**UNIVERSITY OF EDUCATION, WINNEBA**

**COLLEGE OF TECHNOLOGY EDUCATION-KUMASI**

# ASSESSING CONSUMER ACCEPTABILITY OF WATERMELON SEED BRITTLE

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**7161180008**

**MARCH, 2019**

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**A DISSERTATION IN THE DEPARTMENT OF HOSPITALITY AND TOURISM EDUCATION, FACULTY OF VOCATIONAL EDUCATION, SUBMITTED TO THE SCHOOL OF GRADUATE STUDIES, UNIVERSITY OF EDUCATION, WINNEBA, IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR AWARD OF THE MASTER OF TECHNOLOGY (CATERING AND HOSPITALITY) DEGREE**

**MARCH, 2019**

## DECLARATION

I hereby declare that, this thesis was written by me. No part nor whole of this thesis has ever been presented to University of Education, Kumasi Campus or any other institution for an award of any academic degree. All references I consulted have also been acknowledged.

**FLORENCE BRENYAH**

..... .....

**(CANDIDATE)** **DATE**

I, the undersigned supervisor, attest that this is an original work I supervised the candidate to produce. I am also convinced that, this thesis is in conformity to the required standards set by the University of Education for an award of an MTECH Catering and Hospitality Degree.

**DR. ELLEN OLU**

..... .....

**(SUPERVISOR)** **DATE**

## DEDICATION

This thesis is dedicated to the memory of my beloved Grandmother Mrs Kwao-Sarbah. May her soul rest in perfect peace.

## ACKNOWLEDGEMENT

I give appreciation to my supervisor, Dr. Ellen Olu for the interest and concern she shown for this work. May God Almighty grant her good health and success in all her endeavours. The next appreciation goes to my MTECH classmates for their indirect support in shaping this work. I am equally grateful to my nuclear family for given me the necessary peace of mind to put together this piece of work.

## ABSTRACT

Poor health has been noted as a development challenge especially in developing countries. Inadequate nutritional intake has been cited as one contributory factor. Though many products are available and can be used as food, many people are not aware of this. Watermelon seed has been noted as one of the products that can be used for food and medicine. One product that uses watermelon seed is watermelon seed brittle. The objective of the study was to develop an acceptable food product from watermelon seed and ascertain consumer acceptability. The study involved 50 respondents in Kwadaso sub metropolis. It was an experimental study design involving controlled and uncontrolled respondents. The study revealed that, watermelon seeds are used as medicine and food. 33 (66 %) of the respondents mentioned that, watermelon seeds are edible. The study also discovered that, watermelon seed brittle was appreciated by more than half of the respondents. The sensory comparison revealed that, groundnut seed brittle was ranked higher in all the sensory characteristics by recording 36.1 and closely followed by watermelon seed brittle with total points of 35.5 on the hedonic ratings. In assessing the sensory characteristics of watermelon seed brittle product alone, it was found that, respondents scored the colour (16 %), the taste (25 %), the texture (26 %), the flavour (19 %) and the appearance (14 %). The study recommended that, effective public education in creating awareness on the uses of watermelon seed is very necessary. NGO's and other governmental institutions should support people to learn more products developed from watermelon seeds since it can serve as an income generating activity. The Public Health Institutions should educate the public on the health benefits of watermelon seed products. Finally, the study recommends that, further studies should be carried out on nutritional analysis, microbial analysis and the shelf life of watermelon seed brittle.


**Key words:** Assessing, Consumer, acceptability, Watermelon Seed brittle, Ghana.

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# ABBREVIATIONS

| | |
|---|---|
| DOI | Diffusion of Innovation |
| FAO | Food and Agriculture Organization |
| SDGs | Sustainable Development Goals |
| USD | United States Dollar |
| WHO | World Health Organization |

# CHAPTER ONE

# INTRODUCTION

## 1.0 Background to the Study

The achievement of good health status has become a major concern of policy-makers in recent times. This can be deduced from the sustainable development goals targeting the achievement of some goals and targets by 2030. Among such goals are the measures to end hunger (Goal 2), to ensure good health and well-being (Goal 3). As at 2015, more than 800 million people around the globe still live under $1.25 a day and that has serious repercussion on their dietary intake and health status (UNDP, 2015). Poor health has therefore remained a challenge, especially in developing countries. For instance, whilst some parts of the world have recorded over-nutrition, others have track records of under-nutrition (WHO, 2016: Staub, 2016; Thow, 2016).

In the developed countries, daily intake of fruits is routine unlike the case of developing countries. Fruits form part of daily diet of the rich and hardly the poor. In Ghana, the entire country consumes about 4,729 tonnes of fruits (Ghana Agricultural Sheet, 2014). The principal fruits consumed are pineapple, citrus, banana, cashew, pawpaw, mangoes, tomatoes, watermelon, pepper, okro, eggplant and onion (Ghana Agricultural Sheet, 2014). Among these fruits, water melon is gaining prominence globally.

Watermelon otherwise (Citrullus lanatus) is one fruit that can be developed into many products. Watermelon which is from the cucumber group is an oval or round in shape with very smooth skin, dark pre-pale green in colour. It becomes yellowish green when matured. The watermelon fruit is a good source of vitamins and it is usually used for breakfast, snacks and served as appetizer in most homes and events. The watermelon fruit provides

phytochemical and lycopene which serves as antioxidant during normal metabolism and guards against cancer and other non-communicable diseases (Perkins & Collins, 2004)

The Juice or flesh of watermelon is consumed whilst the rind and seeds are normally treated as solid wastes (Koocheki & Razavi, 2007). However, kernel from watermelon seeds can be used for bread, cake, confectionery and snack (Koocheki, 2007; Barone, 2018). Apart from these, the seed of the watermelon fruit can be used in other areas such as food application. The seeds can also be cooked, grounded and fermented to be used as species in gravies and local soups (Fatimat, 2018; Nwokolo & Sim, 1987; Ejinkeonye, 2018).

Watermelon seeds have their own nutritional constituents; proteins, fats, iron and other nutrients. Watermelon seeds are also a source of calories. Its seed are rich in nutrients and minerals. It contains crude protein and oil in appreciable quantities. The seed oil contains 80 % unsaturated fatty acids with linoleic acid being the dominant fatty acid (Prajakta, 2015).

## 1.1 Statement of the Problem

Watermelon is one of the principally under-utilized fruits (Hassan, 1993; Godawa & Jalali, 1995; Mahla, 2014). While the juice or pulp is used for human consumption, and serves as medicinal, the rind and the seed are considered a major waste (Prajakta, 2015; Onifiole, (2002). Some of the nutrients are wasted when the seeds are discarded. Even though the seeds offer numerous nutrients such as vitamins (A, B, and C), minerals (iron, manganese, calcium), fats (poly unsaturated and mono saturated), antioxidants, not many people are aware of the uses of the seeds (Dimitrovski et al., 2010).

The seeds and rinds of watermelon are generally excluded in regular diet as the concentration has been on the juice or pulp (Reetapa, Asmita, & Santa, 2013). Much of the

concentration of the research on watermelon has centred on the physical and chemical properties of the fruits (Alam et al., 2013; Paris, 2015). Therefore not much research has been carried out in watermelon seed especially in Ghana**.** In order to ascertain more information about public awareness of uses of watermelon seeds, it has become very necessary, to conduct this research in Ghana in the Kumasi metropolis. A search through the literature did not find watermelon brittle and sensory evaluation in Ghana. Therefore it has become very necessary to develop food products from the watermelon seed and sensory evaluation done to ascertain consumer acceptability. The current study therefore seeks to bridge that gap and add to knowledge.

### 1.2 General Objectives:

To develop an acceptable food product from watermelon seed.

### 1.3. Specific Objectives

1. To ascertain people's awareness of the use of watermelon seeds.
2. To develop watermelon seed brittle.
3. To ascertain consumer acceptability of watermelon seed brittle.

### 1.4 Research Questions

The awareness of uses of fruit seeds, the case of watermelon seeds were guided by the Richie and Spencer's categorization of research questions (Richie & Spencer, 1994) as stated below:

1. What is the level of public awareness of the uses of watermelon seeds?
2. How is watermelon seed brittle developed?
3. What is the consumer sensory acceptability of watermelon seed brittle?

