DEVELOPMENT AND CONSUMER ACCEPTABILITY OF A POTATO-BASED VEGETABLE CHIP FOR PRE-SCHOOLERS IN SOUTH AFRICA

By

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Submitted in fulfillment of the

requirements for the degree of

MASTER OF SCIENCE

In the Department of Consumer Science

Faculty of Natural and Agricultural Sciences

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DECLARATION

I, *PETRO ZONDAGH SWART*, declare that the Masters Degree dissertation or interrelated, publishable manuscripts / published articles that I herewith submit for the Masters Degree qualification in *Consumer Science* at the University of the Free State is my independent work, and that I have not previously submitted it for a qualification at another institution of higher education.

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22-Nov-2016

Dear **Mrs Petro Swart**

Ethics Clearance: **Development of sensory acceptable vegetable chips for children**

Principal Investigator: **Mrs Petro Swart**

Department: **Consumer Science (Bloemfontein Campus)**

APPLICATION APPROVED

This letter confirms that a research proposal with tracking number: **UFS-HSD2016/0077** and title: **'Development of sensory acceptable vegetable chips for children'** was given ethical clearance by the Ethics Committee.

Your ethical clearance number, to be used in all correspondence is: **UFS-HSD2016/0077**

Please ensure that the Ethics Committee is notified should any substantive change(s) be made, for whatever reason, during the research process. This includes changes in investigators. Please also ensure that a brief report is submitted to the Ethics Committee on completion of the research.
The purpose of this report is to indicate whether or not the research was conducted successfully, if any aspects could not be completed, or if any problems arose that the Ethics Committee should be aware of.

Note:

1. This clearance is valid from the date on this letter to the time of completion of data collection.
2. Progress reports should be submitted annually unless otherwise specified.

Yours Sincerely

Prof. RR (Robert) Bragg
Chairperson: Ethics Committee
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GLOSSERY OF ABBREVIATIONS

AAFP	American Academy of Family Physicians
AHA	American Heart Association
ANOVA	Analysis of variance
AOAC	Association of Official Agricultural Chemists
ASM	Analytical Standard Method
BHA	Butylated hydroxyanisole
BHT	Butylated hydroxytoluene
BMI	Body mass index
Ca	Calcium
cal	Calories
Cl	Chloride
Co	Cobalt
CQHR	Comparative quantification of health risk
Cu	Copper
DALY’s	Disability adjusted life years
DM	Dry matter
DRI’s	Daily recommended intakes
EDTA	Ethylene diamine tetra acetic acid
F	Fluoride
FAOSTAT	Food and Agricultural Organization Statistics
FBS	Food balance sheets
FDA	Food and Drug Administration
Fe	Iron
FSA	Food Standard Agency
HIV	Human immunodeficiency virus
HPLC	High performance liquid chromatography
I	Iodine
K	Potassium
kJ	Kilo Joules
M	Mean

MC	Mineral concentration
ME	Metabolisable energy
Mg	Magnesium
Mn	Manganese
Na	Sodium
NCD’s	Non-communicable diseases
NCSS	Number Cruncher Statistical System
NFCS	National Food Consumption Survey
NFCS-FB	National Food Consumption Survey Fortification Baseline
NHMR’s	National Health and Medical Research
NICUS	National Information Centre of the University of Stellenbosch
NIH	National Institutes of Health
NSA	Not statistically analyzed
NUMRC	National Health and Medical Research Centre
P	Phosphorus
PFBC	Packed food and beverage consumption
PROP	Propyl thiouracil
PTC	Phenylthiocarbamide
RDA	Recommended daily allowance
S	Sulfur
SA	South Africa
SAM	Severe acute malnutrition
SANHANES	South African National Health And Nutrition Examination Survey
SD	Standard deviation
Se	Selenium
UNSCN	United Nations Standing Committee on Nutrition
UK	United Kingdom
USDA	United States Department of Agriculture
WHO	World Health Organization
WHR	World Health Report
XDR	Extensive drug resistant tuberculosis
Zn	Zinc

CHAPTER 1

INTRODUCTION

Knowledge of nutrition and health has increased substantially during resent times. The human body needs different nutrients, about 40, to stay healthy. Some nutrients are macro-nutrients, like carbohydrates, fats and proteins, and are required in larger quantities. Other nutrients are needed in small quantities and are known as micro-nutrients, like vitamins, minerals and trace elements (Love & Sayed, 2001; Faber & Wenhold, 2007; Von Grebmer *et al.*, 2014).

Every person has different energy needs, e.g., active people need more energy, which they get from their food intake. Less active people use less energy and should eat less food. Women and children need less energy than men do, while men usually need more energy and adults need more energy than children do. Thus, nutrient requirements differ with stage of development, as well as age (Labadarios *et al.*, 2001).

The incidence of chronic diet-related diseases in the population is rising, despite greater understanding of nutritional requirements and the nutrition provided by food. Examples of these diseases include diabetes, certain forms of cancer and heart disease. These illnesses are becoming the main source of ill health and account for a significant part of public health expenditure (Nicklas *et al.*, 2001; Lock *et al.*, 2005; Wang & Lobstein, 2006).

Insufficient quantity or quality of food was the main reason for diet-related ill health during the past generations. Ironically, the diet-related health scene is dominated by a rise in the incidence of obesity (Puoane *et al.*, 2002).

Obesity can be prevented, but is one of the leading causes of death worldwide. The incidence is increasing in adults and children. Obesity is a pathological condition in which excess body fat accumulates in the body and starts exerting adverse effects on the body, leading to reduced life expectancy. Obesity can be blamed on the adverse effect of modern lifestyle and changing food habits (Alam *et al.*, 2014).

People has faced big shifts in physical activity, dietary patterns and body composition, since Palaeolithic man emerged on Earth. The concept of the nutritional transition focuses on large shifts in diets (reductions in whole grain and fibre intake, increases in refined carbohydrate intake like sugars, and an increase in animal and partially hydrogenated fats) and more inactive physical patterns. These changes can be seen in nutritional outcomes, like changes in stature and body composition. The major changes in health status are paralleled by dietary and activity changes, as well as by demographic and socioeconomic changes, due to urbanisation (Popkin, 2006).

The image of families sitting around a proper laid table tucking into healthy meals, consisting of home-made slow-cooked food from the vegetable garden, has become a thing of the past, as a result of changing lifestyles, urbanisation and the disappearing traditional housewife. Meals have become more informal, more individual and less predictable, because of less time spend at home. A demand for whole new ranges of convenience foods are generated by the fact that more women work full time, the demands on time for work and other activities, as well as increasing numbers of single-person households (Popkin, 2006).

Other factors that also should be considered is economic and social issues. In the last 20-30 years, the cost of fruit and vegetables has increased dramatically. A few years ago, poorer people benefited from a healthy diet, mainly based on cheaper vegetables. Today, poorer people can only afford to purchase a few vegetables (Temple & Steyn, 2011; Ronquest-Ross *et al.*, 2015).

It is impossible for a single food source to supply all the essential nutrients. One needs a broad range of nutrients for a balanced diet and, because of the immense diversity in the composition of foods, one of the fundamental principles of healthy eating is variety, i.e. the need to consume a broad range of foods on a regular basis (Ronquest-Ross *et al.*, 2015).

Food choices, i.e. the type of food that are consumed, are influenced by factors, such as season, geography, demography, education, disposable income, globalisation, urbanisation, religion, culture, social networks, ethnicity, time and the consumer (Kearney, 2010). South African women do most of the household grocery shopping.

For them, the most important consideration when choosing a food item, is the price. Taste and health, in this order, are considered after price. Healthier diets cost 69% more than the typical South African diet. A healthy diet is, thus, largely unaffordable for most South Africans (Temple *et al.*, 2011). Therefore, it is becoming a reality that children in South Africa (SA) (and worldwide) need to eat more and a wider variety of vegetables on a daily basis.

The first aim of this study was to determine the parents'/caretaker's knowledge and attitude towards vegetables, and how conscious they are about their health, portion sizes, food safety and food security.

> <u>The following hypothesis was formulated</u>:
>
> Parents'/caretakers' knowledge and attitudes of vegetables differ from different demographic backgrounds, as well as culture. According to Story *et al.* (2002) and Taylor *et al.* (2005), children eat what their parents eat and if the parents'/caretakers' diets are nutritiously sound, then the children will benefit from that. A hypothesis for knowledge and attitude, consciousness of health and food security would, thus, be that despite cultural differences and level of education and even income, people would be knowledgeable about nutritious foods, as delivered to them from previous generations.

The second aim was to develop a sensory acceptable potato-based vegetable chip for children, between four and six years, to enhance the vegetable intake amongst this group.

> <u>The following hypothesis was formulated:</u>
>
> Children like chips more than vegetables. There is an increasing demand for healthier and nutritious food, and this contributes to a continuous need for healthy products by consumers (Zink, 1997; Deliza *et al.*, 2003; Allende *et al.*, 2006). The hypothesis for developing such is product would, thus, be that the children will still eat a potato chip, but filled with the healthy nutrients of selected vegetables, thereby increasing their intake of vegetables.

The third aim was to compare the nutritional content of potato-based vegetable chips, using three different cooking methods, namely baking, deep frying and air frying.

<u>The following hypothesis was formulated:</u>

Vegetables should rather be eaten raw, but cooking improves the palatability, flavour and texture of vegetables. Over-processing should be guarded against, as it destroys vitamin C (Bennion & Scheule, 2004). A hypothesis for nutritional quality would, thus, be that different cooking methods (baking, deep frying and air frying) would have different effects on the nutritional value of vegetable chips.

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CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

A well-balanced diet is imperative for a healthy lifestyle. Children's fruit and vegetable consumption, however, is below recommended level, in spite of the health benefits that it offers (Miller *et al*., 2011). The Food Standard Agency (FSA) lists fresh vegetables, fruit, whole grain foods and lean protein, along with low or non-fat dairy products, as constituents of a healthy diet. Parallel with, and supportive to a healthy diet, are food choices that are limited in sugar, sodium (Na), fat and cholesterol (Schuna, 2014).

Modern society is well aware and exhaustively informed about fruits' and vegetables' vitality to sustain good health (Love & Sayed, 2001). From so many different perspectives, the nature of vegetable and the nature of human health are matched up. Other food groups, including fruits, legumes, nuts and seeds, grains, seafood or poultry and meats, cannot duplicate it. Vegetables as a group are low in kilojoules (kJ). The world's healthiest vegetables average 50 kJ per 250 ml. Despite this universal awareness, most studies have reported that children from all backgrounds and across the globe consume less fruits and vegetables than necessary to sustain good health (Love & Sayed, 2001; Ramsay *et al*., 2014).

In a study by Ramsay *et al.* (2014), researchers found that children consumed three times as many fruit servings as vegetable servings, regardless of age, gender, body mass index (BMI), ethnicity and poverty index ratio. The most frequently consumed, and in the greatest amounts, were potato products and fruit juice. They further indicated that a variety of fruit and vegetables for children's diets should be promoted.

Vegetables play a vital role in the prevention of certain cancers, coronary heart disease, high blood pressure, osteoporosis and diabetes. The World Health Report (WHR) (2000) states that in 2000, 26.662 million disability adjusted life years (DALY's) and 2.726 million deaths were attributed to inadequate vegetable consumption worldwide.

Insufficient vegetable consumption is further credited for being responsible for 14.0% gastrointestinal cancer deaths, 11.0% ischemic heart disease deaths and 9.0% stroke deaths globally (Lock *et al.*, 2005; WHO, 2005). It is further estimated that 32.0% of the global burden of disease would be removed by eliminating malnutrition, including micronutrient deficiency (WHO, 2004 b).

2.2 GLOBAL STATISTICS ON VEGETABLE CONSUMPTION

Both developed and developing countries, although for varying reasons, face the burden of under-consumption of vegetables, resulting in malnutrition. This is an abnormal physiological condition, typically due to eating the wrong amount and/or kinds of foods (Von Grebmer *et al.*, 2014). Every country has its own set of standards for daily recommended intakes (DRI's) of vegetables, but most are in line with the World Health Organization's (WHO's) global recommendations of 400g / five portions of fruits and vegetables daily. The "5-a-day" principle states that every individual should consume five servings of fruits and vegetables each day, every serving being equal to 80g (Lock *et al.*, 2005; Naudé, 2007).

The WHO's comparative quantification of health risk (CQHR), conducted in 2004, set specific DRI standards, which identify the amount of fruits and vegetables required for the theoretical-minimum-risk distribution of developing cardiovascular disease, ischemic heart disease and ischemic stroke (Naudé, 2007). These standards exclude the consumption of potatoes and other starchy tubers, and are set at 600g of fruit and vegetables daily for adults, 480g for children aged five to 14 years and 330g for children aged zero to four years (Table 2.1) (Naudé, 2007).

Table 2.1: World Health Organisation DRI's for vegetables and fruit for theoretical minimum risk distribution according to various age groups (Naudé, 2007)

Age group (years)	g/day
0 – 4	330
5 – 14	480
15 +	600

The Comparative Quantification study also estimated the regional mean intake of fruit and vegetables of various regions and countries, according to age groups. Europe A, including Belgium, Denmark, Finland, France, Germany, Ireland, Israel, Italy, Norway and the United Kingdom (UK), recorded the highest mean intakes, with children, aged zero to 14 years, consuming a daily average of 266g fruit and vegetables, and adults, aged 15 to 79 years, consuming a daily average of 470g fruit and vegetables (Table 2.2) (Lock *et al.*, 2005).

The second highest recording was for the Western Pacific A region, including Australia, Japan, Singapore and New Zealand, where children, aged zero to 14 years, consume slightly more fruit and vegetables than Europe A, at a daily average of 296g, while adults, aged 15 to 79 years, consumed a daily average of 427g fruit and vegetables. While these statistics were sufficient, they did not meet the WHO DRI's for theoretical-minimum-risk distribution and, therefore, did not contribute to the prevention of the serious diseases mentioned earlier (Table 2.2) (Lock *et al.*, 2005).

The counties identified as the lowest consumers of fruits and vegetables were America B, Europe C, South East Asia regions B and D, and Africa E. All these regions consumed half or barely more than half the recommended intake of fruit and vegetables, for varying age groups, as established by the WHO (Table 2.2) (Lock *et al.*, 2005).

Despite society's knowledge and well-informed state of the vital and beneficial role of especially vegetables to a healthy diet and a quality life, intake levels are strikingly low in large parts of the world. Although selective regions consume sufficient amounts of fruit and vegetables to sustain good health, none consumed the amounts recommended by the WHO for the theoretical-minimum-risk distribution of an array of life threatening diseases. These low consumption statistics indicate a society plagued by poor socio-economic status, reduced productivity, malnutrition and an increased risk of developing chronic disease, signifying the need for more effective intervention programs on a global, national and provincial scale (Lock *et al.*, 2005).

Table 2.2 Estimated regional mean intake of fruit and vegetables (Lock *et al.*, 2005)

Regions	Mean Daily Intakes in g		Mean Daily Intakes in g	
	0-4 years	5-14 years	0-14 years	15-79 years
Africa D	142	288	215	366
Africa E	93	187	140	257
America B	77	140	108.5	201
America D	193	346	269.5	338
Eastern Mediterranean B	218	331	275.5	353
Eastern Mediterranean D	174	338	256	377
Europe A	233	299	266	470
Europe B	251	373	312	364
Europe C	201	190	195.5	221
South East Asia B	108	191	149.5	223
South East Asia D	95	174	134.5	243
Western Pacific A	248	344	296	427
Western Pacific B	197	272	234.5	326

Africa D - Algeria, Angola, Benin, Burkina Faso, Cameroon, Cape Verde, Chad, Comoros, Equatorial Guinea, Gabon, Gambia, Ghana, Guinea, Guinea Bissau, Liberia, Madagascar, Mali, Mauritania, Mauritius, Niger, Nigeria, Sao Tome and Principe, Senegal, Seychelles, Sierra Leone, Togo **Africa E** - Botswana, Burundi, Central African Republic, Congo, Côte d'Ivoire, Democratic Republic of the Congo, Eritrea, Ethiopia, Kenya, Lesotho, Malawi, Mozambique, Namibia, Rwanda, South Africa, Swaziland, Uganda, United Republic of Tanzania, Zambia, Zimbabwe **America B** - Antigua and Barbuda, Argentina, Bahamas, Barbados, Belize, Brazil, Chile, Colombia, Costa Rica, Dominica, Dominican Republic, El Salvador, Grenada, Guyana, Honduras, Jamaica, Mexico, Panama, Paraguay, Saint Kitts and **America D** - Bolivia, Ecuador, Guatemala, Haiti, Nicaragua, Peru **Eastern Mediterranean B -** Bahrain, Cyprus, Iran (Islamic Republic of), Jordan, Kuwait, Lebanon, Libyan Arab Jamahiriya, Oman, Qatar, Saudi Arabia, Syrian Arab Republic, Tunisia, United Arab Emirates **Eastern Mediterranean D -** Afghanistan, Djibouti, Egypt, Iraq, Morocco, Pakistan, Somalia, Sudan, Yemen **Europe A** - Belgium, Denmark, Finland, France, Germany, Ireland, Israel, Italy, Norway, UK **Europe B** - Albania, Armenia, Azerbaijan, Bosnia and Herzegovina, Bulgaria, Georgia, Kyrgyzstan, Poland, Romania, Serbia and Montenegro, Slovakia, Tajikistan, The former Yugoslav Republic of Macedonia, Turkey, Turkmenistan, Uzbekistan **Europe C** - Belarus, Estonia, Hungary, Kazakhstan, Latvia, Lithuania, Republic of Moldova, Russian Federation, Ukraine **South East Asia B** - Indonesia, Sri Lanka, Thailand **South East Asia D** - Bangladesh, Bhutan, Democratic People's Republic of Korea, India, Maldives, Myanmar, Nepal WPR A Australia, Brunei Darussalam, Japan **Western Pacific A** - Australia, Japan, Singapore, New Zealand **Western Pacific B** - Cambodia, China, Cook Islands, Fiji, Kiribati, Lao People's Democratic Republic, Malaysia, Marshall Islands, Micronesia (Federated States of), Mongolia, Nauru, Niue, Palau, Papua New Guinea, Philippines, Republic of Korea, Samoa, Solomon Islands, Tonga, Tuvalu, Vanuatu, Viet Nam

2.2.1 A global epidemic

Malnutrition of children, because of insufficient fruit and vegetable consumption, is seen in counties worldwide. Economically developed countries face low fruit and vegetable consumption by children, resulting in the increasing occurrence of obesity, due to poor food choices, which over-shadow sufficient intake of fruits and vegetables (Nicklas *et al.*, 2001; Lock *et al.*, 2005; Wang & Lobstein, 2006). Increased consumption of fruit and vegetables have shown to decrease short-term energy intake in children. This also helps reduce body weight in obese and overweight children. Miller *et al.* (2011) found that obese and overweight children consumed on average three fewer servings of fruit and vegetables per day.

According to Nicklas *et al.* (2001), 97.0% of American children over the age of two years, consumed less than three of the five recommended portions of fruit and vegetables daily. Guenther *et al*. (2006), who reported that less than 15.0% of American children between the ages of four and eight consumed the recommended intake level of fruit and vegetables, support these findings. It has also been reported that Australian children consumed less than the DRI's of five portions of fruits and vegetables daily, with only 34.7% of children, aged four to 12 years, meeting the National Health and Medical Research Council's (NHMRC's) targets for fruit and vegetable intake (Victoria State Government: Department of Education and Early Childhood Development, 2010). These low consumptions statuses are replaced by an increasing struggle with obesity amongst Australian children, which has tripled between 1985 and 1997 for children between the ages of seven and 15 years (Booth *et al*., 2003; Lock *et al*., 2005; Timperio *et al*., 2007). Dutch children are also reported facing under-consumption, with children aged four to 12 years consuming on average only 71g of fruit and vegetables daily (Reinaerts *et al*., 2007). This very same trend is observed in children from the UK. Blissett (2011) reported that only 21.0% of children in the UK consumed the recommended five portions of fruit and vegetables daily.

In developing countries, low fruit and vegetable consumption is a common result of a lack of availability and accessibility, along with economic challenges (Love & Sayed, 2001; Naudé, 2007). In 2004, the WHO's CQHR quantified the fruit and vegetable consumption of children in various sub-regions globally. It was determined that children from the Africa E sub-region (including SA), within the age range of zero to

14 years, all consumed far less fruit and vegetables than recommended for optimal health and development. The rest of Africa A, as well as America B, South East Asia D and Europe C's children were rated as very low consumers, consuming barely half of the daily recommendations (WHO, 2004 a).

2.3 SOUTH AFRICAN STATISTICS

South Africa is listed as a low consumption country, rating amongst the lowest consumers of fruit and vegetables globally (WHO, 2004 b). This report is supported by several studies, which have identified South African consumers as eating well below the recommended averages of fruit, and especially vegetables, daily (Love & Sayed, 2001; Lock *et al.*, 2005; Naudé, 2007; Naudé, 2013).

Naudé (2007) determined that South Africans consume more fruit than suggested, but consume less than the suggested amount in vegetables. The National Food Consumption Survey (NFCS) conducted in 1999 reported that South African children (one to six years) consume on average only 193g of fruit and vegetables daily, 212g less than the WHO's DRI's for theoretical minimum-risk distribution and 207g less than normal standard (Table 2.3) (Labadarios *et al.*, 2001). The WHO (2004 a) reported slightly higher daily intake levels of about 257g of fruit and vegetables by South Africans, amounts which are still well below recommendation.

Table 2.3 Estimated fruit and vegetable intake of South Africans according to age group (Labadarios *et al.*,2001; WHO, 2015)

Age group	g/day	DRI in g/day
1 – 3	180.2	330.0g
4 – 6	206.2	480.0g
7 – 9	273.0	480.0g
15 +	226.0 – 235.0	600.0g

2.3.1 Problems in SA

More than 18.5 million children and young people call SA home. Due to the growing gap between urban and rural life, some children face under-nutrition and stunting, while others face over-nutrition and obesity, both associated with poor micronutrient intake. Stunting, predominantly found in poverty stricken rural areas, is a condition brought on by long-term under-nutrition, which results in children being short for their age. Occurrences of stunting are higher in boys than girls, with 23.0% of boys in rural areas being stunted. Urban life, providing higher income and easy access to fast-food chains and restaurants, results in children facing over-nutrition and obesity, due to higher intake levels of fat and sugars, and lower levels of micronutrients in the urban diet (Discovery, 2014).

The patterns of food consumption in SA have changed dramatically over the past decades and will likely continue to change in future. Food consumption has shifted toward a more Western-orientated diet. According to Ronquest-Ross *et al.* (2015), the nutritional consequences contribute to increased obesity and other non-communicable diseases.

Food availability, accessibility and choice affect food consumption. Factors, such as geography, season, education, demography, disposable income, government and other support services, urbanisation, globalisation, marketing, religion, culture, ethnicity, social networks, time and the consumer, influence food intake choices. In 1994, there were many changes in SA. These dramatic changes affected food consumption patterns and will continue to do so, because of shifts in food availability, choices and accessibility (Ronquest-Ross *et al*., 2015).

Since 1994, for example, there was a significant growth of supermarkets, which accounted for almost 50.0-60.0% of retail sales. Rising urbanisation and growing per capita income doubled the demand for food, such as meat, dairy, fresh fruit and vegetables, as well as packaged, prepared and processed foods. The total food expenditure on maize and wheat flour has declined, while the expenditure increased for fruit, vegetables and processed food (Ronquest-Ross *et al.*, 2015).

South African women do most of the grocery shopping. For them, the most important consideration when shopping for a food item is the price. In decreasing order, factors like taste, health, nutrient content, safety, hygiene and ease of preparation are considered after price (Ronquest-Ross *et al.*, 2015). Temple and Steyn (2011) stated that a healthier diet is largely unaffordable for most South Africans and can cost almost 69.0% more than a typical South African diet.

The most commonly consumed food items of children, aged one to nine years old, were maize, sugar, tea, whole milk and brown bread. According to information from the largest national food consumption survey conducted in SA in 1999, the intake of energy, calcium (Ca), iron (Fe), zinc (Zn), selenium (Se), vitamins A, D, C and E, riboflavin, niacin, vitamin B6 and folic acid were two thirds lower than the recommended daily allowances (RDA) for children (Steyn *et al.*, 2001). In the one to five year group, maize porridge, sugar, tea, full-cream milk and white bread were eaten most (Steyn *et al.*, 2003). The cut-off level for the national diversity dietary score is 4.0. Recently, the South African National Health and Nutrition Examination Survey (SANHANES-1) study indicated a national dietary diversity score of 4.2 (Shisana *et al.*, 2013).

The consumption of fruit and vegetables plays a vital role in providing a micronutrient dense diet. The South African Food Based Dietary Guidelines recommend eating plenty, as well as a wide variety, of fruit and vegetables every day. Dry beans, peas, lentils and soya should be eaten regularly. In SA, 25.6% people eat only two or fewer portions per day (Ronquest-Ross *et al.*, 2015), in contrast to the WHO's recommended intake of 400g/five portions of fruit and vegetables daily (Lock *et al.*, 2005). Most fruit and vegetables were consumed by people in formal urban areas, suggesting that cost and availability may be the reason for the low intake. South Africans show an increase of about 6.0% in fruit consumption since 1994, due to a rise in the consumption of mainly bananas, apples and grapefruits. In their research on consumption of street food, Steyn *et al.* (2011) found that fruit was the most commonly purchased item. Unfortunately, there was a decrease in vegetable consumption, with tomato and onion consumption, as well as consumption of starchy roots (mainly potatoes) increasing moderately. There was a slight decrease in sweet potato consumption (Table 2.4). The consumption of peas and other pulses was declining, while the consumption of beans increased with 16% (Ronquest-Ross *et al.*, 2015).

Table 2.4 Comparison of total vegetable, fruit, starchy root, pulses and tree nut consumption in SA, assessed by FAOSTAT food balance sheets (FBS) and Euromonitor Packaged Food and Beverage Consumption (PFBC) (Ronquest-Ross *et al.*, 2015)

FOOD ITEM	FAOSTAT FBBS (kg/capita/year)				
	1994	1999	2004	2009	% change (1994-2009)
Total vegetables	**43.1**	**44.4**	**42.4**	**42.9**	**-0.5**
Tomatoes	8.7	9.0	9.3	10.4	19.5
Onions	5.4	7.5	7.0	7.9	46.3
Vegetables, other	29.1	27.9	26.2	24.6	-15.5
Total fruits	**32.8**	**41.3**	**38.4**	**34.8**	**6.1**
Grapefruit	0.8	1.4	2.1	3.7	362.5
Bananas	2.9	7.0	5.4	7.1	144.8
Apples	4.8	3.6	5.7	6.8	41.7
Fruits, other	6.7	8.7	9.8	5.8	-13.4
Total starchy roots	**26.1**	**29.9**	**30.8**	**30.6**	**17.2**
Potatoes	24.8	28.9	29.8	29.5	19.0
Sweet potatoes	1.4	1.0	1.0	1.1	-21.4
Total pulses	**3.3**	**3.0**	**3.2**	**3.6**	**9.1**
Beans	2.5	2.5	2.5	2.9	16.0
Peas	0.5	0.3	0.4	0.4	-20.0

The 1999 National Food Consumption Survey (NFCS) of SA reported that both the consumption and the frequency of fruit and vegetables intake by children were poor, with intake levels well below WHO guidelines on both national and provincial scale, and across the age range of one to nine year olds (NICUS, 2010). The survey determined that, in general, one out of every two children consumed less than half of the recommended amount of several important micro-nutrients, all of which can be obtained by consuming sufficient amounts of fruit and vegetables.

The survey was also able to determine that South African children aged one to nine years consumed only 110 - 205g fruit and vegetables daily, 220 - 275g less than what is recommended for optimal health. A look at the consumption status of the various age subdivisions, (one to three years; four to six years and seven to nine years), found that fruit and vegetable intake increased as children progressed in life years; however, all the age subgroups still consumed less than the recommended intake levels of fruits and vegetables (NICUS, 2010).

These findings strongly correlate with the WHO's 2004 CQHR study, which estimated that South African children (along with certain other African countries) consume very low quantities of fruit and vegetables, with children aged zero to four years consuming only 91 - 94g fruits and vegetables daily, while children aged five to fourteen years consumed only 181 - 193g fruit and vegetables on average daily (WHO, 2004 b; Lock *et al.*, 2005). There might be a small difference in absolute values reported by the WHO and NFCS, but the findings of both studies were supportive of inadequate intake of fruit and vegetables by South African children.

The NFCS of 1999 reported the frequency of consumption to be approximately twice per day, and this low statistic is applicable across all age groups (Labadarios *et al.*, 2001). The study established that, on average, fruits were not eaten every day, while vegetables were consumed only once daily. The study also found that children who consumed less fruit and vegetables, both in quantity and frequency, showed inferior growth patterns (Labadarios *et al.*, 2001).

2.4 VEGETABLES AND THEIR RELATION TO HUMAN HEALTH

Vegetables are defined as food low in energy, comparatively rich in micro-nutrients, phytochemicals and other bioactive compounds, which serve as good sources of dietary fibre (Agudo, 2004). Furthermore, it also provides the body with most macro-nutrients, proteins, carbohydrates, dietary fibre, cholesterol and water. To fully grasp the importance of sufficient consumption of vegetables, it is imperative to understand the micro-nutrient and non-nutrient status of vegetables, and how it contributes to human health. Vegetables contain a rich spectrum of both nutritive and non-nutritive components, which help maintain a healthy diet. Some components are found widely spread across vegetables, while others are characteristic of only certain vegetables (Naudé, 2007; Heneman & Zidenberg, 2008).

The precise mechanisms through which vegetables contribute to disease prevention are not yet fully understood. However, it is thought that disease prevention may not be attributed to any single nutrient, but rather to the additive and synergistic effects of both nutritive vitamins and minerals, and non-nutritive phytochemical compounds found across the spectrum of vegetables (Heneman & Zeidenburg, 2008). This stresses the importance of consuming a wide variety of different vegetables and not merely large amounts of certain vegetables.

Micronutrient components of vegetables include a wide variety of vitamins, such as fat-soluble vitamins A, D, K and E, and water-soluble vitamins C, niacin, folate, thiamine, riboflavin, biotin, pyridoxine, pantothenic acid and vitamin B_{12}. In addition to its chock-full vitamin content, vegetables also contain essential minerals, most important of which are potassium (K), phosphorus (P), magnesium (Mg), Ca, Fe, Zn, copper (Cu), manganese (Mn), sodium (Na) and Se. Furthermore, vegetables provide the body with essential non-nutrient phytochemical compounds, such as pigments, phenolic compounds, terpenoids and natural anti-oxidants (NIH, 2015 b; USDA, 2015).

Vitamins are organic compounds that play a key role in a wide variety of biological processes in the body, most important of which are: growth; digestion; and nerve functioning. The body requires 13 essential vitamins to sustain human life. These vitamins are categorised by the American Academy of Family Physicians (AAFP) into two distinctive groups, namely water-soluble and fat-soluble vitamins (FDA, 2015; USDA, 2015).

Water-soluble vitamins, collectively referred to as B-vitamins, are easily absorbed into the body with water acting as carrier. However, these vitamins are not stored in large amounts at one time and are swiftly removed via the kidneys if not needed, thus, requiring frequent intake into the body. Fat-soluble vitamins A, D, K and E are less readily absorbed into the body, and require fat in the diet as a carrier, to assist absorption through the action of bile acid-fluids. However, contradictive to water-soluble vitamins, fat-soluble vitamins are stored in the body for lengthier periods, thus, requiring less frequent intakes (FDA, 2015; USDA, 2015).

Minerals are naturally occurring inorganic compounds, vital to sustain healthy human life and those required for human functioning are referred to as essential minerals. Essential minerals form part of various critical functions and components of the body, such as heartbeat regulation, hormone production and the construction of teeth and bones. These essential minerals are commonly divided into two groups, namely macro minerals and trace minerals (NIH, 2015 a; USDA, 2015). Macro minerals are required by the body in larger quantities and include Ca, P, Mg, Na, K, chloride (Cl) and sulphur (S). Trace minerals are only needed in small quantities in the body and include Fe, Mg, Cu, iodine (I), zinc (Zn), cobalt (Co), fluoride (F) and Se. It is important to note that the quantities needed are not indicative or relative to their importance in the body; both macro and trace minerals are equally important in their exact amounts (NIH, 2015 b; USDA, 2015)

Phytochemicals are plant-derived compounds and are hypothesised to be responsible for much of the disease protection conferred from diets high in fruits and vegetables (Arts & Hollman, 2005). The precise action of phytochemicals in the body is still unclear and requires further research to be fully understood. However, their contribution to health, as part of vegetables, cannot be denied (Heneman & Zidenberg, 2008) and include several important health benefits: (1) reduces blood pressure; (2) increases vain-vessel dilation; (3) has neuro-protective action; (4) inhibits oxidation of low density lipids; (5) inhibits cellular oxygenase; (6) neutralises free radicals which prevents cell damage; (7) inhibits nitric oxide production; (8) induces apoptosis; (9) reduces platelet aggregation; and (10) inhibits pro-inflammatory responses in the arterial walls. Phytochemicals also improve vision and, very importantly, provide protection against certain cancers. Good vegetable sources of phytochemicals include carrots, tomatoes, broccoli, crucifiers, garlic, onions, leeks and olives (Heneman & Zidenberg, 2008).

Given the extremely profound contribution of both nutritive and non-nutritive compounds to health, it is surprising to report that in most countries, developed and developing, many of the above-mentioned essential compounds are in grave shortage in many of the populations' diets (Naudé, 2013). Vitamin D has been identified as the vitamin most often inadequately present in the human body. This vitamin is necessary for muscle movement, a strengthened immune system, Ca and Mg absorption, development of healthy teeth and bones, and maintaining adequate levels of Ca and P in the blood. Mushrooms are the only vegetables deemed a rich source of vitamin D (Labadarios *et al*., 2001; USDA, 2015). Minerals seem to be in greater absence, with four essential minerals often lacking from the human diet. Potassium, required for growth and maintenance, regulation of water balance between body and cell fluids, and proper heart functioning, is most commonly deficient in people's diets. Calcium has also been identified as an important mineral often lacking in the human body. Considering Ca's vital contribution to strong teeth and bones, correct muscle contraction, blood clotting, nerve message carrying and nutrient passage regulation through cell walls, its shortage in the body can have a detrimental impact on long term health and wellbeing (Labadarios *et al*., 2001; USDA, 2015). Yet, another essential mineral often present in insufficient amounts is Fe. Iron is important for growth and development, plays a role in the production of some hormones and connective tissue, and forms part of red blood cells, namely in haemoglobin and myoglobin. Zinc, another important mineral for both adults and children, has also been identified as a mineral insufficiently present in many diets. It is required for protein and carbohydrate metabolism, growth, vision, wound healing, immune system activities, and the production of proteins and DNA. Furthermore, Zn is of special importance to children, as it is necessary for growth and development during pregnancy, infancy and childhood (Labadarios *et al*., 2001; USDA, 2015).

The Centre for Evidence-Based Health Care (in Stellenbosch) has identified several micro-nutrients lacking from children's diet in regions throughout SA. Folate, responsible for red blood cell formation, production of components of the nervous system, formation of DNA, normal brain functioning, cell growth, development of the embryo and part of the critical components of spine fluid, is a very important mineral in grave shortage in many children's diets. Vitamin A, necessary for cell production, formation of certain hormones, vision, bone growth, tooth development, healthy skin and hair, healthy mucus membranes and immunity, is another essential vitamin many children consume in insufficient amounts. Vitamin C, required for collagen production, wound healing, iron absorption, strengthened immune system and anti-oxidant effect, also often occurs in amounts less than is necessary for healthy growth and development (NICUS, 2010; USDA, 2015).

When looking, not only at the essential vitamins and minerals required to sustain health, but their contribution to vital functions in the body, it is understandable why so much emphasis is placed on daily consumption of sufficient amounts of vegetables. Understanding the functions of these compounds puts into perspective the momentous impact their deficiency has on the growth and development of children, functioning of the adult human body and overall quality of life.

2.4.1 Vegetable consumption of children, and its effect on early childhood health and development

It has been extensively cited that children eat fewer vegetables than is recommended for good health (Timperio *et al.*, 2007). Most growth takes place in the early years of childhood development, during which teeth, bones, muscles and blood develops (NICUS, 2010). This growth-spurt-driven life stage requires more nutrient dense food than any other life stage, and is vital for healthy physical and cognitive development of young children (NICUS, 2010). Yet, global consumption statistics indicate that low fruit and vegetable consumption, and micronutrient deficiencies as a result thereof, plagues children in countries worldwide.

Micronutrient deficiencies are responsible for an estimated 30 million infants being born with impaired growth, because of poor nutrition during foetal life (ACC/SCN, 2000). Furthermore, an estimated 1.1 million children die each year due to under nutrition (Black *et al.*, 2008; Black *et al.*, 2013). Annually, almost 18 million babies are born with brain damage because of iodine deficiency, while 50 000 women die during labour every year due to severe anaemia (Ramachandran *et al.*, 2015).

In resource-poor countries, malnutrition remains prevalent, especially in the group under five years. More than a quarter of the under-fives (161 million) worldwide are stunted, with the highest prevalence in Asia (56.0%) and Africa (36.0%). Furthermore, severe acute malnutrition (SAM) leads to two well recognised syndromes, namely kwashiorkor and marasmus (Kramer & Allen, 2015). Kwashiorkor means "the disposed child". These children present with oedema and features, like 'flaky paint' dermatitis, sparse de-pigmented hair, areas of hypo- and hyper-pigmentation and angular stomatitis. Furthermore, they are also described as apathetic. With marasmus, children have an "old man face", severe wasting and enlarged limbs, ribs that are clearly visible, wasting of the buttock and increased axillary skin folds, which are usually irritable. The child's skin and hair will differ from their peers and they will have infections (Kramer & Allen, 2015) (Figure 2.1).

Kwashiorkor	Marasmus
	
Swelling of legs (oedema) Sparse hair Swollen abdomen Thin muscles, but fat present Moon face, little interest in surroundings, flaky skin appearance	Thin limbs Normal hair Very underweight body Little muscle or fat Old man's face

Figure 2.1 Children with kwashiorkor and marasmus (Types of malnutrition, 2015)

The WHO has identified optimal fruit and vegetable DRI standards for children, according to specific age groups. As mentioned earlier, these standards recommend that children aged one to four years should consume 330g fruits and vegetables daily, and children aged five to 14 years, 480g fruits and vegetables daily (WHO, 2015). For simplified consumer use, an 80g portion is equal to one fruit, half a cup cooked or one cup raw leafy vegetables (Naudé, 2007).

