \_\_\_\_\_ (name of researcher), about the nature, conduct, benefits and risks of this study - Research Ethics Clearance Number: \_\_\_\_\_,
- I have also received, read and understood the above written information (Participant Letter of Information) regarding the study.
- I am aware that the results of the study, including personal details regarding my sex, age, date of birth, initials and diagnosis will be anonymously processed into a study report.
- In view of the requirements of research, I agree that the data collected during this study can be processed in a computerised system by the researcher.
- I may, at any stage, without prejudice, withdraw my consent and participation in the study.
- I have had sufficient opportunity to ask questions and (of my own free will) declare myself prepared to participate in the study.
- I understand that significant new findings developed during the course of this research which may relate to my participation will be made available to me.

|  |             |             |                          |
|--|-------------|-------------|--------------------------|
| _____  | _____       | _____       | _____                    |
| <b>Full Name of Participant<br/>Thumbprint</b> | <b>Date</b> | <b>Time</b> | <b>Signature / Right</b> |

I, \_\_\_\_\_ (name of researcher) herewith confirm that the above participant has been fully informed about the nature, conduct and risks of the above study.

|  |             |                  |
|--|-------------|------------------|
| _____  | _____       | _____            |
| <b>Full Name of Researcher</b>                     | <b>Date</b> | <b>Signature</b> |
| _____  | _____       | _____            |
| <b>Full Name of Witness (If applicable)</b>        | <b>Date</b> | <b>Signature</b> |
| _____  | _____       | _____            |
| <b>Full Name of Legal Guardian (If applicable)</b> | <b>Date</b> | <b>Signature</b> |



**Please note the following:**

Research details must be provided in a clear, simple and culturally appropriate manner and prospective participants should be helped to arrive at an informed decision by use of appropriate language (grade 10 level

- use Flesch Reading Ease Scores on Microsoft Word), selecting of a non-threatening environment for interaction and the availability of peer counselling (Department of Health, 2004)

If the potential participant is unable to read/illiterate, then a right thumb print is required and an impartial witness, who is literate and knows the participant e.g. parent, sibling, friend, pastor, etc. should verify in writing, duly signed that informed verbal consent was obtained (Department of Health, 2004).

If anyone makes a mistake completing this document e.g. a wrong date or spelling mistake, a new document has to be completed. The incomplete original document has to be kept in the participant's file and not thrown away, and copies thereof must be issued to the participant.

## **References**

Department of Health: 2004. *Ethics in Health Research: Principles, Structures and Processes*

<http://www.doh.gov.za/docs/factsheets/guidelines/ethnics/>

Department of Health. 2006. *South African Good Clinical Practice Guidelines*. 2nd Ed. Available at: [http://www.nhrec.org.za/?page\\_id=14](http://www.nhrec.org.za/?page_id=14)

## Appendix D – Key informant interview guide



### **Key Informant Interview of Harjod Research: Demographic Questionnaire**

Please answer the following questions in the spaces provided tick the appropriate option.

1. Age:    ☐50-60    ☐60-70    ☐70-80    ☐80 and above

2. Gender: ☐ Male    ☐ Female

Thank you for taking the time to complete this questionnaire.

### **KEY INFORMANT INTERVIEW GUIDE**

**Welcome:** Good morning/day/afternoon thank you for allowing me to interview you. I do realise you are busy; hopefully I do not take up too much of your time. I really do appreciate your help.

**Introduction:** This interview is solely for the purpose of understanding your knowledge of Cissus Quadrangularis aka Harjod, how it is used, what it used for and how it is prepared and cooked. This interview will take up no more than one hour. This interview with your permission will be recorded for recollection purposes only.

**Anonymity:** Despite being taped; I would like to assure you that the discussion will be anonymous. The tapes will be kept safely in a locked facility until they are transcribed word for word, then they will be destroyed.

**Ground rules:**

**Do not be afraid to speak freely**

**There is no right or wrong answers**

**Feel free to take a break from the interview, if need be.**

**Guiding questions:**

What is Cissus Quadrangularis?

Do you know of any medicinal properties of Cissus Quadrangularis?

What do you use Cissus Quadrangularis for?

Do you know of any health benefits of Cissus Quadrangularis?

What are some methods (fry, simmer, add to curries) you have use to cook it?

Are there any recipes using Cissus Quadrangularis you are willing to share?