### 1.5 Significance of the Study

The study is significant as the outcome will reveal the perception of the uses of watermelon seed and inform policy on public nutritional education. Moreover, the awareness of the uses of watermelon seeds will open new opportunities to section of the population who may wish to make a livelihood out of that. The research outcome may also sensitize the public on the health benefits of watermelon seeds. With recent efforts by global stakeholders on food security, the outcome of the research may provide other sources of food for the world's growing population.

### 1.6 Scope of the Study Area

The study departed from the usual concentration of researchers on the chemical and physical properties of watermelon fruits. The current study focused on the public awareness of the uses of watermelon seed in the production of brittle. The study began with an inquiry on the public knowledge of uses of some fruit seeds in general. The study then narrowed the focus to uses of watermelon seeds and further prepared sample product for the public consumption, assessment and acceptability based on sensory characteristic.

### 1.7 Limitation of the Study

Geographically, the study covered Kwadaso sub-metro of Kumasi Metropolis. It would have been better if the study had covered at least three Metropolitan areas. This would have made it clearer for the readers to appreciate the awareness of the uses of watermelon seeds. Notwithstanding, the researcher captured all the needed indicators on the public awareness of the uses of watermelon seeds and the sensory reasons for accepting the watermelon seed brittle. By this the researcher brought down the effects of these limitations to the barest minimum and that, the quality of the research was not compromised.

### 1.8 Organization of the Study

The study was organized under five chapters. Chapter one discussed the background of the study, statement of the problem, research questions, objectives of the study, significance of the study and organization of the study. Chapter two was devoted to literature review relating to the objectives. Chapter three focused on the methods used in carrying out the research. The methods were step by step illustration of all the procedures involved in the research process. Chapter four focused on background of respondents and results of the study while chapter five presented major findings, conclusion and recommendations.

# CHAPTER TWO

# LITERATURE REVIEW

## 2.0 Introduction

This chapter highlights the empirical literature about fruits globally and narrows the literature to watermelon seeds. The reviews stem from global perspective to the local setting and puts forward published opinions about usage of fruit seeds including watermelon seeds.

## 2.1 Uses of Fruits Seeds

Fruits seeds have both high levels of nutrients and anti-oxidants that help fight diseases and ailments. Some known examples of fruits seeds include blackcurrants, blackberries, cranberries, watermelon and pomegranates.

### 2.2.1 African Oil Bean (Pentaclethra macrophylla)

The African oil bean seed, which is known as Pentaclethra macrophylla, is found in tropical regions of Africa since 1937. The smooth, brown seeds average eight in number are confined in a flattened pod that explodes when ripe, scattering the seeds. The seeds are then fermented into a product called ugba, a popular condiment and meat before they can be eaten (Enujiugha & Akanbi, 2005). The seeds are good source of oil. The seeds are composed of up to 44% protein and have all the 20 essential amino acids, which serves as meat supplement. Moreover, the seeds contain essential fatty acids and minerals like magnesium, iron, manganese, copper, phosphorous, and calcium (*Cangao*, 2015; Bonnie, 2017).

Researchers have also found that, the African oil bean seeds contain phytochemicals that can decrease cholesterol levels. Results in a study done in Nigeria revealed that patients who frequently eat ugba had decreased risks of cancer and tobacco-related diseases *(Cangao*, 2015). In a separate study, the oil extract from the seed was found to be an effective treatment for diarrhoea and treat anaemia since it increases the amount of haemoglobin (Agbogidi, 2010)

**Plate 2.1 Sample Africa Oil Bean Products (*Pentaclethra macrophylla*)**

Source: Ken Fem, (2014)

**2.2.2 African Mango (**Irvingia gabonensis**)**

The African Mango fruit is fairly nutritious. The fruit contains calcium, phosphorous, iron, and vitamin C. Compared to the fruit, the seeds have six times more calcium, about twice more iron, and additional thiamin, riboflavin, and niacin. The seeds also have a high fiber content that aids in reducing cholesterol in the body (*Cangao*, 2015, Ross, 2011)). Products that can be developed from the African Bush Mango are flour, Oil and kernel (Ogunsian et al, 2012).

**Plate 2.2 Samples of African Mango Seed Products (Irvingia gabonensis)**

Sources: Anna Muse, (2018)

### 2.2.3 Pumpkin Seeds

Pumpkin originated in Greek word 'Pepon' which means large melon. The word was gradually transformed by the French, English and the Americans to ''Pumpkin'. Pumpkin is technically a fruit. Pumpkins are members of the gourd family which includes cucumber, honeydew and lemond. The pumpkin seeds have many health benefits such as prevention of diabetes, heart diseases, prostate cancer, and among others. Major products that can be developed from the pumpkin are raw pumpkin seed flour, roasted pumpkin seed flour, oil and kernel and also serve as fibre sources in confectionary products (Milovanic, et al. 2014)


**Plate: 2.3 Sample of Pumpkin Fruit Seeds**

**Source: Gettyimages, (2019)**

### 2.2.4 Groundnut

Groundnut is valued for the protein content (26%). On equal weight basis (kg for kg), groundnut contains more protein than meat and close to about 3 times more than eggs. Groundnuts are a good source of calcium, phosphorus, iron, zinc and boron. The groundnuts also contains vitamin E and small amounts of vitamin B complex. High in calories, (Msrivani, 2009). Groundnut promotes fertility (folate) and boost brain memory through the provision of vitamin nacin.

**Plate: 2.4 Sample of Groundnut**

Source: Groundnut Stock Photos & Images, (2019)

## 2.3 Factors Accounting for the Choice of Fruits Seeds

Scientific evidence reveals the protective effects of fruits, fruits seeds and vegetables against a number of diseases such as cardiovascular diseases and some types of cancers (WHO, 1990; Guo-Yi et al., 2017; Cai-Ning et al., 2017). Pollard, Kirk, & Cade, (2002) and United Nation Food and Agriculture Organization (2015), many factors affect food choice in relation to fruits, fruit seeds and vegetable intake. The choices of fruit seeds determine which nutrients are consumed and its health benefits to the human body. People do not choose fruits seed mainly because of the nutrients. A number of other factors accounts for the selection of fruit seeds.

### 2.3.1 Demographic and lifestyle factors affecting fruit, fruit seed and vegetable consumption

WHO has revealed that, intake of 400 g fruit and vegetables should be included in the daily diet to protect against diseases (WHO, 1990; Sandeep, 2013; WHO, 2002). Variations in intake of fruits, fruits seeds and vegetables are recorded between regions, social classes, gender and financial status. Studies have noted that, while individuals in the urban areas consume large amount of fruits, fruit seeds and vegetables, their rural counterparts consume less and this pattern is not only applicable to developing countries but also developed countries (Leather, 1995; National Agricultural Research Institute, 2010, Milene, 2015).

### 2.3.2 Sensory Appeal Factors

People do not take in fruit seeds just for its nutritive value. Many people take in fruits, fruits seeds and vegetables for pleasure, enjoying experience and distinctive experiences (Clark, 1998; Human Environments Analysis Laboratory, 2013; Evans, 2012). Sensory factors such as taste, texture, quality, smell and appearance play an important role in whether a person would choose a fruit seed or not. Some studies have found sensory factors to be accounting for the choice of eating behaviour which include the intake of fruits and fruit seeds (Slavin, 2012; Sommer, 2013). These authors noted that, 'satisfaction', beliefs, 'good' taste were essential precondition for the consumption of fruits, fruit seeds and vegetables.

### 2.3.3 Degree of Familiarity and Habit to Food

Food habits are formed based on how individuals in society are socially and culturally addicted to consume and utilise some food products (Khan, 1981; Barry et al, 2012; Weranuj & Quiroga, 2016). Food habits relate to learned experience, which leads to the development of attitudes towards particular foods. The choice of Fruits, fruit seeds and

vegetables for consumption are based on cultural and traditional practices. Mostly, fruits and fruit seeds products that are alien to a geographical areas are not mostly accepted and consumed by people in that geographical area. Culture and beliefs therefore influence food choice by given out the norms, values, and therefore restricting the patronage of some foods such as fruits, fruit seeds and vegetables (Khan, 1981; Weranuj & Quiroga, 2016).