2.4.2 Not vegetables, but rather micronutrients

A lot of emphasis is placed on the amounts of vegetables children should consume, but this is not indicative of a well-balanced diet, filled with all the essential micronutrients. The most important aspect of consumption is not necessarily the amount vegetables children consume, but rather the variety and colours of vegetables children enjoy. Different types and colours of vegetables provide different vitamins and minerals, which requires the consumption of a wide variety of different vegetables to ensure intake of all the essential micronutrients.

Children who consume plenty of certain types of foods, but do not enjoy a wide variety of foods, including vegetables, are at risk of developing "hidden hunger", referred to as such, as the consequences thereof often go unnoticed (Faber & Wenhold, 2007). It also refers to micronutrient deficiency, resulting from inadequate consumption of micronutrient dense foods. Hidden hunger affects over two billion people world-wide and can wreak havoc on an individual's health and quality of life (Von Grebmer *et al*., 2014). Hidden hunger, in poverty stricken developing countries where food insecurity dominates, is a direct result of insufficient consumption of food, including micronutrient dense foods, such as fruits and vegetables. These populations face hunger, stunting and underweight of both adults and children, due to vast food scarcity (Von Grebmer *et al*., 2014).

Hidden hunger, within the developed world, occurs within higher income urban areas. Here, hidden hunger is in a "coexistence" with overweight and obesity, due to over consumption of calorie-dense, micronutrient-poor foods, such as fast-foods and processed convenience foods high in fat and sugar, and low in micronutrients and fibre. Thus, it is very possible for obese children to suffer from hidden hunger and is especially worrisome, as it is most often unseen in these children, yet its effects are equally detrimental (Von Grebmer *et al*., 2014).

Hidden hunger cannot always be observed in a child's physical appearance, yet it will have devastating effects on the life of children whose health appears to be normal. Children suffering from hidden hunger are at risk of mental and physical impairment, poor health and possibly even fatality. The effect of hidden hunger is especially volatile during the first 1000 days of a child's life, where physical and cognitive development passes through a sensitive phase (Von Grebmer *et al*., 2014).

The NFCS reported in 1999 that children's' micronutrient intakes of Ca, Fe, Zn, Se, folic acid, vitamins A, D, C and E, riboflavin, niacin and vitamin B6 to be less than 67.0% of the recommended daily intakes. In a more recent Executive Summary of the National Food Consumption Survey Fortification Baseline (NFCS-FB-I), conducted in 2005, it was reported that: two out of every three children had a poor vitamin A status; one third of children were anaemic; one in seven children had a poor Fe status; and almost half of all children had inadequate intakes of Zn and were at risk of developing Zn deficiency. The poor vitamin A and Fe statuses appeared to have worsened over the past several years, when compared to earlier national data, such as the NFCS of 1999 (Labadarios *et al*., 2007).

2.4.3 South Africa and the nutrition transition

While many countries fight the battle against malnutrition due to over or under nutrition, SA is faced with a much greater mêlée. South Africa is currently undergoing, what is commonly referred to as, a nutrition transition (Crush *et al*., 2011; Schönfeldt, 2012). The nutrition transition, defined as "the coexistence of under- and over-nutrition", describes a change in the structure of dietary intakes and an increase in obesity in developing countries, characterized by low to moderate income (Schönfeldt, 2012; Tathiah *et al*., 2013). This implies that over-nutrition related diseases in SA start to rise before the battle against under-nutrition and its related deficiencies are overcome (Vorster, 2010). Countries undergoing such a transition not only face the burden of malnutrition, but further extend to a double burden of disease - a high occurrence of infectious diseases related to under-nutrition, as well as a high prevalence of non-communicable diseases (NCDs) related to over-nutrition (Tathiah *et al*., 2013).

Packed foods are a simple, convenient food solution and a major global food trend. In SA, there was an increase in sales in packed foods (all categories) and beverages in the recent years. The packed food sector has grown from 2007 to 2012 by 15.0% in volume – from 4.515 k tons to 5.202 k tons and in monetary value from R91 billion to R143 billion. The manufacturing sector for food and beverage grew from 2000 to 2009 from 8.7% to 32.6% (Ronquest-Ross *et al*., 2015).

In the bakery section, the consumption of bread is the largest contributor. White bread remained the most popular bread type in 2012 at 49.0% value share, because of its appeal with lower income consumers. Biscuits (sweet and savoury) increased by more than 50.0%. Sweet biscuits accounted for 50.0% of the overall value sales in 2012 and this was the lower income consumers' attraction (Ronquest-Ross *et al*., 2015).

Because of perceived freshness and lower costs, frozen processed vegetables, rather than canned vegetables, attracted consumers. The consumption of canned beans and canned ready meals, like spaghetti in sauce, meat in sauce and soup, grew with 50.0% in 2012. Frozen processed foods grew by 21.7% from 1999 to 2012. The consumption of frozen ready meals, frozen pizza, frozen processed potatoes, like chips, and frozen processed poultry, have doubled (Ronquest-Ross *et al*., 2015).

Sweet and savoury snacks' consumption experienced significant growth between 1999 and 2012 of 53.3%. The drivers of this consumption are snacking between meals, busy lifestyles and new flavours. South Africans are increasing their consumption of soft drinks, especially in urban areas. The most commonly purchased street food is firstly fruit and secondly, soft drinks (Steyn *et al*., 2011). This high consumption is associated with obesity and non-communicable diseases due to the added sugar. The annual consumption of Coca-Cola products in SA increased with 80.0% from 1999 to 2012. The worldwide average of soft drink consumption is 22.3 ℓ. capita/year and in SA it is 61 ℓ. capita/year (Ronquest-Ross *et al*., 2015).

In the NFCS of 1999, it was estimated that 6.0% of children, aged one to nine years, were obese. A summary of the UNSCN Country Policy Analysis compared statistics from the 1999 NFCS, the 2005 NFCS and the 2012 SANHANES, and reported an increase in overweight and obesity in children over the past few years, with 22.9% of children today being either overweight or obese (Schönfeldt *et al.*, 2013). Armstrong *et al.* (2006) examined more than 10 000 primary-school children and concluded that these children showed trends of obesity and overweight, like values in developed countries about ten years ago.

2.4.4 Physical and cognitive developmental implications

To truly and overwhelmingly grasp the impact of malnutrition on children's life quality, it is imperative to consider the health and developmental implications low fruit and vegetable consumption have on children in the early years of development. Early development also precedes conditions for development during the school age period and adolescence, and, therefore, not only relates to the younger life years, but also carries through into adulthood and will result in a lifetime of economic, social and personal benefits or impairment (Kudlová & Schneidrová, 2012).

Delayed cognitive development, long-term intellectual and psychological developmental damage, impaired physical development, severe infection and reduced disease resistance are amongst the most important issues brought on by poor nutrition in early years (Nicklas *et al.*, 2001). In adulthood, these impairments resonate and pave the way for a wide range of deficiency disorders and/or non-infectious chronic diseases, such as malignant and cardiovascular disease, cancer, osteoporosis and dementia (Kudlová & Schneidrová, 2012).

Under-nutrition is also a major contributor to the chances that an infant or child will succumb to a life-threatening disease, and it is estimated that poor nutrition accounts for about 70.0% of under-five mortality in developing countries (Kudlová & Schneidrová, 2012). It is also important to note the impact of micro-nutrient deficiency on the affectivity of energy. Consumption of energy, without adequate intake of critical nutrients, leads to an increase in weight, but not height, promotes fat gain and obesity, and most alarming, restricts and retards physical and cognitive development (Figure 2.2) (Schönfeldt, 2012).

The Centre for Evidence-Based Health Care provides several guidelines to promote sufficient intakes of essential micronutrients among children. These guidelines include enjoying a wide variety of foods, making starchy foods the basis of most meals, eating plenty of fruits and vegetables daily, eating legumes regularly, and consuming animal

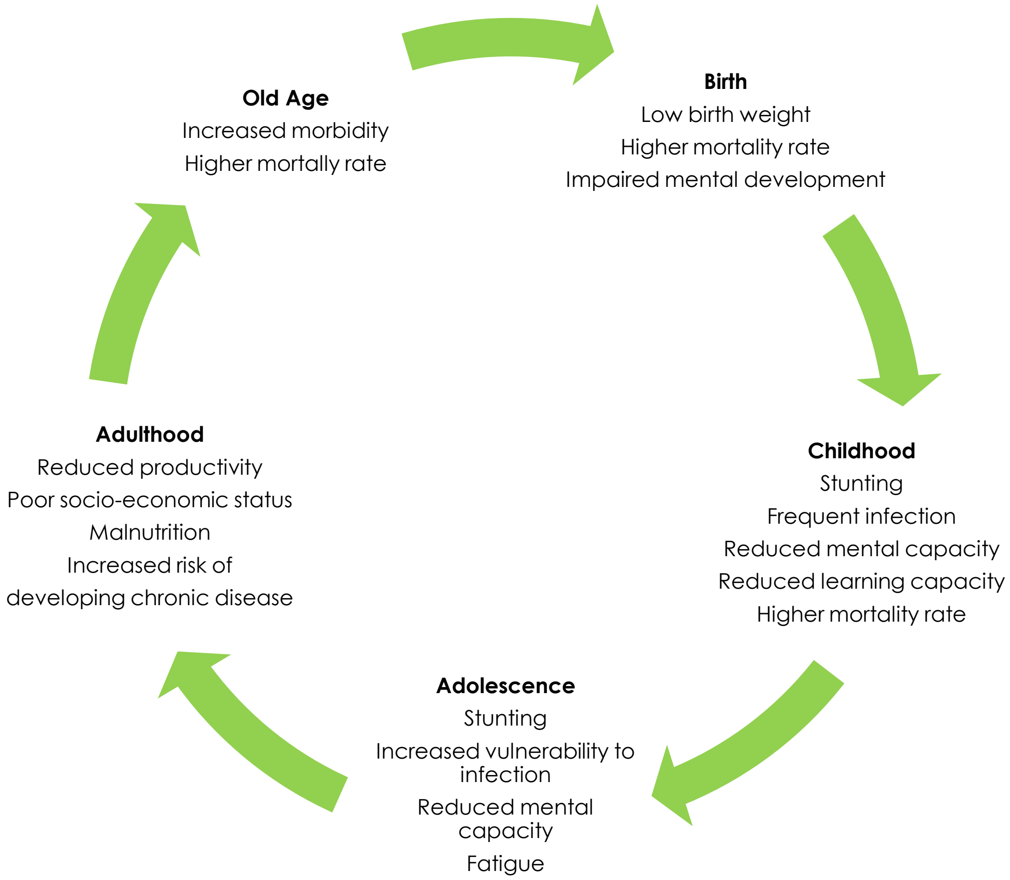

Figure 2.2: The effect of malnutrition throughout the individual's life cycle (ACC/SCN, 2000)

products daily in controlled amounts, consuming fat and sodium sparsely, and being active (NICUS, 2010).

2.5 THE DEVELOPMENT OF EATING BEHAVIOUR: BIOLOGY AND PSYCHOLOGY

According to Gahagan (2012), the development of feeding in humans relies on complex interplay between homeostatic mechanisms, neural rewards systems and child motor, and sensory and social-emotional capability. The most rapid development of eating behaviour occurs during early childhood from infancy to school age, with the acceptance of novel food sources peaking at the age of two to three years, after which a resistance to new and unknown food sources comes about (Skinner *et al.*, 2002; Gahagan, 2012). Normal development during early childhood ensures healthy eating behaviour, characterised by sufficient, but not exclusive weight gain, which will carry over into adolescence and adulthood (Gahagan, 2012).

Energy need drives long term food choices, but when considering human eating behaviour, flavour, odour, texture, temperature and presentation serve as the most important factors influencing food choices. Gahagan (2012), however, argues that even more important than these sensory cues are the influence of social factors on the development of eating behaviour. Several studies have established the three most important predictors of child food choices: 1) whether the child likes how the food tastes; 2) how long the child was breastfed, as well as maternal food choices; and 3) if the child has been exposed to the food source from a young age (Skinner *et al.*, 2002; Cooke *et al.*, 2004; Northstone & Emmett, 2008). It is very important that the developmental processes during weaning ensure that young mammals learn what to eat and how to forage (Provenza & Launchbaugh, 1999; Mennella, 2007). It is found in many species that youngsters first learn through transmitted flavour cues from the mother's dietary choices, which in turn cause neurological and psychological changes that will influence and predict later behaviour (Mennella, 2007).

2.5.1 Biology (sensory experience and digestion)

Although most people view food choices as a cultural trait, not directly related to human biology, overwhelming evidence suggests that children's biology makes them especially vulnerable to the current food environment of processed foods, which are high in fat, salt and sugars (Mennella, 2014). According to Mennella and Ventura

(2010), children and infants live in a different sensory world than adults and, therefore, have different sensory experience of the very same foods. Children, from birth, prefer higher levels of sweet and salty tastes compared to adults, and show less tolerance for bitter tastes, rejecting them more readily than adults would. This is the first indication that children are predisposed to prefer substances associated with an unhealthy diet, and are not favourable of today's modern diet, namely low in sugar and Na, and rich in vegetables (Menella, 2014).

Flavour is considered as one of the most powerful determinants of human consumption behaviour, influencing food choices from earliest childhood into adulthood, until old age. It is a product of numerous sensory systems, particularly that of taste and smell (Mennella, 2014). Flavour senses are independent and already well-developed at birth and continue developing throughout life, controlling one of the most common and important human decisions - whether to accept or reject foreign substances (Forestell & Mennella, 2013; Mennella, 2014).

Several different theories have tried to explain why children are biologically wired to prefer sweet and salty tastes, while rejecting bitter and sour tastes. Together, these various theories may provide the best comprehensive understanding of the various factors, which synergistically predict and influence children's vegetable aversion from a biological point of view.

The first and strongest theory is based on evolution and survival of humans. This theory argues that children's taste qualities most likely evolved for survival, detecting and rejecting substances that are possibly harmful, and look for and ingest those substances that are beneficial (Cowart, 2005). According to Reed and McDaniel (2006), mammals, such as humans, are biologically wired to associate sweetness with readily available energy from carbohydrate sources, such as mother's milk or fruits. Furthermore, mammals associate salty flavours with essential minerals, also imperative for survival (Jacobs *et al.*, 1978). Naturally, innate preference for these flavours drives higher consumption volumes of foods containing these substances.

Bitterness, on the other hand, signals potentially harmful toxins and poisons, and therefore explains the avoidance of bitter substances by mammals (Glendinning, 1994). Salty, sweet and high fat foods are, therefore, classified as highly preferred tastes, while whole grains, low-fat dairy products, legumes, fish, fruits and vegetables are classified as non-preferred tastes, due to the detection of bitter notes in most of these foods (Mennella & Ventura, 2010). This theory is supported by studies conducted on foetal acceptance of flavour (Liley, 1972). One of the first indications that the preference for sweet and salty tastes, and the rejection of bitter tastes is biologically driven (Beauchamp & Mason, 1991), can be seen in the frequency with which the foetus's swallowing increases in response to sweet solutions being introduced into the amniotic fluid, and in turn, decreases with the introduction of bitter solutions (Liley, 1972). It has been established that vegetables, especially green leafy vegetables, are associated with bitter tastes, and are, therefore, persistently rejected by infants and children alike (Gidding *et al.*, 2006; Lichtenstein *et al.*, 2006; Mennella, 2014).

Building on the theory of survival, is the theory of genes and gene inheritance. Children's ability to detect and taste bitter compounds varies according to the presence of certain inheritable genes. The capacity to taste the bitter compound 6-*n*-propylthioracial (PROP) is largely influenced by the presence of certain genes, and specifically the TAS2R38 gene. 6-*n*-propylthioracial is related to perceiving bitter foods as less appetizing and, therefore, results in greater food aversion and lower vegetable intake (Anliker *et al.*, 1991).

Further strengthening the already firm foundation of bitter flavour aversion imprinted into our inherited biology, is the very influential mechanism of pre-natal intra-uterine taste programming. Many studies argue that the recognition and acceptance of taste and odour (constituents of flavour) develop before birth. Amniotic fluid acts as the first food of mammals, and contains a variety of nutrients including glucose, fructose, lactic acids, fatty acids and amino acids (Liley, 1972). Amniotic fluid also contains aromatic compounds and flavours from the mother's diets, such as garlic, anise and onion. These aromatic compounds are ingested by the foetus when swallowing amniotic fluid, programming taste preference of children according to specific flavour exposure via the pre-natal diet (Gerrish & Mennella *et al.*, 2001).

The first introduction to flavour starts around the 12th week of development, during which the foetus begins to ingest large quantities of amniotic fluid (Pritchard, 1965). In the last three months, the primary receptors of taste and flavour perception start communicating with the central nervous system, in reaction to a variety of taste and flavour stimuli (Ganchrow *et al.*, 2003). These aromatic compounds and flavours are detected by the foetus, programming taste perception and acceptance, and are evidenced by children's favoured response to these programmed flavours during early childhood (Faas *et al.*, 2000). The influence of the maternal diet continues into early infancy, further establishing and modifying taste preference through compounds transferred via breast milk during breastfeeding. As the young infants are exposed to the flavour of the milk, it further paves the taste preferences of infants, for when baby foods and non-milk beverages are introduced (Gahagan, 2012).

These biological and early programmed sensory cues explain, to some extent, why children resist eating unfamiliar foods which are not to their taste liking, are predisposed to prefer foods which are higher in sugar and salt, and resist foods which are sour and bitter by nature, such as fruits and vegetables (Mennella & Ventura, 2010). This ingrained biology of children makes it very difficult to change children's liking for sweet and salty foods, while avoiding bitter and sour foods. However, Mennella and Ventura (2010) argue that flavour preference of children can be shaped by introducing early exposure to a wide variety of healthy foods and flavours, starting in-utero. From a biological standpoint, taste preference is, therefore, modelled through a combination of evolution, genes, pre-natal intra-uterine taste programming and flavour transmittance during breastfeeding, together laying the foundation for learned behaviours preceding birth and infancy (Gahagan, 2012).

The post-natal period and early experience of flavours have a strong effect on the behavioural taste development of children (Mennella, 2014). During the post-natal period, the brain has heightened sensitivity to influences from the direct surrounding environment, because of periods of brain plasticity, causing the early environment to shape neural-circuits and, thus, also behaviours (Roth & Sweatt, 2011; Mennella, 2014).

2.5.2 Psychology

From the age of two years, there is a shift in taste preference from biology to that of environmental influences and psychology, and by the age of three, eating is no longer a function of need, but becomes a product of the environmental cues surrounding a child's food environment (Patrick *et al.*, 2005) This explains findings that the most noticeable period of change in human dietary patterns is seen in childhood, with the acceptance of new foods peaking around the initial learning stages of age two to three years and stabilizes between the ages of three to four years, after which changes become increasingly more difficult to incur (Skinner *et al*., 2002; Mennella, 2014).

Children undergo three developmental feeding periods during the first two years: the nursing period (birth to six months); the transitional period (six months to two years); and the modified adult feeding period (two years and older). The development of these feeding stages typically evolves, based on well-described neuro-developmental milestones (Gahagan, 2012). While biology can be used to explain taste acceptance and preference during the nursing and transitional period, as seen above, food preference of young children during the modified adult period shifts to that of a more psychological nature.

Around the age of two years, children's diets shift towards that of the family, consuming foods preferred by the rest of the family members. This is the prime age in which to model children's taste preference, as they are both most open and accepting to novel foods and flavours, as well as eager to please and easily influenced by social suggestion and the direct social environment (Gahagan, 2012). Introducing and exposing children to a wide variety of healthful foods and tastes at this age will lay the preference foundation, which will influence and predict later food choices (Gahagan, 2012).

Much of man's behaviour is learned. It has been well established that social facilitation – the sight and sound perceived by children when others engage in behaviour - can increase their own behaviour of the same activity. This is seen as a determinant of eating behaviour of primates, as well as children and adults, and is referred to as social learning systems in Albert Bandura's theory of social learning (1977). He states that, while traditional theories of learning explain behaviour as the result of directly experienced response consequences, the social learning theory accepts that almost all learning phenomenon is a result of direct experience through the observation of other people's behaviour and the consequences of their behavioural actions. Bandura's theory of social learning assumes that the influence of models in the direct environment produces learning via informative functions, which are acquired as symbolic representational activities carried out by the model (Bandura, 1977).

During the early years of childhood development, children's imitative responses result directly and immediately from a model's behaviour. In later years, long after the model has displayed the behaviour, children will go on to perform these learned behaviours in the absence of the model. However, to ensure that the behaviour will be passed on, a model must show certain characteristics: 1) demonstrate the desired response repeatedly; 2) demand that others reproduce the action; 3) physically prompt the behaviour when it fails to occur; and 4) administrate powerful rewards. These characteristics will, eventually, elicit the same response in the observer (Bandura, 1977).

Social influence is greatest in the child's direct environment where parents, siblings, peers and teachers act as models, shaping food, and taste preference and acceptance (Kohl & Hobbs, 1998). Many articles discuss the powerful influence of social suggestion as modifier of children's food preference and acceptance, especially that of a familiar adult model, mostly the parent. Children in their early years are more eager to consume foods, which they observe models (parents or caretakers) consume enthusiastically and deliver positive verbal commentary about the food (Johnson & Birch, 1994; Adessi *et al.*, 2005; Lumeng *et al.*, 2008; Gahagan, 2012). Johnsons and Birch (1994) found that around the age of three years, children come to understand that their food liking differ from that of adults. During this phase, children also come to understand that "adult testimony" cannot always be trusted, but until the age of around six years, will still try these foods if the adult consumes it in their presence. A child is even more likely to try the food if the food of both adult model and child is the same in shape, size and colour. Even though a child might not like the taste of the consumed food, children remember the flavour, and over the age of four will have greater chances of developing a liking and preference for the once disliked flavour (Lumeng *et al.*, 2008). This influence is strengthened when the model uses specific verbal communications. Absolute terms, such as "great" or "delicious" as opposed to relative terms such as "better" or "more" have an immense impact on a child's willingness to try new foods (Lumeng *et al.*, 2008).

Thus, the social contexts in which a child's eating patterns develop is very important during these early years, as the eating behaviour of the models in that environment shape and develop a child's food acceptance and preference, establishing a preference for "inherently unpalatable substances", such as vegetables (Kohl & Hobbs, 1998).

2.6 FACTORS WHICH INFLUENCE PRE-SCHOOL CHILDREN'S VEGETABLE CONSUMPTION PATTERNS AND BEHAVIOUR

Eating behaviour has been conceptualised as a function of the social and physical environment within which a child lives, the socio-economic climate of the family and individual factors of the child itself (Story *et al.*, 2002; Taylor *et al.*, 2005). The development of eating behaviour is affected by factors, such as availability and accessibility, cultural values of the family and the family environment - including parents and siblings, mealtime structure, preference for foods, preparation style, portion size, parents' nutritional knowledge and parent feeding style. Other components of the external environment, which strongly influence children's eating behaviour, are the school environment, teachers and peers. On an individual level, children's eating behaviour depends largely on biological factors, such as age and gender, the child's own nutritional knowledge and attitude, as well as food exposure and the development of food neophobia.

2.6.1 Economic

When considering the economic environment's influence on a child's vegetable consumption, food cost, parent education level and employment status are high-lighted as the three most influential determinants (Taylor *et al.*, 2005).

A restriction of the household income results in food price becoming one of the most important considerations of the food purchasing decision (Basiotis *et al.*, 1998).

Drewnowski and Darmon (2005) explain that refined grains, added sugars and added fats are among the lowest costing sources of dietary energy. Its appeal, therefore, lies in the combination of low cost, good taste and convenience. Furthermore, they also explain that nutrient-dense foods, such as fish, lean meat, and fresh fruits and vegetables, generally come at a higher price with lower energy density. Meals, which consist of refined grains, sugars and fats, cost less per cal/kJ, in comparison to healthy foods, which costs more per cal/kJ. This, along with the fact that more of the healthy food is required to obtain the same amounts of energy, explains why lower income households may sometimes make unhealthy food choices.

Numerous studies have found a correlation between lower educational statuses of parents and their family's dietary quality (Crawford *et al*., 1995; Guillaume *et al*., 1998; Cullen *et al*., 2002). These studies found that lower educational status of parents is strongly associated with families whose diets are higher in fat and sugar, and lower in fibre and micro-nutrients, effecting especially young children. This phenomenon could be ascribed to a link between lower educational status and lower household income, as well as less nutritional knowledge, both fundamental to healthy food habits (NICUS, 2010).

Contradicting findings surround the issue of social status. Billson *et al.* (1999) reported that higher social-economic status, indexed by either occupational status or educational level, is consistently related to fruit and vegetable intake in both adults and children, and similar findings were published by De Irala-Estevez *et al.* (2000). However, Gibson *et al.* (1998) found no correlation between socio-economic status and higher levels of vegetable intake, stating that social class has nothing more than a weak effect on consumption of vegetables.

Employment status of the mother also correlates with children's vegetable intake levels. Maternal employment has been linked to irregular and infrequent family meals, and is, therefore, associated with poor dietary quality, as family meals have been identified an important determinant to healthful eating (Neumark-Sztainer *et al*., 2003).

2.6.2 Physical

The physical environment consists of food availability, food preparation and portion sizes, as well as the school environment. Within the physical environment, availability of foods in the child's various environments, including school, home and neighbourhood fast-food facilities, has proven to be a major influence on children and healthful eating (Taylor *et al.*, 2005). Portion size and various food preparation methods used both at home and by the school can also strongly affect and prompt children's willingness to try to prefer vegetables.

2.6.3 Food availability

The availability of vegetables in the home can be a very important. It is directly physical correlated to the consistent daily vegetable intake, and has been positively associated with higher vegetable intake levels and overall dietary quality of young children (Rasmussen *et al.*, 2006; Brug *et al.*, 2008). This refers not merely to having vegetables in the home, but having a wide variety of vegetables in a form that is ready for consumption at all times. Thus, providing children easy accessibility to vegetables in the form of finger snacks, readymade salads, etc. will prompt more frequent consumption of vegetables (Blanchette & Brug, 2005). Shepherd *et al.* (2006) argues that, although greater availability of vegetables and other healthful foods in the home is very important, it is not a guaranteed "enabler" of healthy eating. Research has shown that providing children with a wide variety of easily accessible vegetables and vegetable packed home cooked meals is not a guarantee that they will like them, but are more likely to consume them if they are readily available (Shepherd *et al.*, 2006).

When talking about food availability, one must also consider the availability of non-healthy foods in and around the home, which is counter active to the consumption of healthful foods, such as vegetables. Having unhealthy "snacks" in the home favours the consumption of such foods and undermines the intake of healthy foods. Consistent with this problem is the occurrence of vegetable deprived fast-food outlets close to home, which provides parents with a quick way out of meal preparation during busy week days (Timperio *et al.*, 2007). Sweetman *et al.* (2011) stated that children who are frequently presented with convenience foods, as opposed to freshly prepared home cooked meals, liked and preferred vegetables less. Timperio *et al.* (2007) concluded that the availability of convenience stores and fast food outlets close to home might have detrimental effects on children's vegetable intake.

2.6.3.1 Portion size

When learning the acceptance of novel foods, the portion size of vegetables provided to children has also come to the forefront as a prominent predictor of children's willingness to try to accept these novel foods (Cousins *et al.*, 1993). Pre-school children appear to be more open to novel vegetables when they are presented with these foods in small amounts at first, rather than full portions. Starting with small initial portions may not adhere to the recommended nutrient intakes necessary for health, but will encourage children to try the novel food. Once children start accepting the novel food, portion sizes can be increased over a period, until the child willingly consumes sufficient amounts (Spill *et al.*, 2010).

2.6.3.2 The school environment

The pre-school environment can act as a key influence and strong developer of healthy eating patterns in young children, which in turn, may assist parents in the process of teaching children to accept novel vegetables. The pre-school's choice of foods served, along with their nutritional policies and health curricula, determine, to a large extent, children's food exposure and later preference (Taylor *et al.*, 2005).

The pre-school provides a good environment for social learning through peer and teacher modelling, encouraging the acceptance of novel vegetables and install later preference of these vegetables (Neumark-Szteiner *et al.*, 2000; Briggs *et al.*, 2003). Taylor *et al.* (2005) emphasises their findings that "enthusiastic teacher and peer modelling" increases children's acceptance of healthful foods and promote healthy food choices among pre-school children. It is, however, imperative that schools ensure that the meals they serve align with the nutritional education children receive in the classroom. Furthermore, teachers must provide stimulating nutritional discussions during meal times to create an understanding and concern for health, with relation to the vegetables they consume (Nicklas *et al.*, 2001; Taylor *et al.*, 2005).

2.6.4 Individual factors

Individual determinants of vegetable acceptance and preference patterns in children include biological factors, such as children's age and gender, along with nutritional knowledge, attitude, repeated exposure and food neophobia (Taylor *et al.*, 2005). Several different factors, resulting from the properties of both food product and the individual, guides human food consumption behaviour. The intrinsic biological sensory systems are fundamental in modulating the experience the individual has, while approaching and consuming the food product extrinsically (Desor *et al.*, 1975).

2.6.4.1 Biology (age and gender)

Biology, in specific age, has shown to be closely linked to children's vegetable consumption patterns (Taylor *et al.*, 2005). Studies vary in their reports on child vegetable consumption and gender; however, general data are supportive of higher intake levels among females (Cook *et al.*, 2004).

A strong correlation exists between children's food habits and age. Numerous studies found that younger children aged two to five years are more reluctant to try to accept novel foods. Reluctance is lowest in very young children aged six months to two years. Children in this age range are less fussy when it comes to eating, enjoy food more and have low satiety responsiveness, deeming them "plate cleaners". These traits make children in this phase very open and accepting of novel foods, including a wide variety of vegetables. As children grow into the three to five year age range, they become increasingly more resistant to trying and accepting novel foods. During this phase children tend to eat less food in general, are fussier about food and are defined as non-eaters, compared to the behaviour of children under the age of three years (Caton *et al.*, 2014).

2.6.4.2 Nutritional knowledge and attitude

The nutritional knowledge and attitude of children predict, to some extent, their vegetable intake levels and often reflect that of the family's, predominantly the mother's (Gibson *et al.*, 1998; Savage *et al.*, 2007). Mothers', with a greater sense of health and healthy lifestyle choices, children also tend to show greater understanding of the importance of health and healthy food choices (Gibson *et al.*, 1998; Howard *et al.*, 2012). However, in general, pre-school children do not have much nutritional knowledge, and display little understanding of the importance of healthy choices and the relationship between food choice, physical activity and health (Taylor *et al.*, 2005).

An even bigger problem than the lack of knowledge among children is their lack of concern for health. Several studies reported that even when children possess knowledge and understanding of the importance of health, and the role nutritious food play in maintaining a healthy body, children generally just are not concerned about their health. This problem is further prompted by children's common belief that healthy foods are unpalatable and unappetising, a prejudice detrimental to children trying and accepting novel vegetables (Wellman & Johnson, 1982; Wardle & Huon, 2000).

2.6.4.3 Food neophobia

Food neophobia can be defined as the tendency to avoid foods never encountered before and is a direct result of the fear that tasting a new or unknown food product will have a negative outcome (Pliner *et al.*, 1993; Dematte *et al.*, 2014). Food neophobia's role in nature is to protect organisms from ingesting potentially harmful or poisonous substances (Prescott, 1999). This very mechanism is also what often prohibits organisms from consuming highly nutritious foods. The tension between these two pressures and the balancing thereof, is commonly referred to as "omnivores' dilemma" (Rozin & Vollmecke, 1986). Although this might have been a very effective mechanism for survival during foraging in prehistoric society, it no longer is adaptive to human diets in the modern food environment, and results in poor dietary variety and quality with harmful long term effects (Fox *et al.*, 2004; Savage *et al.*, 2007).

A general profile of food neophobics can be compiled from literature: they are most likely between the ages of two to six years; may be of any gender; show higher levels of anxiety; are likely to avoid adventurous situations; avoid strong emotions; and are generally less open as beings (Dovey *et al.*, 2008; Knaapila *et al.*, 2011; Blisset & Fogel, 2013; Dematte *et al.*, 2014). Food neophobia is very closely linked to age, reaching a pinnacle in children aged two to six years and decreases as the child moves into adolescents, with adulthood being characterised by the lowest tendencies of neophobia. When neophobia develops in children, they will even start rejecting foods they enjoyed eating prior to developing neophobia (Dovey *et al.*, 2008; Schwartz *et al.*, 2011).

Wardle and Cooke (2008) found that this reluctance is mostly seen in fruit and vegetable consumption of children, and not so much in other foods. This refusal can be ascribed to two dominant factors, that of taste sensitivity and odour perception. Pliner *et al.* (1993) reported that heightened taste sensitive, especially to that of bitter tastes, has a negative influence on the amount and variety of vegetables consumed by children.

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CHAPTER 3

CONSUMERS' KNOWLEDGE ABOUT AND ATTITUDE TOWARDS VEGETABLES

ABSTRACT

The objectives of this study were not only to determine consumers' knowledge from different demographic groups, but also to investigate the role of specific variables as forerunners of consumers' attitude towards vegetables. Consumers' beliefs regarding the advantages, disadvantages and associations of eating vegetables were recorded. Data were collected from consumers (*n* = 173) from different parts of SA, on a three-part self-completion questionnaire, consisting of knowledge, attitude and demographical questions. Consumers' knowledge of vegetables was statistically analysed by means of descriptive statistics. For the attitude part, a hypothesis was represented via the conceptual model, where health benefit, food safety risk, sensory qualities and synonyms were depicted as forerunners of consumers' attitude towards vegetables. Statistical measures, such as reliability and factor analysis, descriptive statistics, correlation analysis and multiple linear regression were performed. The coloured respondents (11.7%) had significantly ($p<0.0001$) better overall knowledge of vegetables than the black respondents. The coloured respondents (10.2%) also had significantly ($p=0.0011$) better knowledge about portion sizes than the white respondents. Family_health_consciousness ($p=0.2082$) did not contribute significantly to the consumers' attitude towards vegetables, while food_safety_consciousness ($p=0.0307$), vegetables_are_healthy ($p=0.0001$) and vegetables_are_pleasant ($p<0.001$) contributed significantly ($p<0.05$) to attitude towards vegetables.

3.1 INTRODUCTION

Children's eating behaviour is shaped through the social environment, as well as communal learning from people within the child's direct social environment. This environment is usually characterized by family culture, family environment, meal setting structure, parental knowledge, behaviour and parenting style, as well as peers (Taylor *et al*., 2005).

Culture has long been considered one of the most important factors contributing to good health and good dietary quality (Taylor *et al*., 2005). Caprio *et al.* (2008) explain that a culture's traditional beliefs and behaviours are designed to promote healthy food habits. In recent years, this cultural mechanism has been upstaged by globalization, i.e., a social process in which the constraints of geography on social and cultural arrangements regress (Caprio *et al*., 2008). Mennell (2000) explains that food habits are undergoing globalisation and, in turn, has led to a decrease in inter-cultural differentiation of food habits and practices, within society (Taylor *et al*., 2005).

Globalisation of food habits are influenced by travel, trade, communication, an increased gap between rich and poor, and an epidemiologic transition in global burdens of disease (Chopra *et al*., 2002). On the other hand, acculturation is defined as the changing of original cultural patterns of one or more groups, when they come into continuous contact with one another. The result is encouragement of traditional beliefs and behaviours, which were developed inter-culturally, to promote healthy food habits. However, beliefs and behaviours are also adopted in the process that encourages unhealthy food habits. Both acculturation and globalisation bring about changes in preferences for certain foods, leisure and physical activity (Caprio *et al*., 2008).

As children grow up, they must learn to accept a diet that consists of a variety of foods. In this process, children develop a preference for the food of their culture and the cuisine of their country (Birch, 1992). The diversity of world eating patterns indicates the role of culture and environment in shaping eating patterns (Kroll & Popper, 2003). The habit of eating a variety of foods ensures adequate amounts of all the macro- and micronutrients (Naudé, 2007; Heneman & Zidenberg-Cherr, 2008).

Preference to flavours develops early and could be due to milk-related flavour exposures during breastfeeding. When introduced to solid foods, food preferences start to develop form repeated exposures to a different variety of foods. Food variety habits that are formed before the neophobic phase, leads to eating a more varied diet in childhood, adolescence and early adulthood (Nicklaus, 2009).

Children are now more exposed to fast foods than ever before, and the more children become familiar with a certain food, the more a preference toward the food will develop. The average child will prefer high-energy dense food, e.g. fried chips, to foods that do not have that energy content, e.g. vegetables (Birch, 1992). This was confirmed in a study by Camps *et al.* (2011), where children had to choose between deep fried fries and apple fries, with 65.0% choosing deep fries.

Family environment, consisting of parents and siblings, as well as meal settings and meal structure combined, form, perhaps, the most influential external component of children's vegetable consumption. Numerous studies positively correlate family meals with higher dietary quality of children, emphasising greater consumption of vegetables (Neumark-Sztainer *et al.*, 1999; Tibbs *et al.*, 2001; Taylor *et al.*, 2005). This has much to do with the effect of socialisation that accompanies family meal times. Food socialisation refers to the process by which parents' preferences, beliefs and attitudes towards food shape their children's food related beliefs, attitudes, knowledge, preferences and consumption, which in turn influences eating behaviour (Birch, 1980 a, b; Cousins *et al.*, 1993; Crockett & Sims, 1995; Birch, 1998).

The social context that surrounds a child's meal times strongly shapes his/her acceptance of and preference for certain foods, i.e., social experience dictates consumption habits (Birch, 1980a; Casey & Rozin, 1989). When a child is exposed to a negative meal experience, his/her preference for, and liking of foods consumed during that meal, would decrease. Similarly, a positive meal experience increases preference for foods, including vegetables, eaten during that specific meal (Casey & Rozin, 1989).

Companionship during meals have also been proven to increase children's' preference for basic food groups, including vegetables (Stanek *et al.*, 1990). Presumably, family meals with parents and siblings create a positive social experience, encouraging food consumption by young children (Hobden & Pliner, 1995; Hendy, 2002). The occurrence of increased consumption, with companionship, is further strengthened when conversation with companions surrounds the importance of nutrition, nutritional explanations and discussions of the nutritional value of the foods being eaten during that meal (Anliker *et al*., 1990).