How do you prepare it?

Were there any side effects when you ate Cissus quadrangularis?

**Conclusion:**

Thank you for participating. Your knowledge and expertise will be a very valuable asset to my study.

{Stop recorder}

## Appendix E – 9-point Hedonic scale and paired preference test



### 9 Point Hedonic Scale (FAO. 2016)

|   |             |          |  |
|---|-------------|----------|--|
| Name:   |             | Product: |  |
| Panelist No.:   |             | Date:    |  |
| Instructions:<br>Taste the given samples, then place an x mark on the point in the scale which best describes your feeling. |             |          |  |
| SCORE*  | SAMPLE CODE |          |  |
| (9) Like extremely  |             |          |  |
| (8) Like very much  |             |          |  |
| (7) Like moderately   |             |          |  |
| (6) Like slightly   |             |          |  |
| (5) Neither like nor dislike  |             |          |  |
| (4) Dislike slightly  |             |          |  |
| (3) Dislike moderately  |             |          |  |
| (2) Dislike very much   |             |          |  |
| (1) Dislike extremely   |             |          |  |

### Paired Preference test

Which sample do you prefer?

Kindly use a tick to indicate which sample you prefer.

|                     |                     |
|---------------------|---------------------|
| <u>Sample code:</u> | <u>Sample code:</u> |
|                     |                     |

## Appendix F – Letter of information for sensory evaluation participants



### LETTER OF INFORMATION

#### **Title of the Research Study:**

Creating awareness of Cissus Quadrangularis using a sensory acceptable product developed for young adults.

#### **Principal Investigator/s/researcher:**

Vihara Singh (B-Tech Consumer Science: Food and Nutrition)

#### **Co-Investigator/s/supervisor/s:**

Dr Ashika Naicker (PhD: Nutrition)/ Co-supervisor: Ms Govender (Masters Consumer Science: Food and Nutrition)

#### **Brief Introduction and Purpose of the Study:**

The nature of this upcoming product development research study is to create awareness of Cissus Quadrangularis, also known as “Harjod”, and its benefits among young adults by developing a sensorially acceptable food product. The purpose of the study is to determine South African’s knowledge and use of Cissus Quadrangularis; and to determine sensory acceptability of the developed food product. The study will use a mixed methods approach, i.e. both quantitative and qualitative. The study will use methods such as, key informant interviews, a desktop study on food and nutrition trends, product development and sensory evaluation as well as to conduct nutrient, microbial and shelf life analysis will be conducted on the developed product, in addition to creating an awareness tool with Cissus Quadrangularis. The awareness tool developed will be able to educate young people on healthy food choices and practices that use local and fresh foods.

#### **Outline of the Procedures:**

This study uses non-invasive methods. Sensory analysis will be conducted. The study will be explained to you in detail before sensory analysis takes place. You will need to sign a consent form agreeing to take part in the study on a voluntarily basis. There will be two groups of sensory evaluation groups. If you are part of the pilot sensory evaluation group (Third year Food and Nutrition Students) you will be given the food product to taste after your lectures, this will take you no more than 30minutes to evaluate. If you are part of the final sensory evaluation group you will be expected to come to the department of Consumer Science: Food and nutrition, where the sensory evaluation will take place, this will take no more than 45minutes of your time. Once the you are done, you will receive a fruit as a gesture of gratitude.

**Risks or Discomforts to the Participant:** There will be no risk or discomfort made to the Participant.

**Benefits:****Intellectual property rights:**

The academic property rights will belong to the Durban University of Technology (DUT) where the publication will be kept and made available to the public.

**Relevance and outcomes:**

The outcome of this study can lead to an affordable, sensory acceptable and nutrient dense food product available to the market. The development of a food product with *Cissus Quadrangularis* will help South Africans receive its vast variety of benefits that aid in both under and over malnutrition as well as many other health issues.

**Scientific Outcomes:**

The submission of this study will result in a Master of Applied Science qualification in Food and Nutrition for the researcher. The results will be scientifically measured and published in publications and presented at conferences.

**Community capacity building:**

The community will be involved in sharing their knowledge on *Cissus Quadrangularis*. The results from this study will be shared with participants. A final copy will be given to DUT where it will be made available to the public.