### 2.3.4 Cost of Fruit Seeds

The cost of food is a major factor that influence food choice (Mintel, 2001a).When prices of fruits are high, less people are able to afford especially among poor families. Price is therefore found as a factor that influences the choice of fruits seeds by those in low socio-economic groups such as students, the retired and the unemployed ( Delaney & McCarthy, 2009; Turrell, 2009).

### 2.3.5 Access and Availability of Fruit Seeds

This relates to the availability and accessibility to the fruit seeds and the physical effort required to obtain them. When markets and shops in the communities do not sell fruits seeds, the cost of transportation becomes a burden hence affecting the use of that particular fruit seed (Mintel, 2001a). Therefore availability may account for a large proportion of the fruit choice process. For instance some people are dependent on public transport or walk to shops to buy fruits seeds.

## 2.4 Brief Overview of Watermelon Fruits

It is believed that, watermelon was first harvested in Egypt about 5,000 years ago. Egyptians put watermelon in the tombs of their kings to nourish them in the transition to the next world. Pictographs drawn on walls in caves and tombs revealed the Egyptians' early harvest

of watermelons (Wasylikowa & Van der, 2004). Historians assert that, watermelon spread along the Mediterranean Sea due to the activities of merchants. Watermelon became known in Italy and Greece from where it spread to other parts of the World (National Watermelon Promotion Board, 1999, Strauss, 2015) Watermelon fruits became known to China in the 10th century and currently the largest producer of watermelon globally. The Moors in the 13th century brought watermelons to the European continent and made way to America through the African slaves. The cookbook which was published first in the United States in 1776 contained a recipe for watermelon rind pickles. Currently, watermelon is the highest consumed melon in the United States (Stuckrath, 2016: Szalay, 2017; Herrera, 2018).

### 2.4.1 Production of Watermelon

Watermelon is a fruit crop and a herbaceous creeping plant. It belongs to the larger family of cucurbitaceous. It is principally propagated by seeds and flourishes best in warm areas. The watermelon plant is a tropical plant and requires much sunshine and temperature of about 25ºC (Tabiri, et al, 2016). This means that, watermelon strives well in warm climates (United States Department of Agriculture, 2015; Ufoegbune, 2014). Growing watermelons requires the right combination of soil, water, weather and care. According to Ministry of Food and Agriculture, (2011), their fact sheets revealed that, watermelon grows well in fertile soil of fairly acidic environment. It can be grown along the coast, forest and savannah areas. In the Africa continent, watermelon accounted for about 5.4% of the total harvested area devoted to vegetable production in 2008 (FAOSTAT, 2008).

Watermelons are cultivated in rows that are about eight to twelve feet away from each other. In about 60 days after planting, the watermelon fruits root which is called the “crown set,” are developed. Within the following 30 days these watermelons can be harvested, as more

of the watermelon may continue to mature along the vein. The watermelon is fragile and as such, they are hand-picked on the farm, hand-packed in cartoons or bins and transported.

Watermelon is currently a common fruit globally. For instance, Watermelons are grown in more than 96 countries worldwide and are produced in 44 states in the U.S. (National Watermelon Promotion Board 2003d; Stuckrath, 2016: Szalay, 2017; Herrera, 2018). The world noted countries of water production are United States, China, Turkey and Iran. For instance, in 2004, the U.S. produced approximately 3,682 million pounds of watermelon. Within the United States enclave, as of 2005, Alabama was ranked fifteenth in national production with 20.3 million tonnes produced, while Florida, Texas, Georgia and California top the list for production year after year.

The main critical factors which determines the quality of watermelon is its sweet taste and sugar content. According to Okonmah, et al. (2011), watermelon is fermented and a fresh alcoholic drink is made from it in Namibia. Again, the rind of watermelon is sliced, dried, cooked and eaten in some parts of United States.

### 2.4.2 Challenges with Watermelon Production

Just like any other fruit seeds, watermelon may be affected by variety of challenges. Among such challenges is insect infestation. Included in these insects are cabbage loppers, cucumber beetles, cutworms, leafhoppers, thrips, leaf miners and spider mites (Sanders, 2001; Webb, 2017). Again watermelon has short shelf life and delicate to handle which exposes the fruit to frequent injury or bruises which impacts on the quality of the fruit.

### 2.4.3 Description of Watermelon Seeds

There are varieties in watermelon seeds. These are charleston grey, kaolack, and sugar baby, petite treat, and among others. These seeds may come about five categories of watermelon namely, all sweet, ice-box, seedless, crimson, and yellow flesh (Razavi & Milani, 2006, Reetapa, 2017). The seeds are typically extracted from the fruit by manual maceration. There are seedless watermelon and watermelons with seeds. One watermelon fruit may contain more than 50 seeds depending upon the size and the variety (Mann, 1943). Although the seeds are usually discarded, they are edible and delicious when roasted. The average seed size is between 7cm-14cm, with a diameter of 13-14mm (Razavi & Milani, 2006).


**Plate 2.5 Types of Watermelon Seeds**

**Source:** Razavi & Milani, (2006).

### 2.5 Comparing Nutritional Content of Watermelon Seed and Groundnut

Watermelon seeds are rich in nutrients. For instance, 100gram watermelon seeds provides about 600 calories which is equivalents to 10 slices of bread. Virginia & Ajit (2014), Reetapa, Tiyasa, & Santa, (2016) and Gopalan , et al., (2000), have stated that, out of this, 400 calories are supplied in the fat of watermelon seeds. Watermelon seeds have a high nutritional value because of the high protein (25.2–37%) and oil (37.8–45.4%) contents (Raihana, 2015). This means that about, a third of watermelon seeds hold protein. Among the Vitamin B provided by the watermelon seeds are thiamine, niacin and folic. Aside these, about 100 gram of watermelon seeds hold magnesium (139%), Manganese (87%),

phosphorous (82%), zinc (74), iron (44%), potassium (20%) and copper (37%). Despite these essential nutrients, people have some negative perception about watermelon seeds. The current study compared watermelon seed with groundnut in terms of nutritive value and other chemical properties. This is because, watermelon seed and groundnut are going to be used to develop brittle for consumer sensory evaluation. Seyed & Elnaz (2006) and Abdulrazak, Otie & Oniwapele (2014) have categorised these nutritive properties as shown on Table 2.1. It was noticed that, watermelon seed is high in protein, fibre, water and sugar than groundnut as on Table 2.1

**Table: 2.1. Nutritive Properties of Watermelon and Groundnut**

| **Nutrients** | **Watermelon Seed (100g)** | **Groundnut (100g)** |
|---|---|---|
| Protein, | 28g | 25.8g |
| Carbohydrates | 15g | 16.1g |
| Fat, | 47g | 49.2g |
| Fibre | 8.5g | 2g |
| Calories | 557 | 567 |
| Water | 5.5g | 2.3g |
| Sugar | 9.5g | 4.7g |

**Source:** Seyed & Elnaz (2006); Abdulrazak, Otie & Oniwapele (2014)

### 2.5.1 Fibre in Watermelon Seeds

Dietary fibre is that part of plant which is resilient enzyme digestion and includes cellulose, polysaccharides, gum, mucilages and pectic (Dhingre, Mona, Rajput & Patil, 2012). Dietary fibre is essential for our digestive health and regular bowl movements. Fibre also has high satiety value, can improve cholesterol and blood sugar level and can assist in preventing some diseases such as diabetes, heart disease and bowl cancer (Li, & Komarek, 2017). In the reduction of cholesterol, fibre binds with bile salt for excretion leading to reduction in cholesterol. Again, in terms of blood sugar control, soluble fibre slows the absorption of sugar and helps improve blood sugar level. Moreover, fibre controls weight gain and reduce constipation. Watermelon seed is therefore essential to health with its higher fibre contents.