Companions' attitude, as models of behaviour towards the food being eaten, also plays a vital role in the food acceptance of children (Bandura, 1979). Lindsay *et al.* (2006) explain that it is difficult to encourage or intervene in children's consumption of vegetables, when certain members of the family are displaying attitudes and behaviours that are counteractive to this goal. When children observe parents and siblings eating and enjoying foods they do not prefer, the positive attitude the family creates surrounding the non-preferred foods, encourages children to consume that very food (Hobden & Pliner, 1995).

Regularity of family dinners is also associated with higher dietary quality and healthier dietary patterns in young children (Gillman *et al*., 2000). Cooke *et al.* (2004) provide several reasons for this occurrence: foods served at regular family dinners are more likely to be freshly prepared from scratch; eating and enjoying foods during regular family dinner encourage children's intake of these foods; and eating together possibly promotes family conversations concerning healthy eating. The presence of these three components shapes and guides young children's food behaviour towards healthier food habits and overall healthy lifestyles.

In-the-home-eaten-meals are most often also strongly correlated with children's vegetable consumption habits. Sweetman *et al.* (2011) report that main meals taken in front of the television are linked to lower preference for and intake of vegetables. Television-meals are often associated with convenience and comprise of fast-foods, ready-prepared foods and/or processed foods. These foods are known for their inferior dietary quality in comparison to meals prepared from scratch, and contain high levels of fat, Na and sugar, while fibre and micro-nutrients are sparse (Timperio *et al*., 2007; Sweetman *et al*., 2011).

Parents lay central to the creation of a home and family environment that foster a firm foundation for healthy habits (Birch *et al*., 2007; Anzman *et al*., 2010). Parents are, thus, vital in shaping, not only children's dietary practices, but also their sedentary behaviours and overall health status throughout life. Parents can shape children's food habits directly and indirectly. Wardle and Cook (2008) provide three ways in which parents directly dictate what children eat: by choosing which foods are made available in the home; how foods are prepared; and portion sizes. Indirectly, parents influence what children eat by means of their own nutritional knowledge, food choices and food behaviour (Lindsay *et al*., 2006). Children's daily consumption of fruit and vegetable is also closely related to their mothers' consumption patterns of fruit and vegetables (Kinder & Green 1978; Miller *et al*., 2011).

Birch and Davidson (2001) have identified two very distinctive aspects of parental control: restriction of certain foods; and pressure to eat other foods. Restriction of food refers to the act of limiting a child's access to certain foods, mostly high-sugar and fatty foods. Pressure to eat refers to the act of pressurised encouragement to consume healthy foods, such as vegetables, often followed by the promise of a reward of a restricted food (Wardle *et al*., 2005). Many parents instinctively argue that these feeding practices would positively effect and increase children's consumption of healthy foods, while decreasing the consumption of unhealthy foods (Birch *et al*., 1982; Newman & Taylor, 1992). However, research by Fisher and Birch (1999) found that by restricting the availability of certain foods, parents establish a strengthened preference for the forbidden food, while creating resentment for foods children are pressurised to eat.

Three distinct parenting styles and their effect on child consumption habits have also been identified (Taylor *et al*., 2005). The authoritarian parenting style uses orders, directions, guidelines and bullying to obtain the desired outcomes (Heptinstall *et al*., 1987). Parents will employ food as a bonus or penalty, using high-fat and high-sugar foods as rewards, while restricting the intake of "junk food"; both actions create preference (Birch *et al*., 1984; Casey & Rozin, 1989; Newman & Taylor, 1992). Once the child gains access to a restricted food or the restriction is lifted, children's intake of these foods increases tremendously (Birch, 1998; Fisher & Birch, 1999; Gillman *et al*., 2000; Nicklas *et al*., 2001; Videon & Manning, 2003).

The permissive parenting style is described as a less strict parenting style and follows a no power trend of "letting the child eat what he/she wants" (Nicklas *et al*., 2001).

This type of parenting style is strongly associated with inappropriate snacking and consumption of very large quantities of high energy foods, giving way to weight gain and obesity (De Bourdeaudhuij, 1997). Therefore, it is negatively associated with children's vegetable intake and shows increased levels of fat consumption, with decreased fibre, micro-nutrient intake and children ranking amongst the lowest 10.0% in terms of dietary quality (Eppright *et al.*, 1970).

The authoritatively parenting style is based on a foundation of understanding, led by questions, compromises and discussion, to help form and guide children's perception and conduct, regarding food choices and control (Iannotti *et al.*, 1994). This is the only parenting style positively associated with vegetable intake and portion control of young children (Nicklas *et al.*, 2001). Common approaches used may include: leaving food decisions to the child; using discussion as a method to persuade children to eat healthy foods; providing children with small quantities when introducing novel foods; and explaining to children the benefits of the healthy foods on their plates (Seagren & Terry, 1991; Cousins *et al.*, 1993).

From the discussion above, it is clear that parents' nutritional knowledge influences the type of foods bought, their nutritional quality and variety, and, thus, also food accessibility and portion size (Gibson *et al.*, 1998; Davison & Birch, 2001; Zive *et al.*, 2002). At the core of the family's dietary quality lays the mother's nutritional knowledge and attitude, which is especially influential, forming a strong connection between mother and child nutritional knowledge and attitude (Gibson *et al.*, 1998; Howard *et al.*, 2012). This is supported by Anliker *et al.* (1990), who found that there is a definite exchange of nutritional knowledge and health alertness between mothers and children as young as pre-school.

Furthermore, mothers' attitudes towards vegetables also strongly dictate the vegetables children are subjected to (Howard *et al.*, 2012). Mothers tend to avoid exposing children to vegetables they themselves do not like, and in doing so, creates food choosiness, due to decreased contact (Cooke *et al.*, 2004; Dovey *et al.*, 2008). Similar findings are reported by Gibson *et al.* (1998), who also found a convincing and impartial relation between mothers and their children's nutritional knowledge, food preference and dietary quality.

The aims of this study were, to determine the parents/caretaker's knowledge and attitude towards vegetables, and how conscious they are about their family's health, portion sizes, food safety and food security.

3.2 MATERIALS AND METHODS

3.2.1 Data collection

Data were collected from white, black and coloured respondents from eight provinces (Gauteng, Western Cape, Northern Cape, Eastern Cape, Free State, KwaZulu Natal, Northern Province, North West and Limpopo) in SA during 2016, on a self-completion questionnaire (ANNEXURE 1). Honours students handed out questionnaires during their winter break at home. The questionnaires were administered at the Department of Consumer Science, Agricultural Building of the Free State University, Bloemfontein, SA. Consumers (*n* = 173), 33 males and 140 females, completed the questionnaire to determine consumers' knowledge about and attitude towards vegetables.

3.2.2 Knowledge about vegetables-questionnaire

Part 1 of the questionnaire on knowledge about vegetables consisted of 29 questions, which had a specific right or wrong answer (Table 3.1). For better interpretation, the questions were grouped into specific sections in this table, while for respondents the questions were shuffled. Included were questions on familiar vegetables, such as pumpkin ("pumpkin should always be sweet"), starchy vegetables ("potato is a vegetable"), synonyms for familiar vegetables ("zucchini, courgette and baby marrows are not the same"), age and the consumption of vegetables ("babies under one year need vegetables"), relatively unknown vegetables ("artichoke is not a vegetable") and portion sizes ("you need five portions of vegetables per day"). Knowledge were, therefore, tested on preparation of vegetables, unfamiliar vegetables, names of vegetables, "new" vegetables,

Table 3.1: Knowledge about vegetables – questions and correct answers, according to literature

NO	QUESTION	YES	NO	REFERENCE
1	Pumpkin should always be sweet.		✓	Fox *et al.*, 2004.
2	Eggplant, brinjal and *aubergine* are all the same type of vegetable.	✓		Brown, 2015.
3	Artichoke is not a vegetable.	✓		Brown, 2015.
4	You are not supposed to eat vegetables that grow under the ground.		✓	Brown, 2015.
5	You can substitute green vegetables with potatoes.		✓	Brown, 2015.
6	Squash is for babies.		✓	Brown, 2015.
7	Babies under one year need vegetables.	✓		Brown, 2015.
8	The older you get, the less vegetables you need.		✓	Brown, 2015.
9	You have to eat vegetables only every second day.		✓	Brown, 2015.
10	I will consume genetic manipulated vegetables.	✓		Mercenier *et al.*, 2001
11	Vegetables are better when it is cooked.		✓	Key, 2010.
12	Cauliflower rice is not a vegetable.		✓	Noakes, 2014.
13	*Zucchini*, *courgettes* and baby marrows are not the same.		✓	Kays & Silva Dias, 1995.
14	You need five portions of vegetables per week.		✓	Frobisher & Maxwell, 2003.
15	You need five portions of vegetables per day.	✓		Frobisher & Maxwell, 2003.
16	A portion is as big as your fist.	✓		Frobisher & Maxwell, 2003.
17	The size of the plate determines the size of a portion.		✓	Frobisher & Maxwell, 2003.
18	You only check portions when you are dieting.		✓	Frobisher & Maxwell, 2003.
19	If you are hungry, the portion size is not applicable.		✓	Frobisher & Maxwell, 2003.
20	The portion size of meat can be bigger than all the vegetables on your plate.		✓	Frobisher & Maxwell, 2003.
21	The time of the day determines the portion size.		✓	Frobisher & Maxwell, 2003.
22	An extra little bit will not have an effect on the portion size.		✓	Frobisher & Maxwell, 2003.
23	Potatoes are vegetables.	✓		Brown, 2015.
24	Sweet potato can be purple	✓		Woolfe, 1992.
25	Red potatoes can only be used in salad.		✓	Lachman & Hamouz, 2005.
26	Sweet potato is not a vegetable		✓	Woolfe, 1992.
27	Gnocchi is made from potato.	✓		De Vita, 2009.
28	You can replace peas with potato.		✓	Brown, 2015.

('cauliflower rice is not a vegetable'), serving sizes, nutrition for babies and the elderly, and new cultivars. Attention was given to questions that had a 50/50 split result, thereby indicating that the respondents did not know the correct answer. A very high percentage found for a "wrong" answer to a specific question, also served as indication that there was a lack of knowledge in that area.

3.2.3 Development of research hypotheses

According to the method described by Michaelidou and Hassan (2008), the following hypotheses were represented via the conceptual model, as to depict family_health-consciousness, food_safety_consciousness, vegetables_are_healthy and vegetables_are_pleasant, as forerunners of consumers' attitude towards vegetables (Figure 3.1). These forerunners were categorised as independent variables, while an attitude towards vegetables (a direct measurement) was categorised as the dependent variable. The researchers hypothesized that:

- H1: family_health_consciousness will positively affect attitude towards vegetables;
- H2: food_safety_consciousness will positively affect attitude towards vegetables;
- H3: vegetables_are_healthy will positively affect attitude towards vegetables; and
- H4: vegetables_are_pleasant will positively affect attitude towards vegetables.

3.2.4 Questionnaire development

The survey instrument was based on prior literature, with attitude measures developed as suggested by Ajzen (1991), Francis *et al*. (2004), and Michaelidou and Hassan (2008). Part II ('Attitudes') included Likert scale statements and three open ended questions: 'What do you believe are the advantages of eating vegetables?'; 'What do you believe are the disadvantages of eating vegetables?'; and 'Please indicate if there is anything else you associate with eating vegetables?'. In part III ('Demographics'), demographical information, such as gender, age, population group, highest level of education and household income, was collected. Table 3.2 provides examples of the questions in part II of the questionnaire. Demographical variables were used to detect whether these variables could be linked to consumers' knowledge of vegetables.

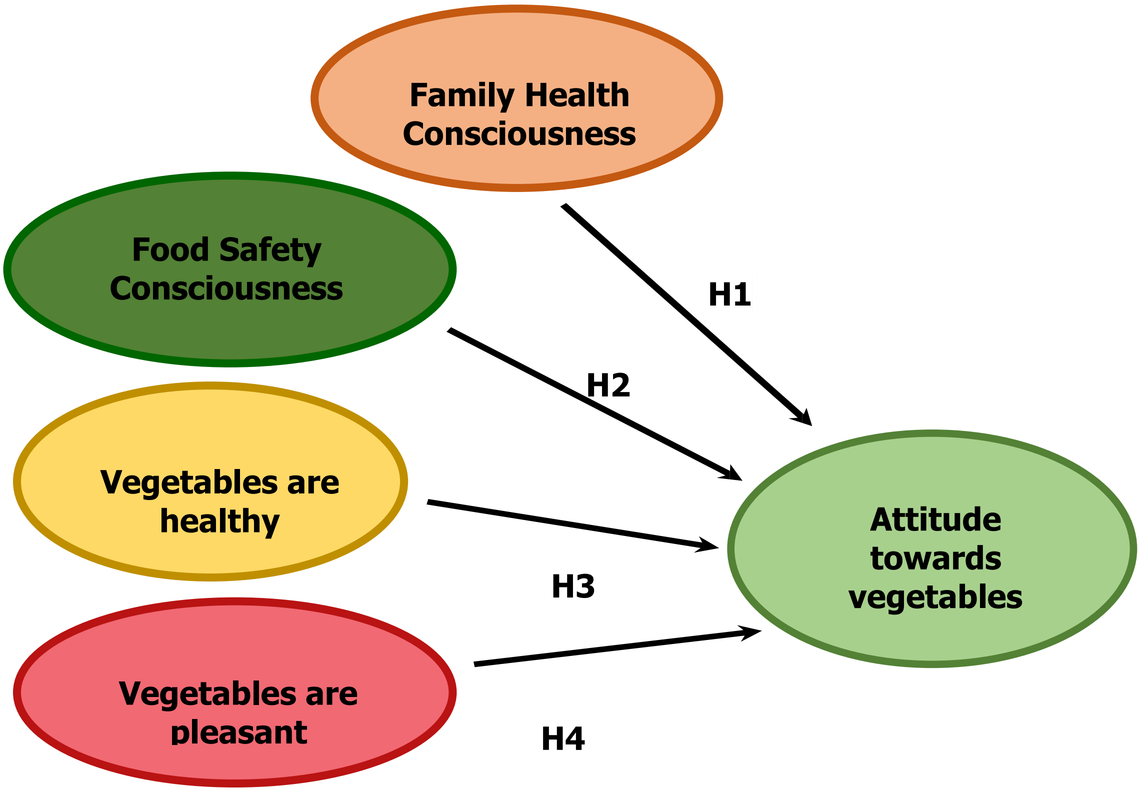

Figure 3.1: Conceptual model (adapted from Michaelidou & Hassan, 2008; Mielman, 2014)

Table 3.2: Examples of questions used to measure consumers' attitudes towards vegetables

Statements	Domain	Example	Points
1 – 6	Family_health_consciousness	'I reflect a lot about my family's health	-2 = strongly disagree +2 = strongly agree
7 – 9	Food_safety_consciousness	'Nowadays most food contain residues from chemical sprays and fertilizers'	-2 = strongly disagree +2 = strongly agree
14, 15; 28 -30	Vegetables_are_healthy	'Vegetables are natural products'	-2 = strongly disagree +2 = strongly agree
16 -19	Vegetables_are_pleasant	'Vegetables have a pleasant taste'	-2 = strongly disagree +2 = strongly agree
24 – 27	Overall_attitude	'Overall I think that eating vegetables is pleasant'	-2 = strongly disagree +2 = strongly agree

3.2.5 Thematic analysis (qualitative data)

In part II of the questionnaire, open-ended questions (qualitative data) were asked, to obtain unrehearsed answers from participants (Delport, 2005). Thematic analysis was used to produce clear and interpretable data (Kruger *et al.*, 2005). This is a method to identify themes or groupings in a document, the latter being type of text (Trochim & Donnelly, 2008). Similar statements from participants (n = 101) were filed into categories and sub-categories, from repeated occurrence (Strauss, 1987). All findings were tabulated and the categories were coded to quantitative data. According to Trochim and Donnelly (2008), all qualitative data can be coded quantitatively.

3.2.6 Statistical analysis

Frequencies and percentages of responses to the various questions in the knowledge questionnaire were calculated, both overall for the three groups combined, and separately per group, using SAS Proc FREQ (SAS, 2013).

Descriptive statistics of the averages of the various domains of the attitude questionnaire were calculated, both overall for the three groups combined, and separately per group. For questions not included into one of the domains (namely questions A10-A13, A20-A23 and A31-A35), descriptive statistics of the responses to these questions, one question at a time, were also calculated, both overall for the three groups combined and separately per group. Furthermore, for those single questions, frequencies and percentages of the responses to the various questions were calculated, again overall for the three groups combined and separately per group.

The questionnaire domains were defined as follows: family_health_consciousness (A1-A6); food_safety_consciousness (A7- A9); vegetables_are_healthy (A14, A15, A28 - A30); vegetables_are_pleasant (A16 - A19); and overall_attitude (A24 - A27). For each respondent the average score of the above domains was calculated and then presented, using descriptive statistics and analysed further statistically. Software that was used for these analyses included SAS Proc TABULATE and SAS Proc FREQ (SAS, 2013).

For the knowledge questions, the number of correct answers for each respondent was calculated, both for all 28 questions, and for each of the two categories knowledge_about_vegetables (K1 - K13 and K23 - K28) and knowledge_about_portion_sizes (K14 - K22). The proportions of correct answers were calculated by group and those proportions were compared by calculating the between-group differences of the proportions of correct answers, together with 95.0% confidence intervals and p-values.

This statistical analysis was carried out by fitting a generalized linear model to the data, specifying a binomial distribution and the identity link function. Binomial over-dispersion was accounted for by estimating the scale parameter, using the Pearson chi-square goodness-of-fit statistic and SAS Proc GENMOD (SAS, 2013).

For the attitude domains defined above, Cronbach alpha coefficients were calculated, using SAS Proc CORR (SAS, 2013). These coefficients were used as measures of internal consistency, to determine the reliability of the factor analysis and to detect the domains (family_health_consciousness, food_safety_consciousness, vegetables_are_healthy, vegetables_are_pleasant and overall_attitude) connexion to each other.

Pearson correlation coefficients were calculated for all pairs of the attitude domains defined above, both overall for the three groups combined and separately per group.

It should be mentioned here that the score for the overall-attitude domain was five (out of five) for every respondent in the black group; therefore, correlations involving this domain could not be calculated.

SAS Proc CORR was used for these analyses (SAS, 2013). Using the Pearson correlation coefficient, inter-correlations between variables were performed. Correlation is used to look at the 'net strength' relationship between two continuous variables (Jaafar *et al.*, 2012). In this study, correlation was used as the predicted change in the value of the dependent variable (i.e., attitudes towards vegetables), for one-unit change in the independent variable (i.e., family_health_consciousness, food_safety_consciousness, vegetables_are_healthy, vegetables_are_pleasant and overall_attitude).

Overall_attitude was regressed against the other domains of the attitude questionnaire listed above, both overall for the three groups combined, and separately per group. In the overall analysis (three groups combined), the factor group was also fitted in the regression model, using SAS Proc GLM (SAS, 2013).

Multiple linear regression was used to explain the dependent variable, 'attitude direct measurement' by four other predictor variables (i.e. family_health_consciousness, food_ safety_consciousness, vegetables_are_healthy and vegetables_are_pleasant). Multiple linear regression is applied to examine how two or more variables act together to affect the dependent variable and it is an equation that represents the best prediction of a dependent variable, from several independent variables (Jaafar *et al.*, 2012).

3.3 RESULTS AND DISCUSSION

3.3.1 Demographic profiling of respondents

Table 3.3 summarizes the demographic composition of the respondents who took part in the questionnaire. In each case, there were higher percentages of females to males completing the questionnaires. More white and coloured males (24.0% and 20.0%) took part, with only 13.7% black male respondents. Husbands and fathers take on an indirect and supportive role, providing food for the family and financial resources (Aubel, 2012).

The age range of the coloured group was 70.0% for 33 to 65 years, 30.0% for 18 to 32 years, excluding the extremes of the age range. In contrast, for the black group, 42.5% were older than 65 years and 31.5% were 18-32 years old, with only 20.6% in the age group 33 to 65 years. Ethno-graphic research done in low-resource settings across SA, Namibia and Swaziland found that mothers mainly rely on their own mothers and other elderly female family to care for their children. A woman's child does not belong only to her and her husband. The grandmothers (maternal and paternal) and other older family kin feel responsible and are collectively involved in child care and feeding (Buskens *et al.*, 2007) For the white participants, the highest percentage

(52.0%) was between 33 and 65 years, followed by 36.0% for the age range 18 to 32 years. Only 4.0% were older than 65 years and 8.0% younger than 18 years.

Table 3.3: Demographic profile (%*) of black, coloured, white and all respondents

	Black n=73	Coloured n=50	White n=50	All Respondents n=173
GENDER				
Male	13.7	20.0	24.0	18.5
Female	86.3	80.0	76.0	81.5
AGE				
Younger than 18 years	5.5	0.0	8.0	4.6
18 to 32 years	31.5	30.0	36.0	32.4
33 to 65 years	20.5	70.0	52.0	43.9
Older than 65 years	42.5	0.0	4.0	19.1
LOCATION				
Gauteng	0.0	0.0	12.0	3.5
Western Cape	0.0	0.0	2.0	0.6
Northern Cape	0.0	0.0	2.0	0.6
Eastern Cape	0.0	100.0	4.0	30.0
Free State	1.4	0.0	64.0	19.1
KwaZulu Natal	95.9	0.0	0.0	40.5
Northern Province	0.0	0.0	0.0	0.0
North West	0.0	0.0	16.0	4.6
Limpopo	2.7	0.0	0.0	1.1
HIGHEST LEVEL OF EDUCATION				
Some Primary	0.0	0.0	0.0	0.0
Primary completed	2.7	0.0	0.0	1.2
Some High	26.0	2.0	6.0	13.3
Grade 12	24.6	48.0	30.0	33.0
Technical University diploma/degree	12.3	30.0	18.0	19.0
University degree	24.7	16.0	40.0	26.0
Other	9.7	4.0	6.0	7.5
LEVEL OF INCOME (per annum)				
R0 - R100 000	71.2	74.0	70.0	71.7
R101 000 - R500 000	21.9	16.0	24.0	20.8
R501 000 - R750 000	6.9	8.0	6.0	6.9
More than R750 000	0.0	2.0	0.0	0.6
DIET TYPE				
None	100.0	96.0	70.0	90.2
Banting (high protein, low carbs)	0.0	2.0	18.0	5.8
Weight watchers	0.0	0.0	2.0	0.5
Vegetarian	0.0	0.0	8.0	2.3
Vegan	0.0	0.0	0.0	0.0
Pescaterian (only fish as major protein)	0.0	2.0	2.0	1.2

*According to official statistician of UFS, one decimal is sufficient with percentages (Schall, 2017).

Ninety-five-point nine percent of the black respondents came from KwaZulu Natal and only 1.4% from the Free State. All the coloured respondents were from the Eastern Cape (East London). Sixty-four-point zero percent of the white respondents were from the Free State, with 12.0% from Gauteng, 2.0%, 4.0% and 2.0% each from the Western Cape, Eastern Cape and Northern Cape, and 16.0% from North West.

Forty-point-zero percent of the white respondents had a university degree, followed by 24.7% of the black respondents and only 16.0% of the coloured group. Ninety-four-point zero percent of the coloured, 88.0% of the white and 61.7% of the black respondents completed matric and achieved some or other technical university diploma/degree or university degree. This is an indication that all these respondents should be knowledgeable about nutrition. Only 2.7% of the black respondents completed primary school and 26.0% did not complete high school. Six-point-zero percent of the white respondents did not complete high school, while only 2.0% of the coloured respondents dropped out.

Most coloured (74.0%), black (71.2%) and white (70.0%) participants had an income of R0 - R100 000 per year, placing them in the second lowest income group in SA. Twenty-four-point zero percent of the white, 21.9% black and 16.0% coloured participants earned R101 000 – R500 000 per year (emerging middle class). Six-point-zero percent white, 8.0% coloured and 6.9% black participants earned R501 000 – R750 000 per year, placing them in the lower middle class income bracket. Two-point-zero percent of the coloured group’s income were more than R750 000 per year, placing them in the upper middle class in SA (Hunter 2016).

None of the black respondents was on any diet during the completion of the questionnaire. Low-income groups traditionally spend proportionally more of their income on food than higher income groups. People on low incomes tend to consume less fruit and vegetables, and this is believed to contribute to current social health inequalities. They also have a greater tendency to consume unhealthy diets and develop chronic diseases at an earlier stage. Healthy food is more expensive and because of this and the availability thereof, special diets are not an option for low-income consumers (Dibsdall *et al.*, 2002). Seventy-point-zero per cent of the white respondents and 96.0% of the coloured respondents were not on any diet. Diets followed by the white respondents were banting (18.0%), Weight Watchers' (2.0%), vegetarian (8.0%) and pescaterian (2.0%). Only 2.0% of the coloured participants were pescaterian. Of these diets, Weight Watchers' encourages the consumption of vegetables and allows four portions of vegetables per day, as well as unlimited amounts of their so-called free vegetables (Weigh Less, 2016; Weight Watchers, 2016). Vegetarians, for obvious reasons, consume many vegetables daily (Key *et al.*, 2007), while pescaterians cut out all meat products, except fish, which is eaten with starch and vegetables (Kaplan & Bahnmaier, 2015). The only diet of concern, regarding the consumption of vegetables, is banting, which prohibits the eating of most vegetables and allows limited daily amounts of specific vegetables. This is due to the high sugar (carbohydrate) content of vegetables, which as the vegetable matures, turns into starch. Banting has its foundation in the exclusion of all starch (Noakes *et al.*, 2014).

3.3.2 Consumers' knowledge of vegetables

Table 3.4 is a summary of the percentages of coloured, black, white and all respondents' knowledge about vegetables. The first and last two questions did not have a specific correct answer. Only the coloured group did not score 100.0% on the first question "do you know what vegetables are". Twenty-eight questions followed that had specific correct or wrong answers (Table 3.1).

Both the coloured (72.0%) and white (66.0%) respondents indicated that pumpkin should not always be eaten sweet. However, the overwhelming response of the black respondents of 94.5% (only 5.5% disagree with the statement that pumpkin should be sweet) shifted the result for all respondents to an almost 50/50 split (Table 3.4). A study done by Charlton *et al*. (2004), found that 46.9% of their respondents strongly agreed that black people have been brought up eating sugar. Almost 64.2% of the subjects in that study agreed that 'too much sugar makes a person fat'. Traditionally and culturally a larger body size in the black women are acceptable (Mvo *et al.*, 1999). Their research also found that being obese is perceived to reflect affluence and happiness in many sectors of the SA black population (Mvo *et al.*, 1999). All groups were familiar with the synonyms for eggplant, with the coloured group having the

Table 3.4: Percentages* of coloured, black, white and all respondents' knowledge about vegetables

QUESTIONS	COLOURED		BLACK		WHITE		ALL RESONDENTS	
	YES	NO	YES	NO	YES	NO	YES	NO
Do you know what vegetables are?	98.0		100.0		100.0		99.4	
Pumpkin should always be sweet.		72.0		5.5		66.0		42.2
Eggplant, brinjal and aubergine are all the same type of vegetable.	66.0		83.6		78.0		76.9	
Zucchini, courgette and baby marrows are not the same.		78.0		26.0		54.0		49.4
Artichoke is not a vegetable.	24.0		35.6		42.0		34.1	
Cauliflower rice is not a vegetable.		82.0		38.4		82.0		63.6
You are not supposed to eat vegetables that grow under the ground.		88.0		91.8		86.0		89.0
Potato is a vegetable	69.0		100.0		96.0		97.7	
Sweet potato is not a vegetable.		92.0		97.3		82.0		91.3
Sweet potato can be purple.	86.0		79.5		86.0		83.2	
Red potatoes can only be used in salad.		82.0		45.2		82.0		66.5
Gnocchi is made from potato.	76.0		16.4		66.0		48.0	
You can substitute green vegetables with potatoes.		78.0		91.8		66.0		80.4
You can replace peas with potato.		76.0		100.0		54.0		52.6
Babies under one year need vegetables.	84.0		41.1		84.0		65.9	
Squash is for babies.		90.0		68.5		70.0		75.1
The older you get, the less vegetables you need.		94.0		98.6		88.0		94.2
You have to eat vegetables only every second day.		92.0		90.4		76.0		86.7
You need five portions of vegetables per week.		68.0		5.6		20.0		27.9
You need five portions of vegetables per day.	64.0		49.3		14.0		42.8	
I will consume genetic manipulated vegetables.	10.0		20.6		48.0		25.4	
A portion is a big as your fist.	60.0		83.6		84.0		76.9	
The size of the plate determines the size of the portion.		84.0		69.9		80.0		76.9
You only check portions when you are dieting.		88.0		72.6		76.0		78.0
If you are hungry, the portion size is not applicable.		82.0		80.8		80.0		80.9
The portion size of meat can be bigger than all the vegetables on you plate.		82.0		84.9		70.0		79.8
The time of the day determines the portion size.		86.0		93.2		66.0		83.2
An extra little bit will not have any effect on the portion size.		66.0		28.8		74.0		52.6
Vegetables are better when it is cooked.		66.0		94.5		56.0		75.1
In which form do you consume vegetables? Raw/Fresh	78.0	22.0	100.0	0.0	74.0	26.0	86.1	13.9
In which form do you consume vegetables? Cooked	96.0	2.0	100.0	0.0	96.0	4.0	97.7	2.3

*According to official statistician of UFS, one decimal is sufficient with percentages (Schall, 2017). Percentages are only indicated for correct answers.

lowest percentage (66.0%). For the zucchini synonyms, 78.0% of the coloured and 54.0% of the white respondents got it right, while only 26.0% of the black respondents knew that they were synonyms. Similarly, all groups knew that the artichoke is not a vegetable, with the white group having the highest percentage (42.0%). The new 'it' vegetable, cauliflower rice, was known to 82.0% of both the white and coloured respondents. This is because of the 'banting' diet, which was made (in) famous by Dr Tim Noakes and is for all purposes a westernised phenomenon (Noakes *et al.*, 2014). Only 38.4% of the black respondents were familiar with cauliflower rice and could not identify it as a vegetable. Furthermore, all groups knew their root vegetables, indicated by their knowledge that vegetables which grow under the ground are edible.

A few questions dealt with potato and sweet potato as starchy vegetables. Ninety-six-point zero percent of white and coloured respondents, and 100.0% of black respondents agreed that potato is a vegetable, while only 82.0% of the white respondents, and 97.3% and 92.0%, respectively, of the black and coloured groups were sure that sweet potato is also a vegetable. This is because in popular westernised diets, such as Weight Watchers and Weigh Less, potatoes and sweet potatoes are categorized as starches and are, thus, limited in these diets (Weigh Less, 2016; Weight Watchers, 2016). According to 83.2% of all respondents, sweet potato can also be purple in colour. Eighty-two-point zero percent of the coloured and white respondents disagreed that red potatoes could only be used for salads, indicating that they knew about this relatively new cultivar in SA (Lachman & Hamouz, 2005). In the black group, 45.2% disagreed on whether red potatoes could be used for more than just salads, indicating that they were unfamiliar with this new potato cultivar. Furthermore, gnocchi, which is a specialised dish made with mash potatoes and flour, was only known to 66.0% of white respondents, 16.4% of black respondents and 76.0% of coloured respondents, which is a bit surprising, as it is a classic Italian dish, served in many upmarket restaurants in SA (De Vita, 2009). Only 66.0% per cent of the white respondents knew that you could not substitute green vegetables with potatoes, while the other groups (black and coloured) were more confident about this fact, with 91.0% and 78.0%, respectively. There were 54.0% in the white group who disagreed on the replacement of peas with potato, as in favourite diets, peas are categorized as a starch, due to the high content of sugar it contains during the young stage, which is turned into starch upon aging (Brown, 2015). Hundred-point-zero percent of the black participants and 76.0% of coloured participants disagreed on the replacement of peas with potato. Despite being recognised as a starchy vegetable, people still regard peas as a green vegetable, due to its colour.

Answers to the questions on different age requirements for and frequencies of having vegetables were quite interesting. On the statement 'babies under one year need vegetables', 41.1% of the black respondents agreed and 58.9% disagreed. For the coloured and white respondents, 84.0% answered affirmative. Surprisingly, only 68.5% of the black and 70.0% of the white respondents recognised that squash is not just for babies, while 90.0% of the coloured respondents knew this fact. Of the white respondents, 88.0% disagreed on the statement that 'the older you get, the less vegetables you need', while 98.6% black and 94.0% coloured respondents disagreed on this statement.

On the suggestion of eating vegetables every second day, the coloured and black respondents disagreed with 92.0% and 90.4%, respectively, while only 76.0% white respondents answered no. There was confusion amongst the white group whether one should eat five portions vegetables per day (14.0% agreed) or per week (20.0% disagreed). Only 5.6% of the black group disagreed that one needed five portions of vegetables per week, while 49.3% of them agreed that one needed five portions of vegetables per day. Sixty-eight-point zero percent of the coloured group disagreed that one needed five portions of vegetables per week, while 64.0% agreed that one needed five portions of vegetables per day.

There were still major misconceptions about the consumption of genetically manipulated vegetables among the coloured and black respondents, because only 10.0% and 20.6%, respectively, agreed to its consumption. For the white respondents there were 48.0% who agreed on this matter, indicating that this possibly group has more information on the positive aspects of genetically manipulated food.

A series of questions were asked on portion sizes. On a question regarding the size of a vegetable portion, the white and black respondents agreed with 84.0% and 83.6%, respectively, that it was as big as your fist, while only 60.0% of the coloured group agreed to this. Both the coloured and white group knew that the size of the plate did not determine the size of the portion (84.0% and 80.0%, respectively), while the black respondents were less sure, with 69.9%. All three groups felt equal about the fact that one did not only check for portion size when dieting and that the portion size was not bigger when one was hungry. The coloured and black respondents agreed with 82.0% and 80.8%, respectively, that the portion size of meat could not be bigger than all the vegetables on the plate, while the white group agreed with only 70.0%. There was a tendency amongst white respondents that time of day might have something to do with portion size, as only 66.0% disagreed on this statement. It is common practice in westernised countries to eat bigger portions during lunch time and smaller portions towards the evening, to lessen the impact on the digestive system during the night (De Castro, 2007). The black and coloured groups felt that time of day had nothing to do with portion size (93.2% and 86.0%, respectively). There was quite a difference between the different groups' opinions on whether an extra little bit would influence portion size. The white and coloured groups disagreed with 74.0% and 66.0%, respectively, while the black group disagreed with only 28.8%.

More white respondents preferred to eat vegetables cooked (96.0%) than raw (74.0%). Hundred-point-zero percent of black respondents indicated that they would eat vegetables both cooked and raw. More coloured respondents indicated that they would eat vegetables cooked (96.0%) than raw (78.0%).

Table 3.5 summarizes the probability of the different groups of respondents being correct on the knowledge questions. For knowledge of portion sizes of vegetables, the coloured respondents had the most correct answers with 68.4%, followed by the white respondents with 58.2% and black respondents with 55.3%. The coloured respondents answered 13.2% more answers correctly than the black group, which was highly significant ($p<0.0001$). Also, highly significant ($p=0.0011$) was the 10.2% that the coloured group knew more about portion sizes than the white respondents did. The comparison for the black and white group was not statistically significant ($p=0.3185$). The percentage correct responses for the black respondents were 2.9% lower than for the white group. For this comparison the difference was, thus, negative (-2.9), because the percentage correct responses for the black group was lower than for the white group, for all questions.

Table 3.5: Probability of black, coloured and white groups of being correct on knowledge questions

Knowledge of portion sizes of vegetables (Q2.19 - 2.28)

%* correct answers of respondents			Difference of group					
			Coloured - Black		Coloured - White		Black - White	
Black	Coloured	White	%*	p-value	%*	p-value	%*	p-value
55.3	68.4	58.2	13.2	<0.0001	10.2	0.0011	-2.9	0.3185

Overall knowledge of vegetables (Q2.1 - 2.18)

%* correct answers of respondents			Difference of group					
			Coloured - Black		Coloured - White		Black - White	
Black	Coloured	White	%*	p-value	%*	p-value	%*	p-value
64.5	75.4	71.7	10.9	<0.0001	3.7	0.1419	-7.2	0.0027

Knowledge on all Questions (Q2.1 - 2.29)

%* correct answers of respondents			Difference of group					
			Coloured - Black		Coloured - White		Black - White	
Black	Coloured	White	%*	p-value	%*	p-value	%*	p-value
61.5	73.1	63.4	11.7	<0.0001	5.8	0.0155	-5.9	0.0105

*According to official statistician of UFS, one decimal is sufficient with percentages (Schall, 2017).

For overall knowledge on vegetables, the coloured group again had the most correct answers with 75.4%, followed by the white respondents (71.7%) and the black respondents (64.5%) (Table 3.5). When comparing the groups, the coloured group again knew significantly ($p<0.0001$) more about vegetables than the black group (10.9%). The comparison for the coloured and white group was not statistically significant ($p=0.1419$), because the percentage correct responses for the coloured respondents was only 3.7% higher than for white respondents. However, for these questions, the comparison for the black and white group was statistically significant (p=0.0027). The percentage correct responses for the black group were 7.2% lower than for the white group. This comparison's difference was again negative (-7.2), because the percentage correct responses for the black respondents was, for all questions, lower than for the white respondents.

For knowledge on all questions, the coloured group, thus, had the most correct answers with 73.1%, followed by the white group (63.4%) and the black group (61.5%) (Table 3.5). When comparing the groups, the coloured respondents had 11.7% more knowledge than the black respondents (p<0.0001). The comparison for the coloured and the white groups was statistically significant (p=0.0155), because the percentage correct responses for the coloured respondents was 5.8% higher than for white respondents. The comparison for the black and white group was again statistically significant (p=0.0105). The percentage correct responses for the black group were 5.9% lower than for the white group. This comparison's difference was again negative (-5.9), because the percentage correct responses for the black respondents was, for all questions, lower than for the white respondents.

These results could be verified by looking at the demographic profile of the respondents again (Table 3.3). The coloured group was far better educated on a technical level and earned more money than the white and black groups.