An awareness tool will be developed in the form of a short video clip. Which aims to raise awareness on *Cissus Quadrangularis* and its benefits as well as to show easy steps on how to make the developed product. This will aid the public's knowledge on what *Cissus Quadrangularis* is and how it can be used.

**Capacity building:**

Food and Nutrition students will assist in gathering the information, which will contribute to the student's level of understanding in research and fieldwork. Food and Nutrition students will also assist in the pilot sensory evaluation. This will aid students' knowledge and experience in sensory evaluation and its procedures.

**Reason/s why the Participant May Be Withdrawn from the Study:** If the participant does not wish to comply to the procedures of the study, the researcher has full right to withdraw the participant. Should the participant have an adverse reaction to the study the researcher can withdraw the participant. Should the participant wish to withdraw from the study, there will be no adverse consequence to him/her.

**Remuneration:** The participant will not receive any remuneration. However, the participants will receive a fruit as a gesture of gratitude.

**Costs of the Study:** There will be no cost incurred to the participant.

**Confidentiality:** Raw data on paper will be stored in a locked cupboard at the Durban University of Technology: Department of Consumer Sciences: Food and Nutrition. This information will only be available to the researcher and supervisor and will be shredded after a retention period of 5 years. Electronic data that is collected will be password protected.

**Research-related Injury:** The study is of such, where there is no room for any possible injury.

**Persons to Contact in the Event of Any Problems or Queries:**

Please contact the researcher Vihara Singh ( 0782389341), my Supervisor Dr Ashika Naicker (0822009726) or the Institutional Research Ethics Administrator on 031 373 2375. Complaints can be reported to the Director: Research and Postgraduate Support, Prof S Moyo on 031 373 2577 or [moyos@dut.ac.za](mailto:moyos@dut.ac.za)

## Appendix G – Consent form for sensory evaluation participants



### CONSENT

#### Statement of Agreement to Participate in the Research Study:

- I hereby confirm that I have been informed by the researcher, \_\_\_\_\_ (name of researcher), about the nature, conduct, benefits and risks of this study - Research Ethics Clearance Number: \_\_\_\_\_,
- I have also received, read and understood the above written information (Participant Letter of Information) regarding the study.
- I am aware that the results of the study, including personal details regarding my sex, age, date of birth, initials and diagnosis will be anonymously processed into a study report.
- In view of the requirements of research, I agree that the data collected during this study can be processed in a computerised system by the researcher.
- I may, at any stage, without prejudice, withdraw my consent and participation in the study.
- I have had sufficient opportunity to ask questions and (of my own free will) declare myself prepared to participate in the study.
- I understand that significant new findings developed during the course of this research which may relate to my participation will be made available to me.

\_\_\_\_\_  
**Full Name of Participant  
Thumbprint**

\_\_\_\_\_  
**Date**

\_\_\_\_\_  
**Time**

\_\_\_\_\_  
**Signature / Right**

I, \_\_\_\_\_ (name of researcher) herewith confirm that the above participant has been fully informed about the nature, conduct and risks of the above study.

\_\_\_\_\_  
**Full Name of Researcher**

\_\_\_\_\_  
**Date**

\_\_\_\_\_  
**Signature**

\_\_\_\_\_  
**Full Name of Witness (If applicable)**

\_\_\_\_\_  
**Date**

\_\_\_\_\_  
**Signature**



\_\_\_\_\_  
**Full Name of Legal Guardian (If applicable) Date**

\_\_\_\_\_  
**Signature**

**Please note the following:**

Research details must be provided in a clear, simple and culturally appropriate manner and prospective participants should be helped to arrive at an informed decision by use of appropriate language (grade 10 level

- use Flesch Reading Ease Scores on Microsoft Word), selecting of a non-threatening environment for interaction and the availability of peer counselling (Department of Health, 2004)

If the potential participant is unable to read/illiterate, then a right thumb print is required and an impartial witness, who is literate and knows the participant e.g. parent, sibling, friend, pastor, etc. should verify in writing, duly signed that informed verbal consent was obtained (Department of Health, 2004).

If anyone makes a mistake completing this document e.g. a wrong date or spelling mistake, a new document has to be completed. The incomplete original document has to be kept in the participant's file and not thrown away, and copies thereof must be issued to the participant.