### 2.5.2 Protein in Watermelon Seeds

Watermelon contain higher content of protein than groundnut (Seyed & Elnaz, 2006; Abdulrazak, Otie & Oniwapele, 2014). Protein provides body structure which makes up integration part of the body. For instance, keratin, is a type of protein found in the hair, nails and skin that helps give these structures strength. Also provides structure to every cell in the body. Example, collagen, which is a structural protein found in various connective tissues, provides the framework for the ligament that holds the bones together and the tendons that attach muscles to these bones.

In addition, protein is essential for the regulation of body processes as clearly in the functions of enzymes which are essentially proteins that speed up chemical reactions in the body. Without enzymes, basic activities like breaking down the foods eaten would happen too slowly to support life.

Furthermore, hormones which are also proteins, regulates the activities of cells or organs. Hormones are like chemical messengers that transmit from one part of the body to the other. For instance, insulin is a hormone that regulates blood sugar by transmitting information to the cells about how much sugar is present in the blood. Furthermore, transporting materials through the body is another function of protein. A significant example is the haemoglobin which transports oxygen to all parts of the body (Barley & Fitzpatrick, 2011).

### 2.5.3 Phytochemical and Antioxidants from Watermelon Seeds

Watermelon seed provides Phytochemical and antioxidant activity. Phytochemicals are any of various biologically active compounds found in plants. Tabiri et al. (2016) reported that, watermelon seed contains phytochemical such as saponins, tannis, glycosides and alkaloids. For instance, these researchers established that, tannis is a major plant polyphenol that

functions as anti-tumor, anti-mutagenic, anti-diabetic, anti-proliferative, anti-bacteria and anti-mycotic properties.

Antioxidants are known to quench free radicals, hence important components of anti-ageing formulations (Tabiri et al, 2016). Antioxidants also provide protection against damage of tissues due to effects of environmental and other agents and promotes the growth of collagen. Consumption of watermelon seeds may decrease the probability of acquiring cardiovascular diseases and cancers due to the increased amount of total phenols found in the seeds and its antioxidant activities. In the provision of antioxidant activities, Oseni & Okoye (2013), found 56.93% DPPH free radical scavenging capability of watermelon seeds.

### 2.5.4 Essential Fatty Acids in Watermelon Seeds and Groundnut

According to the National Nutrient Database for Standard Reference (USDA) data, the oil content in 100g of groundnut ranges from 42% to 52% and that of watermelon seed is 50%. Tarek & Khaled (2001) and Vassiliou et al. (2009) have also categorised the essential oils in watermelon seed and groundnut as shown on Table 2.6.4. It was realised that, watermelon seed has more content per 100g, and more of omega-6 than groundnut.

**Table 2.2 Essential Fatty Acids in Watermelon Seeds and Groundnuts**

| Essential Oils | Watermelon Seed (100g) | Groundnut (100g) |
|---|---|---|
| Oil content per 100g | 50% | 42% to 52% |
| saturated fat | 9.8g | 17.7 g |
| Monounsaturated fat | 7.40g | 48.3 g |
| Polyunsaturated fat | 28.04g | 33.4 g |
| Omega-3 | 0g | 0g |
| Omega-6 | 30.3g | 15.56g |

**Source:** Tarek & Khaled (2001); Vassiliou et al. (2009); Zcan, (2010)

Omega 6 fatty acids are essential for human health. However, it cannot be synthesized by the body. Therefore, the body gets it through food. Together with omega 3 fatty acids, omega 6 fatty acid play an important role in cognitive function, normal growth and development. Omega 6 fatty acid is a type of polyunsaturated fatty acid (PUFA) which helps stimulates skin and health growth, maintains bone health, controls metabolism and maintain the reproductive system (Abreu, 2017). The properties of the three products can also be assessed through sensory evaluation.

Sensory property is the acceptance of sensory attributes of a product by consumers (Galvez & Resurrection, 1992). Beyond taste, sensory properties such as smell, sound, appearance and texture influence what people select to eat. Food must taste delicious, texture, looks and smell are also important to the overall eating experiences (Hartman, 2016; Watson, 1992). For instance, taste is perceived by the feeling of the receptors of tongue. The four main taste tested were sweet, salty, sour and bitter. Equally, texture was measured in terms of tenderness/hardness when chewing the brittle.

## 2. 6 Contribution of Watermelon Seeds Products to Health

### 2.6. 1. Digestive System

Watermelon seeds have positive effects on most important parts of the human body. The seeds of watermelon are rich in fibre and therefore helps relieves constipation, promote healthy digestive tract and regulates body processes (Perkins-Veazie & Collins, 2004). In addition, watermelon is a diuretic. It purifies the kidney and thus facilitates the elimination of harmful substances in the body. Toxins are therefore released through urine.

### 2.6.2 Watermelon Seeds and Disease Prevention

The importance of watermelon seeds are also seen in the area of provision of zinc and magnesium. They block the deterioration of cells and thus prevent diseases like alzheimers

and parkinsons. Consuming watermelon seeds provide arginine and lysine. These are the amino acid which regulates blood pressure. The body receive these amino acids in the form of glutamate acid and tryptophan.

The watermelon seeds are known source of lycopene and carotenoid which quench the free radicals that promote conditions like asthma, atherosclerosis, diabetes, colon cancer and arthritis (Oyeleke, Olagunin, & Ojo, 2012; National Watermelon Promotion Board 1999). The lycopene is a phytonutrient in a natural compound found in fruits and vegetables and reacts with the human body to trigger healthy conditions (Jarzabkowski, 2013).

### 2.6.3 Reduce Blood Cholesterol and Heart Diseases

Research has revealed that, the fats found in watermelon seeds are mono-unsaturated, poly-unsaturated and omega 6. According to the American Heart Association (2010), these fats have the potential of reducing the cholesterol and blood pressure of the human system. A study published in the American Journal of Hypertension corroborated the assertion by the America Heart Association that, consumption of watermelon seeds products extracts reduces hypertension and lower blood pressure in obese adults.

### 2.6.4 Male Fertility Enhancement

Again, lycopene is obtained in the consumption of watermelon seeds. This substance has significant impact on male's sexual drive and fertility. Based upon the above revelation, watermelon seeds consumption prolongs erection and provides stronger immune system (Folaranmi, Seye & Ademuyiwa, 2017; Jimoh, et tal. 2017).

### 2.6.5 Promote Hair Growth and Skin Care

Watermelon seeds promote hair growth since they contain copper. One of the body's requirements is pigment that gives colour to the hair and the skin. The copper contained in watermelon seeds produces haemoglobin. Watermelon seeds products provide about 192 micro gram or about 21% of copper for daily needs. The oil provided by watermelon seeds are used as moisture in the hair as it is light and easily absorbed without any disruption in the pores of the scalp. Similarly, the oil of watermelon seeds contains antioxidants, which makes the skin look much younger and therefore disguises aging by regenerating the skin, prevents skin cancer and skin infection (Lemond, 2011)

### 2.6.6 Watermelon Seed Used as Food

Watermelon seeds are used to prepare snacks, milled into flour which can be used in fortification and enrichment. For instance, the flour can be used in fortifying babys' foods, can be added to wheat flour for baking and can also be used in preparing stew. Aside these, the oil from the watermelon seeds are used in cooking. (Jensen, et., al, , 2011).

## 2.7 Summary of Literature Review

This chapter has given a fair idea of the empirical or existing knowledge on watermelon seeds. With this knowledge acquisition, the literature gaps identified under the problem statement are all noted and the researcher will make efforts to methodologically tailor the questionnaires to address these data gaps by satisfying the objectives of the research. The chapter has established that, watermelon seed has higher nutritive values in protein, fibre and omega 6 fatty acid than groundnut. Again, it was discovered that watermelon seed has phytochemical and antioxidant properties which are essential to health.

# CHAPTER THREE

# METHODOLOGY

## 3.0 Introduction

This section presents the method used for the study. The study design, search strategy, population of study, sampling technique and sample size, structure of the questionnaire, administration of the questionnaire, ethical consideration and data management were also discussed. The summary of the methods to achieve the objectives of the study is presented below.

## 3.1 Study design

This is an experimental study. The study was in two parts. Initially, consumer awareness and utilization of watermelon seeds were evaluated using questionnaires. Subsequently, consumer acceptability of watermelon seeds based brittle was also evaluated using point hedonic rating scales.