3.3.3 The role of family_health_consciousness, food_safety_consciousness, vegetables_are_healthy and vegetables_are_pleasant on consumers' attitudes towards vegetables

For the domain family_health_consciousness, six questions were asked (Table 3.6) and the coloured respondents agreed to strongly agree to all of them, in percentages varying from 18.0% to 72.0%, while the white respondents also agreed to strongly agree on all of them, in percentages varying from 26.0% to 46.0%. The results for all the respondents showed a trend moving from agreed (34.7%) to strongly agree (44.5%).

Table 3.6: Percentages* of coloured, black, white and all respondents' attitude towards vegetables

DOMAIN / QUESTIONS	COLOURED n = 50					BLACK n = 50					WHITE n = 50					ALL RESPONDENTS n = 173				
	-2	-1	0	1	2	-2	-1	0	1	2	-2	-1	0	1	2	-2	-1	0	1	2
FAMILY HEALTH CONCIOUSNESS:																				
I reflect about my family's health a lot	0.0	2.0	4.0	26.0	68.0	1.4	2.7	30.1	41.1	24.7	10.0	6.0	12.0	34.0	38.0	3.5	3.5	17.3	34.7	41.0
I'm very conscious about my family's health.	2.0	2.0	6.0	22.0	68.0	0.0	0.0	31.5	43.8	24.7	10.0	4.0	12.0	32.0	42.0	3.5	1.7	18.5	34.1	42.2
I'm alert to changes in my family's health.	2.0	0.0	2.0	20.0	76.0	0.0	0.0	31.5	43.8	24.7	8.0	6.0	14.0	30.0	42.0	2.9	1.7	17.9	33.0	44.5
I'm usually aware of my family's health.	4.0	0.0	4.0	20.0	72.0	0.0	0.0	27.4	49.3	23.3	6.0	12.0	10.0	26.0	6.0	2.9	3.5	15.6	34.1	43.9
I take responsibility for the state of my family's health.	4.0	2.0	4.0	18.0	72.0	0.0	1.4	27.4	47.9	23.3	10.0	4.0	22.0	32.0	32.0	4.1	2.3	19.0	34.7	39.9
I'm aware of the state of my family's health as we go through the day	2.0	2.0	6.0	26.0	64.0	1.4	1.4	39.7	34.2	23.3	8.0	10.0	16.0	40.0	26.0	3.5	4.1	23.1	33.5	35.8
FOOD SAFETY CONCIOUSNESS:																				
Nowadays most foods contain residues from chemical sprays and fertilizers.	0.0	0.0	2.0	64.0	34.0	53.4	4.1	35.6	5.5	1.4	8.0	8.0	16.0	36.0	32.0	24.9	4.1	20.2	31.2	19.6
I'm very concerned about the amount of artificial additives and preservatives in food.	0.0	0.0	8.0	54.0	38.0	53.4	1.4	38.3	5.5	1.4	4.0	4.0	12.0	32.0	48.0	23.7	1.7	22.0	27.2	25.4
The quality of and safety of vegetables nowadays concern me.	0.0	4.0	6.0	54.0	36.0	43.8	1.4	35.6	16.5	2.7	6.0	4.0	14.0	38.0	38.0	20.3	2.9	20.8	33.5	22.5
VEGETABLES ARE HEALTHY:																				
Vegetables is a natural product.	2.0	2.0	2.0	12.0	82.0	0.0	0.0	1.4	2.7	95.9	6.0	8.0	14.0	240	48.0	2.3	2.9	5.2	11.6	78.0
Vegetables is very healthy for me.	0.0	0.0	0.0	8.0	92.0	0.0	0.0	1.4	1.4	97.2	4.0	2.0	10.0	30.0	4.0	1.2	0.6	3.5	11.6	83.1
If we as a family eat vegetables, I will feel that I am doing something positive for the health and wellbeing of my family.	0.0	0.0	4.0	6.0	90.0	0.0	0.0	0.0	0.0	100.0	4.0	4.0	18.0	30.0	44.0	1.2	1.2	6.3	10.4	80.9
If we eat vegetables, I will feel that I add natural goodness to the family's meal.	0.0	4.0	0.0	4.0	92.0	0.0	0.0	0.0	0.0	100.0	4.0	4.0	16.0	24.0	52.0	1.2	2.3	4.6	8.1	83.8
If I am aware of the benefits of vegetables, I will feel more comfortable to eat vegetables.	2.0	4.0	2.0	2.0	90.0	0.0	0.0	0.0	0.0	100.0	6.0	4.0	18.0	26.0	46.0	2.3	2.3	5.8	8.1	81.5
Vegetables have a pleasant taste.	0.0	0.0	14.0	44.0	42.0	0.0	0.0	0.0	0.0	100.0	10.0	2.0	24.0	34.0	30.0	2.9	0.6	11.0	22.5	63.0
Vegetables have a pleasant smell.	2.0	4.0	40.0	30.0	24.0	0.0	0.0	0.0	0.0	100.0	8.0	4.0	46.0	14.0	28.0	2.9	2.3	24.9	12.7	57.2
Vegetables have a pleasant mouth feel.	0.0	6.0	34.0	42.0	18.0	0.0	0.0	0.0	1.4	98.6	2.0	4.0	40.0	22.0	32.0	0.6	2.9	21.4	19.0	56.1
Vegetables have a pleasant appearance	0.0	14.0	8.0	64.0	14.0	0.0	0.0	0.0	26	74.0	18.0	0.0	30.0	34.0	18.0	5.2	4.0	11.0	39.3	40.5
OVERALL ATTITUDE:																				
Overall, I think that eating vegetables is beneficial.	0.0	2.0	4.0	10.0	48.0	0.0	0.0	0.0	0.0	100.0	4.0	2.0	2.0	38.0	54.0	1.2	1.2	1.7	13.9	82.0
Overall, I think that eating vegetables is pleasant.	0.0	0.0	2.0	22.0	76.0	0.0	0.0	0.0	0.0	100.0	8.0	0.0	6.0	50.0	36.0	2.3	0.0	2.3	20.8	74.6
Overall, I think that eating vegetables is the right thing to do.	0.0	0.0	0.0	12.0	88.0	0.0	0.0	0.0	0.0	100.0	4.0	0.0	8.0	36.0	52.0	1.1	0.0	2.3	13.9	82.7
Overall, I think that eating vegetables is good practice	0.0	0.0	0.0	10.0	90.0	0.0	0.0	0.0	0.0	100.0	2.0	0.0	14.0	34.0	50.0	0.6	0.0	4.1	12.7	82.6

-2 = strongly disagree; -1 = disagree; 0 = neutral; 1 = agree; 2 = strongly agree
*According to official statistician of UFS, one decimal is sufficient with percentages (Schall, 2017).

According to Michaelidiou and Hassan (2008), health-conscious consumers are aware and concerned about their health and are motivated to improve and/or maintain their health. They are motivated to prevent ill health, by engaging in healthy behaviours and being self-conscious regarding health. Urala and Lähteenmäki (2004) also commented that health-related attitudes have become a very central and important aspect to many consumers, who form preferences based on health-related attitudes, motivated by expectations of both a longer life and a higher quality of life. Furthermore, in modern western societies, health is a central value, and governments focus their policies on health promotion and preventive measures against illnesses.

For many consumers, health has become a life-long project of keeping well and fit, including self-control and continuous work towards better health. In line with these developments, the healthy attributes of food and ways of eating are recurring themes in health policies, the media and everyday discussions around food (Niva & Mäkelä, 2007).

On the other hand, the black respondents were neutral to agreeing on all the questions on family_health_consciousness, from 23.3% to 49.7%. In a developing country, such as SA, a continuous, seeming invincible, battle is fought against human immunodeficiency virus (HIV) infection and one of the worst tuberculosis epidemics in the world. In addition, there is also the extensively drug-resistant (XDR) tuberculosis in rural areas and SA reports the most XDR tuberculosis cases in the world (Mayosi & Benatar, 2014). Healthcare in SA is such that black South Africans have less accessibility, especially in rural areas. Difficulties to attend follow-up appointments, transport cost and availability thereof, long waiting periods, large numbers of patients with only a few healthcare staff to treat them and lack of accessibility to medication at the clinics, lead to a disruption in continuity and may lead to poor adherence and patient dissatisfaction. An overall feeling of dejectedness takes place and people do not care anymore (Masango-Makgobela *et al.*, 2013).

Food_safety_consciousness had three questions and again the coloured (36.0% to 64.0%) and white (32.0% to 48.0%) respondents agreed to strongly agree on all of them. Pesticides should be lethal to targeted pests, but not to non-targeted species, including man. Benefits include improvement of productivity, protection of crop losses, direction of disease control and high quality food. Disadvantages are the serious health implications to man and his environment (Aktar *et al*., 2009), such as world-wide deaths and chronic diseases, which number about one million per year (Environews Forum, 1999). Besides contamination of food commodities, pesticides also contaminate the air, soil and non-target vegetation, insects, birds, fish and other wildlife. Although pesticides are often considered a quick, easy and inexpensive solution, it comes at a significant cost (Aktar *et al*., 2009).

On the other hand, the black group's consciousness of food safety differed a lot. Here the respondents disagreed strongly or remained neutral to all questions, with percentages ranging from 35.6% to 53.4%. This negative shift caused the result for all the respondents to remain at low values for agreement (33.5%) and strong agreement (25.4%). The reasons why this group was not concerned about food safety might be have a few different answers. Street vendors supply large numbers of food at affordable prices, particularly in developing countries. People are used to this type of food and cannot afford anything better. Instances have been reported of contamination of street foods with pathogenic microorganisms like *Shigella*, *Staphylococcus aureus* and *Salmonella.* These microorganisms were also found in boiled rice from four- and five-star hotels in Egypt. Furthermore, in some cases, hazardous chemicals and additives, and unauthorized colourants and preservatives have also been found in street foods (Abdussalam & Käferstein, 1993).

Other daily problems of consumers in developing countries, as well as street food vendors, are the following: keeping prices reasonable; purchasing raw materials of dubious quality by consumers, as well as vendors purchasing raw materials of dubious quality; inadequate storage, cooking and processing facilities in most cases; insufficient supply of water for washing, cleaning and cooking; and intermittent availability of piped drinking water. In addition, refrigeration is not always possible, and facilities for disposal of solid and liquid waste may be unsatisfactory (Abdussalam & Käferstein, 1993). Consumer attitudes and knowledge towards food safety in third world countries suggest that this issue may not be of much interest (Wilcock *et al*., 2004).

Five questions made up the domain of vegetables_are_healthy and here the coloured (82.0% to 92.0%) and black (59.9% to 100.0%) respondents agreed strongly. The white respondents again agreed to strongly agree, varying from a low percentage of only 24.0% to 54.0%. The result for all the respondents was an overwhelmingly strong agreement (83.8%). Urala and Lähteenmäki (2004) confirmed that the issue of naturalness is quite visible in the hierarchical value maps, indicating that consumers attach increasing importance to the way food is produced. Thus, assessments of the naturalness of foods seem to be correlated with sensory appeal (Steptoe *et al.*, 1995).

Furthermore, natural food is associated with better looks and better taste, in comparison to foods containing additives or artificial ingredients (Mac Fie, 2007). Fresh vegetables generally have few or no additives. Examples used in this industry include the ink diluent for marking fruit and vegetables, which is silicon dioxide, the wax with which cucumbers are coated to prevent moisture loss and the preservative EDTA (ethylene diamine tetra acetic acid) which may be present in canned vegetables, as well as salt and sucrose. Sodium bicarbonate (baking soda) is used to clean vegetables and to absorb excess acid in some canned products, such as soups, and may also be used, along with ascorbic acid, in picked vegetables. Butylated hydroxytoluene (BHT) and butylated hydroxyanisole (BHA) are preservatives and antioxidants that are used in dried potato flakes, cereals and other processed foods (Brown, 2015).

For the statement 'vegetables have a pleasant taste and smell' 100.0% of black respondents agreed strongly, while for pleasant mouth feel, 98.6% agreed strongly. On the statement 'vegetables have a pleasant appearance', 74.0% agreed strongly. This is because this group is non-tasters and can appreciate the mouth feel (Duffy & Bartoshuk, 2000). For the same question, vegetables have a pleasant taste', the coloured respondents agreed (44.0%) or agreed strongly (42.0%), while for a pleasant appearance, they mainly agreed (64.0%). On vegetables having a pleasant smell and mouth feel, the coloured respondents gave a neutral answer (40.0/34.0%), agreed (30.0/42.0%), and strongly agreed (24.0/18.0%). On all the questions in the vegetables_are_pleasant domain, neutrality crept in for the white respondents, along with agreement and strong agreement, now ranging from a low percentage of 14.0% (agreement on pleasant smell) to a high percentage of 46.0% (neutral on pleasant smell). Again, all respondents agreed strongly with 63.0% to 40.5% that vegetables are pleasant.

Sensory properties may be regarded as a disadvantage of eating vegetables and some people have stated that the use of vegetables is limited by their negative sensory properties: colour; mushy, crunchy or fibrous texture; and bitter and sour tastes (Drewnowski & Gomez-Carneros, 2000). Furthermore, many misconceptions exist about vegetable consumption and these could possibly be due to consumers' lack of knowledge of the benefits (Bogers *et al.*, 2003).

A diet rich in vegetables offers the possibility of health benefits beyond that of a protective role against cancer. Large-scale intake of vegetables, along with an otherwise balanced diet, reduces coronary heart disease by approximately 15.0% and stroke by 27.0% (Appel *et al.*, 1997). Furthermore, a diet rich in vegetables may be a low-cost and practical means to delay cataracts, and prevent chronic obstructive pulmonary diseases, particularly among children. It may also provide an additional approach for the prevention and treatment of hypertension (Appel *et al.*, 1997). Vegetables are a rich source of fibre, aiding in controlling high serum cholesterol levels and protecting against diverticulosis. Folic acid, found particularly in green leafy vegetables, may have a protective role in heart disease and hypertension, as well as cancer, while vitamin K, found in a variety of vegetables, may also control hypertension (Van Duyn & Pivonka, 2000).

Overall attitude comprised of four statements and the black respondents strongly agreed on all four, with 100.0% for all questions. This group liked vegetables and, in many cases, may have their own vegetable garden. In addition, they also make use of wild vegetables if they cannot afford to buy it (Modi *et al.*, 2006). The coloured respondents also strongly agreed on all four questions, with the highest percentage of 90.0% for strong agreement on the statement 'overall I think that eating vegetables is good practice', and the lowest percentage of 76.0%, for agreement on the statement 'overall I think that eating vegetables is pleasant'. The white respondents also agreed to strongly agree on all four questions. The highest percentage of 54.0% was for strong agreement on the statement 'overall I think that eating vegetables is beneficial', and the lowest percentage of 34.0% was for agreement on 'overall I think that eating vegetables is good practice'. The overall attitude of all respondents was overwhelming positive, with 74.6% to 82.7% who strongly agreed.

Some consumers have difficulty in consuming vegetables. Mac Fie (2007) states that informing the public about new food products may often fail to increase acceptance, unless factors, such as personal or societal benefits and the values placed on these new food products, are also properly addressed. Coulthard and Blissett (2009) also confirm that personality variables may shape consumers' attitudes toward new foods. It has been shown that some people have a stronger tendency to avoid new foods than others, a phenomenon that has been labelled food neophobia. Both picky eating and neophobia have repeatedly been found to be associated with reduced consumption of vegetables, both in relation to the amount of vegetables consumed, as well as the variety vegetables consumed.

Table 3.7 is a summary of the respondents' answers to the remaining questions on attitude and can be divided into a well-being and a sensory section. Sixty-point-zero percent of the coloured respondents indicated a feeling of neutrality after consumption of vegetables. Fifty-two-point zero to 32.9% of black respondents felt neutral or agreed feeling calm after consumption of vegetables, while the white group showed a neutral (30%) to agreeable (32%), to very agreeable (24%) feeling after consumption of vegetables. An overall feeling of guilt was noted for all groups after eating vegetables (55.5%). The reason for the guilt may be because consumers know that vegetables is better when raw, and when it is cooked, and in some cases even overcooked, with added butter, cream and sugar, the goodness of the vegetables is no longer there. Cauliflower with cheese sauce, sweet pumpkin tart and vegetable quiche is no longer full of goodness (Reicks *et al.*, 1994).

The black respondents agreed strongly, with the highest percentage of 61.6%, that vegetables have major market potential. The coloured group remained neutral with 50.0% and the white respondents stayed neutral with 30.0%, agreed with 28.0% and strongly agreed with 30.0% on this statement. Eighty-point-zero percent of the coloured group strongly agreed that they would recommend vegetable to other people,

Table 3.7: Percentages* of coloured, black, white and all respondents on remaining questions

-2 = strongly disagree; -1 = disagree; 0 = neutral; 1 = agree; 2 = strongly agree

QUESTIONS / RESPONSE	COLOURED (n=50)					BLACK (n=73)					WHITE (n=50)					ALL RESPONDENTS (n=173)				
	-2	-1	0	1	2	-2	-1	0	1	2	-2	-1	0	1	2	-2	-1	0	1	2
I feel calm after eating vegetables	6.0	10.0	60.0	10.0	14.0	1.4	4.1	52.0	32.9	9.6	8.0	6.0	30.0	32.0	24.0	4.6	6.4	48.0	26.0	15.0
I think vegetables has major market potential	10.0	2.0	50.0	20.0	18.0	1.4	2.7	20.6	13.7	61.6	8.0	4.0	30.0	28.0	30.0	5.8	2.9	31.8	19.6	39.9
I feel guilty after eating vegetables	8.0	6.0	2.0	14.0	70.0	4.1	2.7	16.4	31.6	45.2	6.0	8.0	14.0	16.0	56.0	5.8	5.2	11.5	22.0	55.5
I will recommend vegetables to other people	0.0	0.0	0.0	20.0	80.0	2.7	2.7	17.9	26.0	50.7	4.0	2.0	14.0	36.0	44.0	2.3	1.7	11.6	27.2	57.2
Vegetables has a bitter taste	30.0	42.0	20.0	6.0	2.0	95.8	2.8	1.4	0.0	0.0	12.0	40.0	38.0	6.0	4.0	52.3	25.0	17.4	3.5	1.8
Vegetables has a sour taste	34.0	50.0	14.0	0.0	2.0	91.8	5.5	2.7	0.0	0.0	22.0	42.0	28.0	4.0	4.0	54.9	28.9	13.3	1.2	1.7
Vegetables has a salty taste	36.0	46.0	16.0	0.0	2.0	6.8	34.2	48.0	11.0	0.0	10.0	30.0	38.0	14.0	8.0	16.2	36.4	35.8	8.7	2.9
Vegetables has a sweet taste	20.0	38.0	30.0	6.0	6.0	0.0	4.1	46.5	38.4	11.0	6.0	8.0	56.0	24.0	6.0	7.5	15.0	44.5	24.9	8.1
Experiencing a bitter taste	58.0	32.0	4.0	2.0	4.0	95.9	2.7	0.0	0.0	1.4	48.0	28.0	20.0	0.0	4.0	71.1	18.5	6.9	0.6	2.9
Experiencing a fibrous mouth feel is	8.0	30.0	54.0	6.0	2.0	61.6	26.0	12.4	0.0	0.0	16.0	28.0	44.0	6.0	6.0	33.0	27.7	33.5	3.5	2.3
Experiencing a crunchy mouth feel is	4.0	10.0	46.0	32.0	8.0	5.5	6.8	63.0	19.2	5.5	4.0	12.0	32.0	44.0	8.0	4.6	9.2	49.1	30.1	7.0
Experiencing a mushy mouth feel is	10.0	38.0	40.0	10.0	2.0	32.9	37.0	24.7	5.4	0.0	18.0	32.0	38.0	8.0	4.0	22.0	35.8	33.0	7.5	1.7
Experiencing a sour taste is	58.0	28.0	8.0	4.0	2.0	98.6	1.4	0.0	0.0	0.0	24.0	36.0	24.0	10.0	6.0	65.3	19.1	9.3	4.0	2.3

*According to official statistician of UFS, one decimal is sufficient with percentages (Schall, 2017).

while only 36.0% to 44.0% of the white and 26.0% to 50.7% of the black respondents agreed to strongly agree, that they would recommend vegetables to others.

For the four basic tastes, sweet, bitter, salty and sour, the coloured respondents predominantly disagreed strongly, disagreed or stayed neutral on the taste of vegetables. They agreed that experiencing bitter or sour tastes would be very undesirable (58.0%/58.0%) to undesirable (32.0%/28.0%). On the bitter and salty tastes of vegetables, the white respondents also disagreed (40.0%/30.0%) or remained neutral (38.0%/38.0%). On the sour taste of vegetables, there was a three-way split between disagree strongly (22.0%), disagree (42.0%) and neutral (28.0%). For the sweet taste of vegetables, they remained neutral (56.0%) or agreed (24.0%).

On 'vegetables having a salty taste', 34.3% of the black respondents disagreed, while 48.0% remained neutral. On the statement that 'vegetables have a sweet taste', 46.6% remained neutral and 38.4% agreed. Very interesting was the fact that the black respondents further disagreed strongly on the statements that vegetables have a bitter (95.8%) and sour taste (91.8%). They viewed experiencing a bitter (95.9%) and a sour taste (98.6%) as being very undesirable.

Many fruits and vegetables are bitter tasting and are disliked for this reason. Sensitivity to the bitter taste of phenylthiocarbamide (PTC) and the related thiourea compound, 6-*n*-propylthiouracil (PROP), is a heritable trait (Turnbull & Matisoo-Smith, 2002). Thioureas and related chemical compounds are prevalent in cruciferous and non-cruciferous vegetables. Variation in sensitivity to the bitter taster of thiourea compounds is a well-known genetic trait. This may be a marker for individual differences in acceptance of bitter tasting vegetables, bitter citrus fruits and bitter foods (Bell & Tepper, 2006). The frequency can vary by sex and race (Duffy & Bartoshuk, 2000). Glucosinolate compounds, occurring naturally in cruciferous vegetables (broccoli, Brussels sprouts, cabbage, spinach and kale), share this chemical grouping and, additionally, the common bitter taste (Turnbull & Matisoo-Smith, 2002).

The white respondents disagreed strongly (48.0%/24.0%), disagreed (28.0/36.0%) and remained neutral (20.0%/24.0%) on experiencing bitter and sour tastes as desirable, while the coloured group also agreed that experiencing bitter or sour tastes would be very undesirable (58.0%/58.0%) to undesirable (32.0%/28.0%).

On the sensory attribute texture, the black group experienced both fibrous texture (61.6%) and mushy mouth feel as very undesirable (32.9%) to undesirable (26.0%/37.0%), while a crunchy texture would be neutral (63.0%) to desirable (19.2%). For the white respondents, fibrous or mushy texture would be very undesirable (16.0%/18.0%), undesirable (28.0%/32.0%) and neutral (44.0%/38.0%). A crunchy mouth feels varied from neutral (32.0%) to desirable (44.0%). The coloured group experienced both fibrous and mushy textures as very undesirable (8.0%/10.0%) to desirable (6.0%/10.0%), while crunchy texture would be accepted as neutral (46.0%) to desirable (32.0%). Crunchiness appears to be a desired characteristic for vegetables in young children (Zeinstra *et al.*, 2010).

The competing demands of taste and health pose a dilemma for the food industry. The major determinant of food selection is taste. Foods that are bitter, acidic or astringent tend to be rejected by the consumer. The instinctive rejection of bitter taste may not be modifiable, because it is a key mechanism for survival. Bitter taste is the main reason for the rejection of diverse food products. Bitterness of cruciferous vegetables has been linked repeatedly to their low acceptance and it was found that dislike of certain vegetables was a major barrier to vegetable consumption. Bitter brassica vegetables were thought to taste good only if sauces were added, i.e., after the addition of fat, sugar or salt (Reicks *et al.*, 1994). This is a western phenomenon. In African culture, black people are non-tasters and do not experience the bitter taste as undesirable (Turnbull & Matisoo-Smith, 2002). Black people depend on the elderly people to show them what is not edible and rely on their cultural inherent (Airhihenbuwa & DeWitt Webster, 2004).

Table 3.8 shows the Cronbach alpha coefficients for all the questions for all the respondents. A value of 0.70 is sufficient to indicate whether there is a measure of internal consistency (Reynaldo & Santos, 1999), to detect the domains' (family_health_consciousness, food_safety_consciousness, vegetables_are_healthy, vegetables_are_pleasant and overall_attitude) connection to each other. The alpha coefficient for the six questions in the domain family_health_consciousness was 0.94 and for the four questions in the domain overall_attitude 0.91, suggesting the questions in both domains had very high internal consistency. For food_safety_consciousness, the coefficient was 0.74, which is still higher than the acceptable value of 0.70. This lower value was due to question A14 ('If I am aware of the benefits of vegetables, I will feel more comfortable eating vegetables'), which may have caused trouble with interpretation. The correlation of this question with the total was only 0.03 (Annexure 2). The five questions in the domain vegetables_are_healthy and four questions in the domain vegetables_are_pleasant had coefficients of, respectively, 0.87 and 0.88, signifying relatively high internal consistency.

Table 3.8: Cronbach alpha values for attitude domains for all respondents

Questions	Domain	Cronbach alpha
A1 – A6	Family_health_consciousness	0.94
A7 – A9; A14, A15	Food_safety_consciousness	0.74
A14, 15; A28-30	Vegetables_are_healthy	0.87
A16 – A19	Vegetables_are_pleasant	0.88
A24 – A27	Overall_attitude	0.91

Based on the descriptive data for the coloured respondents in Table 3.9, overall_attitude (mean (M)=4.82, standard deviation (SD)=0.33) and vegetables_are_healthy (M=4.81, SD=0.42) became the most important criteria in these consumers' attitude towards vegetables, followed by family_health_consciousness (M=4.56, SD=0.66), and food_safety_consciousness (M=4.28, SD=0.54). Vegetables-are-pleasant (M=3.87, SD=0.65) was the lowest scoring criteria.

To determine the most influencing factor predicting consumers' attitude towards vegetables, relationships between all variables were determined through correlation analysis, before proceeding to regression analysis. Table 3.9 depicts the r-value for the relationship between independent and dependent variables for the coloured respondents. Correlation readings usually indicate a 'no/negligible to very strong' relationship between variables (Quinnipiac University, 2013). Variables can then be grouped into 'important determinants' and 'least important determinants' as influential factors (Jaafar *et al.*, 2012), predicting consumers' attitudes towards vegetables.

Table 3.9: Descriptive statistics of independent and dependent variables to determine factors, contributing significantly towards coloured respondents' attitudes about vegetables

Variable	Mean (SD)	1	2	3	4	5
1. Family_health_consciousness	4.56 (0.66)	1.00				
2. Food_safety_consciousness	4.28 (0.54)	0.01	1.00			
3. Vegetables_are_healthy	4.81 (0.42)	0.18	-0.12	1.00		
4. Vegetables_are_pleasant	3.87 (0.65)	0.36	0.27	0.28	1.00	
5. Overall_attitude	4.82 (0.33)	0.14	-0.05	0.03	0.21	1.00

Moderate positive correlations were perceived between vegetables_are_pleasant and family_health_consciousness (r=0.36), vegetables_are_pleasant and food_safety_consciousness (r=0.27), vegetables_are_pleasant and vegetables_are_healthy (r=0.28), and overall_attitude towards vegetables and vegetables_are_pleasant (r=0.21). All the other variables had low r–values, ranging from -0.12 to 0.14 (Table 3.9). Thus, for this group, all variables could, in fact, be grouped as 'least important determinants' and seemed to have no significant influence on this groups' attitudes towards vegetables.

Table 3.10 is the descriptive data for the white respondents and for them, overall_attitude (M=4.26, SD=0.85) became the most important criterion in their attitude toward vegetables, followed by vegetables_are_healthy (M=4.10, SD=0.89), food_safety_consciousness (M=3.97, SD=0.94) and family_health_consciousness (M=3.83, SD=1.11). Vegetables-are_pleasant (M=3.59, SD=0.99) was the lowest scoring criterion.

Table 3.10: Descriptive statistics of independent and dependent variables to determine factors, contributing significantly towards white respondents' attitudes about vegetables

Variable	**Mean (SD)**	**1**	**2**	**3**	**4**	**5**
1. Family_health_consciousness	3.83 (1.11)	1.00				
2. Food_safety_consciousness	3.97 (0.94)	0.70	1.00			
3. Vegetables_are_healthy	4.10 (0.89)	0.52	0.57	1.00		
4. Vegetables_are_pleasant	3.59 (0.99)	0.48	0.36	0.34	1.00	
5. Overall_attitude	4.26 (0.85)	0.53	0.60	0.55	0.66	1.00

Very strong correlations were perceived between: food_safety_consciousness and family_health_consciousness (r=0.70); overall_attitude and vegetables_are_pleasant (r=0.66); overall_attitude and food_safety_consciousness (r=0.60); vegetables_are_healthy and food_safety_consciousness (r=0.57); overall_attitude and vegetables_are_healthy (r=0.55); overall_attitude and family_health_consciousness (r=0.53); and vegetables_are_healthy and family_health_consciousness (r=0.52). Moderate positive correlations were perceived between: vegetables_are_pleasant and family_health_consciousness (r=0.48); vegetables_are_pleasant and food_safety_consciousness (r=0.36); and vegetables_are_pleasant and vegetables_are_healthy (r=0.34) (Table 3.10). All variables seemed to have a significant influence on this group's attitudes towards vegetables.

Table 3.11 is the descriptive data for the black respondents and for them, overall_attitude (M=4.82, SD=0.33) and vegetables_are_healthy (M=4.81, SD=0.42) became the most important criteria in their attitude toward vegetables, followed by family_health_consciousness (M=4.56, SD=0.66), and food_safety_consciousness (M=4.28, SD=0.54). Vegetables_are_pleasant (M=3.87, SD=0.65) was the lowest scoring criterion.

Table 3.11: Descriptive statistics of independent and dependent variables to determine factors, contributing significantly towards black respondents' attitudes about vegetables

Variable	Mean (SD)	1	2	3	4	5
1. Family_health_consciousness	4.56 (0.66)	1.00				
2. Food_safety_consciousness	4.28 (0.54)	0.03	1.00			
3. Vegetables_are_healthy	4.81 (0.42)	0.03	0.07	1.00		
4. Vegetables_are_pleasant	3.87 (0.65)	-0.04	-0.21	0.18	1.00	
5. Overall_attitude	4.82 (0.33)	-	-	-	-	1.00

Very weak correlations were perceived for this group of respondents and only one negatively correlated correlation was observed for vegetables_are_pleasant and food_safety_consciousness (r=-0.21). None of the variables seemed to have a significant influence on this group's attitudes towards vegetables.

Further examination to determine the most significant factor, influencing consumers' attitudes towards vegetables, was then conducted through multiple linear regression tests. As highlighted in Table 3.12, the overall result for the regression model was significant ($p<0.001$). This indicated that all the independent factors were simultaneously significant to the dependent variable (Chen & Chai, 2010), proof that consumers' attitude on family_health_consciousness, food_safety_consciousness, vegetables_are_healthy and vegetables_are_pleasant contributed significantly ($p<0.001$) to the attitude towards vegetables. The R^2 values (0.59) showed that the independent variables contributed 59% to the dimension of attitude towards vegetables.

From the analysis, family_health_consciousness ($p=0.2082$) did not contribute significantly to the consumers' attitude towards vegetables. However, food_safety_consciousness ($p=0.0307$), vegetables_are_healthy ($p=0.0001$) and vegetables_are_pleasant ($p<0.001$) contributed significantly ($p<.05$) to the dependent variable (attitude on vegetables) (Table 3.12).

Table 3.12: Results of multiple linear regressions for all respondents

Variables	Dependent	Attitude		
Independent	**B**	**SE B**	**p – value**	**T**
Family_health_consciousness	0.05	0.04	0.2082	1.26
Food_safety_consciousness	0.07	0.03	0.0307	2.18
Vegetables_are_healthy	0.24	0.06	0.0001	3.99
Vegetables_are_pleasant	0.31	0.05	<0.0001	6.29
p - value overall attitude	<0.0001			
R^2	0.59			
F Ratio	3910.60			

B = unstandardized coefficient; SE = Standard Error; R^2 = Square root; T = $\frac{B}{SE}$

Concerning hypothesis 1, the results indicated no significant relationship between consumers' attitude on family_health_consciousness and their attitude towards vegetables (Table 3.12). This could be explained by the fact that almost one third of the respondents did not pay as much attention to this domain as the rest of the group (Table 3.5). Most of the black respondents were not conscious about the health of their families. According to Airhihenbuwa and DeWitt Webster (2004), culture plays a vital role in determining the level of health in the individual, the family and the community. This is particularly relevant in the context of Africa, where the values of extended family and community significantly influence the behaviour of the individual. Culture is the foundation on which health behaviour is expressed in general and through which health must be defined and understood. One example is the isolation (resulting from stigma) of the sick HIV-infected person in cultures, where the sick is traditionally cared for by families and communities. This reality makes it even more critical that the role of culture is appreciated in understanding behaviour in the context of health in general (Airhihenbuwa & DeWitt Webster, 2004).

Table 3.13: Summary of results to confirm hypotheses of the conceptual model

Hypothesis	Predicted effect	Confirmed (Yes/No)
H1	Family_health_consciousness will positively affect attitude towards vegetables	No
H2	Food_safety_consciousness will positively affect attitude towards vegetables	Yes
H3	Vegetables_are_healthy will positively affect attitude towards vegetables	Yes
H4	Vegetables_are_pleasant will positively affect attitude towards vegetables	Yes

As for hypotheses 2, 3 and 4, the results showed that there was a significant relationship between consumers' attitude to food_safety_consciousness ($p=0.0307$), vegetables_are_healthy ($p=0.0001$) and vegetables-are-pleasant ($p<0.0001$), and their attitude towards vegetables (Table 3.12). These differences might be explained by the fact that respondents like to eat vegetables, because some of them have their own vegetable gardens, they are knowledgeable about its nutritional values and they like the taste of it. Aikman and Crites (2007) suggest that general sensory qualities (e.g. taste, texture) and specific sensory qualities (e.g. bitter, mushy) will influence consumers' attitude towards food products.

3.3.4 Consumers' attitude towards vegetables (qualitative measure)

A summary of participants' beliefs, regarding the advantages, disadvantages and associations of eating vegetables, are presented in Tables 3.14, 3.15 and 3.16 respectively. According to Ajzen (1991), an attitude consists of an arrangement of several beliefs, focused on a specific target or setting.

Beliefs are defined as relevant communication that is appropriate to the behaviour. An individual may hold several beliefs toward an object and with each of these beliefs comes an assessment (Dreezens *et* al., 2005). Additionally, a belief can develop into

Table 3.14: Frequencies of responses to questions regarding advantages, disadvantages and associations of vegetables amongst respondents (n = 101)

	FREQUENCY (n)				PERCENTAGE OF SAMPLE (%)			
	White n = 47	Black n = 6	Coloured n = 48	All n = 101	White	Black	Coloured	All
			Advantages					
Health_general	23	6	22	51	48.0	100	45.8	50.5
Health_body	9	2	10	21	19.1	33.3	20.8	20.8
Nutritious_general	20	0	14	34	42.6	0.0	29.2	33.7
Nutritious_fibre	3	0	1	4	6.4	0.0	2.1	4.0
Nutritious_energy	5	0	7	12	10.6	0.0	14.5	11.9
Natural	3	0	10	13	6.4	0.0	20.8	12.9
Sensory_properties	2	0	0	2	4.3	0.0	0.0	2.0
Cost	0	0	1	1	0.0	0.0	2.1	1.0
			Disadvantages					
Health risks_general	3	0	3	6	6.4	0.0	6.3	5.9
Health risks_allergies	1	0	0	1	2.1	0.0	0.0	1.0
Health risks_digestion	0	0	0	0	0.0	0.0	0.0	0.0
Health risks_chemical	1	0	6	7	2.1	0.0	12.5	6.9
Nutrious	1	0	2	3	2.1	0.0	4.2	2.9
Sensory_propoerties	3	0	0	3	6.4	0.0	0.0	2.9
Positive_feedback	15	2	15	32	31.9	33.3	31.3	31.7
Preparations	1	0	0	1	2.1	0.0	0.0	1.0
Costs	0	0	2	2	0.0	0.0	4.2	2.0
Frequency_of_consumption	2	3	1	6	4.3	50	2.1	5.9
			Associations					
Health_general	5	2	12	19	10.6	33.3	25.0	18.8
Health_negative	1	0	0	1	2.1	0.0	0.0	1.0
Health_body	2	0	4	6	4.3	0.0	8.3	5.9
Health_other	4	0	5	9	8.5	0.0	10.4	8.9
Vegetables_other	0	0	1	1	0.0	0.0	2.1	1.0
Cost	1	0	1	2	2.1	0.0	2.1	2.0
Sensory_properties	0	0	3	3	0.0	0.0	6.3	2.9
Serving_suggestions	0	0	5	5	0.0	0.0	10.4	4.9

*According to official statistician of UFS, one decimal is sufficient with percentages (Schall, 2017).