## **References**

Department of Health: 2004. *Ethics in Health Research: Principles, Structures and Processes*

<http://www.doh.gov.za/docs/factsheets/guidelines/ethnics/>

Department of Health. 2006. *South African Good Clinical Practice Guidelines*. 2nd Ed. Available at: [http://www.nhrec.org.za/?page\\_id=14](http://www.nhrec.org.za/?page_id=14)



### **Cissus quadrangularis**

Cissus quadrangularis is an indigenous plant in South Africa.

Cissus quadrangularis is said to assist with many health and nutrition issues such as:

- Bone healing
- Inflammation
- Arthritis
- Ulcers
- Lowering Cholesterol levels
- Aiding in weight loss
- Reduce swelling

Cissus quadrangularis can be found in the vast South African veld, in many plant nurseries and the plant powders can be found online.



### **Cissus quadrangularis infused energy bite.**

#### **Ingredients:**

10g Sunflower seeds (1Tbsp)  
10g Pumpkin seeds (1Tbsp)  
30g Almonds (20 Almonds)  
35g Oats (1/3Cup)  
4g Cissus quadrangularis powder (1tsp)  
50g Dried cranberries (0.4 Cup)  
20g Chickpeas (1/4Cup)  
60g whole dates (1/2Cup)

#### **Method:**

1 Blend sunflower seeds, Pumpkin seeds, almonds and oats.  
2 Mix Cissus quadrangularis powder to the blended mixture.  
3 Blend Cranberries, Chickpeas and dates until fine.  
4 Mix the two mixtures together and roll into balls.  
5 Enjoy!



### **Cissus quadrangularis infused juice.**

Fresh fruit and vegetables are important for a healthy diet. They contain minerals and vitamins that are essential for good health.

#### **Ingredients:**

200g Green Apple (1.7Cup)  
5g Ginger (1tsp)  
5g Cissus quadrangularis (1tsp)  
(Washed and peeled)  
150ml Water (2/3Cup)  
10ml Lemon Juice (1Tbsp)

#### **Method:**

1 Blend the Green apple, ginger, Cissus quadrangularis stem with the water until fine.  
2 Once blended add the mixture to a sieve and squeeze out all the juice.  
3 Add the lemon juice and mix.  
4 Enjoy!

## Appendix I - Pilot awareness tool survey



### To develop an awareness tool for *Cissus quadrangularis* using the developed food product.

Dear participant, by participating in this survey you will be volunteering to contribute to a research study on *Cissus Quadrangularis*. *Cissus quadrangularis* is an indigenous plant in South Africa that has many health benefits. *Cissus quadrangularis* grows largely over South Africa, however, it is not widely known about. *Cissus quadrangularis* is said to be high in many Vitamins and minerals such as Vitamin C, Vitamin A as well as Potassium, Iron and Zinc.

We developed two food products using *Cissus quadrangularis* along with a recipe awareness tool aimed to create awareness of *Cissus quadrangularis* amongst young adults. We would like to evaluate the effectiveness of this tool through this survey.

Your participation in this survey is voluntary. Your answers will be used anonymously and will not be shared. The survey will take you 5 minutes to complete.

Thank you for your time and assistance.

...

---

### 1. Consent \*

☐ I provide informed consent and agree to participate. ( Thank you, please respond to the below question by clicking your preferred answers) Clicking on this radio button indicates that: you have read the above information, you voluntarily agree to participate and that you fall into the 18-25 age group..

☐ I do not provide consent and therefore, do not agree to participate. ( Thank you for your time)

### 2. Race \*

☐ Black

☐ Indian

☐ White

☐ Coloured

### 3. Gender \*

☐ Female

☐ Male

### 4. Age group \*

☐ 18-20

☐ 20-22

☐ 22-25

### 5. Was this video informative? \*

☐ Yes

☐ No

6. Were the recipes easy to follow? \*

☐ Yes

☐ No

7. Will you make the recipes from this video? \*

☐ Yes

☐ No

8. If you chose no, Kindly explain why.

Enter your answer

9. On a scale from 1-10, how much did you enjoy the video. \*

|   |   |   |   |   |   |   |   |   |   |    |
|---|---|---|---|---|---|---|---|---|---|----|
| 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|----|