## 3.2 Population of Study

The study population was drawn from households in Kwadaso Sub-metropolitan area of Kumasi Metropolis in the Ashanti Region of Ghana. The Kwadaso sub-metropolis has a population of 210,000 (2010 Population and Housing Census). Ashanti Region was chosen based on its urbanized nature, multi-ethnicity, busy administrative works, business orientation and the easy access to fruits and high level of fruit usage based on the population volume of the region.

### 3.3 Selection of Sample Size of the Study

The sample size was determined by adopting the following statistical formula for minimum sample size calculation (Yamane, 1967).

$$n = \frac{N}{1 + N(e)^2}$$

Where n=minimum sample size

N=210,000 (Population in the Kwadaso sub metro area)
e = 5% (the margin of error)

$$\frac{210{,}000}{1 + 210{,}000\ (0.05)^2}$$

n=210,000 /526

(1st Stage) 1st n=400 respondents

In the 2nd stage, the researcher was interested in selecting a respondents from households. The total number of households in Kwadaso sub-metro =19,964. To get the number of households for the semi-structured interviews the 19,964 was divided by 400 respondents and the result was 50 households which was used for the study.

Therefore 2nd n=50 households

### 3.4 Households Members Selection for the Semi-Structured Interviews

The Kwadaso sub metropolitan area is divided into 8 enumeration areas. These are Kwadaso Nsuom, Apatrapa, Nyankyerenease, Kagyare, Edwenease, Ohwimasi, Tanoso and Kwadaso Estates. In 6 of enumeration areas, simple random selection was used to select 6 households for the interviews and 7 households each selected at Tanoso and Kwadaso estates which are the biggest enumeration areas to get a total of 50 households. Simple random sampling is used to the person to be interviewed. All the names of the persons above 15years are written on pieces of papers and people blinded to pick. The person who picks the folded paper with

the word 'interview' is then interviewed. After the interview, the phone number of the interviewee was collected and was contacted for the second part of the interview pertaining to the consumer acceptability of watermelon seed brittle.

### 3.5 Pre-Testing

The instruments were pretested at Suame in Kumasi Metropolitan Area. This area equally had the characteristics of the Kumasi Metropolitan Area in terms of cluster of schools, population characteristics, commercial activities, and among others. The outcome of the pretesting was assessed and questions that need amendments were amended accordingly.

### 3.6 Ethical Consideration

Ethical approval was sought from the Department of Catering and Hospitality, University of Education Kumasi.

### 3.7 Informed Consent and Confidentiality

The respondents chosen were briefed about the research and the various objectives it hoped to achieve. For those who may not understand English the researcher explained to them in the Twi language. The respondents were assured of strict confidentiality as especially in the management of data and report writing. No identity of respondents was revealed. Those who agreed to take part in the research were given a consent form to sign and date and the time for the interview was fixed. This arrangement was made for those respondents who could not have time instantly to fill the questionnaire. However, those respondents who had the time, questionnaires were given instantly.

### 3.8 Formulation of Watermelon Seed Products

#### 3.8.1 Using Watermelon Seed to Prepare Brittle.

The following steps were taken to prepare watermelon seed brittle for the respondents to comment on the sensory characteristics. Watermelon brittle is a snack. The ingredients used are crushed watermelon seeds and Sugar.

**Table 3.1 Watermelon Seed Brittle Preparation.**

| **Ingredient** | **Quantity** |
|---|---|
| Crushed watermelon seed | 100gms |
| Sugar | 50gms |

Sources: Authors Own Recipe, (2018)

Watermelon seeds were procured. The seeds were put in a bowl of water for 1 hour. The seeds floated were not good and thus discarded. The seeds were washed with water and sundried for 48 hours and after which it was roasted for 15 minutes in the oven at 162°C to make them brown and crispy. The seeds were crushed to get a flaky texture. Subsequently, sugar was melted into a caramel at a temperature of between 160°C and 171°C for 10minutes. The crushed seed was added to the caramel and was stirred for 5minutes until thoroughly mixed. After which the mixture was poured on a smooth working board. Rolling pin was used to spread the mixture to a thickness of 1cm. It was then quickly cut into a desired size and shape. This is shown on flow chart 3.1

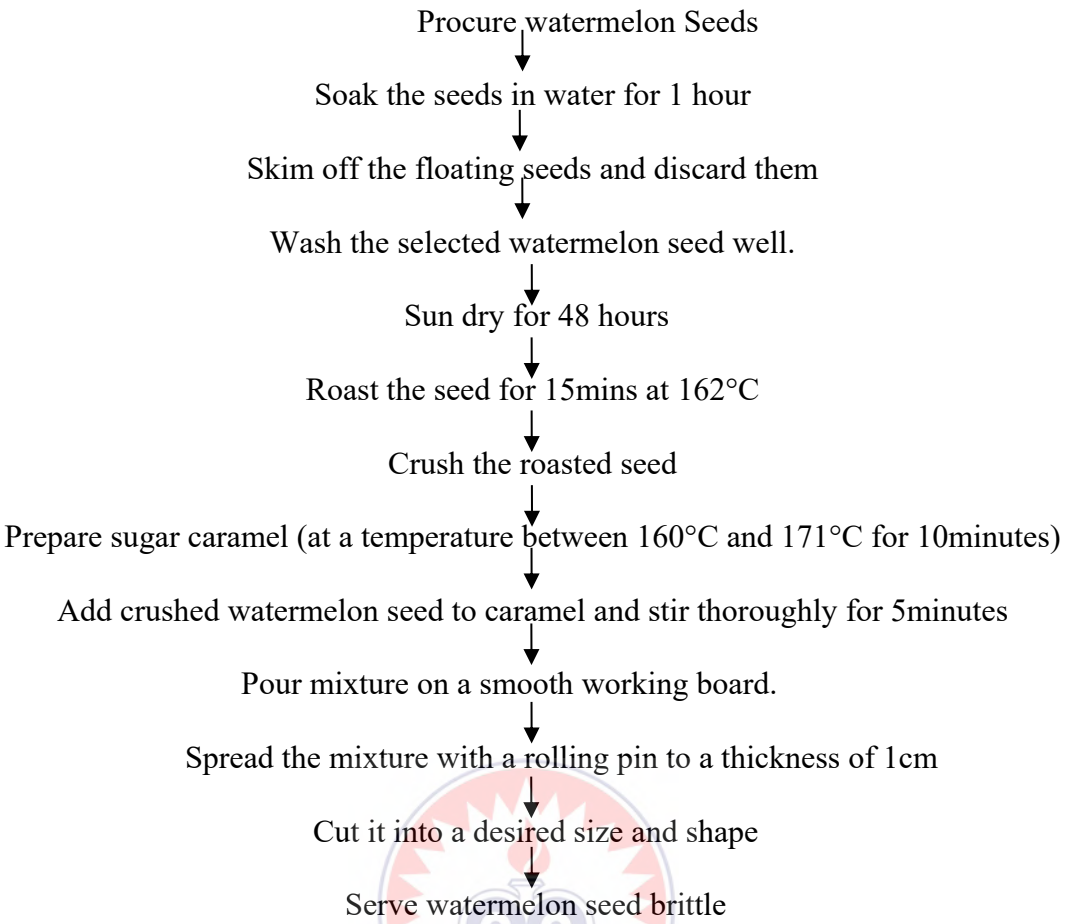


**Chart 3.1. Flow Chart of Watermelon Brittle Preparation**
**Source:** Author's Own Construct, 2018

### 3.8.2 Mixture of Watermelon Seed and Groundnut Brittle Preparation

The study also prepared a mixture of watermelon seed and groundnut brittle. The ingredients and quantities used are illustrated on Table 3.2

**Table 3.2 Watermelon Seed and Groundnut Brittle Preparation.**

| **Ingredient** | **Quantity** |
|---|---|
| Crushed watermelon seed | 50gms |
| Groundnut | 50gms |
| Sugar | 50gms |

**Sources:** Authors Own Recipe, (2018)

Watermelon seeds and groundnuts were procured. The watermelon seeds were put into a bowl of water for 1 hour. The floated seeds were discarded. The seeds were washed with water and sundried for 48hours. The groundnut was washed with brine and sun dried for a day. The watermelon seeds and groundnuts were roasted separately at a temperature. The watermelon seeds were roasted for 15 minutes in the oven at 162°C to make them brown and crispy. The groundnuts were roasted for 20minutes at Temperature of 176°C. The shells on the groundnut were removed. Both the watermelon seeds and groundnut were crushed to obtain a flaky texture. Sugar was melted into a caramel at a temperature of between 162°C and 171°C for 10minutes. The crushed watermelon seed and groundnut were added to the caramel and was stirred for 5minutes until thoroughly mixed. After which the mixture was poured on a smooth working board. Rolling pin was used to spread the mixture to a thickness of 1cm. It was then cut it into a desired size and shape. The preparation process is shown on 3.2.