Table 3.15: Summary of participants' beliefs regarding the advantages of eating vegetables

health_general

Quotes from white respondents	Quotes from black respondents	Quotes from coloured respondents
'Vegetables are incredibly healthy and only have benefits to our health' /'Keeps you healthy' / 'Healthy'	'Be very healthy'	'Contributes to healthy lifestyle' / 'Keeps a person healthy' /'Prevent diseases' / 'Nutrition'
'Good for general health' / 'It keeps you healthy'	'Gives goodness in life'	'It is good for your health and wellbeing' / 'General good health' / 'Keeping one healthy'/ 'Healthier'
'Very good for your health' / 'Being healthy'	'Good life'	'Good health, physically, mentally and spiritually'/ 'Reduces the risk of heart diseases'
'Eating vegetables is good for your health'	'Good for health'	'Reduces the risk of diseases' / Reduces the risk of heart diseases' / beneficial for good health
'Health benefits' / 'Better all-round wellbeing'	'Healthy life'	'Essential for general wellbeing and child's health' / 'Full of antioxidants – helps fight diseases'
'Healthy lifestyle and wellbeing' / 'You will be healthier'	'I believe vegetables are good, healthy'	'Important for good health. Reduces the risk of diseases' /
'Vegetables are nutritious and healthy'	'Health'	'Growing bodies need nutrition found in fruit and vegetables'
'Helps you to stay healthy and strong'	You will stay healthy, strong if you eat vegetables every day	'Eating plenty of fruit and vegetables will help avoid minor infections like colds and flu, because your immune system will be stronger'
'It is very healthy' / Promotes good health and energy levels'		'A diet rich in vegetables can reduce the risk of diseases'
'It is very good for you and your health'		''Can help protect our bodies from diseases'
'To be healthy' / 'Good health for children'		'We need them for good healthy bodies and to boost our immune system'
'Good health' / 'Healthy lifestyle'		'A balanced diet including lots of vegetables is good for mental and physical health'

health_body

Quotes from white respondents	Quotes from black respondents	Quotes from coloured respondents
'It is very good for your body' / 'fights diseases'	'Helps your metabolism'	'Helps with growth' / 'Beneficial for growth'
'Helps the body to grow and be healthy'	'Good hair, good skin'	'Good for healthy growth' / 'Essential for the growth and general wellbeing'
'Imperative for healthy colour'		'Beneficial for cell development' / 'Help maintain a healthy body and strong teeth and bones'
'It promotes healthy skin, hair and nails'		'Necessary for our children's growth and health'
'Eating vegetables is good for immune system'		'A balanced diet including lots of vegetables is good for growth'
'It gives stamina and helps keeping you healthy'		'They contain nutrients for brain development, strong teeth and bones'
'A long and healthy life and a sharp brain'		'Essential for a child's growth'
'Less sickness like cancer, heart diseases and obesity'		'Cell growth; motor and brain development. Basically beneficial to all vital organs, blood and body function'

Nutritious_general

Quotes from white respondents	Quotes from black respondents	Quotes from coloured respondents
'You get in all the vitamins' / 'Good vitamins' /'For your daily vitamins and minerals' 'The antioxidants and vitamins are very important for your health' 'It gives you all the vitamins that your body needs' / 'Nutrients' 'Your body get the minerals it needs' 'You get most of the nutrients by eating vegetables' / 'Vitamins and minerals' 'It gives your body the vitamins and nutrition it needs' 'It provides the essential vitamins and minerals' 'Added vitamins and minerals' ''Minerals and vitamins' / 'Enhances nutrition' 'It contains a lot of vitamins that is good for your health' / 'Vitamin intake' Will get all the nutrients you need' Vitamins and minerals and balance in your diet' / 'Filled with healthy vitamins and minerals'		'Provides all needed vitamins and nutrients' / 'Source of vitamins' 'You get vitamins and minerals through vegetables' / 'Vegetables are important sources of many nutrients' / 'It also has nutrients that the body needs and could lost over time' / 'Full of vitamins' 'Give vitamins for good health and growth for children' / 'Full of nutrients' 'They are nutritious and have vitamins needed by family for their health' 'You get all the vitamins and iron (green veggies)' / 'They provide our bodies with vitamins needed to fight diseases and maintain a strong and healthy body' You need to eat vegetables as much/often as possible to provide the vitamins our bodies need for good health' If we eat a variety of fruit we will provide our bodies with all the vitamins and nutrients we need for a healthy body and state of mind' 'Important source of nutrients' 'Supplies nutrients necessary for good health'

Nutritious_energy

Quotes from white respondents	Quotes from black respondents	Quotes from coloured respondents
'Balanced meal. Appropriate meal portion' 'Balanced nutrition' / Low calorie food' 'It makes you full, but it does not make you fat' 'To still my hunger, cannot live just on meat'		'No fat in veggies, veggies have a low energy density' / 'Low in calories' /' Low in fat' 'More energy and you feel and are much healthier' 'Necessary for a balanced diet' / 'They fill me up quicker' 'Low in fat'

nutritious_fibre

Quotes from white respondents	Quotes from black respondents	Quotes from coloured respondents
'Healthy fibres' / 'Fibre' 'It aid with healthy digestion' 'Source of fibre'		'Source of fibre'

NATURAL

Quotes from white respondents	Quotes from black respondents	Quotes from coloured respondents
'Natural vitamins and minerals are consumed'		Natural source of necessary vitamins and minerals' / "Natural product' / "Adds natural goodness to the meal'
'Consuming natural form of vegetable nutrients'		'Getting natural vitamins and minerals into our bodies to enable our bodies to fight off ill health and diseases' / 'Provides vitamins and nutrients in a natural way'
'Natural vitamins and minerals'		'Taking the natural nutrients needed by the body' / "Full of natural goodness'
		'Provides a balanced and natural source of vitamins, minerals and nutrients necessary for strong bones, healthy bodies and general good health'
		'We need natural foods and not only processed foods for strong and healthy bodies and good health and to help our children grow, both mentally and physically'
		'Vegetables provide natural nutrients but must not be overcooked as all the goodness is then lost'

COST

Quotes from white respondents	Quotes from black respondents	Quotes from coloured respondents
		'Veggies are cheaper than meat'

Table 3.16: Summary of participants' beliefs regarding the disadvantages of eating vegetables

Quote from white respondents	Quote from black respondents	Quote from coloured respondents
	health risks: general	
'Withdrawal symptoms'	'Can get tired of eating vegetables'	'Veggies like cabbage, broccoli cause stomach winds'
'Nausea'	'You can be fat when you have too much vegetables'	'Risk of getting obese, and increase risk of heart diseases. In children, lack of vitamins may lead to malnutrition. Can lead to unhealthy bowl habits and constipation'
'Upset tummy'	'Can make you fat (potatoes and chips)	'Sickness, decay, malnutrition'
	health_risks_allergies	
'Some people can be allergic'		
	health_risks_chemicals	
'Pesticides that you get in'		'The chemical additives & enhancements' 'They might not be fresh and maybe have chemicals in them' 'Pesticides' / "Pesticides and chemicals' 'Pesticides used are very harmful' 'No disadvantages – only the pesticides that have been used to grow the vegies'
	Nutritious	
'Some vitamins are short, like omega 3, fatty acids, vitamin B12'		'Vegetables are low in protein and healthy fats' 'Not enough protein'
	sensory_properties	
'Bitter taste' 'Only in some cases the taste is not good' 'Unpleasant taste'		
	positive _feedback	
'No disadvantages'	'None'	'No disadvantages'

an attitude, according to the potency of the feeling involved. When the belief gets stronger, the attitude will also become stronger and will then affect behaviour (Wright, 2006). Advantages, disadvantages and associations were categorized in five, seven and five categories, respectively, with appropriate sub-categories.

According to the results in Tables 3.13 and 3.14, white respondents regarded the categories health_general (48.0%) (e.g. 'vegetables are incredibly healthy and only have benefits to our health'), health_body (19.1%) (e.g. 'it promotes healthy skin, hair and nails') and nutritious_general (42.6%) (e.g. 'the antioxidants and vitamins are very important for your health') as the most important advantages of eating vegetables. The black respondents did not actively complete this part of the questionnaire and only used two categories, namely health_general (100.0%) ('gives goodness in life') and health_body (33.3%) ('helps your metabolism'). Contrary to this, the coloured respondents actively completed this question and health_general (45.8%) ('important for good health'), health_body (20.8%) ('they contain nutrients for brain development, strong teeth and bones'), nutritious_general (29.2%) ('they provide our bodies with vitamins needed to fight diseases and maintain a strong and healthy body'), as well as natural (20.8%) ('provides vitamins and nutrients in a natural way') were noted as the most important advantages of eating vegetables.

Vegetables are defined as food low in energy, comparatively rich in micro-nutrients, phytochemicals and other bioactive compounds, while serving as good sources of dietary fibre (Agudo, 2004). Furthermore, it also provides the body with most macro-nutrients, proteins, carbohydrates, dietary fibre, cholesterol and water. Vegetables also contain a rich spectrum of both nutritive and non-nutritive components, which help maintain a healthy diet. Some components are found wide spread across vegetables, while others are characteristic of only certain vegetables (Naudé, 2007; Heneman & Zidenberg-Cherr, 2008).

Other advantages included the belief, by some consumers, that vegetables are healthy for the body (Table 3.15). For example, from the white respondents the following quotes were noted: 'imperative for healthy colour'; 'it promotes healthy skin, hair and nails'; 'they contain nutrients for brain development, strong teeth and bones'; 'eating vegetables is good for your immune system'; 'it gives you stamina and helps keeping you from getting sick easily'; 'a long and healthy life as well as a sharp brain'; and 'less sicknesses like cancer, heart diseases and obesity'. Two quotes from the black group included 'helps your metabolism' and 'good hair, good skin'. The coloured group commented a lot on these advantages: 'they contain nutrients for brain development, strong teeth and bones'; 'cell growth, motor and brain development'; 'basically beneficial to all vital organs, blood and body function'; 'beneficial for cell development'; 'help maintain a healthy body and strong teeth and bones'; and 'a balanced diet including lots of vegetables is good for growth'. They also emphasized that it is 'necessary for our children's growth and health' and is 'essential for a child's growth'. Some of the advantages of eating fruits and vegetables are that it supplies dietary fibre, and fibre intake is linked to lower incidence of cardiovascular disease and obesity. Fruits and vegetables also provide vitamins and minerals to the diet and are sources of phytochemicals that function as antioxidants, phytoestrogens and anti-inflammatory agents (Slavin & Lloyd, 2012).

Other advantages (Table 3.15) included the belief, by some white and coloured consumers, that vegetables are generally nutritious, supplying vitamins and minerals, antioxidants ('the antioxidants and vitamins are very important for your health') and iron ('you get all the vitamins and iron [green veggies]'). Especially the coloured group believed that vegetables are natural sources of vitamins and minerals, e.g. 'natural source of necessary vitamins and minerals', 'getting natural vitamins and minerals into our bodies to enable our bodies to fight off ill health and diseases', 'provides vitamins and nutrients in a natural way', 'taking the natural nutrients needed by the body', 'provides a balanced and natural source of vitamins, minerals and nutrients necessary for strong bones, healthy bodies and general good health', 'we need natural foods and not only processed foods for strong and healthy bodies and good health and to help our children grow, both mentally and physically', 'adds natural goodness to the meal' and 'they provide natural vitamins and nutrients'. Vegetables provide the body with most macro-nutrients, proteins, carbohydrates, dietary fibre, cholesterol and water (Naudé, 2007; Heneman & Zidenberg-Cherr, 2008). Micronutrient components of vegetables include a wide variety of vitamins, such as fat-soluble vitamins A, D, K and

E, and water-soluble vitamins C, niacin, folate, thiamine, riboflavin, biotin, pyridoxine, pantothenic acid and vitamin B12. In addition, vegetables also contain essential minerals, most important of which are K, P, Mg, Ca, Fe, Zn, Cu, Mn, Na and Se. Furthermore, vegetables provide the body with essential non-nutrient phytochemical compounds, such as pigments, phenolic compounds, terpenoids and natural anti-oxidants (NIH, 2015; USDA, 2015).

Of the white, black and coloured respondents, respectively, 31.9%; 33.3% and 31.3%, provided feedback on the question requesting disadvantages of vegetables, e.g.: 'none'; 'no disadvantages'; 'there are no disadvantages' and 'keeps you healthy'. It was also commented that 'there are no disadvantages unless we over cook or over sugar it' (Table 3.16). The fact that positive feedback was given for a negative (disadvantages) question, could imply that consumers have a generally positive attitude towards consuming vegetables.

White respondents (6.4%) saw general health risk as a disadvantage ('withdrawal symptoms', 'nausea' and 'upset tummy') and coloured respondents (6.3%) ('veggies like cabbage, broccoli cause stomach winds', 'risk of getting obese and increase risk of heart diseases; 'in children, lack of vitamins may lead to malnutrition; can lead to unhealthy bowl habits and constipation', 'sickness, decay, malnutrition'). Only the white respondents noted the possibility of an allergic reaction to certain vegetables (2.1%). Again, it was mostly the white (2.1%) ('pesticides that you get in') and coloured (12.5%) ('the chemical additives and enhancements', 'they might not be fresh and maybe have chemicals in them', 'pesticides', 'pesticides used are very harmful'; 'pesticides and chemicals', no disadvantages – only the pesticides that have been used to grow the veggies') respondents who were concerned about the disadvantages of chemicals used in the cultivation of vegetables.

The relationship between gas production and the consumption of food reported to produce large amounts of gas (beans, Brussels sprouts, onions, celery, carrots, raisins, bananas, apricots, wheat germ, etc.), suggests that the mechanism involved (fermentation) is a reaction between the low molecular-weight carbohydrates and anaerobic spore-forming clostridia-type bacteria found in the small intestine and colon.

The carbohydrates responsible are monosaccharides (glucose, fructose, and galactose), disaccharides (maltose and sucrose) and the starchyose and raffinose type. Fermentation starts within two to three hours and normally disappears after 24 hours (Heizer *et al.*, 2009).

Other disadvantages (Table 3.16) included lack of nutrients ('some vitamins are short, like omega 3, fatty acids, vitamin B_{12}', 'vegetables are low in protein and healthy fats' and 'not enough protein'). Sensory disadvantages were only noted for white respondents (6.4%) and included 'bitter taste', 'only in some cases the taste is not good' and 'unpleasant'. Frequency of consumption was a disadvantage for all respondents. White respondents (4.3%) felt that 'too much potatoes are not good' and that 'you cannot have as much meat'. Black respondents' quotes included that 'you can be fat when you have too much vegetables', 'can make you fat (potatoes and chips)' and 'you can be fat when you have too much vegetables'. Fresh potato is carbohydrate-rich, energy-providing food, with little fat and high vitamin C-content. Potatoes are also a good source of several B and K vitamins, contributing to antioxidant activity. The skin provides substantial dietary fibre. Despite this, consumers tend to believe that potatoes are high in cal/kJ and fat, compared to other carbohydrate sources, such as rice or pasta - an incorrect assumption, since potato has negligible fat and low energy density. Unfortunately, consumption of fresh potatoes has declined, while processed potato products have increased in popularity (Camire *et al.*, 2009). Thus, the extra oil, butter and cream cause the problem and not the potato itself. Potatoes should be boiled, cooked and eaten unpeeled to enjoy the goodness of this vegetable.

3.4 CONCLUSIONS

Consumers' knowledge and attitude towards vegetables were investigated by means of qualitative and quantitative methods, to understand consumer behaviour towards vegetables. It was evident that the differences in the vegetable knowledge of respondents, from different demographic backgrounds, indicated a need to inform and educate specific population groups in SA, on the benefits of consuming vegetables. It is important to note that attitude and behaviour are separate things. Simply because an individual has a positive or negative attitude towards vegetables, does not mean that the individual will act on the attitude. It is recognised that understanding consumer attitudes and behaviour is essential information and ought to be known before researchers introduce new food products.

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CHAPTER 4

DEVELOPMENT AND CONSUMER ACCEPTABILITY OF VEGETABLE POTATO-BASED CHIPS AMONGST 4-6 YEAR OLDS

[Part of this chapter was named one of the five top manuscripts at the IFHE Congress in Daejeon, Korea, 2016 and was subsequently published in the International Journal of Home Economics – see Annexure 3]

ABSTRACT

To increase children's preference for and consumption of vegetables, potato-based vegetable chips were developed, using a basic *choux* paste. Hundred children, in the age range four to six years, participated in the study. A specially adapted five-point hedonic Smiley face scale was used. Children preferred pictures of potato chips to pictures of beetroot, green beans and carrots. For colour choice, carrot chips were ranked significantly ($p<0.001$) higher than green bean and beetroot chips. For brown-coloured vegetables, sweet potato, butternut, butternut + sweet potato and sweet corn chips were ranked significantly ($p<0.001$) higher than cauliflower and cabbage chips. The sweet potato chip had the highest numerical rank of 4.16. Further tests performed with this chip found no significant differences in the liking between cooking methods. The oven baked option was subsequently chosen for further tests, because it was proposed to be the most accessible option. There were no significant differences in the liking of different oils, coatings and replacement of potato flour with chickpea flour. Population group had a significant effect on green bean ($p=0.0189$), butternut ($p=0.0018$) and cauliflower ($p=0.0218$) chip liking, while gender had a significant effect on beetroot ($p=0.0158$), butternut ($p=0.0307$) and cauliflower ($p=0.0371$) chip liking. Age had a significant effect on the liking of green bean ($p=0.0338$) and sweet potato ($p=0.0445$) chips. The interaction between gender and age had a significant effect on the liking of 50% replacement with chickpea flour, in oven baked sweet potato chips ($p=0.0378$). From the questionnaire on frequency of vegetable consumption by children, it was found that parents and children disliked cauliflower and cabbage, while children also disliked green beans. All children liked potatoes the

most, followed by carrots and butternut. Thirty-two-point zero percent of the children never tasted cauliflower before. Black children liked cabbage more than white children, while white children liked sweet potato more than black children did.

4.1 INTRODUCTION

In most countries of the world, children's vegetable preference and consumption are below the recommended daily allowance (RDA) (Graaf *et al.*, 2010). According to the American Heart Association (AHA) (2014), childrens' RDAs range from ¾ - 1 cup of vegetables for one to three year olds, 1 - 2½ cups for four to 18 year old females, and 1½ - 3 cups for four to 18 year old males. These portions are based on an inactive lifestyle; when physical activity increases, portion sizes will also increase. Portions should be selected out of a variety of vegetables (AHA, 2014).

Many factors play a role in children's vegetable preferences, one being socio-economic background, which influences perceptions and eating patterns of a child; others include age and gender (Baxter *et al.*, 2000). Children's influence on food choices increases with age (Holdert & Antonides, 1997). Parents are often not aware that children have 'likes' and 'dislikes', which will cause dietary imbalances. In general, children prefer snack foods, such as crisps, fried potatoes, chips and fizzy drinks, and meat and starchy food to vegetables and cheeses (Edelenbos & Sondergraad, 2007). It was found that children, who watch more television, made more unhealthy food choices and often consumed more snack foods (Amboni *et al.*, 2008) and that the television viewing habits lead to increased development in higher fat and sugar diets (Ahrens *et al.*, 2012).

Children all over the world are exposed to fast foods. The more children become familiar with a certain food, the more a preference will develop towards the food. The average child will prefer high energy dense food, e.g. fried chips, to foods that do not have that energy content (Birch, 1992; Camps *et al.*, 2011).

Preference towards vegetables can, however, be developed, because of its unique texture, which is important for enjoying food. Humans have an instinct to have full control over everything they put into their mouth (Szczesniak, 2002). Because of vegetables' crunchy texture, children cannot manipulate all the textures, which lead to either a dislike or preference. Thus, preparation methods have a crucial influence on children's acceptance and could promote the eating of vegetables. For some vegetables, the raw version is better accepted than the cooked one, because of its texture and the preparation method. Raw vegetables remain crunchy and are in some cases preferred over other preparation methods (Graaf *et al*., 2010). Graaf *et al.* (2010) also mention that for children who dislike eating vegetables, the preparation method for the vegetable is more important to be accepted. Steamed and boiled vegetables were preferred over mashed, grilled, stir-fried or deep-fried vegetables. The explanation for these findings was that participants were mostly familiar with boiling as a preparation method. This emphasized the fact that familiarity plays a role in favouritism (Graaf *et al*., 2010).

In general, children's food choices are heavily influenced by odour and textural preferences, and to a lesser extent by visual aspects and taste preferences (Delahunty & Poelman, 2010). According to Kildegraad (1997), however, the appearance of food gives the first interest in food choice and sets an expectation for real sensory perception. Visual aspects consist of colour, background characteristics and various segmentation factors (Delahunty & Poelman, 2010), such as size and shape (Kildegaard *et al*., 2011). De Graaf *et al.* (2007) also confirm this regarding colour of vegetables and suggest that colour affects children's acceptance for vegetables. Coloured, small, brittle vegetables were preferred to dark, large, green vegetables. Children, seven years and younger, had to depend on colour to decide the taste of a vegetable (Delahunty & Poelman, 2010).

Studies, examining children's preferences, found that fatty and sugary foods feature highly among children's top ten 'like' foods. It was found that fat food preference was higher for boys than girls. This could be due to larger energy demand for boys compared to girls (Kildegraad, 1997). Peers also play an important role in influencing what children like. They will easily change their preference when they see what other children eat (Kroll & Popper, 2003). In this study, pictures were shown on a computer screen of peers eating healthy food, which influenced children to be more willing to like healthy food. Additionally, fat preferences were more frequent for girls in this study, while a combined preference for sweet and fat foods was found for boys. When applying bivariate analyses, it was found that when a child was frequently exposed to fatty foods, it related to a higher preference. Researchers concluded that fat flavour and sweet taste preferences in these children were directly related to the weight status of a child (Ahrens *et al.*, 2011).

Fat gives a unique texture, flavour and aroma to food, resulting in fat 'taste' (Almiron-Roig & Drewnowski, 2010). Furthermore, fat in food gives the ability to create textures, e.g. crispy or creamy. When foods are fried, the extreme hot temperatures expand the steam and create crispy bubbles, giving chips its unique crunch and crispness (Zhang, 2014). Fat makes food also more fresh and moist, because it binds with water molecules (Almiron-Roig & Drewnowski, 2010). Food absorbs some oil, which replaces some water that is lost during frying (Moreira *et al.*, 1995).

The first aim of this study was to determine children's acceptability of a potato-based vegetable chip, by using a five-point Smiley face scale. Secondly, information was analysed to determine vegetable likes and dislikes of the childrens' caregivers or parents.

4.2 MATERIALS AND METHODS

4.2.1 Consumer acceptability

The study involved 100 children (male and female) from two South African pre-primary schools, between the ages of four to six years, and from low and medium income households. Before sensory testing, parents or guardians had to sign an informed consent form (Annexure 4) for their children's participation and provide information about any medical condition that may put the children at risk during the study.

Before the first session, posters of the chips (Figure 4.1) were put on the walls of the classrooms to familiarise the children with the product and to avoid neophobia. Prior to every sensory test, all the children played a game using pictures of food. These games were designed to illustrate and reinforce the cognitive skill inherent in the sensory test, with the assumption that the child would transfer the skill to the test itself (Guinard *et al.,* 1994). All sensory tests were performed in the school's classroom, which was familiar to the children.

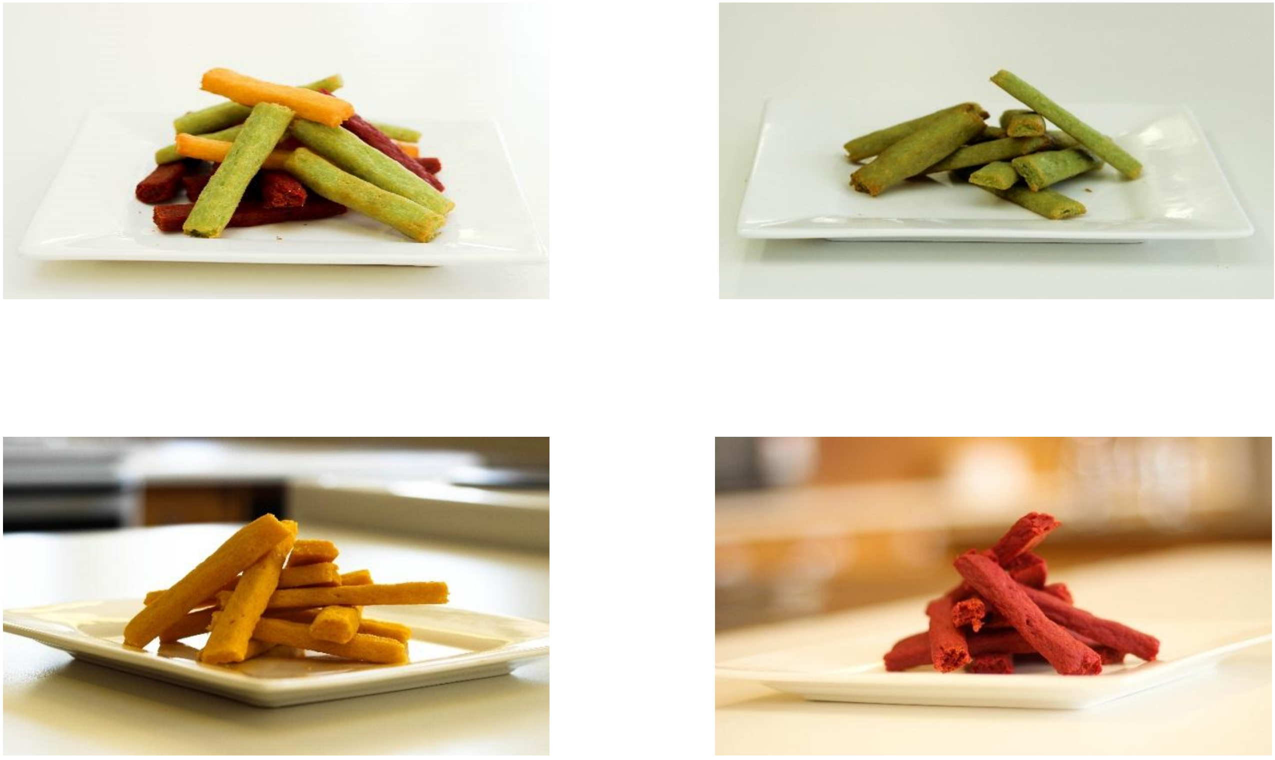

Figure 4.1: Posters to avoid neophobia (student's own photo's)

Nine adult student interviewers assisted the children throughout the study. The students were trained to explain the process to each child and to deal with unexpected incidents. They were instructed to record negative behaviour or complaints, if any. Arrangements were set up so that the children did not face other tables. Children and the interviewers remained seated throughout the test (Guinard & Davis, 2001; Arumugam, 2012b)

Table 4.1 summarizes the different sensory testing methods, which included discrimination and consumer tests. The hedonic scale for the discrimination test was a five-point scale with both faces and words ('dislike a lot' to 'like a lot'), to indicate the different degrees of like/dislike (Stone & Sidel, 2004) (Figure 4.2). Children were asked to point to their choices.

Table 4.1: Picture games and sensory tests

Type of test	
Discrimination (n=100)	*Food pictures*
Paired preference test	French fries vs green beans
	French fries vs beetroot
	French fries vs carrots
Consumer (n=100)	*Stimuli*
Hedonic scaling	Green bean chip vs carrot chip vs beetroot chip
	Carrot chip: oven fried vs deep fried vs air fried
	Butternut chip vs cauliflower chip vs sweet potato
	Sweet corn chip vs cabbage chip vs butternut + sweet potato chip
	Sweet potato chip with sunflower oil vs sweet potato chip with olive oil
	Sweet potato chip with *Smash Herb** coating vs sweet potato chip with *Kellogg's Crumble*** coating
	Sweet potato chip + 50.0% chickpea flour vs sweet potato chip + 100.0% chickpea flour

*Bokomo Foods. 40 Meil Hare Road, Atlantis 7349. A Division of Pioneer Foods (PTY) LTD. Product of SA.

** Kellogg's Company of SA (PTY) LTD, 77 Steel Road, New Era, Springs, Product of SA.

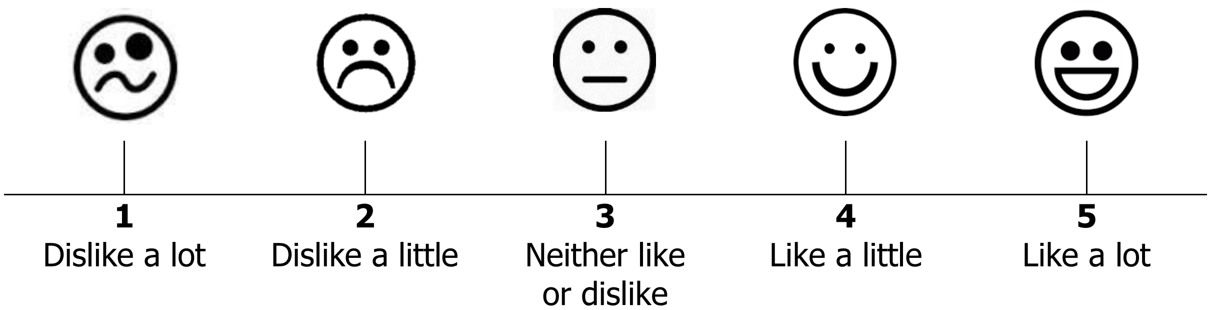

Figure 4.2: Five-point Smiley face scale (adapted form Stone & Sidel, 2004)

The potato-based chips were made by adapting a basic c*houx paste* recipe (Table 4.2) (Foods and Cookery, 1991). The cake flour was partly replaced by *Smash (*Bokomo Foods, 40 Meil Hare Road, Atlantis 7349, a division of Pioneer Foods (PTY) LTD. Product of SA), a type of dried potato starch, with added salt, flavouring and preservative. The water in the original recipe was replaced by a mixture of vegetable juice and pulp, obtained after processing the desired fresh vegetable in a juice extractor (engine strength 400 watt). The prepared mixture was piped in long strips onto a greased baking tray, to resemble the shape of potato chips and baked in a Defy 631-T (Thermo fan) oven for 15 minutes (min) at 180°C. These long strips were then cut into chip sizes, about 50 mm in length. Before testing, the chips were deep fried, air-fried or oven baked. All chips were prepared the day before the test and heated prior to serving.

Table 4.2: Formulation of potato-based vegetable chips (Food and Cookery, 1991)

Ingredient	Percentage (%)
Smash*	10.95
Butter	12.10
Egg	22.10
Vegetable pulp	21.05
Vegetable juice	26.30
Cake flour	7.40
Salt	0.10

*Bokomo Foods. 40 Meil Hare Road, Atlantis, 7349. A Division of Pioneer Foods (PTY) LTD. Product of South Africa.

Table 4.3 summarizes the different vegetables used in the study, as well as specifications for frying/baking. Carrot, beetroot and green beans were used in the first study, to determine the influence of colour on children's preference for vegetables. The most preferred vegetable from this test, the carrot, was used to determine the preferred cooking method. Oven baking, deep fat frying and air frying were chosen as suitable methods and again, the most preferred method was used for the next studies.

Table 4.3: Different potato-based vegetable chips used in sensory studies

Test	Vegetables used	Specifications
Hedonic Scaling	Beetroot, carrot and green beans	Deep fat frying: 7 min; 200°C; sunflower oil; Kenwood 7879/1
Hedonic scaling	Cooking method: carrot	Oven baking:15 min; 180°C; Defy 631-T Deep fat frying: 7 min; 200°C; sunflower oil; Kenwood 7879/1 Air frying:10 min; 160°C; Philips Air Fryer
Hedonic scaling	Brown colour vegetables: butternut, sweet potato, cauliflower, butternut + sweet potato, sweet corn and cabbage	Oven baked: 15 min; 180°C; Defy 631-T
Hedonic scaling	Oil: sunflower* and olive**	Oven baked: 15 min; 180°C; Defy 631-T
Hedonic scaling	Coating: *Smash Herb**** and *Kellogg's Crumble*****	Oven baked: 15 min; 180°C; Defy 631-T
Hedonic scaling	Smash replacement: *Nature's Choice* Chickpea flour*****	Oven baked: 15 min; 180°C; Defy 631-T

* Wilmar Continental, 114 Main reef Road, Randfontein, 1760, SA. Product of SA.
** Aceites Borges Pont, S.A.U. Josep Trepat Avenue s/n-25300 Tarraga-Spain.
*** Bokomo Foods. 40 Meil Hare Road, Atlantis 7349. A Division of Pioneer Foods (PTY) LTD. Product of SA.
**** Kellogg's Company of SA (PTY) LTD, 77 Steel Road, New Era, Springs, Product of SA.
***** Nature's Choice. Product of India. Packed in SA. 73 Cypress Avenue, Meyerton, SA 1960.

For the third and fourth tests, some more brown vegetables were tested, namely butternut, sweet potato, cauliflower, sweet corn, cabbage and a combination of butternut and sweet potato. In the next test, the influence of types of oils sprayed on the chips was determined, using sunflower and olive oil. It was also decided to enrobe the chips, to increase the crispiness, and two very different coatings were used, namely a powdery and a crumbly one. Finally, the protein content of the chip was increased by a 50.0% replacement of the *Smash* with chickpea flour, as well as a 100.0% replacement with chickpea flour.

4.2.2 Questionnaire on consumer behaviour of children's caregiver

The consent form also contained a questionnaire, where data about the preferences of the child and parents were collected (Annexure 4). Questions focused on the age and gender of the child, and included allergies and diet-related illnesses, such as diabetes. Information about the children's likes and dislikes regarding vegetables, as well as vegetables that they have never tasted before, were gathered. The same information about the caregiving parent was also obtained, as it could have a definite influence on the child's consumption of vegetables. Foods, such as egg and chickpeas, which are obviously not vegetables, were included in the list, as especially the eggs formed an integral part of the newly developed potato-based vegetable chip (Table 4.2). Furthermore, chickpea was added to increase the nutritional, and specifically the protein content, of the vegetable chip (Table 4.3).

4.2.3 Statistical analysis

All sensory data were collected in spreadsheets, using Microsoft Excel 2007 and statistical analyses were done using NCSS (2007). The significance of the overall acceptance measured for each sample was tested by means of analysis of variance (ANOVA). If the main effect was significant, Fisher's LSD-test was applied to determine the direction of the differences between mean values (Heymann, 1995).

After the data was calculated, the results were represented as a spider plot, where a specific spoke denotes a specific attribute. The distances of attribute mean from the centre of the plot along each spoke directly corresponds to attribute intensity. The plot provides a visual presentation of product similarities and differences (Heymann, 1995).

For the questionnaire on consumer behaviour of the children's caregiver, percentages and averages were determined.

4.3 RESULTS AND DISCUSSION

4.3.1 Consumer acceptability

The demographic composition of the panel is given in Table 4.4. Fifty-point-zero percent of the panel members were black children and 50.0% were white children. For the age split, 25.0% were four years old, 55.0% were five and 20.0% were six years old. Forty-six-point zero percent were female and 54.0% were male.

Table 4.4: Demographic profile of children's panel (n=100)

Population Group	%* of Total	Gender	%* of Total	Age	%* of Total
Black	50.0	Female	46.0	4	25.0
White	50.0	Male	54.0	5	55.0
				6	20.0

From Table 4.5 it was clear that there was a significant (at least $p<0.01$) difference in the preference of vegetables versus chips, for green beans, carrots and beetroot. In all cases, the potato chip picture was significantly (at least $p<0.01$) preferred to the respective vegetable picture. When shown the picture of beetroot, there was a significant ($p<0.01$) increase in the number of children (37) preferring this vegetable to the picture of chips. This may be due to the red colour. Most ripe fruits turn red and children associate red with sweetness (Lavin & Lawless, 1998). A study by Jansen *et al*. (2007) revealed that when children were restricted to eat red food, because of the colorant's bad effects, an urge was created to do just that. In another study by Grubliauskiene *et al*. (2012), children had to choose between chips and grapes. Children with higher behaviour ratings were more likely to choose the healthier option, than children with lesser behaviour ratings. Pre-schoolers want to please their caretakers and that could also be a reason why they chose the beetroot chips in the present study. On the other hand, potatoes are the fourth most important food in the world after wheat, rice and maize (Messer, 1994). It contains carbohydrates, vitamins B and C, fibre and folate, and has a mild taste that children easily adapt to. Potato is also a satisfying, nutritious and an inexpensive vegetable (Mumiece *et al*., 2011).

Table 4.5: Paired preference analysis of children's panel

Vegetable		n = 100	Significance Level
Beans/Chips	Vegetables vs Chips	33 vs 67[a]	$p<0.001$
Carrots/Chips	Vegetables vs Chips	34 vs 66[a]	$p<0.001$
Beetroot/Chips	Vegetables vs Chips	37 vs 63[b]	$p<0.01$

Means with different superscripts differed significantly.

Children's hedonic scaling for the preference of colour, cooking method, brown vegetable, oil type, coating and potato flour replacement, is given in Table 4.6. Firstly, there was a significant ($p<0.01$) preference between the carrot chip and the green bean and beetroot chips, but not between the green bean chip and beetroot chip. The carrot chip had the highest ranking (4.4) and green bean chips the lowest (3.4). Most people associate green beans with vegetables that do not taste good (Poelman *et al.,* 2015) and children grow up with this perception as they adopt the habits form their parents (European Food Information Council, 2012). Akis (2014) stated that the reason people dislike beetroot, is because they think it taste like dirt. Carrots, on the other hand, are one of the most widely eaten foods in the world and are enjoyed as a savoury and sweet dish. It is also one of the first solid foods that is introduced to children and is available in every shop throughout the year (Poelman *et al.,* 2015).

There was no difference between the liking for oven baked (4.2), deep fried (4.2) and air fried carrot chips (4.2) (Table 4.6). This was an interesting observation in that children four to six years old showed no preference for oily food. Graaf *et al.* (2010) found that steamed and boiled vegetables are preferred over mashed, grilled, stir fried or deep-fried vegetables. In their study, children were more familiar with boiling and steaming and these familiarities influenced favouritism. Deep fat frying is not considered a healthy cooking method, as fat is a major contributor to heart disease, diabetes, hypertension and some types of cancers (Krukowski, 2011). The air fryer is a rather sophisticated and expensive apparatus, but could in the long-term save money on the oil that would have been used in the traditional method (Taste.Com.AU, 2014). It was decided to use oven baking for the remaining three tests, as baking is thought to be the healthiest option (Gokemen *et al.*, 2010).

Table 4.6: ANOVA of children panel's hedonic ranking for vegetable chips (n=100)

	Vegetable chips	Hedonic scaling	Rounded*
Study 1: colour	Green bean	3.35^{a}	*3.4
	Carrot	4.39^{cdefgh}	*4.4
	Beetroot	3.63^{a}	*3.6
Study 2: cooking method	Oven baked carrot	4.21^{bcdef}	*4.2
	Deep fried carrot	4.18^{bcde}	*4.2
	Air fried carrot	4.20^{bcde}	*4.2
Study 3: brown vegetable	Butternut	4.07^{bc}	*4.1
	Sweet potato	4.16^{bcd}	*4.2
	Cauliflower	3.63^{a}	*3.6
	Sweetcorn	4.02^{b}	*4.0
	Cabbage	3.55^{a}	*3.6
	Butternut + sweet potato	4.02^{b}	*4.0
Study 4: oil type	Sunflower oil sprayed oven baked sweet potato	4.47^{defg}	*4.5
	Olive oil sprayed oven baked sweet potato	4.56^{g}	*4.6
Study 5: coating	Smash coated oven baked sweet potato	4.31^{bcdefg}	*4.3
	Kellogg's crumbed oven baked sweet potato	4.49^{efg}	*4.5
Study 6: replacement of potato flour	50.0% chickpea replacement oven baked sweet potato	4.48^{defg}	*4.5
	100.0% chickpea replacement oven baked sweet potato	4.53^{fg}	*4.5
Significance level		p < 001	

Means with different superscripts in the same column differed significantly.