Not at all

Extremely

10. Did you know about Cissus quadrangularis before watching this video? \*

☐ Yes

☐ No

11. Please leave a comment on how effective this awareness tool was and how it can be improved.

Thank you. \*

Enter your answer

12. Were the questions in this survey easy to answer? \*

☐ Yes

☐ No

13. If you chose no, kindly explain how it can be improved

Enter your answer

14. Did you experience any technical difficulties/ glitches in answering the questions other than connectivity issues? \*

☐ Yes

☐ No

15. If you did, Kindly expand on the issues you experienced.

Enter your answer

## Appendix J – Final awareness tool survey



### To develop an awareness tool for *Cissus quadrangularis* using the developed food product.

Dear participant, by participating in this survey you will be volunteering to contribute to a research study on *Cissus Quadrangularis*. *Cissus quadrangularis* is an indigenous plant in South Africa that has many health benefits. *Cissus quadrangularis* grows largely over South Africa, however, it is not widely known about. *Cissus quadrangularis* is a strong green stem, that is 3cm in diameter and has joints and nodes. The plant has tender leaves and flowers that grow from its nodes.

*Cissus quadrangularis* is said to be high in many Vitamins and minerals such as Vitamin C, Vitamin A as well as Potassium, Iron and Zinc.

We developed two food products using *Cissus quadrangularis* along with a recipe awareness tool aimed to create awareness of *Cissus quadrangularis* amongst young adults. We would like to evaluate the effectiveness of this tool through this survey.

Your participation in this survey is voluntary. Your answers will be used anonymously and will not be shared. The survey will take you 5 minutes to complete.

Thank you for your time and assistance.

...



### 1. Consent \*

☐ I provide informed consent and agree to participate. (Thank you, please respond to the below question by clicking your preferred answers) Clicking on this radio button indicates that: you have read the above information, you voluntarily agree to participate and that you fall into the 18-25 age group.

☐ I do not provide consent and therefore, do not agree to participate. (Thank you for your time)

### 4. Age Group \*

☐ 18-20

☐ 20-22

☐ 22-25

### 5. Was this video informative? \*

☐ Yes

☐ No

### 2. Race \*

☐ Black

☐ Indian

☐ White

☐ Coloured

☐ Asian

### 6. Will you make the recipes from this video? \*

☐ Yes

☐ No

### 3. Gender \*

☐ Female

☐ Male

### 7. If no, Kindly explain why?

Enter your answer

### 8. On a Scale from 1- 5 how much did you enjoy this video?

1- Not at all

2- I Slightly enjoyed the video

3- Neutral

4- I liked the video

5- I extremely enjoyed the video \*

1

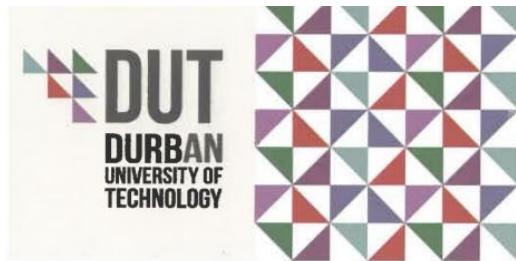
2

3

4

5

## Appendix K - IREC approval letter



Institutional Research Ethics Committee  
Research and Postgraduate Support Directorate  
2<sup>nd</sup> Floor, Berwyn Court  
Gate 1, Steve Biko Campus  
Durban University of Technology

P O Box 1334, Durban, South Africa, 4001

Tel: 031 373 2375  
Email: [lavishad@dut.ac.za](mailto:lavishad@dut.ac.za)  
[http://www.dut.ac.za/research/institutional\\_research\\_ethics](http://www.dut.ac.za/research/institutional_research_ethics)

[www.dut.ac.za](http://www.dut.ac.za)

25 July 2019

Ms V Singh  
87 Bayswater Road  
Bellair

Dear Ms Singh

**Sensory acceptable product development of *Cissus quadrangularis* to create awareness among young adults**

**Ethical Clearance number: IREC 076/19**

The Institutional Research Ethics Committee acknowledges receipt of your gatekeeper permission letter.

Please note that FULL APPROVAL is granted to your research proposal. You may proceed with data collection.

Any adverse events [serious or minor] which occur in connection with this study and/or which may alter its ethical consideration must be reported to the IREC according to the IREC Standard Operating Procedures (SOP's).

Please note that any deviations from the approved proposal require the approval of the IREC as outlined in the IREC SOP's.

Yours Sincerely

Professor J K Adam  
Chairperson: IREC