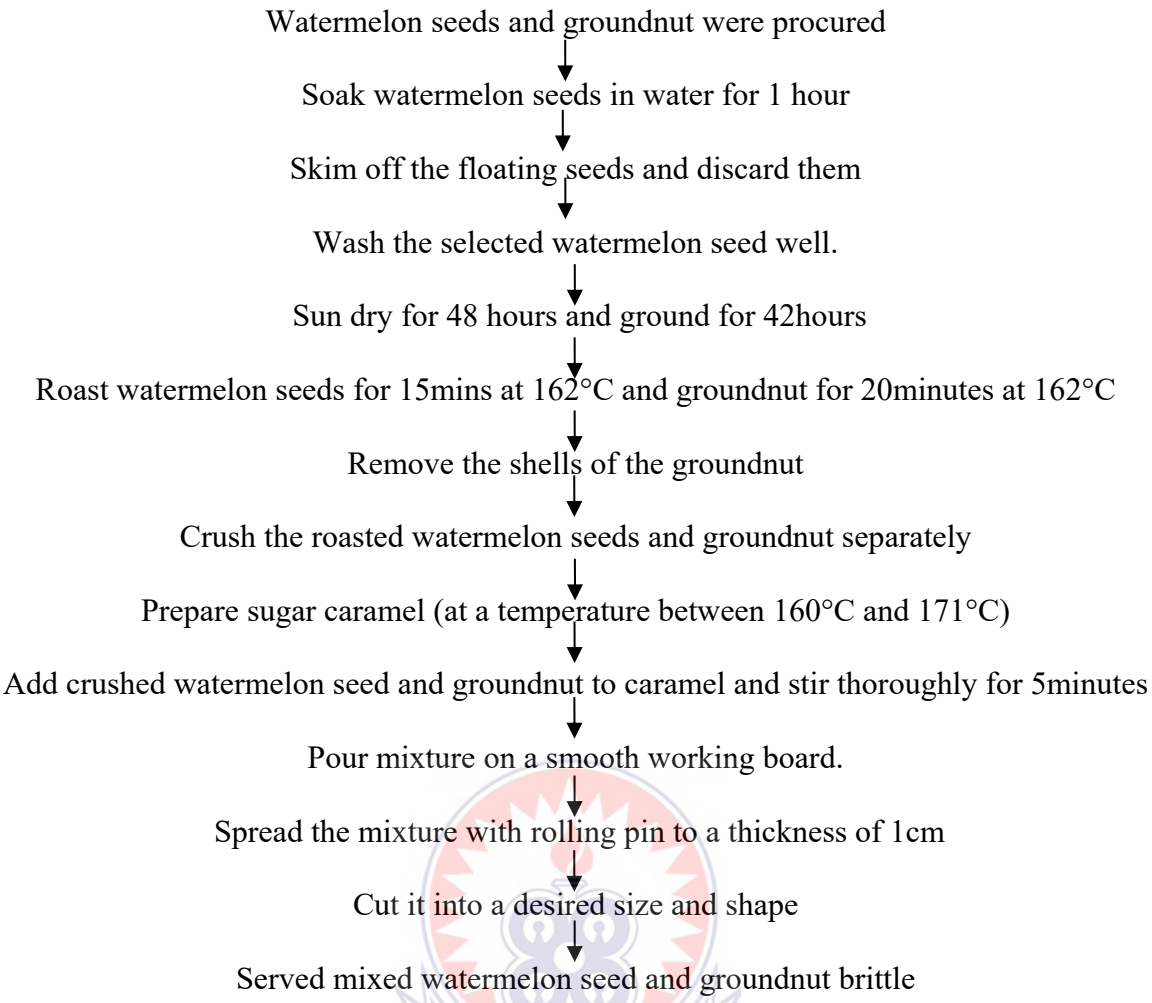


**Chart 3.2. Flow Chart of Mixed Watermelon Seed and Groundnut Brittle Preparation**
**Source:** Author's Own Construct, 2018

### 3.8.3 Groundnut Brittle Preparation

The ingredients and quantities of groundnut brittle preparation are illustrated on Table 3.3

**Table 3.3 Groundnut Seed Brittle Preparation.**

| **Ingredient** | **Quantity** |
|---|---|
| Crushed Groundnut | 100gms |
| Sugar | 50gms |

**Sources:** Authors Own Recipe, (2018)

Groundnut was procured. Groundnuts were washed with brine and sun dried for 24 hours. The groundnut was roasted for 20minutes at a temperature of 176°C. The shells of the groundnuts were removed. Sugar was melted into a caramel at a temperature of between 160°C and 171°C for 10minutes. The crushed groundnuts was added to the caramel and was stirred for 5minutes until thoroughly mixed. After which the mixture was poured on a smooth working board. Rolling pin was used to spread the mixture to a thickness of 1cm. I then quickly cut it into a desired size and shape. This is shown on the flow chart 3.3

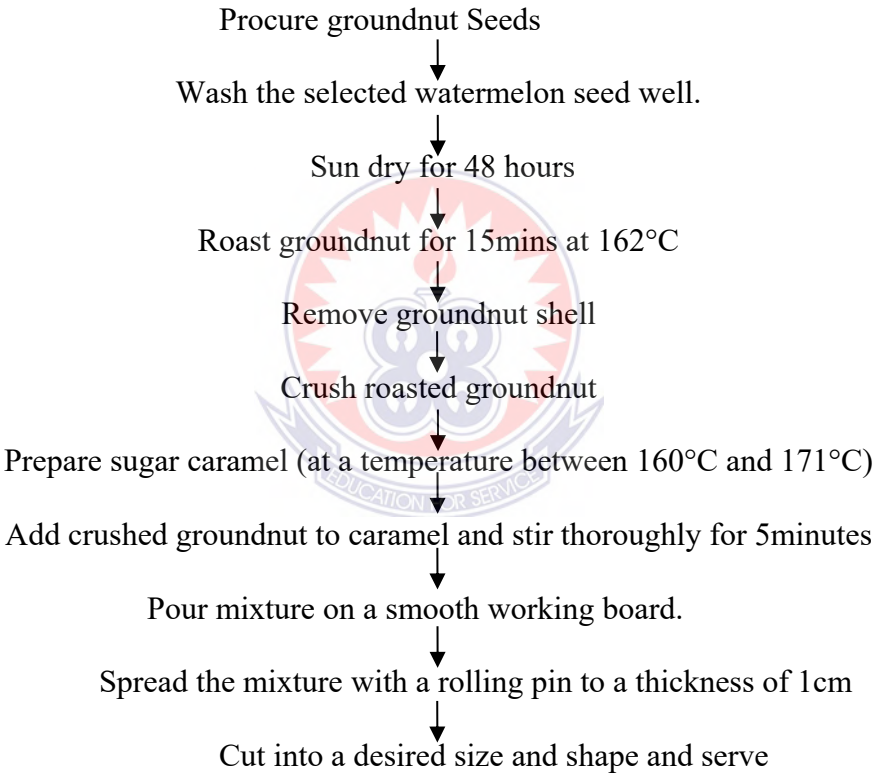


**Chart 3.3. Flow Chart of Groundnut Brittle Preparation**
**Source:** Author's Own Construct, 2018

### 3.9 Sensory Evaluation of Watermelon Seed and Groundnut Products

The current study did a sensory evaluation of the watermelon seed and groundnut products to assess acceptability using the hedonic rating scales (Larmond 1970, Lim, 2011).