Only one decimal will be used in discussion, as it is not possible for humans to taste to two decimals (Muller, 2014).

A selection of brownish vegetable chips was prepared, as this colour is nearer to the colour of deep fried chips. In this test, the lowest ranked vegetable chips were cauliflower (3.6) and cabbage (3.6), which differed significantly ($p < 0.001$) from butternut + sweet potato (4.0), sweet corn (4.0), butternut (4.1) and sweet potato (4.2) (Table 4.6). Cauliflower and cabbage are both known for their characteristic umami taste and although the amino acid taste is favoured by children when used as a seasoning, they are not fond of it occurring naturally in vegetables. Flavour-active compounds are responsible for the "sulphur" and "bitter" flavours of cooked cauliflower, and are potentially implicated in cauliflower rejection by consumers (Engel *et al*., 2002). Sweet, umami and salty substances are initially preferred by children, and bitter and sour substances are rejected (Beauchamp & Menella, 2009). Seasonings only contain salty, sweet and umami tastes, which are preferred, while fresh vegetables, like cauliflower, also contain a bitter taste. The bitter taste can possibly be caused by growing conditions and overcooking (Grantenstein, 2014). Hargreaves (2012) found that consumers' preference for cauliflower starts to increase when the preparation method changes; consumers prefer it crunchy above mushy. There is a definite change in consumers' attitude towards the consumption of cauliflower, considering the popularity of the low carbohydrate diet or banting, which is endorsed by internationally acclaimed researcher and athlete Tim Noakes. Recipes and new products are developed where cauliflower is used to prepare carbohydrate free 'mash' and 'rice' (Noakes *et al*., 2014).

Regarding the liking of butternut, sweet corn, sweet potato and butternut + sweet potato chips, there were no differences. The popularity of butternut is increasing, because of increasing awareness of healthier diets. Butternut squash has the best nutritional value of any squash type (Wright, 2008). In SA, butternut and sweet potato are usually eaten as sweet vegetables, cooked with butter and sugar (Sarie Kos, 2012; Kreatiewe kos idees, 2013). Furthermore, corn is a staple for most South Africans (Smyth *et al*., 2014), thus explaining the liking for the sweet corn chip. The sweet potato chip had the highest numerical ranking of the brownish vegetable chips and it was decided to continue the other studies with this chip type.

From Table 4.6 it is also clear that there was no preference for the kind of oil used. Thus, the children in this study did not really care for the kind of oil if there was an oily aroma present. Fat gives food a unique texture, flavour and aroma, which children associate with chips (Almiron-Roig & Drewnowski, 2010).

When the sweet potato chip was covered with a coating, again there was no preference for either of the coatings (Table 4.6). Although natural human instinct is to have full control over everything they eat (Szczesiak, 2002), not all children can manipulate textures that are crunchy and this can lead to either a dislike or a preference towards the food consumed (Graaf *et al.*, 2010).

For the replacement of the potato flour with 50.0% and 100.0% chickpea flour, there was also no preference between the two samples. Both were ranked very high at 4.5 (Table 4.6), representing 'like a little' to 'like a lot' on the hedonic scale (Figure 4.3). This result is very important, as it showed that the nutritional composition of the vegetable chip could be improved, without losing flavour and taste appeal. Chickpea flour has an earthy, beany flavour, which could be overwhelming for some people, but it can be balanced out with other ingredients, such as sweet potato, as in this case (Meng *et al.*, 2010).

Figure 4.4 is the spider plot, representing the results from all the hedonic scaling tests. Most of the vegetable chips were ranked higher than four on the hedonic scale, translating into 'like a little'. Green beans, beetroot, cauliflower and cabbage were ranked lower than four, but higher than three, representing 'neither like nor dislike' on the hedonic scale. No sample was ranked lower than three, with green beans having the lowest numerical ranking of 3.4 (Table 4.6). The oven baked sweet potato chip, sprayed with olive oil had the highest numerical ranking of 4.6 (Table 4.6).

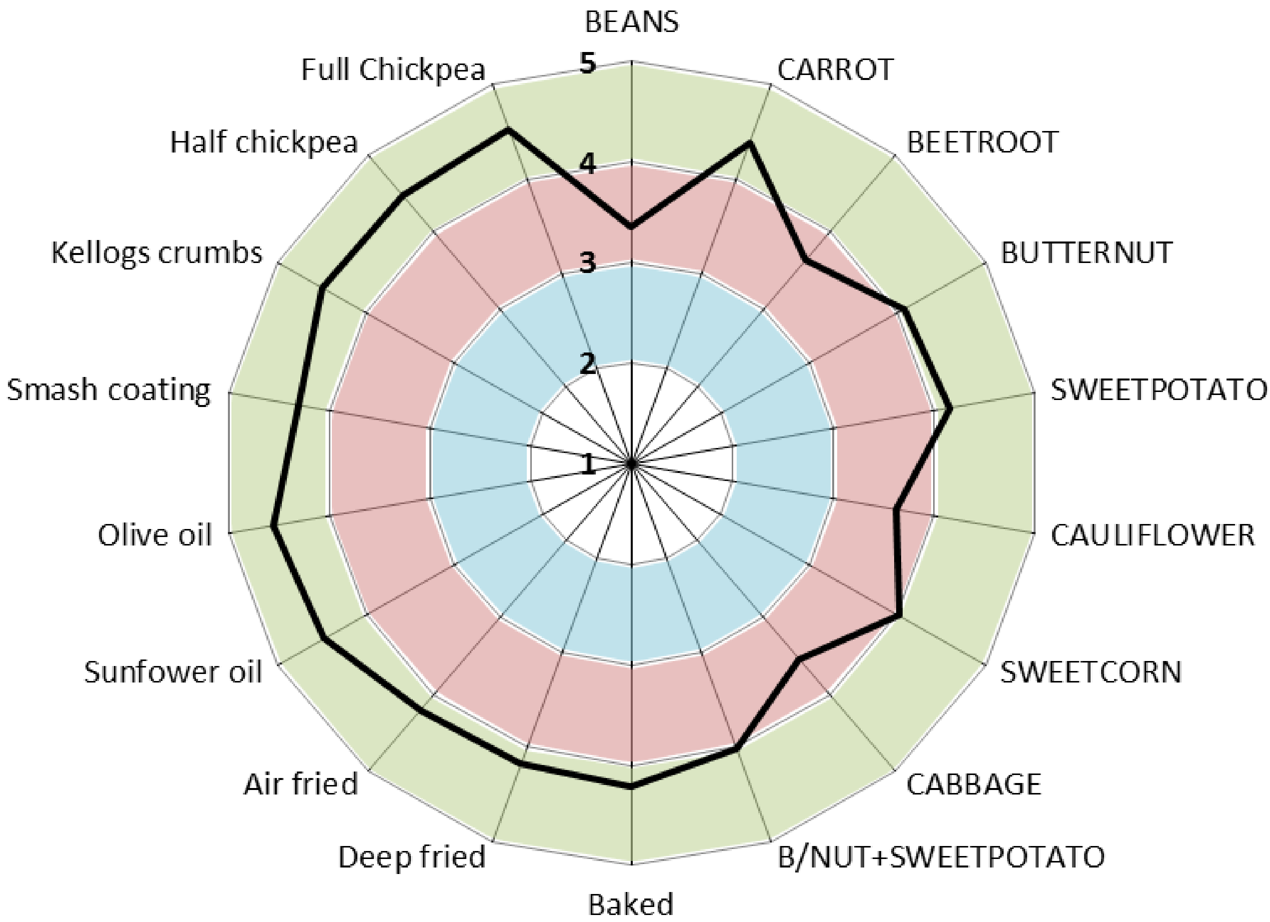

Figure 4.3: Spider plot of children panel's preference ranking for vegetable chips

Table 4.7 is a summary of the ANOVA on the effect of population group, gender and age and their interactions on sensory ranking scores for different vegetable chips. Population group had a significant effect on green bean (p=0.0189), butternut (p=0.0018) and cauliflower (p=0.0218), while gender had a significant effect on beetroot (p=0.0158), butternut (p=0.0307) and cauliflower (p=0.0371) chips. Age had a significant effect on green bean (p=0.0338) and sweet potato (p=0.0445) chips. The interaction between gender and age had a significant effect on 50.0% replacement with chickpea flour in oven baked sweet potato chips (p=0.0378) (Table 4.7).

Table 4.7: ANOVA on the effect of population group, gender and age, and their interactions on sensory preference rankings for different vegetable chips

Chip	Population group	Gender	Age	Population group X Gender	Population group X Age	Gender X Age	Population group X gender X Age
Beans	p = 0.0189*	p = 0.1923	p = 0.0338*	0.2224	0.4719	0.5908	0.5507
Carrot	p = 0.9293	p = 0.4691	p = 0.1428	0.9140	0.7556	0.8310	0.9239
Beetroot	p = 0.2349	p = 0.0158*	p = 0.2275	0.3487	0.3016	0.2915	0.7813
Oven baked	p = 0.7502	p = 0.8882	p = 0.1386	0.6503	0.2599	0.2612	0.1472
Deep fried	p = 0.6816	p = 0.6839	p = 0.2474	0.9756	0.7378	0.5235	0.7272
Air fried	p = 0.1855	p = 0.8206	p = 0.6744	0.8213	0.5010	0.4811	0.1989
Butternut	p = 0.0018*	p = 0.0307*	p = 0.2258	0.2143	0.7184	0.9113	0.5997
Sweet potato	p = 0.0607	p = 0.2652	p = 0.0445	0.5381	0.2926	0.8531	0.9994
Cauliflower	p = 0.0218*	p = 0.0371*	p = 0.1645	0.6670	0.9647	0.7248	0.7959
Sweetcorn	p = 0.7469	p = 0.7364	p = 0.9886	0.4911	0.5668	0.1593	0.8986
Cabbage	p = 0.9436	p = 0.1664	p = 0.3568	0.2968	0.9192	0.0645	0.9013
Butternut + Sweet potato	p = 0.6512	p = 0.7533	p = 0.3759	0.2343	0.9934	0.5360	0.4546
Sunflower oil	p = 0.9166	p = 0.8964	p = 0.8474	0.7325	0.8462	0.2977	0.9709
Olive oil	p = 0.6230	p = 0.2947	p = 0.4826	0.4543	0.9138	0.8409	0.9991
Smash coating	p = 0.1725	p = 0.8767	p = 0.1022	0.8491	0.7149	0.4748	0.3972
Kellogg's crumbs	p = 0.2969	p = 0.2997	p = 0.3634	0.1805	0.1822	0.1891	0.1956
50.0% chickpea	p = 0.9999	p = 0.5433	p = 0.2439	0.2289	0.4434	0.0378*	0.4932
100.0% Chickpea	p = 0.7387	p = 0.4187	p = 0.4981	0.1652	0.5112	0.2186	0.3586

* Significant interactions.

For the green bean chip, the white children gave significantly (p=0.0189) higher rankings (3.7) than the black children (3.0). Black children (4.4) ranked butternut chips significantly (p=0.0018) higher than white children (3.7). White children know pumpkin as a sweet vegetable, while black children are used to vegetables without sugar. Pumpkin without sugar is a taste that the black children are used to. Also, for cauliflower chips the black children's ranking (4.0) was significantly (p=0.0218) higher than that of the white children (3.3) (Table 4.8). The girls' ranking (4.0) for beetroot chips was significantly (p=0.0158) higher than that of the boys (3.3). The reddish/ pinkish colour may be the reason for this. Little girls at this age are just in love with this colour, while boys avoid the colour (Marshall *et al.*, 2006) For both the butternut (4.3) and cauliflower (3.9) chips, the boys' rankings were significantly (p=0.0307/p=0.0371) higher than that of the girls (3.8/3.3) (Table 4.8). Again, the colour could have been more acceptable to the boys.

Table 4.8: ANOVA of the significant effects of population group, gender and age on children panel's hedonic rankings for vegetable chips

	Population group				Significance level
Chip	**Black**	**Rounded***	**White**	**Rounded***	
Green bean	2.96[a]	3.0*	3.74[b]	3.7*	p = 0.0189
Butternut	4.42[b]	4.4*	3.72[a]	3.7*	p = 0.0018
Cauliflower	3.96[b]	4.0*	3.30[a]	3.3*	p = 0.0218

	Gender				
	Female	**Rounded***	**Male**	**Rounded***	
Beetroot	4.04[b]	4.0*	3.28[a]	3.3	p = 0.0158
Butternut	3.80[a]	3.8*	4.30[b]	4.3	p = 0.0307
Cauliflower	3.30[a]	3.3*	3.91[b]	3.9	p = 0.0371

	Age						
	4 years	**Rounded***	**5 years**	**Rounded***	**6 years**	**Rounded***	
Green bean	3.75[b]	3.8*	2.94[a]	2.9*	2.80[a]	2.8*	p = 0.0338
Sweet potato	4.23[b]	4.2*	4.31[b]	4.3*	3.60[a]	3.6*	p = 0.0445

Means with different superscripts in the same row differed significantly.

* Only one decimal will be used in discussion, as it is not possible for humans to taste to two decimals (Muller, 2014).

Also, from Table 4.8 it is clear that the four year olds (3.8) ranked the green beans significantly (p= 0.0338) higher than the five (2.9) and six year olds (2.8). From the age of two years, there is a shift in taste preference and by the age of three, eating becomes the product of environmental cues surrounding the child's food environment. The acceptance of new foods peaks around two to three years and stabilizes between three and four years. Thereafter, changes become increasingly difficult to incur (Skinner *et al.*, 2002; Gahagen, 2012). The four year olds (4.2), this time along with the five year olds (4.3), also ranked the sweet potato chips significantly (p=0.0445) higher than the six year olds (3.60). There was, furthermore, a significant (p=0.0378) interaction between gender X age effect for the oven baked sweat potato chip, where 50% of the potato flour was replaced with chickpea flour (Table 4.7).

The five year old girls (3.6) ranked this chip significantly (p=0.0378) lower than the four (4.6) and six year old girls (4.9), as well as the four (4.4), five (4.6) and six year old boys (4.6) (Table 4.9). Factors, which could play a role in these variations, would include the difference in socio-economic development and wealth, as well as the diversity in prices, availability and accessibility of these foods, as well as taste preferences (Love & Sayed, 2001; Naude, 2013). Food neuphobia can also be accounted for these results as it affects children mostly between the ages of two to six years. With the development of neophobia, children will even start rejecting food that they previously enjoyed eating (Dovey *et al.*, 2008; Schwartz *et al.*, 2011).

Table 4.9: ANOVA on the significant interaction between genders X age effect on child panel hedonic rankings for 50% chickpea replacement chips

Gender	Age	Sensory preference ranks	Rounded ranks
Female	4	4.64^{b}	4.6*
	5	3.55^{a}	3.6*
	6	4.86^{b}	4.9*
Male	4	4.44^{b}	4.4*
	5	4.62^{b}	4.6*
	6	4.63^{b}	4.6*
Significance level		**p = 0.0378**	

* Only one decimal will be used in discussion, as it is not possible for humans to taste to two decimals (Muller, 2014).

4.3.2 Questionnaire on consumer behaviour of children's caregiver

The frequencies of responses to statements the care-taking parents had to answer on their children's consumption of vegetables, are summarised in Table 4.10.

No children had allergies to the ingredients used in the vegetable chips. One child each had an allergy for dog and cat hair, *Oros-* concentrate and nuts, while no child suffered from diabetes type 1. The next three questions dealt with children's liking and dislike of vegetables, as well as whether they had tasted a specific vegetable before. The last question focused on the care-giving parent's dislike(s) of certain vegetables. The vegetables consumed by the care-taking parent are very important, since this will determine the vegetables consumed by the family (Pearson *et al.*, 2009). Children are likely to adopt the eating habits of their caretaker; therefore, it is important to set good examples (European Food Information Council, 2012). Children's daily consumption of fruit and vegetable is closely related to their mothers' consumption patterns of fruit and vegetables (Kinder & Green, 1978; Miller *et al.*, 2011). Of the care-taking parents, 25.0%, 17.0% and 18.0% did not like chickpeas, cauliflower and cabbage, respectively. All the parents liked potatoes and only 2.0% did not like sweet potatoes. Furthermore, green beans and carrots were disliked by only 7.0% and 3.0% of the parents, respectively (Table 4.10).

From the list provided, children liked potatoes (89.0%) and eggs (79.0%) the most, followed by carrots (78.0%) and butternut (65.0%). All the children had eaten potatoes, eggs and carrots before. The least liked food was chickpea at 32.0%, which could be explained by the fact that 45.0% of them had never eaten chickpeas before, which could be attributed by the fact that 2.1% of the parents did not like chickpeas. Cauliflower had not yet been tasted by 32.0% of the children, while only 8.0% had never tasted green beans before (Table 4.10). Cauliflower was the vegetable that was mostly disliked by 36.0% of the children, followed by green beans and chickpeas, both at 32.0%. Potatoes and eggs were only disliked by 3.0% and 8.0%, respectively. Ten-point-zero percent of the children did not like carrots, while 29.0% did not like cabbage (Table 4.10).

Table 4.10: Frequencies of responses to statements regarding consumption of vegetables by respondents and family (n = 100)

Statement		Frequency (n)	Percentage* of sample (%)
Allergies:	none	97	97.0
	dog & cat hair	1	1.0
	Oros	1	1.0
	Nuts	1	1.0
My child is diabetic:	Yes	0	0.0
	No	100	100.0

My child likes to eat:	Black %*	White %*	Total %*
Potato	82.0	96.0	89.0
Green beans	32.0	50.0	41.0
Sweet potato	54.0	74.0	46.0
Cauliflower	22.0	20.0	21.0
Carrot	76.0	80.0	78.0
Sweet corn	54.0	76.0	64.0
Butternut	54.0	76.0	65.0
Chick pea	20.0	24.0	22.0
Egg	80.0	78.0	79.0
Beetroot	64.0	54.0	59.0
Cabbage	56.0	20.0	38.0
My child has never eaten:	**Black %***	**White %***	**Total %***
Potato	0.0	0.0	0.0
Green beans	12.0	4.0	8.0
Sweet potato	10.0	2.0	6.0
Cauliflower	53.0	12.0	32.0
Carrot	0.0	0.0	0.0
Sweet corn	16.0	4.0	10.0
Butternut	2.0	0.0	1.0
Chick pea	44.0	46.0	45.0
Egg	0.0	0.0	0.0
Beetroot	6.0	16.0	11.0
Cabbage	6.0	30.0	18.0
My child does not like:	**Black %***	**White %***	**Total %***
Potato	4.0	2.0	3.0
Green beans	28.0	36.0	32.0
Sweet potato	12.0	12.0	12.0
Cauliflower	26.0	46.0	36.0
Carrot	14.0	6.0	10.0
Sweet corn	12.0	10.0	11.0
Butternut	16.0	6.0	11.0
Chick pea	26.0	38.0	32.0
Egg	10.0	6.0	8.0
Beetroot	20.0	22.0	21.0
Cabbage	18.0	40.0	29.0
I, as a parent, do not like:	**Black %**	**White %**	**Total %**
Potato	0.0	0.0	0.0
Green beans	10.0	2.0	7.0
Sweet potato	4.0	0.0	2.0
Cauliflower	26.0	8.0	17.0
Carrot	0.0	6.0	3.0
Sweet corn	14.0	8.0	11.0
Butternut	2.0	2.0	2.0
Chick pea	2.0	22.0	25.0
Egg	2.0	8.0	5.0
Beetroot	4.0	4.0	4.0
Cabbage	8.0	28.0	18.0

*According to official statistician of UFS, one decimal is sufficient with percentages (Schall, 2017).

From Table 4.10 there were relevant differences between the two cultural groups. Fifty-six-point zero percent of black children liked to eat cabbage, while only 20.0% of white children liked it. Only 8.0% of black parents did not like cabbage, while 28.0% of the white parents did not like to eat cabbage. If parents do not like a certain food, they normally are not going to prepare it for a meal (Birch *et al.*, 1980; Casey & Rozin, 1989). This may be the reason why 30.0% of white children had never tasted cabbage before, while only 6.0% of black children has never eaten it. This is a good indication why there is such a big difference (18.0% to 40.0%) between the different cultures' liking of cabbage. (Table 4.10) The black children are also more familiar with the kale taste than the white children are, because they consume much more cabbage than the white children do (Table 4.10).

Fifty-point-zero percent of white children liked to eat green beans, in contrast to 32.0% of black children. Twelve-point-zero percent of black children had never eaten green beans, while only 4.0% of white children never tasted it. (Table 4.10) Poelman *et al.* (2015) found that added salt increased the intake and liking of green beans by toddlers. Black people use very little salt, if any, in preparing meals. They do not even add any salt to their porridge, which is one of their staple foods. This may be economically driven, as well as cultural, where the idea of cooking with no salt is handed down from generation to generation (Birch *et al.*, 1980; Casey & Rozin, 1989).

Only 54.0% of black children liked to eat sweet potato, while 74.0% of white children liked it. As mentioned earlier, children like sweet tastes (Beauchamp & Menella, 2009), and Havermans and Jansen (2007) stated that children show an increase in preference for a previously sweetened vegetable taste. Sweet potato is known in European cultures as a vegetable cooked with sugar and/or syrup. Due to cultural and economic factors, Africans will not use sugar in the cooking process, similarly as was the case in cooking without salt. Similarly, they would rather spend money on nutritious food than on unhealthy sweet snacks. This may explain why more white children liked sweet potatoes and why 10.0% black children and only 2.0% white children never tasted sweet potato before.

The cultural difference in the liking of cauliflower was not very big (22.0% black versus 20.0% white children). The taste of cauliflower is strong and slightly bitter. Children (Beauchamp & Menella, 2009) reject bitter tastes. When other flavours and ingredients (like cheese and white sauce) are added to the cauliflower, these disliked flavours become more desirable, because of masking. These specific additions, namely cheese and white sauce, are not part of the black culture. Due to the strong flavour and bitter taste, 53.0% black children had never eaten cauliflower, in contrast to only 12.0% white children, who have not tasted it before. Twenty-six-point zero percent of the black parents, to only 8.0% of the white parents, did not like cauliflower (Table 4.10). The social context that surrounds a child's meal times strongly shapes his/her acceptance of and preference for certain foods, as they like to eat what they see the rest of the family/friends are eating (Birch *et al.*, 1980; Casey & Rozin, 1989).

The percentage black children liking butternut and sweet corn were 54.0% for both, while 76.0% of the white children liked both butternut and sweet corn. Pumpkin is also a type of vegetable that are usually served with sugar and sweet corn is naturally sweet. Both these vegetables are expensive and there are similar pumpkin types that will be cheaper and more economical to use. Black people traditionally eat maize on the cob. They can purchase it on the street where it is cooked over fire. It is usually ripe maize where the sugar is already transmitted to starch, a less sweet taste, and a much lower GI product. That could be the reason why black children are not used to these vegetables, as well as the fact that black people are not used to sweet vegetables (Steyn *et al.*, 2011).

4.4 CONCLUSIONS

According to the DRAs, children need a high-level intake of vegetables, which must consist out of a variety of vegetables. Fast food is a very popular and frequent choice, although it is unhealthy and has negative effects on health. Consumers are becoming more aware of healthier options, but are still looking for satisfying choices.

One hundred children, aged four to six years old, ranked a variety of potato-based vegetable chips above four on the hedonic scale. There was no preference for a specific cooking method, indicating that the less oil containing oven baked method would be sufficient for the younger children. Coatings are also not necessary, while improvement of the nutritional content by the addition of chickpea flour was found acceptable by the children.

These findings are important, because these are healthy alternatives to traditional fried chips, which are still accepted. Caretakers must adopt the healthier principles and feed children more vegetables, using creative methods to improve their acceptability. Consequently, potato-based vegetable chips or the chickpea-based vegetable chips can become very popular in future markets.

It is important to know the nutritional value of the vegetable chips. The inclusion of the whole vegetable in the recipe, as well as the preparation methods that was followed (oven baking, air frying) promise a very healthy product. The chickpea-based option, instead of potato-based, can enhance the nutritional value. A plate of coloured potato-based vegetable chips imply that a variety of vegetables are served to the child at once, ticking the box for an assortment of vegetables, which is necessary for the child to consume in a healthy diet.

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CHAPTER 5

COMPARISON OF THE NUTRITIONAL CONTENT OF A POTATO-BASED VEGETABLE CHIP, PREPARED BY USING THREE DIFFERENT COOKING METHODS

ABSTRACT

Nutritional analyses were done on the raw, baked, deep fried and air fried potato-based sweet potato chips. Dry matter, moisture, protein, fat, energy, free sugars (glucose, fructose and sucrose), minerals, dietary fibre and vitamin A were determined, according to Analytical Standard Methods. For the statistical analysis, three replications were determined, as well as standard deviation. The dry matter of the baked sample was significantly ($p<0.001$) higher than the other three samples, while the moisture content of the deep fried sample was significantly ($p<0.001$) higher than the rest. The ash retention of the air fried sample was significantly ($p<0.001$) higher than the raw and baked samples. The retention of protein in the air fried sample was significantly ($p<0.001$) higher than all the other samples. The fat and energy content of the deep fried samples were significantly ($p<0.001$) higher than the other samples. The retention of fructose and sucrose in the air fried samples were also significantly ($p=0.003$ and $p=0.006$, respectively) higher than the other samples, as were the K and Mg content ($p<0.001$). The nutritional content of the air fried sample was the best of the three cooking methods.

5.1 Introduction

Food preparation and the style in which vegetables are prepared can strongly predict child rejection or acceptance of vegetables (Baranowski *et al.*, 1993; Nicklas *et al.*, 2001; Reinaerts *et al.*, 2006). Thus, for children who do not like to eat vegetables, the cooking method is even more important for the vegetables to be liked (Graaf *et al.*, 2010). Several studies also found that vegetable acceptance and preference increased when the striking flavour of the vegetables are masked or modified by means of various preparation styles (Ireton & Guthrie, 1972; Nicklas *et al.*, 2001).

For almost 150 years potato chips have been a popular salty snack (Marique *et al.*, 2007). The most important processing properties, influencing the sensory quality of a chip, are: the thickness of the chip; frying oil; frying temperature; and frying time (Kimondo, 2007). Colour is an important parameter of potato chips for consumers, as they associate colour with flavour, safety, storage time, level of satisfaction and nutrition content (Marique *et al.*, 2007). During frying there are textural changes that takes place and it is the result of physical, chemical and structural changes, which include heat, mass handover, together with chemical reactions (Pedreschi *et al.*, 2009).

One of the oldest and most popular cooking methods is frying. An edible fat serves as heat transfer medium and is heated above the boiling point of water (Amany *et al.*, 2012). Food is then immersed into the hot oil, where the high temperature causes the water to evaporate out of the food. The water moves out of the food particals, through the very hot oil and into the atmosphere. The water that is lost during frying is then replaced by the oil that is absorbed (Moreira *et al.*, 1995). By dipping the food into the hot oil, the food is sealed, so that the flavours are reserved in the crispy crust (Pedreschi *et al.*, 2009).

Fried chips differ from baked or other forms of preparation, because of the higher temperatures and oil absorption. When potatoes are fried, the content of water is reduced from 80.0% to 1.0-2.0%. This is important, because it influences the chip's stability from microbial spoilage, as the final moisture content plays an important role and affects the texture, turning it crispy (Kimondo, 2007). After frying, the potato chip has an uptake of about 35.0% oil (Marique *et al.,* 2007) or between 30.0%-40.0% (Kimondo, 2007). This oil content gives chips the unique texture-flavour combination, thus making them so desirable. Blanching beforehand increases oil uptake and decreases frying temperature. The most oil absorption takes place in the surface and happens during the cooling process after the chips are removed from the fryer (Cocio *et al.*, 2008).

The air fryer makes crispy, delicious chips and is a cheaper method than the ordinary deep fat frying method (Kemp, 2012). The food is no longer emerged into hot oil. The air fryer circulates very hot air (up to 200 °C) to fry the food and make the outer layer crispy. Food cooks quickly and gets a crispy outer layer. Deep fried chip portions of 300g contain 3001 kJ, with 37g of fat; using this method, the chips only contain 2149 kJ, with 9g of fat. Only 14ml of oil is needed to cook 1kg of chips (Kemp, 2012). The traditional method of deep-frying needs 1.5 to 2 litres vegetable oil to fry 1kg of potato chips (Taste.com.AU, 2014).

Oven-baked, air-dried and air-fried chips are lower in fat content. Oven or air drying of chips takes more time, but the result can be good. Chefs put some oil on the chips before drying them to enhance the flavour (Rogers, 2009). A study was performed to investigate the effect of baking and frying of potato chips on the formation of acrylamide in the chip. According to results, prolonged baking of chips at low temperatures (170 °C) led to the formation of more than double the amount of acrylamide, than frying at the same temperature (180 °C – 190 °C). Normal baking (180 °C) did not necessarily resulted in more acrylamide, when compared to frying. Baking was still considered as the healthier option and, despite more acrylamide being formed, baking at 170 °C gave the optimum chip quality (Gokemen *et al.*, 2010).

The aim of this study was to compare the nutritional content of a potato-based vegetable chip, using three different cooking methods.

5.2 MATERIALS AND METHODS

5.2.1 Potato chip

The potato-based vegetable chip that was used for nutritional evaluation was the sweet potato chip, which scored the highest ranking for the group of brown coloured chips (Table 4.6). The potato-based chips were made by adapting a basic c*houx paste* recipe (Table 5.1) (Foods and Cookery, 1991). The cake flour was partly replaced by *Smash* (Bokomo Foods, 40 Meil Hare Road, Atlantis 7349, a division of Pioneer Foods (PTY) LTD. Product of SA), a type of dried potato starch, with added salt, flavouring and preservative. The water in the original recipe was replaced by a mixture of sweet potato juice and pulp, obtained after processing the sweet potatoes in a juice extractor (400 watt) (Table 5.1).

Table 5.1: Formulation of sweet potato-based chips (Foods and Cookery, 1991)

Ingredient	Percentage (%)
*Smash**	10.9
Butter	12.1
Egg	22.1
Sweet potato pulp	21.1
Sweet potato juice	26.3
Cake flour	7.4
Salt	0.1

*Bokomo Foods. 40 Meil Hare Road, Atlantis, 7349. A Division of Pioneer Foods (PTY) LTD. Product of South Africa.

A quarter of the mixture was freeze dried in a Freezone 6 Plus (Vacutex, Johannesburg), as preparation for nutritional analysis. The rest of the mixture was piped in long strips onto a greased baking tray, to resemble the shape of potato chips and baked at 180 °C for 15 min in a Defy 631-T (Thermo-fan, 880Watt) oven. These long strips were then cut into chip sizes, about 50 mm in length. Two additional cooking methods were applied to the oven baked chips: deep frying in sunflower oil at 200 °C for 7min; and sprayed with 3ml olive oil and then air fried (Phillips Air Fryer HD9220; 1425Watt) at 160 °C for 10 min. In final preparation, these samples were also freeze dried.

5.2.2 Nutritional analysis

5.2.2.1 Dry matter

Analytical Standard Method (ASM) 013 was used to determine the % dry matter (DM) (AOAC, 2000). This method was chosen, as it is suitable for the determination of DM in food products. The DM content is the residue expressed in % by weight, which remains after the drying process. The moisture from a sample is driven off by heat (oven drying at 105 °C for 16 hours (h). Weight loss is used to calculate DM content, by the following formula:

$$\% \text{ Total DM} = \frac{(W_3 - W_1) \text{ x } 100}{W_2 - W_1}$$

Where, W_1 = tare weight of dish in g

W_2 = initial weight of sample and dish in g

W_3 = dry weight of sample and dish in g

5.2.2.2 Moisture

Moisture was determined by the ASM 013 method (AOAC, 2000), which is a gravimetric method, where the loss in weight at a constant temperature was measured. A 2.0 g sample, in a pre-weighed glass weighing bottle, is heated in a temperature-controlled oven for about 16 h at 105 °C. The sample is cooled in a desiccator and weighed. The following formula is used to calculate the % moisture:

$$\text{Moisture \% by weight} = \frac{(B-C)\times 100}{B-A}$$

Where, A = weight in g of the empty sample bottle

B = weight in g of the bottle plus material before drying

C = weight in g of the bottle plus material after drying

5.2.2.3 Ash

The % ash was determined according to ASM 048 (AOAC, 2000). The total ash is the inorganic matter of a sample. The organic matter of a sample is removed by heating at 550 °C overnight. The remaining residue is inorganic matter (ash). To calculate the % ash, the following formula is used:

$$\text{\% Ash (DM basis)} = \frac{(W_3 - W_1)\times 100}{(W_2 - W_1)\times \frac{DM}{100}}$$

Where, W_1 = tare weight of crucible in g

W_2 = weight of crucible and sample in g

W_3 = weight of crucible and ash in g

5.2.2.4 Protein

The Kjeldahl method ASM 078 (AOAC, 2000), which measures total organic nitrogen (N), was used to determine the protein content of the chip samples. The organic matter is digested with hot concentrated H_2SO_4. A catalyst mixture is added to the acid, to raise the boiling point. All N is converted to ammonia (NH_3), which is measured by titration. A conversion factor of 6.25 is used in the calculation of the protein content from the total N. The following formula is used to determine the % N:

$$\frac{[(\text{ml standard acid x normality of acid}) - \text{ml blank x normality of base})] - (\text{ml standard base x normality of base}) \text{ x } 1.4007}{\text{weight of sample}}$$

= % N

where, ml blank = ml of base needed to back titrate a reagent blank if standard acid is the receiving solution

% Protein = % N x 6.25

5.2.2.5 Fat (Majonnier)

The fat content was determined according to ASM 004, based on the Röse Gottlieb gravimetric method (AOAC, 2000). One ml ammonia is added to 10 g homogeneous sample, mixed thoroughly, added 10 ml alcohol and mixed again. Twenty-five ml diethyl ether is then added, and after releasing the pressure, shaked for 1 min. A further 25 ml of petroleum ether is added and the sample is shaked for 30 s. After 30 min, the ethereal layer is removed and extracted for a second and a third time. The fat sample is dried in the oven (105 ºC for 1 h) and weighed. The difference in weights represents the weight of fat extracted from the sample. The following formula is used to calculate the % fat:

$$\% \text{ fat m/m} = \frac{\text{weight of fat in g}}{\text{weight of sample in g}} \text{x } 100$$

5.2.2.6 Carbohydrate (calculated)

The carbohydrate content was analysed using ASM 075 (AOAC, 2000). Moisture, crude protein, ash and fat are determined individually, summed and subtracted from the total weight of the sample. This is referred to as *total carbohydrate by difference* and is calculated by the following formula:

% total carbohydrates = 100 - (weight in g of [protein + fat + water + ash + alcohol] in 100 g of food)

5.2.2.7 Energy (calculated)

The energy content (dry material) was determined according to ASM 076 (AOAC, 2000). Metabolisable energy (ME) can be calculated by using energy conversion factors for protein, fat and carbohydrates content. To calculate the ME, the following formula is used:

$$ME = (GE_p - 7.9/6.25)\, D_p + GE_f D_f + GE_{cho} D_{cho}$$

Where, GE_p, GE_f and GE_{cho} = the gross energy of protein, fat and carbohydrate,

Respectively,

and D_p, D_f and D_{cho} = the digestibility coefficient of protein, fat and carbohydrate, respectively.

5.2.2.8 Free sugars

Free sugars, sucrose, glucose and fructose, were determined according to ASM 017 (AOAC, 2000). Sugars are extracted by placing a 30 g sample in a 100 ml beaker, chopping it with a Salton Elite Stick Blender (model SSB40E 230-300W) and stirring after every 30 min with 50 ml 95% ethanol. Samples are shaken 20 times, kept at room temperature overnight and then centrifuged for 15 min at 5800 rpm x g in a Beckman JA-14 rotor, before analysis by high performance liquid chromatography (HPLC). High performance liquid chromatography is carried out on a Waters System (501 pump) and Biorad Aminex column (7.8 mm X 300 mm), with a differential refractive index detector (R401) operated at 42 ºC, and a mobile phase of de-ionised water at a flow speed of 0.6 $ml.min^{-1}$ and temperature of 85 ºC.

5.2.2.9 Minerals

The cooking losses of the macro- and micro-minerals are calculated on a wet weight basis for each replicate. The replicate results are averaged for the sample being analysed. The average value obtained from subtracting the specific mineral concentration, before and after cooking, is considered a loss if positive, or an apparent gain if marked with a positive symbol (Kawashima & Valente Soares, 2003).

$$\% \text{ Cooking loss} = \frac{(MC\ of\ raw\ sample - MC\ of\ cooked\ sample)x\ 100}{MC\ of\ raw\ sample}$$

where, MC = mineral concentration.

5.2.2.10 Dietary fibre

Fibre was determined by the acid detergent fibre method (Goering & Van Soest, 1970; James & Theander, 1981; AOAC, 2000). Twenty g acetyl tri-methyl bromide is dissolved in 28 ml 98% sulphuric acid and 1 ℓ of distilled water. The samples are air dried and milled to pass through a sieve with circular openings (1 mm in diameter). One g of sample, in a small tube, is put overnight in the oven at 105 ºC. Samples are put in a desiccator for 30 min, then placed in a hot extraction unit and cooled on the condenser cooling water. Hundred ml of acid detergent solution is added to each sample and heated on the heating element for 1 h. Samples are filtered with suction and washed three times with hot water and then rinsed twice with acetone. The samples are subsequently incinerated at 500 ºC for 4 h and the weight of the remaining ash is determined.

5.2.2.11 Vitamin A

Samples are centrifuged for 15 min at 5800 rpm. About 30 g of chips are extracted with 250 ml hexane, 125 ml acetone, 125 ml ethanol, where after 4.5 ml hexane plus 0.5 ml sample are mixed and stirred. Carotenoid extraction and determination are performed by filtering samples through a column of aluminum oxide, packed in a

Pasteur pipette, plugged with glass fibre, and then washed with hexane until clear. Two ml of sample are diluted to 10 ml with hexane. Total carotenoid is determined with a Genesys 10 spectrophotometer, at 450 nm (Brubacher *et al.*, 1985).

5.2.3 Statistical analysis

Averages of three replications were determined, as well as the standard deviation, unless otherwise indicated.