### 3.9.1 Selection of Sensory Panelists

A five (5) member panel were selected for the sensory evaluation. The panelist were screened to make sure they are free from psychological and physical conditions which might affect human judgement. The screening was done to ensure that, each panelist was free from defects such as taste perception, odour perception, color blindness, denture defects, allergies, use of medications that affects the ability to taste, prone to minor infections of the nose and throat, among others (Hashmi, 2007; Balazs, 2012).

### 3.10 Sensory Evaluation of the three products

Three products below were prepared and sent to the field for sensory analysis. These were watermelon seed brittle, mixed watermelon seed and groundnut brittle and groundnut brittle. Respondents were asked to compare the three products based on colour, appearance, taste, flavour and texture. The study put the sensory characteristics on a Hedonic Rating Scale 9-1 (Larmond 1970; Lim, 2011). These were: Liked extremely 9, Liked very much 8, Liked moderately 7, Liked slightly 6, Neither liked nor disliked 5, Disliked slightly 4, Disliked moderately 3, Disliked very much 2 and Disliked extremely 1 as shown below:

**Grading Scores**

Liked extremely 9

Liked very much 8

Liked moderately 7

Liked slightly 6

Neither liked nor disliked 5

Disliked slightly 4

Disliked moderately 3

Disliked very much 2

Disliked extremely 1

### 3.11 Data Analysis

#### 3.11. 1 Quantitative Data

The quantitative data was entered on a spread sheet after some data cleaning exercises have been done. The researcher used simple excel to formulate tables, figures and charts to make the aggregated responses per each question to be clear. Again few of the data were also put in percentages. Brief explanation was offered under each table, figure or chart to ensure clarity.

#### 3.11.2 Qualitative Data

The qualitative bit of the semi-structured questionnaire was analysed thematically to ascertain converging and diverging thoughts of respondents from the interviews. The thematic analysis were done by transcribing the respondents' audio responses, developing global themes, organising themes, emerging or basic themes. The thematic analysis also involved the cording of the individual responses of the respondents and supporting each code with a popular samples quotation from the responses of the respondents. The thematic responses were therefore used to offer more explanations to the quantitative outcomes.

### 3.12. Summary of the Chapter

Chapter three has highlighted on the various methods to be used in this study. The chapter has methodologically pinned down the sampling methods and how the interviews were conducted. Again, the chapter has also shown watermelon seed brittle taken to the field after the questionnaire administration as a test case for the interviewees. Moreover, the chapter the important role of panellist and respondent in product acceptability by consumers. Again, the means of evaluation was also established as Hedonic 9-1 point rating scale.

# CHAPTER FOUR

# RESULTS AND DISCUSSIONS

## 4. 0 Introduction

This chapter presents the results and discussions. The chapter is divided into two sections. The first section highlights the background characteristics of respondents. These characteristics include age distribution, gender classification, marital status, religious background, educational status, ethnic relations, occupational category and occupational type and presented on a table for easy understanding.

The second section of this chapter highlights the feedback from respondents on diverse questions relating to the awareness of uses of watermelon seeds and consumer acceptability of watermelon seed brittle.

## 4.1 Respondents Background Characteristics

The Table 4.1 shows the background characteristics of respondents in terms of age, gender, religious affiliations, educational background, among others.

**Table 4.1 Respondents Background Characteristics**

| Demographic Characteristics | Frequency (%) |
|---|---|
| **Age** | |
| *15-25 years* | 5 (10) |
| *26-35 years* | 10 (20) |
| *36-45 years* | 21 (42) |
| *46-55 years* | 8 (16) |
| *56+ years* | 6 (12) |
| **Gender** | |
| *Male* | 10 (20) |
| *Female* | 40 (80) |
| **Marital Status** | |
| *Married* | 35 (70) |
| *Separated* | 3 (6) |
| *Divorced* | 5 (10) |
| *Widowed* | 7 (14) |
| **Ethnicity** | |
| *Akan* | 35(70) |
| *Ga* | 4(8) |
| *Northerners* | 10(20) |
| *Others* | 6 (12) |
| **Religion** | |
| *Christians* | 40 (80) |
| *Muslims* | 6 (12) |
| *Traditional* | 4 (8) |
| **Educational Status** | |
| *None* | 3 (6) |
| *Basic Educ.* | 8 (16) |
| *SHS* | 23 (46) |
| *Tertiary* | 16 (32) |
| **Occupational Status** | |
| *Formal* | 27 (53) |
| *Informal* | 23 (47) |
| **Occupational Type** | |
| *Teaching* | 14 (28) |
| *Matron* | 3 (6) |
| *Trading* | 16 (32) |
| *Mechanic* | 5 (10) |
| *Other Works* | 7 (14) |
| *Student* | 4 (8) |
| *Not Working* | 1 (2) |

**Source:** Field Data, 2018

The characteristics of respondents' background have a crucial role to play in a research study. One such characteristic is the age distribution of respondents. In adult research, it is assumed that, the older the age distribution, the higher the reliability of the feedback. In the current study, the age distribution ranged between 15years to 60years with an average age of 31years. From Table 4.1, it was noted that, persons between the ages of 36-45years were the highest accounting for about 21 out of the total of 50 respondents' while persons between the age ranges of 15-25years recorded the lowest of 5. Knowing the age range and the mean age gives an impression about the categories of people used in the study in terms of their experiences which may also give credibility to the results obtained from the study.

In terms of gender, 40 of the respondents where females while males accounted for 10. The implication is that, the gender dynamics in the current study reflects the national statistics of Ghana in which females have been sampled more than men in all surveys. For instance, in all the Ghana Demographic and Health Surveys (GDHS) women have been sampled more than men (GDHS, 1988, 1993, 1998, 2003, 2008 and 2014). In the 2014 GDHS, out of a total sample of 14,005 respondents, 9,396 were women as against 4,609 men. This gender dynamics is also in line with the 2010 National Population and Housing Census report which revealed that, the sex composition of Ghana was 51.2% for women as against of 48.8% for men.

The study found that, about 70% of the respondents were married and about 3% separated as shown on Table 4.1. Even though there variations in the percentage of married women and men between the results of the current study and the national data, the trends are the same. For instance, the Ghana Living Standard Survey Round 6 has equally reported that, about 39.4% of the Ghanaian population are married as against 5.6% widowed. Moreover, the respondents' ethnic relations were also studied and it was noted that, about 70% of the respondents were Akans, 20% were from the Northern Regions of Ghana and 8% of the

respondents were from the Ga and other tribes classified accounted for 12% as demonstrated on Table 4.1. The ethnic relations results of the current study is in conformity to the national ethnicity composition as the Akans form about 47.5% even though the percentage figures differs (Population and Housing Census, 2010)

Again, the religious background of the respondents was also analysed. The study found that, about 80% of the respondents were Christians while Traditional category accounted for about 8% as shown on the Table 4.1. The national religion statistics show that, Christians form about 71.2% of the population in Ghana. They are made up of Pentecostal/Charismatic 28.3%, Protestant 18.4%, Catholic 13.1%, other 11.4%. Muslim account for 17.6%, traditional 5.2%, other classified religious groups constitute 0.8% and none 5.2% (2010 population and housing census). Therefore the 80% of the respondents in the current study being Christians is in consonance with the national data.

The educational status of respondents was analysed into: No education attendance, basic education, senior high education or its equivalent and tertiary education attainments. The study found that, about 20% of the respondents had basic education, 35% had tertiary education, 50% had senior high education and 5% had never attended formal school in their life. The 2010 population and housing census reports that, about 44.6% of Ghanaians have attained education below middle school living certificate (MSLC) or Basic Education Certificate Examination (BECE). The document further mentioned that, while about 21% had attained MSLC/BECE, only about 14.7% have acquired Senior High School (SHS) or Tertiary Education. Therefore the results of the current study is contrary to the national educational attainment statistics data.