5.3 Results and discussion

In Table 5.2, highly significant differences ($p<0.001$) were found for DM, moisture, ash, protein, fat, carbohydrates, energy, Ca, K and Mg, between the samples. Significant differences were also noted for free sugars, namely glucose ($p=0.011$), fructose ($p=0.003$) and sucrose ($p=0.006$), as well as for the mineral Mn ($p=0.002$). Significant difference in nutrients will be discussed for deep fried and oven baked samples, and then conclusions will be drawn for the effect of air frying on the same nutrients.

For DM, all the samples differed highly significantly ($p<0.001$) amongst one another, with the raw sample (61.1%) having the lowest amount and the baked sample the highest (68.2%). The opposite trend was observed for % moisture, with the raw sample having the highest value, namely 38.9% and the oven baked sample having the lowest value, namely 31.8%. For moisture content, all the samples, again, differed significantly ($p<0.001$) amongst one another (Table 5.2). Oven baking, air frying and deep frying all resulted in a significant moisture loss, and qualify as moderate drying (Marcotte *et al.*, 2004). The oven baked sample had the highest DM content and the lowest moisture content, because of the longest exposure to heat (15 min vs. 7 min vs. 10 min). Moisture content, expressed on a dry basis, is found to decrease linearly as a function of baking time (Marcotte *et al.*, 2004). The moisture content of the deep fried samples were the highest of the cooking treatments, because of crust formation, which may delay the loss of moisture (Fillion & Henry, 1998).

Table 5.2: Comparison between the nutrient content of raw, oven baked, air fried and deep fried sweet potato chips

Treatment	Unit	Raw	Baked	Air fried	Deep fried	Significance level
Dry matter	%*	61.1 ± 0.04[a]	68.2 ± 0.03[d]	65.0 ± 0.02[c]	63.2 ± 0.16[b]	p<0.001
Moisture	%*	38.9 ± 0.04[d]	31.8 ± 0.03[a]	35.0 ± 0.02[b]	36.8 ± 0.16[c]	p<0.001
Ash	%*	2.6 ± 0.02[b]	2.4 ± 0.01[a]	2.7 ± 0.06[c]	2.6 ± 0.03[bc]	p<0.001
Protein (N x 6.25)	%*	6.2 ± 0.29[c]	5.1 ± 0.13[a]	6.7 ± 0.06[d]	5.7 ± 0.05[b]	p<0.001
Fat (Majonnier)	%*	17.7 ± 0.06[a]	20.7 ± 0.03[b]	20.3 ± 0.38[b]	24.0 ± 0.05[c]	p<0.001
Carbohydrates (Calculated)	%*	29.0 ± 0.37[b]	23.4 ± 0.13[a]	31.9 ± 0.36[c]	28.3 ± 0.17[b]	p<0.001
Energy (calculated)	kJ/100g	1 252.27 ± 0.61[b]	1 036.39 ± 0.79[a]	1 407.66 ± 8.26[c]	1 467.75 ± 1.82[d]	p<0.001
Glucose	g/100g	3.36 ± 0.38[b]	3.35 ± 0.10[b]	3.13 ± 0.09[ab]	2.66 ± 0.12[a]	p=0.011
Fructose	g/100g	0.24 ± 0.02[a]	0.23 ± 0.01[a]	0.51 ± 0.09[b]	0.37 ± 0.09[ab]	p=0.003
Sucrose	g/100g	0.94 ± 0.03[a]	0.99 ± 0.15[ab]	1.21 ± 0.07[b]	0.87 ± 0.01[a]	p=0.006
Ca	mg/100g	52.43 ± 1.92[b]	50.97 ± 0.45[b]	52.02 ± 0.92[b]	41.68 ± 0.04[a]	p<0.001
K	g/100g	0.65 ± 0.01[b]	0.65 ± 0.01[b]	0.70 ± 0.02[c]	0.57 ± 0.01[a]	p<0.001
Mg	mg/100g	32.48 ± 0.85[a]	33.31 ± 0.31[a]	36.70 ± 0.15[b]	33.27 ± 0.58[a]	p<0.001
Na	g/100g	0.68 ± 0.10	0.67 ± 0.01	0.65 ± 0.01	0.60 ± 0.01	p=0.291
Cu	mg/100g	0.16 ± 0.08	0.21 ± 0.04	0.16 ± 0.02	0.25 ± 0.06	p=0.209
Fe	mg/100g	2.03 ± 0.75	2.31 ± 0.22	2.29 ± 0.15	1.74 ± 0.17	p=0.348
Mn	mg/100g	0.37 ± 0.04[a]	0.47 ± 0.01[b]	0.45 ± 0.01[b]	0.42 ± 0.01[ab]	p=0.002
Zn	mg/g	0.86 ± 0.15	1.13 ± 0.15	0.95 ± =0.06	1.27 ± 0.23	p=0.051
P	g/100g	0.14 ± 0.01	0.15 ± 0.01	0.15 ± 0.01	0.15 ± 0.01	p=0.131
Dietary Fibre (total)	g/100g	5.57	3.35	5.85	4.57	NSA
Vitamin A	mg/100g	0.04	0.05	0.05	0.04	NSA

Means with superscripts in the same row differ significantly.
NSA = Not statistically analysed.
*According to official statistician of UFS, one decimal is sufficient with percentages (Schall, 2017).

The loss in ash indicates a loss in minerals (Bognár, 1998). The oven baked chip (2.4%) had the lowest percentage ash, and it differed significantly ($p<0.001$) from the raw (2.6%) and deep fried chip (2.6%); the latter two did not differ from one another. Air fried chips had the highest percentage of ash (2.7%) and it differed significantly ($p<0.001$) from the raw (2.6%) and oven baked chips (2.4%) (Table 5.2). Mineral retention is, thus, the best in air fried chips, while deep fried chips did not lose any ash. In a study by Gall *et al.* (1983), the same results were found for fried fish, while losses of major minerals (up to 20%) was found in baked fish, which is in accordance with the low values for baked chips in the present study.

For protein content, all four samples differed highly significantly ($p<0.001$) amongst one another. For the different cooking methods, the highest retention of protein was in the air fried chip (6.7%), followed by the deep fried (5.7%) and the oven baked (5.1%) (Table 5.2). The low protein content of the deep fried chips is in accordance with the results obtained by Tooley and Lawrie (1974), who found that the amount of available lysine in white fish dropped with 20-30% after deep fat frying. The losses were caused by the formation of bonds between the amino groups of the protein and oxidation products of the fat (Gilliatt & Rossell, 1992). The lowest protein content was found for the oven baked samples, because the quality of proteins may be adversely affected by the Maillard reaction. This reaction primarily affects the basic amino acids, of which lysine is particularly significant; in fact, lysine is destroyed during this reaction. Almost all amino acids are adversely affected (Ranhotra *et al.*, 1971).

For fat content, deep fried chips (24.0%) differed significantly ($p<0.001$) from baked (20.7%), raw (17.7%) and air fried (20.3%) chips, but the baked and air fried samples did not differ from one another; they did, however, differed significantly ($p<0.001$) from the raw sample. The fat content of the deep fried chips were the highest (Table 5.2), which was due to the uptake of oil after the frying process (Shaker, 2015). The initial composition of the food (water and fat content) has a great effect on the fat uptake during frying (Ersoy & Özeren, 2009). Makinson *et al.* (1987) reported that plant foods, which initially have high water and low fat contents, absorbed more frying fat than animal foods. Intercellular spaces of plant tissues are filled with air and these results in a greater capacity of plant foods to retain absorbed fat. In a study by Mai *et al*. (1978), it was found that fresh-water fish fillets (trout, red snapper, Spanish mackerel and sucker) lost lipids after baking, which is in accordance with the low value of 20.7% for the baked chips in the present study. Furthermore, since much of the fat taken up by the fried food is located on the surface and in the crust, size and geometry are important features to contemplate when considering fat uptake. In a study on lipids in French fries, Greenfield *et al*. (1984) found that decreased fries size significantly increased fat content of fries in a linear fashion.

The carbohydrate content of the raw (29.0%) chip did not differ from the deep fried (28.3%) chip, but both differed significantly ($p<0.001$) from the baked (23.4%) and air fried (31.9%) samples. The baked chip (23.4%) differed significantly ($p<0.001$) from the raw (29.0%), air fried (31.9%) and deep fried chips (28.3%). The air fried chip (31.9%) differed significantly ($p<0.001$) from the raw (29.0%), baked (23.4%) and deep fried chips (28.3%). The oven baked sample had the lowest carbohydrate content, due to the presence of the potato flour. Participation of simple and hydrolysed complex carbohydrates in the Maillard reaction adversely affects the available carbohydrate of baked products (Ranhotra & Bock, 1988). Deep frying had no effect on starch content, which was in accordance with literature (Fillion & Henry, 1998).

The energy value of the four samples differed significantly ($p<0.001$) amongst one another, with the deep fried sample having the highest value (1 467.8kJ/100g), due to uptake of oil after the frying process (Shaker, 2015). The lowest kJ/100g value was for the baked sample (1 036.3kJ/100g), because of the lower carbohydrate content, as discussed in the previous paragraph.

The free sugars included glucose (simple sugar), fructose (a simple, reducing sugar) and sucrose (=glucose + fructose). The glucose content of the deep fried (2.66 g/100 g) chips were significantly ($p=0.011$) lower than the raw (3.36 g/100 g) and oven baked (3.35 g/100 g) chips; the latter two did not differ from one another. The baked sample had a significantly ($p=0.003$) lower fructose content (0.23 g/100 g) than the air fried sample (0.51 g/100 g); the latter sample also differed significantly ($p=0.003$) from the raw sample (0.24 g/100 g). Furthermore, for sucrose content, the raw (0.94

g/100 g) and deep fried (0.87 g/100 g) samples were significantly ($p=0.006$) lower than the air fried (1.21 g/100 g) samples. The general trend, when comparing the cooking methods to the raw sample, were as follows: the raw sample had a high glucose, and a low fructose and sucrose content; the oven baked sample had a high glucose and low fructose content; the air fried sample had high values for all three free sugars; and the deep fried sample had low values for glucose and sucrose. Thus, the following cooking methods had no adverse effects on free sugars: baking and hot air frying on glucose content; and baking and deep frying on fructose and sucrose contents. Deep frying had the lowest value for glucose content. During this type of heating, the main reaction of sugars is the Maillard reaction with free amino acids or free amino groups of proteins and peptides. Reducing sugars, mainly glucose and fructose, react directly, while sucrose reacts only after previous hydrolysis into a mixture of glucose and fructose. In model experiments, browning proceeded at the same rate in the presence of sucrose as in the presence of glucose (Porkorny, 1999). Furthermore, acrylamide is formed in foods containing reducing sugars (glucose and fructose) and amino acids (asparagine) at high temperatures, and is considered a carcinogenic substance to humans (Rodriguez-Ramiro *et al*., 2011).

The minerals that were affected by the different cooking methods were Ca, K, Mg and Mn. For Ca, the deep fried sample (41.68mg/100g) had a significantly ($p=0.001$) lower content than the other three samples. The K content of raw (0.65 g/100g) and oven baked (0.65 g/100g) chips were significantly ($p<0.001$) lower than that of the air fried chip (0.70 g/100g), and higher than the deep fried chip (0.57 g/100g). The air fried chip's (36.70 mg/100g) Mg content was significantly ($p<0.001$) higher than the other three samples. For Mn content, there was a significant ($p=0.002$) difference between the raw, baked and air fried chips. Thus, the following cooking methods had effects on mineral content: deep frying (↓) on Ca; air frying (↑) and deep frying (↓) on K; air frying (↑) on Mg; and oven baked (↑) and air frying (↑) on Mn. Due to water loss, the weight of fried food decreases during frying. Most mineral components are non-volatile, therefore, the content of minerals on wet basis, would be expected to rise. There occurs, however, another process at the same time, i.e., the uptake of frying oil. The weight of fried material increases, and if the mineral content is expressed on a dry weight basis, a moderate decrease of mineral content would be found (Pokorny, 1999).

Although the total dietary fibre of the samples could not be statistically analyzed, the samples had the same numerical values, except for the oven baked chip, with a value of 3.4 g/100 g (Table 5.2). According to Fillion and Henry (1998), the baking of French fries had no effect on the starch composition, while deep frying increased the percentage of resistant starch (Asp & Bjork, 1992; Thed & Phillips, 1995). The resistant starch acts as dietary fibre in deep fried products (Thed & Phillips, 1995), explaining the increase in dietary fibre of the deep fried sample (4.5 g). During the baking process, some fibre components, e.g. hemicellulose, may undergo transformation. In fact, some fibre components may be formed, e.g. Maillard reaction products. Also, little is known of the effect of baking on protein-mineral and mineral-mineral complexes and how these might affect mineral absorption (Ranhotra & Bock, 1988). Dietary fibre has another very important function in deep fried products. During deep frying, they form a compact film on the surface in the beginning of frying, thus preventing fat migration into the fried food and losses of moisture from food (Pokorny, 1999).

Vitamin A was not much affected by the applied cooking methods. The extent of vitamin destruction is dependent on the temperature and the time of treatment. Deep frying and air frying has two main advantages over other cooking methods: the temperature inside the food, especially during air frying, never exceeds 100°C; and the frying time is usually very short (Fillion & Henry, 1998; Heredia, *et al.*, 2014).

To summarize, it can be said that the DM of air fried sample (65.0%) was lower than the baked sample (68.2%) and the moisture content for the air fried sample (35.0%) was higher than the baked sample (31.8%), because of the shorter time of drying. The air fried sample retained the highest amount of ash (2.7%), because it also retained the most minerals compared to the other cooking methods. The air fried samples also retained the most protein, because of lower levels of Maillard reaction that took place during the shorter cooking time.

The air fried sample had the highest carbohydrate value (31.9%), again due to the slower rate of Maillard reaction that adversely affects carbohydrates. The high carbohydrate content also added to the high energy level (1 407.66 kJ/100 g) of the air fried sample. This sample also had high values for the three free sugars, as well as the highest retention of fructose (0.51 g/100 g) and sucrose (1.21 g/100 g), because of the lower rate of the Maillard reaction. This lower rate also produced less acrylamide, which, in the end, makes it a much healthier option. The high dietary fibre content of the air fried samples (5.85 g/100 g) was due to the high dietary fibre content of sweet potato. Sweet potato is a significant source of dietary fibre, as its pectin content can be as high as 5% of the fresh weight or 20% of the dry matter (Bovell-Benjamin, 2007). Air fried samples' dry matter retention was high and, thus, more fibre was available.

5.4 CONCLUSIONS

When comparing the nutritional contents of the four samples, it was quite unexpected to find that the air fried sample had the best nutritional profile. The cooking method with the worst nutritional content was the oven baked sample, which was expected to be the healthiest option. The deep fried cooking method delivered the second best nutritional content and the only main concern would be the increase in fat content and subsequent rise in energy levels. Air frying involves the same basic principles as deep fat frying, except minimal oil is involved. The only disadvantage to this method is the high cost of the equipment, making it unavailable to most South African consumers.

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CHAPTER 6

CONCLUSION

Modern society is aware and exhaustively informed about fruits' and vegetables' vitality to sustain good health (Love & Sayed, 2001). Despite this universal awareness, most studies have reported that children, from all backgrounds and around the globe, consume less fruits and vegetables than necessary to sustain good health (Love & Sayed, 2001; Ramsay *et al.*, 2014). Every country has its own set of standards for DRI's of vegetables, but most are in line with the WHO's global recommendations of 400g or five portions of fruits and vegetables per day. The "5-a-day" principle states that every individual should consume five servings of fruits and vegetables each day, every serving being equal to 80g (Lock *et al.*, 2005; Naudé, 2007).

A lack of recent literature exists about vegetable consumption in SA, especially amongst children. Thus, in the Literature Review of this thesis an attempt was made to provide an adequate and orderly overview of the literature available, explaining the malnutrition problem experienced worldwide, as well as in SA. The importance of vegetables in children's diet was investigated, as well as how and when to introduce vegetables to children.

The aims of this study were to gather information on consumer behaviour regarding vegetable consumption in SA, to develop a potato-based vegetable chip for children aged four to six years and thirdly, to determine the influence of three different cooking methods on the nutritional content of the developed chip.

Consumers' knowledge about and attitude towards vegetables

A hypothesis was set that knowledge and attitude, and consciousness of health and food security would influence the consumers' decisions on vegetable consumption. People from different cultures and demographic backgrounds in SA have different levels of knowledge, attitudes and tastes for vegetables, which will influence the type and amount of vegetables they consume.

Consumers' beliefs regarding the advantages, disadvantages and associations of eating vegetables were collected from 173 consumers (50 whites, 50 coloureds and 73 blacks) from different parts of SA. Consumers' knowledge of vegetables was statistically analyzed by means of descriptive statistics. For the attitude part, a hypothesis was represented via the conceptual model, where health benefit, food safety risk, sensory qualities and synonyms were depicted as fore runners of consumers' attitude towards vegetables. Statistical measures, such as reliability and factor analysis, descriptive statistics, correlation analysis and multiple linear regression, were performed. For all respondents, family_health_consciousness did not contribute significantly to their attitude towards vegetables, while food_safety_consciousness, vegetables_are_healthy and vegetables_are_pleasant contributed significantly ($p < 0.05$) to attitude on vegetables. The black respondents, who had the least knowledge about vegetables in the present study, found vegetables more pleasant than the other two groups. Vegetables' mouthfeel and smell were almost 100% acceptable for this group and they did not experience any bitter or sour taste, and were, thus, more willing to eat vegetables. All three groups listed advantages of vegetables and being healthy was the most important benefit. Disadvantages, like bloating, bitter and bad taste, low protein content and pesticides that could be harmful, were mostly noted.

To conclude, it remains a concern that knowledge about, and positive attitudes towards vegetables, do not necessarily relate into increased consumption of vegetables.

Development and consumer acceptability of vegetable-based potato chips amongst four to six year olds

The second hypothesis proposed that a chip, made in the shape of French fries, containing vegetable puree and juice, would encourage the consumption of vegetables amongst children. One hundred children, between the ages of four to six years, participated in the consumer acceptability study. For brown coloured vegetables, sweet potato, butternut, butternut + sweet potato and sweet corn chips were ranked significantly ($p<0.001$) higher than cauliflower and cabbage chips. The sweet potato had the highest numerical rank of 4.2 on a five-point Smiley face scale. Concerning the colour of the chips, the children preferred carrot chips to beetroot chips and green bean chips. No significant differences were found for the liking of cooking method (oven baked, air fried and deep fried), different oils, coatings and replacement of potato flour with chickpea flour. Population group had a significant effect on green bean (p=0.0189), butternut (p= 0.0018) and cauliflower (p=0.0158) chip liking, while gender had a significant effect on beetroot (p=0.0158), butternut (p=0.0307) and cauliflower (p=0.0371) chip liking. Age had a significant effect on the liking of green bean (p=0.0338) and sweet potato (p=0.0445) chips. The interaction between gender and age had a significant effect (p=0.0378) on the liking of 50.0% replacement with chickpea flour, in oven baked sweet potato chips.

The mothers or caregivers of the children, who participated in the acceptability test, completed a questionnaire and it revealed that all children liked potatoes the most, followed by carrots and butternut. Thirty-two-point zero percent of the children never tasted cauliflower before, because 17.0% of the parents also did not like cauliflower. Cabbage was liked more by black children than white children, again influenced by the parents' perception of the vegetable. Sweet potato was better liked by white children than by black children, because white children are more used to sweet vegetables than black children are and 10.0% of the black children never tasted sweet potato.

There is, thus, a strong relationship between the likes and dislikes of the parents or caregivers and children's exposure to a variety of vegetables and their liking thereof.

Comparison of the nutritional content of a potato-based vegetable chip, prepared by using in three different cooking methods

The last hypothesis suggested that the nutritional quality of the vegetable chip would be different depending on the cooking method (baking, deep frying and air frying). Nutritional analyses were done on the raw, baked, deep fried and air fried samples, determining DM, moisture, protein, fat, energy, free sugars (glucose, fructose and sucrose), minerals, dietary fibre and vitamin A. The nutrients that were the best retained in the air fryer were: ash (2.7%); protein (6.7%); carbohydrates (31.9%); fructose (0.51%); sucrose (1.21%); Ca (0.92 mg/100g); K (0.70 mg/100g); Mg (36.7 mg/100g); and dietary fibre (5.85 g/100g). For the baked sample, DM (68.2%), glucose (3.35 g/100g) and Mn (0.47 mg/kg) had the highest values, while deep frying caused the highest moisture (36.8%), fat (24.0%) and energy (1 467.75kJ/100g) contents.

Baking or air frying should be encouraged rather than deep frying for health reasons, as well as in the light of increase in obesity amongst children.

Suggestions to increase vegetable consumption in SA

Black consumers' knowledge about vegetables and portion sizes was, to say the least, of great concern and an effort should be made to reach them, even in remote parts of the country. Consumer scientists (home economists) should again, like 20 years ago, be deployed all over the county to educate, train and teach communities about good dietary guidelines. The domains, family_health_consiousness and food_safety_consciousness, did not appear to be important to the black group in the present study and should be addressed.

At entry level in school, elementary courses should be included to enforce good eating practices at a young age. To impose this further, government should be urged to buy surplus vegetables from commercial farmers or subsidise new farmers to grow vegetables, especially for deliverance to schools for lunchtime. As the children are integrated in schools, they will inspire each other to eat a wider variety of vegetables.

Older children, at the age of 12 years and older, are influenced by peer groups and role models. Rather than using film characters, movie stars and athletes to promote the selling of clothes and sweets, campaigns can be launched to promote the consumption of vegetables, e.g. Wade van Niekerk, Bobby van Jaarsveld, and even world stars like Beyoncé. Currently, advertisements from the retail group Checkers, feature British celebrity chef Gordon Ramsay and his daughter, Matilda, in such a media campaign to increase awareness for children to eat healthier. Media in SA should also be involved to increase vegetable consumption amongst South African children. Furthermore, apps for cell phones should be developed to encourage the eating of vegetables, e.g. after eating a portion of carrots, the app will show what it does to your body and how much longer you will live.

The consumer acceptability test indicated clearly that children, aged four to six years old, did not mind the type of cooking method used. This should be viewed positively and used advantageously, because the healthiest method could then be used, ensuring enjoyment of vegetables. In the preference test, they preferred carrot (orange) chips to green (beans) and red (beetroot) chips. This preference could be overcome by serving green and red chips along with brown vegetable chips, thus ensuring that the children would still eat the red and green chips.

It was much unexpected that the air fryer would have the best nutritional results amongst the cooking methods. However, the price of the air fryer is too high for most South Africans, even middle class SA, to afford. Considering the advantages of this cooking method, effort should be made to convince companies, such as Defy, to manufacture it at a cheaper cost to increase sales. Another big advantage of the air fryer is that it resulted in a lower acrylamide content than deep frying. On the other hand, deep frying, as cooking method, is not as bad as it is made out to be. When using fresh oil on a regular basis, the only 'negative' characteristic of deep fried food is the high cal/kJ value. Serving deep fried chips halfway in a long distant running event, may inspire children to participate, resulting in exercise that will be beneficial to the children, while using all the cal/kJ from the chips.

There is an increasing demand for healthier and nutritious food, and the vegetable chip, developed in the present study, contributes to a continuous need for healthy products by consumers. The developing of such a product (vegetable chips) would, thus, be that the children will still eat a potato chip (which they like), but filled with the healthy nutrients of selected vegetables, thereby increasing their intake of vegetables and change their attitudes toward vegetables. The variety of vegetable chips is as endless as the variety of vegetables available. Children need to eat a variety of vegetables and, therefore, these vegetable chips could be an answer to the problem. Results from the sensory tests indicated no negative results, not even for the red and green chips. To enhance the nutritional content of the vegetable chips, future research can be done on the substitution of the potato basis with chickpea flour, thus increasing the protein and fibre content.

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CHAPTER 7

SUMMARY

Every individual should consume five servings of fruits and vegetables each day to sustain good health. Children worldwide consume less than necessary. The aims of this study were to gather information on consumer behaviour regarding vegetable consumption in SA, to develop a potato-based vegetable chip for children aged four to six years and thirdly, to determine the influence of three different cooking methods on the nutritional content of the developed chip.

Consumers' beliefs regarding the advantages, disadvantages and associations of eating vegetables were collected from 173 consumers from three different ethnic groups (black, white and coloured) through a questionnaire. People from different cultures and demographic backgrounds in SA have different levels of knowledge, attitudes and tastes for vegetables, which influence the type and amount of vegetables they consume. The black group had the lowest knowledge on vegetables, less food safety concerns and family health concerns of all three groups. On the other hand, this group's acceptance of the taste (they are not able to taste bitter and sour in vegetables), mouth feel and attitudes toward vegetables were the best. They are, thus, more willing to eat a wider variety of vegetables than the other two groups. The coloured group had the best knowledge on vegetables compared to the other two groups.

The mothers or caregivers of the children, who participated in acceptability test, completed a questionnaire and it revealed that all children liked potatoes the most, followed by carrots and butternut. One hundred children, between the ages of four to six years, participated in the consumer acceptability study on the developed vegetable chips. Interesting to see was the influence of age, gender and culture on preferences. Carrot chips were preferred to red and green chips (beetroot and green beans), but the liking for the coloured chips were just below 'like a little'. The children, thus, did not reject it. No significant differences were found for the liking of cooking method. Further tests were done on oven baked sweet potato chips, featuring different oils, coatings and chick pea flour replacements.

Three different cooking methods were applied to the sweet potato sample and nutritional analyses were done on the raw, baked, deep fried and air fried samples, determining DM, moisture, protein, fat, energy, free sugars (glucose, fructose and sucrose), minerals, dietary fibre and vitamin A. The nutrients that were the best retained in the air fryer were: ash (2.7%); protein (6.7%); carbohydrates (31.9%); fructose (0.51%); sucrose (1.2 g/100g); Ca (0.92 mg/100g); K (0.70 mg/100g); Mg (36.7 mg/100g); and dietary fibre (5.85 g/100g). For the baked sample, DM (68.2%), glucose (3.35 g/100g) and Mn (0.47 mg/100g) had the highest values, while deep frying had the highest moisture (36.8%), fat (24.0%) and energy (1 467.75 kJ/100g) contents.

There is an increasing demand for healthier, convenient and more nutritious food, and the vegetable chip, developed in the present study, contributes to a continuous need for healthy products by consumers. The variety of vegetable chips that can be produced is as endless as the variety of vegetables available. Children need to eat a variety of vegetables and, therefore, these vegetable chips could be the answer to the problem.

Keywords: Consumer behaviour, children, vegetable, product development, nutrition, air fried.

OPSOMMING

Om goeie gesondheid te onderhou, moet elke individu daagliks vyf porsies groente en vrugte inneem. Kinders wêreldwyd eet minder as die aanbevole hoeveelhede. Die doelstellings van die studie was om inligting in te win rakend die verbruikersgedrag in verband met groente-inname in SA, om 'n aartappel-basis groenteskyfie te ontwikkel vir kinders tussen vier tot ses jaar en derdens, om die invloed van verskillende gaarmaakmetodes op die nutriëntwaarde van die ontwikkelde skyfie te bepaal.

Verbruikers se oortuigings rakende die voordele, nadele en aannames ten opsigte van die eet van groente, is versamel by 173 verbruikers uit drie verskillende kultuurgroepe (swart, blank en bruin), deur middel van 'n vraelys. Mense uit verskillende kulture en demografiese agtergronde in SA het verskillende vlakke van kennis, houdings en smake ten opsigte van groente en dit het weer 'n invloed op die soort en hoeveelheid groente wat geëet word. Die swart groep het die minste kennis ten opsigte van groente gehad, asook die minste bekommernis oor voedselveiligheid en gesinsgesondheidskwessies van al drie die groepe. Aan die ander kant was hierdie groep se aanvaarding van smaak (hulle kan nie bitter of suur in groente proe nie), mondgevoel en houding teenoor groente weer die gunstigste van al die groepe. Hulle is dus meer geneë om 'n groter verskeidenheid groente as die ander twee groepe te eet. Vergeleke met die ander twee groepe het die bruin groep die meeste kennis van groente getoon.

Die moeders of versorgers van die kinders wat deelgeneem het aan die aanvaarbaarheidstoets het 'n vraelys ingevul. Hieruit het aan die lig gekom dat al die kinders die meeste van aartappels hou, gevolg deur wortels en botterskorsies. Een honderd kinders, tussen die ouderdom vier en ses jaar, het deelgeneem aan die aanvaarbaarheidstudie vir die ontwikkelde groenteskyfies. Die invloed van ouderdom, geslag en kultuur op voorkeure het interessante resultate getoon. Wortelskyfies is verkies bo rooi en groen skyfies (beet en groenbone), maar die aanvaarbaarheid van die gekleurde skyfies was net minder as 'hou bietjie van' op die "Smily face" skaal. Die kinders het dit dus nie verwerp nie. Geen beduidende verskil is aangedui vir 'n spesifieke gaarmaakmetode nie en daarom kon die verdere toetse gedoen word met die patatskyfies wat in die oond gebak is: tipes olie; tipes bedekking; en vervanging van aartappelmeel met sojameel.

Drie verskillende gaarmaakmetodes is op die patatmonster uitgevoer en voedingsontledings is gedoen op die rou, gebakte, diepvetgebraaide en luggebraaide monsters om die droëmassa, vog, proteïen, vet, energie, vrye suikers (glukose, fruktose en sukrose), minerale, dieetvesel en vitamien A te bepaal. Die voedingstowwe wat die beste in die lugbraaier behoue gebly het was: as (2.7%); proteïen (6.7%); koolhidrate (31.9%); fruktose (0.51%); sukrose (1.2 g/100g); Ca (0.92 mg/100g); K (0.70 mg/100g); Mg (36.7 mg/100g); en dieetvesel (5.85 g/100g). In die oondgebakte monster het die droë massa (68.2%), glukose (3.35g/100g) en Mn (0.47 mg/100g) die hoogste waardes gehad, terwyl die diepvetgebraaide monster die hoogste persentasie vog (36.8%), vet (24.0%) en energie (1467.75 kJ/100g) gehad het.

Daar is 'n toenemende aanvraag vir gesonder, geriefliker en voedsamer kos. Die groenteskyfie, ontwikkel in hierdie studie, dra by tot die voortdurende behoefte aan gesonde produkte deur verbruikers. Die verskeidenheid groenteskyfies wat geproduseer kan word, is so talryk soos die verskeidenheid groente wat beskikbaar is. Kinders moet 'n verskeidenheid groente eet, en daarom kan die groenteskyfies die antwoord op die probleem wees.

Sleutelwoorde: verbruikersgedrag, kinders, groente produkontwikkeling, voeding en lugbraai.

ANNEXURE 1

Dear Parents,

I am a BSc Home Economics Masters student at the University of the Free State and I am busy with research in consumer behaviour.

Under-nutrition of pre-school children is a growing epidemic in both developing and developed countries, and very low levels of vegetable intake are one of the main contributors to this global problem. A good foundation for healthy eating habits is laid in the early years of childhood development and carries over into adulthood.

This study aims to establish the current vegetable consumption patterns and habits of children between the ages of 4 - 6 years, as well as analyse the surrounding environment, which shape and dictate these patterns and habits.

Please complete the following questionnaire.

Thank you very much

Petro Swart

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RECRUITING QUESTIONS

Please complete the following by indicating with a X

1. Are you wholly or partially responsible for household grocery purchases?

1 Yes ☐ 2 No ☐

2. Do you eat vegetables?

1 Yes ☐ 2 No ☐

3. Which of the following vegetables did you buy in the last 3 months?

1	Potatoes	☐
2	Cauliflower	☐
3	Green beans	☐
4	Beetroot	☐
5	Cabbage	☐
6	Sweet potato	☐
7	Sweetcorn	☐
8	Butternut	☐
9	Carrots	☐
10	None of the above	☐

(If you tick nr 10, end questionnaire)

4a. Which types of vegetables do your family eat / consume?

4b. Which types of vegetables do you use regularly in cooking, salads etc.?

		4a Eat regularly	4b Use regularly
1	Potatoes	☐	☐
2	Cauliflower	☐	☐
3	Green beans	☐	☐
4	Beetroot	☐	☐
5	Cabbage	☐	☐
6	Sweet potato	☐	☐
7	Sweetcorn	☐	☐
8	Butternut	☐	☐
9	Carrots	☐	☐
10	None of the above	☐	☐

5a. How often do your family eat vegetables?

5b. How often do your family use vegetables?

		5a Eat	5b Use
1	Everyday	☐	☐
2	Not every day, but 2-6 times a week	☐	☐
3	Once a week	☐	☐
4	Once every two weeks	☐	☐
5	Once every three weeks	☐	☐
6	Once a month	☐	☐
7	Less often	☐	☐

(Respondents must be regular users of vegetables, i.e.
they must have used and eaten vegetables within the last week.)

KNOWLEDGE

Please complete the following by indicating with a X.
No answers are considered incorrect, but honesty will be appreciated.

1. Do you know what vegetables is?

1 Yes ☐ 2 No ☐

2. If answered YES at QUESTION 1, please tell us what vegetables is, by indicating with a X at <u>each</u> statement:

	YES		NO	
Pumpkin should always be sweet.		**1**		**2**
Eggplant, brinjal and aubergine are all the same type of vegetable.		**1**		**2**
Artichoke is not a vegetable.		**1**		**2**
You are not supposed to eat vegetables that grow under the ground.		**1**		**2**
You can substitute green vegetables with potatoes.		**1**		**2**
Squash is for babies.		**1**		**2**
Babies under 1 year need vegetables.		**1**		**2**
The older you get, the less vegetables you need.		**1**		**2**
You have to eat vegetables only every second day.		**1**		**2**
I will consume genetic manipulated vegetables.		**1**		**2**
Vegetables is better when it is cooked.		**1**		**2**
Cauliflower rice is not a vegetable.		**1**		**2**
Zucchini, courgettes and baby marrows are not the same.		**1**		**2**
You need 5 portions of vegetables per week.		**1**		**2**
You need 5 portions of vegetables per day.		**1**		**2**
A portion is as big as your fist.		**1**		**2**
The size of the plate determines the size of a portion.		**1**		**2**
You only check portions when you are dieting.		**1**		**2**
If you are hungry, the portion size is not applicable.		**1**		**2**
The portion size of meat can be bigger than all the vegetables on your plate.		**1**		**2**
The time of the day determines the portion size.		**1**		**2**
An extra little bit will not have an effect on the portion size.		**1**		**2**
Potatoes is a vegetable.		**1**		**2**
Sweet potato can be purple		**1**		**2**
Red potatoes can only be used in salad.		**1**		**2**
Sweet potato is not a vegetable		**1**		**2**
Gnocchi is made from potato.		**1**		**2**
You can replace peas with potato.		**1**		**2**

3. In which form do you consume vegetables?

	YES		NO	
Raw/Fresh		**1**		**2**
Cooked		**1**		**2**

4. How often do you <u>eat</u> vegetables?

	EAT	
Everyday		**1**
Not every day, but 2-6 times a week		**2**
Once a week		**3**
Once every two weeks		**4**
Once every three weeks		**5**
Once a month		**6**
Les often		**7**
Never		**8**

ATTITUDES

Please complete the following by indicating with an X how much you disagree or agree
with the following statements. No answers are considered incorrect, but honesty will be appreciated.

QUESTIONS		STRONGLY DISAGREE		DISAGREE		NEUTRAL		AGREE		STRONGLY AGREE	
1.	I reflect a lot about my family's health.		1		2		3		4		5
2.	I'm very conscious about my family's health.		1		2		3		4		5
3.	I'm alert to changes in my family's health.		1		2		3		4		5
4.	I'm usually aware of my family's health.		1		2		3		4		5
5.	I take responsibility for the state of my family's health.		1		2		3		4		5
6.	I'm aware of the state of my family's health as we go through the day.		1		2		3		4		5
7.	Nowadays most foods contain residues from chemical sprays and fertilizers.		1		2		3		4		5
8.	I'm very concerned about the amount of artificial additives and preservatives in food.		1		2		3		4		5
9.	The quality and safety of vegetables nowadays concern me.		1		2		3		4		5
10.	I feel calm after eating vegetables.		1		2		3		4		5
11.	I think vegetables has major market potential.		1		2		3		4		5
12.	I feel guilty after eating vegetables.		1		2		3		4		5
13.	I will recommend vegetables to other people.		1		2		3		4		5
14.	Vegetables is a natural product.		1		2		3		4		5
15.	Vegetables is very healthy for me.		1		2		3		4		5
16.	Vegetables has a pleasant taste.		1		2		3		4		5
17.	Vegetables has a pleasant smell.		1		2		3		4		5
18.	Vegetables has a pleasant mouth feel.		1		2		3		4		5
19.	Vegetables has a pleasant appearance.		1		2		3		4		5
20.	Vegetables has a bitter taste.		1		2		3		4		5
21.	Vegetables has a sour taste.		1		2		3		4		5
22.	Vegetables has a salty taste.		1		2		3		4		5
23.	Vegetables has a sweet taste.		1		2		3		4		5
24.	Overall I think that eating vegetables is beneficial.		1		2		3		4		5

25.	Overall I think that eating vegetables is pleasant		1		2		3		4		5
26.	Overall I think that eating vegetables is the right thing to do.		1		2		3		4		5
27.	Overall I think that eating vegetables is good practice		1		2		3		4		5
28.	If we as a family eat vegetables, I will feel that I am doing something positive for the health and wellbeing of my family.		1		2		3		4		5
29.	If we eat vegetables, I will feel that I add natural goodness to the family's meal.		1		2		3		4		5
30.	If I am aware of the benefits of vegetables, I will feel more comfortable eating vegetables.		1		2		3		4		5

Please complete the following by indicating with an X how much undesirable or desirable you find the following statements.
No answers are considered incorrect, but honesty will be appreciated.

		VERY UN-DESIRABLE		**UN-DESIRABLE**		**NEUTRAL**		**DESIRABLE**		**VERY DESIRABLE**	
31.	Experiencing a bitter taste is:		1		2		3		4		5
32.	Experiencing a fibrous mouthfeel is:		1		2		3		4		5
33.	Experiencing a crunchy mouthfeel is:		1		2		3		4		5
34.	Experiencing a mushy mouthfeel is:		1		2		3		4		5
35.	Experiencing a sour taste is:		1		2		3		4		5

36. What do you believe are the advantages of eating vegetables?

37. What do you believe are the disadvantages of eating vegetables?

38. Please indicate if there is anything else you associate with eating vegetables?

Thank you for your participation and time!

DEMOGRAPHICS

Please complete the following by indicating with a X

1. What is your gender?

1 Male
2 Female

2. How old are you?

1 Younger than 18 years
2 18 to 32 years
3 33 to 65 years
4 Older than 65 years

3. Where do you live?

1 Gauteng
2 Western Cape
3 Northern Cape
4 Eastern Cape
5 Free State
6 KwaZulu Natal
7 Northern Province
8 North West
9 Limpopo

4. What is your highest level of education?

1 No formal education
2 Some Primary
3 Primary completed
4 Some High
5 Matric (Grade 12)
6 Tech diploma/degree
7 University degree
8 Other

5. What is your population group

1 Black African
2 Coloured
3 Indian
4 White
5 Asian
6 Other

6. What is your income of the household?

1 R0 – R100 000
2 R101 000 – R500 000
3 R501 000 – R750 000
4 More than R750 000

7. Currently I provide for the following diet plan:

1 None
2 Banting (High protein, low carbs)
3 Weight watchers
4 Vegetarian (may include animal products i.e. such as milk, eggs)
5 Vegan (no animal products
6 Pescaterian (eat fish – no red meat)

ANNEXURE 2

Table with Cronbach alpha variables for the following domains: family_health_consciousness; food_safety_consciousness; vegetables_are_healthy; vegetables_are_pleasant and overall_attitude

Vegetables_are_healthy				
Cronbach coefficient alpha with deleted variable				
Deleted variable	**Raw variables**		**Standardized variables**	
	Correlation with total	Alpha	Correlation with total	Alpha
A14	0.496502	0.898382	0.514313	0.896527
A15	0.670581	0.853583	0.663630	0.862834
A28	0.823830	0.813658	0.823635	0.824096
A29	0.832645	0.812364	0.828675	0.822831
A30	0.728394	0.837592	0.734074	0.846122

Food_safety_consciousness				
Cronbach coefficient alpha with deleted variable				
Deleted variable	**Raw variables**		**Standardized variables**	
	Correlation with total	Alpha	Correlation with total	Alpha
A7	0.764988	0.577703	0.617007	0.564458
A8	0.775466	0.571346	0.610080	0.567729
A9	0.783270	0.570903	0.651211	0.548123
A14	0.034789	0.819953	0.153656	0.756872
A15	0.184268	0.780467	0.268094	0.714114

Vegetables_are_pleasant				
Cronbach coefficient alpha with deleted variable				
Deleted Variable	**Raw variables**		**Standardized variables**	
	Correlation with total	Alpha	Correlation with total	Alpha
A16	0.706000	0.872711	0.706016	0.875784
A17	0.825292	0.825895	0.827761	0.829502
A18	0.806383	0.835777	0.804550	0.838553
A19	0.690287	0.881668	0.690148	0.881601

Overall_attitude				
Cronbach coefficient alpha with deleted variable				
Deleted Variable	**Raw variables**		**Standardized variables**	
	Correlation with total	Alpha	Correlation with total	Alpha
A24	0.801466	0.890888	0.799984	0.899048
A25	0.802026	0.896698	0.801476	0.898541
A26	0.874522	0.867956	0.877181	0.872300
A27	0.772794	0.902321	0.775240	0.907406

Family_health_consciousness				
Cronbach coefficient alpha with deleted variable				
Deleted variable	**Raw variables**		**Standardized variables**	
	Correlation with total	**Alpha**	**Correlation with total**	**Alpha**
A1	0.838083	0.935796	0.838462	0.936722
A2	0.890987	0.929553	0.892109	0.930327
A3	0.883669	0.930644	0.884977	0.931184
A4	0.900871	0.928377	0.902042	0.929130
A5	0.872764	0.931588	0.873203	0.932594
A6	0.642942	0.958806	0.642134	0.959131

ANNEXURE 3

To follow

Acceptability of potato-based vegetable chips for children

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Abstract

To increase children's preference for and consumption of vegetables, potato based vegetable chips were developed, using a basic choux paste. *Hundred children, in the age range four to six years, participated in the study. A specially adapted five-point hedonic Smiley face scale was used. Children preferred pictures of potato chips to pictures of beetroot, green beans and carrots. For colour choice, carrot chips were significantly ($p < 0.001$) liked more than green bean and beetroot chips. For brown-type vegetables, sweet potato, butternut, butternut + sweet potato and sweet corn chips were significantly ($p < 0.001$) liked more than cauliflower and cabbage chips. The sweet potato had the highest numerical score of 4.16. Further tests performed with this chip found no significant differences in the liking of cooking method. The oven baked option was subsequently chosen for further tests, because it was the healthiest option. There were no significant differences in the liking of different oils, coatings and replacement of potato flour with chickpea flour. Population group had a significant effect on green bean ($p=0.0189$), butternut ($p=0.0018$) and cauliflower ($p=0.0218$) chip liking, while gender had a significant effect on beetroot ($p=0.0158$), butternut ($p=0.0307$) and cauliflower ($p=0.0371$) chip liking. Age had a significant effect on the liking of green bean ($p=0.0338$) and sweet potato ($p=0.0445$) chips. The interaction between gender and age had a significant effect on the liking of 50% replacement with chickpea flour in oven baked sweet potato chips ($p=0.0378$).*

Introduction

In most countries in the world, children's vegetable preference and consumption are below the recommended daily allowance (RDA) (Graaf, Koenlen, Kok, & Zeinstra, 2010). According to the American Heart Association (AHA) (2014), children's RDA's range from ¾ - 1 cup for one to three year olds, 1 - 2½ cups for four to 18 year old females, and 1½ - 3 cups for four to 18 year old males. These portions are based on an inactive lifestyle; when physical activity increases, portion sizes will also increase. Portions must be selected out of a variety of vegetables (AHA, 2014).

Many factors play a role in children's vegetable preferences, one being socioeconomic background, which influences perceptions and eating patterns of a child; others include age and gender (Baxter, Bower & Schoroder, 2000). Children's influence on food choices increases with age (Holdert & Antonides, 1997). Parents are often not aware that children have 'likes' and 'dislikes', which will cause dietary imbalances. In general, children prefer snack foods, such as crisps, fried potatoes, chips and fizzy drinks, meat and starchy food over vegetables and cheeses (Edelenbos & Sondergraad, 2007). It was also found that children, who watch more television, made more unhealthy food choices and often consumed more snack foods (Amboni, Fiates & Teixera, 2008). Television viewing habits also lead to increased development in higher-fat and sugar diets (Ahrens, Barba, Buchecker, De Henauw, Eiben, Gwozdz, K..., & Reisch, 2012).

Children all over the world are exposed to fast foods. The more children become familiar with a certain food, the more a preference towards the food will develop. The average child will prefer high energy dense food, e.g. fried chips, over foods that do not have that energy content (Birch, 1992; Camps, Shimizu & Wansink, 2011).

Preference towards vegetables can be developed because of its unique texture, which is important for enjoying food. Humans have an instinct to have full control over everything they put into their mouth (Szczesniak, 2002). Because of vegetables' crunchy texture, children cannot manipulate all the textures, which lead to either a dislike or preference. Thus, preparation methods have a crucial influence on children's acceptance and could promote the eating of vegetables. For some vegetables, the raw version is better accepted than the cooked one, because of its texture and the preparation method. Raw vegetables remain crunchy and are in some cases preferred over other preparation methods (Graaf et al., 2010). Graaf et al. (2010) also mention that for children who dislike eating vegetables, the preparation method for the vegetable is more important to be accepted. Steamed and boiled vegetables were preferred over mashed, grilled, stir-fried or deep-fried vegetables. The explanation for these findings was that participants were mostly familiar with boiling as a preparation method. This emphasized the fact that familiarity plays a role in favouritism (Graaf et al., 2010).

In general, children's food choices are heavily influenced by odour and textural preferences, and to a lesser extent by visual aspects and taste preferences (Delahunty & Poelman, 2010). According to Kildegraad (1997), however, the appearance of food gives the first interest in food choice and sets an expectation for real sensory perception. Visual aspects consist of colour, background characteristics and various segmentation factors (Delahunty & Poelman, 2010), such as size and shape (Kildegaard et al., 2011). De Graaf, Doelen, Kok and Zeinstra (2007) also confirm this in regard to colour of vegetables and suggest that colour affects children's acceptance for vegetables. Coloured, small, brittle vegetables were preferred to dark, large, green vegetables. Children, seven years and younger, had to depend on colour to make a decision about the taste of a vegetable (Delahunty & Poelman, 2010).

Studies, examining children's preferences, found that fatty and sugary foods features highly among children's top ten 'like' foods. It was found that fat food preference were higher for boys than girls. This could be due to larger energy demand for boys compared to girls (Kildegraad, 1997). Peers also play an important role in influencing what children like. They will easily change their preference when they see what other children eat (Kroll & Popper, 2003). In this particular study, pictures were shown on a computer screen of pears eating healthy food, which influenced children to be more willing to like healthy food. Additionally, fat preferences were more frequent for girls in this study, while a combined preference for sweet and fat foods was found for boys. When applying bivariate analyses, it was found that when a child was frequently exposed to fatty foods, it related to a higher preference. Researches came to the conclusion that fat flavour and sweet taste preferences in these children were directly related to the weight status of a child (Ahrens, Barba, De Henayw, Knof, Lanfer, Lissner, M..., & Veidebaum, 2011).

Fat gives a unique texture, flavour and aroma to food, resulting in a particular fat 'taste' (Almiron-Roig & Drewnowski, 2010). Furthermore, fat in food gives the ability to create textures, e.g. crispy or creamy. When foods are fried, the extreme hot temperatures expand the steam and create crispy bubbles, giving chips its unique crunch and crispness (Zhang, 2014). Fat makes food also more fresh and moist, because it binds with water molecules (Almiron-Roig & Drewnowski, 2010). Food absorbs some oil, which replaces some water that is lost during frying (Moreira, Palau & Sin, 1995).

Alternative cooking methods and ingredients for traditional deep fried chips would contribute to healthier food choices among children. Consequently, potato based vegetable chips were developed and children's acceptability of these products was determined. Firstly, children's preference for vegetables versus chips was determined in a paired comparison test, followed by hedonic scaling of a variety of potato-based vegetable chips.

Materials and Methods

The study involved 100 children (male and female) from two South African Pre-Primary Schools, between the ages of 4-6 years, and from low and medium income households. Before sensory testing, parents or guardians had to sign an informed consent form for their children's participation and provide information about any medical condition that may put the children at risk during the study.

Before the first session, posters of the chips (Figure 1) were put on the walls of the classrooms to familiarize the children with the product and to avoid neophobia. Prior to each sensory test, every child played a game using pictures of food. These games were designed to illustrate and reinforce the cognitive skill inherent in the sensory test, with the assumption that the child would transfer the skill to the test itself (Guinard, Krimmel & Sifman-Grant, 1994). All sensory tests were performed in the school's classroom, which was familiar to the children.

Nine adult student interviewers assisted the children throughout the study. The students were trained to explain the process to each child and to deal with unexpected incidents. They were instructed to recorded negative behaviour or complaints, if there were any. Arrangements were set up so that the children did not face any other table. Children and the interviewers remained seated throughout the test.

Figure 1 Posters to avoid neophobia

Table 1 summarizes the different sensory testing methods, which included discrimination and consumer tests. The hedonic scale for the discrimination test was a five-point scale with both faces and words ('dislike a lot' to 'like a lot'), to indicate the different degrees of like/dislike (Stone & Sidel, 1993; Figure 2). Children were asked to point to their choices.

Table 1 Picture games and sensory tests.

Type of test	
Discrimination (n=100) Paired preference test	Foods pictured: French fries vs green beans French fries vs beetroot French fries vs carrots
Consumer (n=100) Hedonic scaling	Stimuli: Green bean chip vs carrot chip vs beetroot chip Carrot chip: oven fried vs deep fried vs air fried Butternut chip vs cauliflower chip vs sweet potato Sweet corn chip vs cabbage chip vs butternut + sweet potato chip Sweet potato chip with sunflower oil vs sweet potato chip with olive oil Sweet potato chip with *Smash Herb** coating vs sweet potato chip with *Kellogs Crumble* coating Sweet potato chip + 50% chickpea flour and 50% *Smash** vs sweet potato chip + 100% chickpea flour

* Bokomo Foods. 40 Meil Hare Road, Atlantis 7349. A Division of Pioneer Foods (PTY) LTD. Product of South Africa

Potato-based vegetable chips

The potato based chips were made by adapting a basic *choux* paste recipe (Table 2; Foods and Cookery, 1991). The cake flour was partly replaced by *Smash* (Bokomo Foods, 40 Meil Hare Road, Atlantis 7349, a division of Pioneer Foods (PTY) LTD. Product of South Africa), a type of dried potato starch, with added salt, flavouring and preservative. The water in the original recipe was replaced by a mixture of vegetable juice and pulp, obtained after processing the desired fresh vegetable in a juice extractor [Mean Juice machine, Multi-Purpose 4 in 1 (Millex) juice extractor]. The prepared mixture was piped in long strips onto a greased baking tray, to resemble the shape of potato chips and baked in a Defy 631-T (Thermo fan) oven for 15 minutes (min.) at 180˚C. These long strips were then cut into chip sizes, about 50 mm in length. Before testing, the chips were deep fried, air-fried or oven baked. All chips were prepared the day before the test and heated prior to serving.

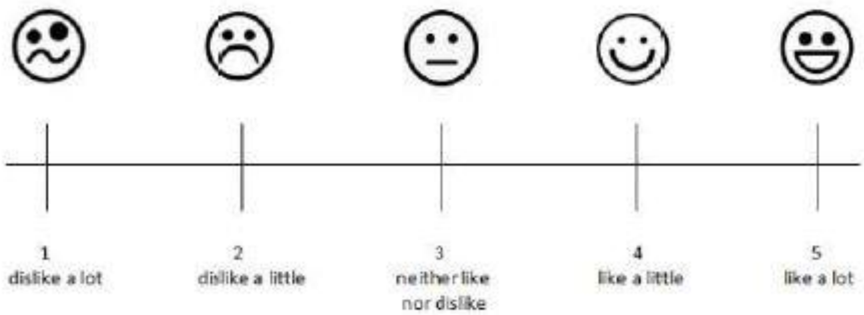

Figure 2 **Five-point Smiley face scale (adapted form Stone & Sidel, 1993**

Table 2 **Formulation of potato-based vegetable chips (Foods and Cookery, 1991).**

Ingredient	Percentage (%)
Smash*	10.95
Butter	12.10
Egg	22.10
Vegetable pulp	21.05
Vegetable juice	26.30
Cake flour	7.40
Salt	0.10

*Bokomo Foods. 40 Meli Hare Road, Atlantis, 7349. A Division of Pioneer Foods (PTY) LTD. Product of South Africa

Table 3 summarizes the different vegetables used in the study, as well as specifications for frying/baking. Carrot, beetroot and green beans were used in the first study, to determine the influence of colour on children's' preference for vegetables. The most preferred vegetable from this test, the carrot, was used to determine the preferred cooking method. Oven baking, deep fat frying and air frying were chosen as suitable methods and again, the most preferred method was used for the next studies. For the third and fourth tests, some more brownish vegetables were tested, namely butternut, sweet potato, cauliflower, sweet corn, cabbage and a combination of butternut and sweet potato. In the next test, the influence of types of oils, sprayed on the chips, was determined, using sunflower and olive oil. It was also decided to enrobe the chips, to increase the crispiness, and two very different coatings were used, namely a powdery and a crumbly one. Finally, the protein content of the chip was increased by a 50% replacement of the *Smash* with chickpea flour, as well as a 100% replacement with chickpea flour.

Table 3 Different potato-based vegetable chips used in sensory studies.

Study	Vegetables used	Specifications
Hedonic Scaling	Beetroot, carrot and green beans	Deep fat frying: sunflower oil; Kenwood 7879/1; 7 min; 200°C
Hedonic scaling	cooking method: carrot	Oven baking:15 min; 180°C; Defy 631-T Deep fat frying: sunflower oil; Kenwood 7879/1; 7 min; 200°C Air frying:10 min; 160°C; Philips Air Fryer
Hedonic scaling	Brownish vegetables: butternut, sweet potato, cauliflower, butternut + sweet potato, sweet corn and cabbage	Oven baked: 15 min; 180°C; Defy 631-T
Hedonic scaling	Oil: sunflower* and olive**	Oven baked: 15 min; 180°C; Defy 631-T
Hedonic scaling	Coating: *Smash Herb**** and *Kellog's Crumble*****	Oven baked: 15 min; 180°C; Defy 631-T
Hedonic scaling	*Smash* replacement: *Nature's Choice Chickpea flour******	Oven baked: 15 min; 180°C; Defy 631-T

* Wilmar Continental, 114 Main reef Road, Randfontein, 1760, South Africa. Product of South Africa
** Aceites Borges Pont, S.A.U. Josep Trepat Avenue s/n-25300 Tarraga-Spain
*** Bokomo Foods. 40 Meil Hare Road, Atlantis 7349. A Division of Pioneer Foods (PTY) LTD. Product of South Africa
**** Kellogg's Company of South Africa (PTY) LTD, 77 Steel Road, New era, Springs, Product of South-Africa.
*****Nature's Choice. Product of India. Packed in South-Africa. 73 Cypress Avenue, Meyerton, South Africa 1960.

Statistical analysis

All the data were collected in spread sheets, using Microsoft Excel 2007 and all the statistical analyses were done using NCSS (2007). The significance of the overall acceptance measured for each sample was tested by means of analysis of variance (ANOVA). If the main effect was significant, Fisher's LSD-test was applied to determine the direction of the differences between mean values (Heymann, 1995).

After the data was calculated, the results were represented as a spider plot, where a specific spoke denotes a specific attribute. The distances of attribute mean from the centre of the plot along each spoke directly corresponds to attribute intensity. The plot provides a visual presentation of product similarities and differences (Heymann, 1995).

Results and Discussion

The demographic composition of the panel is given in Table 4. Fifty percent of the panel members were black and 50% were white. For the age split, 53% were four years old, 32% were five and 15% were six years old. Forty six percent were female and 54% were male.

Table 4 Demographic profile of child panel (n=100).

Population group	% of Total	Gender:	% of Total	Age:	% of Total
Black	50	Female	46	4	53
White	50	Male	54	5	32
				6	15

From Table 5, it was clear that there was a significant (at least $p < 0.01$) difference in the preference of vegetables versus chips for green beans, carrots and beetroot. In all cases, the potato chip picture was significantly (at least $p < 0.01$) preferred to the respective vegetable picture. When shown the picture of beetroot, there was a significant ($p < 0.01$) increase in the number of children (37) preferring this vegetable to the picture of chips. This may be due to the red colour that was either unfamiliar to the children or more appealing. Potatoes, on the other hand, are the fourth most important food in the world after wheat, rice and maize (Messer, 1994). It contains carbohydrates, vitamin B & C, fibre and folate, and has a mild taste that children easily adapt (Farm Fresh Direct, 2012).

Table 5 **Paired preference analysis of child panel.**

Treatment		n = 100	Significance Level
Beans/Chips	Vegetables vs Chips	33 vs 67a	p < 0.001
Carrots/Chips	Vegetables vs Chips	34 vs 66a	p < 0.001
Beetroot/Chips	Vegetables vs Chips	37 vs 63b	p < 0.01

Means with different superscripts differ significantly.

Children's hedonic scaling for the preference of colour, cooking method, brown vegetable, oil type, coating and potato flour replacement, is given in Table 6. Firstly, there was a significant ($p<0.01$) preference between the green bean and beetroot chips and the carrot chip, but not between the green bean chip and beetroot chip (Table 6). The carrot chip had the highest score (4.39) and green bean chips the lowest (3.35). Most people associate green beans with vegetables that don't taste good (Fresh for kids, 2011b), and children grow up with this perception as they adopt the habits form their parents (European Food Information Council, 2012). Akis (2014) stated that the reason people dislike beetroot, is because they think it taste like dirt. Carrots, on the other hand, are one of the most widely eaten foods in the world and are eaten as a savoury and sweet dish. It is also one of the first solid foods that is introduced to children and is available in every shop throughout the year (Fresh for kids, 2011a).

There was no difference between the liking for oven baked (4.21), deep fried (4.18) and air carrot chips (4.20) (Table 5). This is an interesting observation in that children four to six years old showed no preference for oily food. Graaf et al. (2010) found that steamed and boiled vegetables are preferred over mashed, grilled, stir fried or deep-fried vegetables; children in the study were more familiar with boil and steam methods and this familiarity influenced favouritism. Deep fat frying is not considered a healthy cooking method, as fat is a major contributor to heart disease, diabetes, hypertension and some types of cancers (Krukowski, 2011). The air fryer is a rather sophisticated and expensive apparatus, but could in the long-term, save money on the oil that would have been used in the traditional method (Taste.Com.AU, 2014). It was decided to use oven baking for the remaining three tests as baking is the healthiest option (Gokemen, et al. 2010).

A selection of brownish vegetable chips was prepared, as this colour is known to stimulate the digestive system. Orange is also known to treat digestion problems (One earth one design, 2007). In this test, the lowest scoring vegetable chips were cauliflower (3.63) and cabbage

(3.55), which differed significantly ($p < 0.001$) from butternut + sweet potato (4.02), sweetcorn (4.02), butternut (4.07) and sweet potato (4.16) (Table 6).

Table 6 **ANOVA of child panel preference scores for vegetable chips (n=100).**

	Vegetable chips	Preference Score
Study 1: colour	Green bean	3.35^{a}
	Carrot	4.39^{cdefgh}
	Beetroot	3.63^{a}
Study 2: cooking method	Oven baked carrot	4.21^{bcdef}
	Deep fried carrot	4.18^{bcde}
	Air fried carrot	4.20^{bcde}
Study 3: brown vegetable	Butternut	4.07^{bc}
	Sweet potato	4.16^{bcd}
	Cauliflower	3.63^{a}
	Sweetcorn	4.02^{b}
	Cabbage	3.55^{a}
	Butternut + sweet potato	4.02^{b}
Study 4: oil type	Sunfower oil sprayed oven baked sweet potato	4.47^{defg}
	Olive oil sprayed oven baked sweet potato	4.56^{g}
Study 5: coating	Smash coated oven baked sweet potato	4.31^{bcdefg}
	Kellogs crumbed oven baked sweet potato	4.49^{efg}
Study 6: replacement of potato flour	50% chickpea replacement oven baked sweet potato	4.48^{defg}
	100% chickpea replacement oven baked sweet potato	4.53^{fg}
	Significance level	$p < 001$

Means with different superscripts in the same column differ significantly

Cauliflower and cabbage are both known for their characteristic umami taste (Umami Information Centre, 2013) and although the amino acid taste is favoured by children when used as a seasoning, they are not fond of it occurring naturally in vegetables. Sweet, umami and salty substances are initially preferred by children, and bitter and sour substances are rejected (Beauchamp & Menella, 2009). Seasonings only contain salty, sweet and umami tastes, which are preferred, while fresh vegetables, like cauliflower, also contain a bitter taste. The bitter taste can possibly be caused by growing conditions and overcooking (Grantenstein, 2014). Hargreaves (2012) found that people's preference for cauliflower starts to grow when the preparation method changes; people prefer it crunchy above mushy. There is a definite change in people's attitude towards the consumption of cauliflower in light of the popularity of the low carbohydrate diet or *banting*, which is endorsed by internationally acclaimed researcher and athlete Tim Noakes (Noakes, Creed, Proudfoot, Grier & Caradoc-Davies, 2014). Recipes and new products are developed where cauliflower is used to prepared carbohydrate free 'mash' and 'rice'.

Regarding the liking of the butternut, sweet corn, sweet potato and butternut + sweet potato chips, there were no differences. The popularity of butternut is increasing, because of increasing awareness of healthier diets. Butternut squash has the best nutritional value of any squash type (Wright, 2008). In South Africa, butternut and sweet potato are usually eaten as sweet vegetables, cooked with butter and sugar (Sarie Kos, 2012; Kreatiewe kos idees, 2013). Furthermore, corn is a staple for the majority of the South African population (Smyth, Philips & Castle, 2014), thus explaining the liking for the sweet corn chip. The sweet potato chip had the highest numerical value of the brownish vegetable chips and it was decided to continue the other studies with this chip type.

From Table 6 it is also clear that there was no preference for the kind of oil used. Thus, the children in this study did not really care for the kind of oil as long as there was an oily aroma present. Fat gives food a unique texture, flavour and aroma, which children associate with chips (Almiron-Roig & Drewnowski, 2010).

When the sweet potato chip was covered with a coating, again there was no preference for either of the coatings (Table 6). Although natural human instinct is to have full control over everything they eat (Szczesiak, 2002), not all children can manipulate textures that are crunchy and this can lead to either a dislike or a preference towards the food consumed (Graaf et al., 2010).

For the replacement of the potato flour with 50% and 100% chickpea flour, there also was no preference between the two samples. Both scored very high, with the 50% chickpea replacement scoring 4.48 and the 100% chickpea replacement scoring 4.53 (Table 6), representing 'like a little' to 'like a lot' on the hedonic scale (Figure 1). This result is very important, as it showed that the nutritional composition of the vegetable chip can be improved, without losing flavour and taste appeal. Chickpea flour has an earthy, beany flavour, which could be overwhelming for some people, but it can be balanced out with other ingredients, such as sweet potato, as in this case (Oh She Glows, 2013).

Figure 3 is the spider plot, representing the results from all the hedonic scaling. It is clear that most of the vegetable chips scored more than four on the hedonic scale, translating into 'like a little'. Green beans, beetroot, cauliflower and cabbage scored less than four, but more than three, representing 'neither like nor dislike' on the hedonic scale. No sample scored less than three, with green beans having the lowest numerical value of 3.35 (Table 6). The oven baked sweet potato chip, sprayed with olive oil had the highest numerical value of 4.56 (Table 6).

Table 7 is a summary of the ANOVA on the effect of population group, gender and age and their interactions on sensory preference scores for different vegetable chips. Population group had a significant effect on green bean ($p=0.0189$), butternut ($p=0.0018$) and cauliflower ($p=0.0218$), while gender had a significant effect on beetroot ($p=0.0158$), butternut ($p=0.0307$) and cauliflower ($p=0.0371$) chips. Age had a significant effect on green bean ($p=0.0338$) and sweet potato ($p=0.0445$) chips. The interaction between gender and age had a significant effect on 50% replacement with chickpea flour in oven baked sweet potato chips ($p=0.0378$) (Table 7).

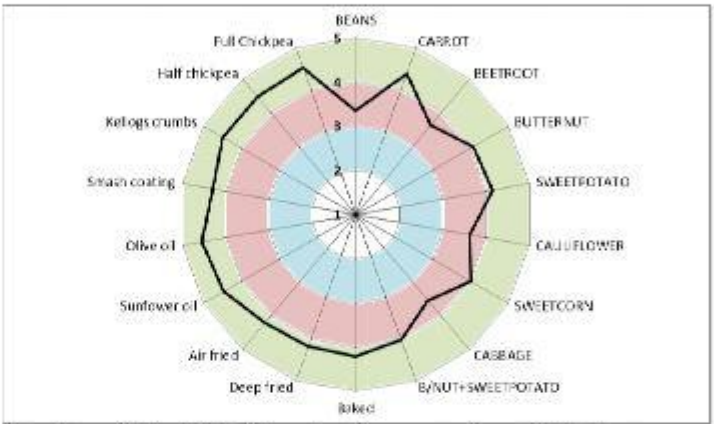

Figure 3 Spider plot of child panel preference scores for vegetable chips

For the green bean chip, the white children gave significantly (p=0.0189) higher scores (3.74) than the black children (2.96). Black children (4.42) scored butternut chips significantly (p=0.0018) higher than white children (3.72). Also for cauliflower chips the black children's score (3.96) was significantly (p=0.0218) higher than that of the white children (3.30) (Table 8). The girls' score (4.04) for beetroot chips was significantly (p=0.0158) higher than that of the boys (3.28). For both the butternut (4.30) and cauliflower (3.91) chips, the boys' scores were significantly (p=0.0307/p=0.0371) higher than that of the girls (3.80/3.30) (Table 8). Also from Table 8 it is clear that the four year olds (3.75) scored the green beans significantly (p= 0.0338) higher than the five (2.94) and six year olds (2.80). The four year olds (4.23), this time along with the five year olds (4.31), also scored the sweet potato chips significantly (p=0.0445) higher than the six year olds (3.60). There was, furthermore, a significant (p=0.0378) interaction between gender X age effect for the oven baked sweat potato chip, where 50% of the potato flour was replaced with chickpea flour. The five year old girls (3.55) scored this chip significantly (p=0.0378) lower than the four (4.64) and six year old girls (4.86), as well as the four (4.44), five (4.62) and six year old boys (4.63) (Table 9). Factors which could play a role in these variations would include the difference in socio-economic development and wealth, as well as the diversity in prices, availability and accessibility of these foods, as well as taste preferences (Love & Sayed, 2001; Naude, 2013).

Table 7 ANOVA on the effect of population group, gender and age and their interactions on sensory preference scores for different vegetable chips.

Chip	Population group	Gender	Age	Population group X Gender	Population group X Age	Gender X Age	Population group X gender X Age
Beans	$p = 0.0189$	$p = 0.1923$	$p = 0.0338$	0.2224	0.4719	0.5908	0.5507
Carrot	$p = 0.9293$	$p = 0.4691$	$p = 0.1428$	0.9140	0.7556	0.8310	0.9239
Beetroot	$p = 0.2349$	$p = 0.0158$	$p = 0.2275$	0.3487	0.3016	0.2915	0.7813
Oven baked	$p = 0.7502$	$p = 0.8882$	$p = 0.1386$	0.6503	0.2599	0.2612	0.1472
Deep fried	$p = 0.6816$	$p = 0.6839$	$p = 0.2474$	0.9756	0.7378	0.5235	0.7272
Air fried	$p = 0.1855$	$p = 0.8206$	$p = 0.6744$	0.8213	0.5010	0.4811	0.1989
Butternut	$p = 0.0018$	$p = 0.0307$	$p = 0.2258$	0.2143	0.7184	0.9113	0.5997
Sweet potato	$p = 0.0607$	$p = 0.2652$	$p = 0.0445$	0.5381	0.2926	0.8531	0.9994
Cauliflower	$p = 0.0218$	$p = 0.0371$	$p = 0.1645$	0.6670	0.9647	0.7248	0.7959
Sweetcorn	$p = 0.7469$	$p = 0.7364$	$p = 0.9886$	0.4911	0.5668	0.1593	0.8986
Cabbage	$p = 0.9436$	$p = 0.1664$	$p = 0.3568$	0.2968	0.9192	0.0645	0.9013
Butternut + Sweet potato	$p = 0.6512$	$p = 0.7533$	$p = 0.3759$	0.2343	0.9934	0.5360	0.4546
Sunfower oil	$p = 0.9166$	$p = 0.8964$	$p = 0.8474$	0.7325	0.8462	0.2977	0.9709
Olive oil	$p = 0.6230$	$p = 0.2947$	$p = 0.4826$	0.4543	0.9138	0.8409	0.9991
Smash coating	$p = 0.1725$	$p = 0.8767$	$p = 0.1022$	0.8491	0.7149	0.4748	0.3972
Kellogs crumbs	$p = 0.2969$	$p = 0.2997$	$p = 0.3634$	0.1805	0.1822	0.1891	0.1956
50% chickpea	$p = 0.9999$	$p = 0.5433$	$p = 0.2439$	0.2289	0.4434	0.0378	0.4932
100% Chickpea	$p = 0.7387$	$p = 0.4187$	$p = 0.4981$	0.1652	0.5112	0.2186	0.3586

Table 8 ANOVA of the significant effects of population group, gender and age on child panel hedonic scores for vegetable chips.

	Population group			Significance level
Chip	Black	White		
Green bean	2.96^a	3.74^b		$p = 0.0189$
Butternut	4.42^b	3.72^a		$p = 0.0018$
Cauliflower	3.96^b	3.30^a		$p = 0.0218$
	Gender			
	Female	Male		
Beetroot	4.04^b	3.28^a		$p = 0.0158$
Butternut	3.80^a	4.30^b		$p = 0.0307$
Cauliflower	3.30^a	3.91^b		$p = 0.0371$
	Age			
	4 years	5 years	6 years	
Green bean	3.75^b	2.94^a	2.80^a	$p = 0.0338$
Sweet potato	4.23^b	4.31^b	3.60^a	$p = 0.0445$

Means with different superscripts in the same row differ significantly

Table 9 ANOVA on the significant interaction between gender X age effect on child panel hedonic scores for 50% chickpea replacement chips.

Gender	Age	Sensory preference score for Half chickpea
Female	4	4.64^b
	5	3.55^a
	6	4.86^b
Male	4	4.44^b
	5	4.62^b
	6	4.63^b
Significance level		$p = 0.0378$

Conclusions

According to the DRA's, children need a high level intake of vegetables, which must consist out of a variety of vegetables. Fast food is a very popular and frequent choice, although it is unhealthy and has negative effects on health. Consumers are becoming more aware of healthier options, but are still looking for satisfying choices.

As proven in the paired preference test, children preferred the picture of a potato chip above a vegetable picture. Using the concept of a chip perception, different vegetables were tested, while they were processed to look like a chip. Carrots were preferred over green beans and beetroot. For brown-type vegetables, the sweet potato, butternut, butternut + sweet potato and sweet corn chips were preferred to cauliflower and cabbage. From all the potato based vegetable chips, the sweet potato was the most preferred vegetable. Further tests performed with this chip found no significant differences in preparation methods. The baked option was subsequently chosen for further tests because it was the healthiest option. There were no significant differences in preference between different oils and different coatings. When the chip was improved with chickpea flour, there was not a significant difference between the samples.

These findings are important, because there are healthy alternatives to traditional fried chips, which are still accepted. Caretakers must adopt the healthier principles and feed children more vegetables, using creative methods to improve their acceptability. Consequently, potato based vegetable chips or the chickpea based vegetable chips can become very popular in future markets.

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ANNEXURE 4

UNIVERSITY OF THE FREE STATE
UNIVERSITEIT VAN DIE VRYSTAAT
YUNIVESITHI YA FREISTATA

UFS·UV
NATURAL AND AGRICULTURAL SCIENCES
NATUUR- EN LANDBOUWETENSKAPPE

Dear Parents

I am an MSc Home Economics student at the University of the Free State and I am busy with research in Product Development.

Generally, children like chips more than vegetables. Therefore, I want to develop chips with vegetables included, to encourage children to eat more vegetables. For this project, I want to obtain information from you as parent/ guardian.

Please complete the following questionnaire and sign the letter as a consent.

Thank you very much.

Petro Swart.

………………………………………………

(Parent)

Geagte Ouer

Ek is 'n MSc Huidhoudkunde-student aan die Universiteit van die Vrystaat en is besig met navorsing in Produkontwikkeling.

Oor die algemeen hou kinders meer van skyfies (chips) as groente. Dus beoog ek om skyfies te ontwikkel waarin daar groente is, om kinders aan te moedig om meer groente te eet. Vir hierdie sudie wil ek graag inligting van u as ouer/ voog bekom.

Vul asb die volgende vraelys in en teken die brief as 'n vrywaring.

Baie dankie.

Petro Swart.

………………………………………………

(Parent)

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Email: bothmac@ufs.ac.za
Website: www.ufs.ac.za/biotech

QUESTIONNAIRE TO BE COMPLETED BY PARENT / CARE-GIVER

1. **Sex of child / Geslag van kind** ____________________
2. **Age of child / Ouderdom van kind**
3. **My child is allergic to: / My kind is allergies vir:**

Potatoes / Aartappels	☐	Garlic / Knoffel	☐
Green beans / Groenboontjies	☐	Sweet potatoes / Patats	☐
Beetroot / Beet	☐	Sweetcorn / Suikermielies	☐
Cabbage / Kopkool	☐	Butternut/ Botterskorsie	☐
Eggs / Eiers	☐	Carrots / Wortels	☐
Cauliflower / Blomkool	☐	Onions / Uie	☐
Sunflower oil / Sonneblomolie	☐	Olive oil / Olyfolie	☐
Sulphur dioxide(Preservative) / Swaweldioksied(Preserveermiddel)	☐	Chick peas(Legumes / Kekerertjies(Peulgroente)	☐

4. **Any other allergy not mentioned? / Enige ander allergie nie genoem nie?**

____

5. **My child is diabetic / My kind is diabeties :** Yes / Ja ☐ No / Nee ☐
6. **My child likes to eat : / My kind eet graag :**

Potatoes / Aartappels	☐	Garlic / Knoffel	☐
Green beans / Groenboontjies	☐	Chick peas / Kekerertjies	☐
Sweet potatoes / Patats	☐	Eggs / Eiers	☐
Cauliflower / Blomkool	☐	Onions / Uie	☐
Carrots / Wortels	☐	Beetroot /Beet	☐
Sweetcorn / Suikermielies	☐	Cabbage / Kopkool	☐
Butternut / Botterskorsie	☐		

7. **My child has never eaten the following vegetables before / My kind het nog nooit die volgende groente geëet nie:**

Potatoes / Aartappels	☐	Garlic / Knoffel	☐
Green beans / Groenboontjies	☐	Chick peas / Kekerertjies	☐
Sweet potatoes / Patats	☐	Beetroot /Beet	☐
Cauliflower / Blomkool	☐	Cabbage / Kopkool	☐
Carrots / Wortels	☐	Butternut / Botterskorsie	☐
Sweetcorn / Suikermielies	☐		

8. **My child does not like the following: / My kind hou nie van die volgende nie:**

Potatoes / Aartappels	☐	Garlic / Knoffel	☐
Green beans / Groenboontjies	☐	Chick peas / Kekerertjies	☐
Sweet potatoes / Patats	☐	Eggs / Eiers	☐
Cauliflower / Blomkool	☐	Onions / uie	☐
Carrots / Wortels	☐	Beetroot /Beet	☐
Sweetcorn / Suikermielies	☐	Cabbage / Kopkool	☐
Butternut / Botterskorsie	☐		

9. **Me as a parent does not like the following : / Ek as ouer hou nie van die volgende nie:**

Potatoes / Aartappels	☐	Garlic / Knoffel	☐
Green beans / Groenboontjies	☐	Chick peas / Kekerertjies	☐
Sweet potatoes / Patats	☐	Eggs / Eiers	☐
Cauliflower / Blomkool	☐	Onions / uie	☐
Carrots / Wortels	☐	Beetroot /Beet	☐
Sweetcorn / Suikermielies	☐	Cabbage / Kopkool	☐
Butternut / Botterskorsie	☐		