The occupational category of the respondents was analysed. The categories were either the respondent was in formal occupation or informal occupation. The formal occupational

categories comprised of those in government paid jobs and the informal category encompasses those in self-employment. It was noted that, greater percentages of the respondents (53%) were in the informal occupation category as shown on Table 4.1. Equally, the employment status in Ghana indicates that, majority (64.8%) of the population are in the informal sector while about 18.2% are in formal employment (Population and Housing Census, 2010). The results of the current study therefore tallies with the national data. The study further noted that, the occupational type of respondents were Teaching, Matrons, Trading, Mechanics, Security work, students and few others not working. The traders accounted for greater percentage of the respondents.

## 4.2 Status of Fruits and Watermelon Seeds in Ghana

### 4.2.1 Awareness of Uses of Fruit Seeds

About 70 % of the respondents asserted that, they are aware fruit seeds are useful as shown Table 4.2. Slavin and Lloyd (2012), discuss how fruits seed have been universally promoted as healthy. According to the authors, the usefulness of fruit seed have been documented by the Dietary Guidelines for America 2010. Therefore fruits seed have been held up as very useful due to the numerous concentration of vitamins, mineral, electrolytes, phytochemicals and antioxidants.

**Table 4.2 Awareness of Respondents on the Uses of Fruit Seeds in Ghana.**

| Category | Freq | Percentage (%) |
|---|---|---|
| People who are aware fruit seeds are useful | 35 | 70 |
| People who are not aware fruits seeds are useful | 10 | 20 |
| Not Sure | 5 | 10 |
| Total | 50 | 100 |

**Source:** Field Data, 2018.

### 4.2.2 Status of Uses of Fruits Seeds in Ghana

An enquiry into the uses of fruit seed shown that, about 50 % of the respondents have use fruit seed before as shown on the Table 4.3. The International Tropical Network (2010) has mentioned that close to about 80 % of the global population has used fruit seed either as food or as medicinal. The importance of fruit seed to the health is therefore noted. Among such fruit seeds are the African Oil Bean**,** Prekese (*Tetrapleura tetraptera*) and the African Mango ***(****Irvingia gabonensis*)

**Table 4.3 Respondents who have actually used fruits in Ghana**

| Category | Freq | Percentage |
|---|---|---|
| Respondents who have used fruits seeds before | 25 | 50 |
| Respondents who have not used fruits seeds before | 15 | 30 |
| Not Sure | 10 | 20 |
| Total | 50 | 100 |

**Source:** Field Data, 2018.

### 4.2.3 Specific Food Items Developed from Fruit Seeds

The studies revealed that, quite a number of people have used specific seed to develop various products as shown on Table 4.4. About 15 respondents used orange seed for medicinal purposes, 25 respondents used pawpaw seed for medicinal purposes, 14 respondents used watermelon seed for both medicinal and as food while 12 respondents used guava for medicinal purposes. Among the medicinal purpose for using the fruit seeds were for correcting skin infections, ulcers, deworming and boosting appetite. The International Tropical Network (2010) has mentioned that, the African Oil Bean seed in the pod is edible. According to them, the seeds are prepared as a fermented snack called ‘ugba’. The seeds are made up of about 44% protein with all 20 essential amino acids, which are ideal substitutes

for areas with limited meat supply. The seeds also contain essential fatty acids and minerals like magnesium, iron, manganese, copper, phosphorous, and calcium.

Similarly, the African Mango seed (*Irvingia gabonensis*) has been cited as containing high fiber content that aid in reducing cholesterol from the body. Evidence-based research has revealed that, a study published in the journal of Lipids in Health and Disease (2008) evaluated the effects of African mango seed capsules on weight loss in overweight and obese human subjects. The result was that, the seed of the African Mango reduces weight when consumed.

**Table 4.4 Typology of Items Developed from Fruit Seeds**

| **Fruit Seed** | **No. of People Who have used specific fruit seed for specific item** | | | **Fruit Seed was used for** |
|---|---|---|---|---|
| Orange Seed | | 15 | | -Medicinal |
| Pawpaw Seed | | | 25 | -Medicinal |
| Watermelon Seed | | 14 | | -Medicinal<br>-Food Product (Soup, Roasted, Brittle) |
| Guava Seed | | 12 | | -Medicinal |
| Apple Seed | 4 | | | -Medicinal |

**Source:** Field Data, 2018.

The current study found that, about 70% of fruit seeds are used for medicinal purposes rather than food products.

### 4.2.4 Fruit Seeds and Health Outcomes

Again 39 (78 %) of the respondents agreed that, the use of fruits seeds contribute positively to the health outcome of people. This is shown on Table 4.5. Equally, studies have found a positive association between fruit seed consumption and health outcomes. For instance, it has been established that, Chia seeds, which are often used in yogurt, homemade trail mixes, baked goods, commercial nutrition bars, beverages and snacks are high in omega-3 fatty

acids, calcium, phytonutrients, vitamins, minerals and antioxidants (Huffman, 2015). According to the same Author, a Canadian study has also linked eating ground whole flaxseed to lowering blood cholesterol. Flaxseeds are good source of protein, fiber, antioxidants, and phytoestrogens in the form of lignans and omega-3 fatty acids. Therefore essential steps to a healthy diet may be mostly foods derived from plants. More than half of the respondents agreed that fruits seeds may contribute to the health outcomes of people.

**Table 4.5: Contribution of Fruits Seeds to the Health Outcome of People in Ghana**

| Fruits Seeds and Health Outcome | Freq. | % |
|---|---|---|
| Agree Fruits Seed Contribute to the Health Outcome of People | 39 | 78 |
| Strongly Agree Fruits Seeds Contribute to the Health Outcome of People | 11 | 22 |
| Total | 50 | 100 |

**Source:** Field Data, 2018.

### 4.2.5 Awareness of Developing Edible Product from Watermelon Seed

Respondents were asked of their awareness of the usage of watermelon seed in preparing an edible product. It was found that, 33 (66 %) of the respondents signed up that, watermelon seeds are useful. They asserted that, the seeds are either used as food or for medicinal. According to the respondents, they are aware watermelon seeds contains many vitamins and mineral salts that they may not be able to mention as lay persons. A study has established that, watermelon seeds are packed with nutrients including fatty acids, essential proteins and lots of minerals. The study further revealed that, Around 100 gram of watermelon seeds provide around 600 calories same as having 10 loaves of bread. Around 400 calories come from fats in watermelon seeds. Fat content in 100 gram of watermelon seeds is around 80% of daily dietary requirement of fats. Around one third of watermelon seeds is proteins,

mainly highly essential proteins like lysine (Ameesh, 2016). These findings are therefore in accordance with the previous findings of Mabaleha et al., (2007) who also reported the potential edible uses of watermelon seed.

**Table 4.6: Awareness of Developing Edible Product from Watermelon Seeds**

| Watermelon Seed Status | Freq. | Percentage (%) |
|---|---|---|
| Watermelon Seeds are edible | 33 | 66 |
| Watermelon Seeds are not edible | 10 | 20 |
| Can't tell | 7 | 14 |
| Total | 50 | 100 |

**Source:** Field Data, 2018.

### 4.2.6: Usage of Watermelon Seeds to Prepare Products for Consumption

As a follow up to the above, watermelon seed was singled out. An enquiry as to whether watermelon seed has been used to prepare a product for consumption, about 37 of the respondents have never used watermelon seed to prepare any food products. The 13 respondents who claim to have used watermelon seeds asserted they produce tea, medicine and brittle.

**Table 4.7: Ever Used Watermelon Seed to Prepare any Product for Consumption**

| Category | Freq. | Percentage (%) |
|---|---|---|
| Respondents who have used watermelon seed before | 13 | 26 |
| Respondents who have not used watermelon seed before | 37 | 74 |
| Total | 50 | 100 |

**Source:** Field Data, 2018.

However, of the 37 (74 %) respondents who have not used the watermelon seed to prepare a product for consumption before, 33 of them believed watermelon seeds can be used to develop other products. Truly, their assertion was confirmed by the report of Noor et al. (2015) who disclosed that, watermelon seeds oil is used for soap, cosmetics, foam and firing of industrial boilers that are used in animal feed formulation.

### 4.2.7 Food Product that Use Watermelon Seeds as Raw Material

Respondents were asked to identify one food products that is prepared from watermelon seeds. It was revealed that, 20 (40%) of the respondents identified that brittle is made from watermelon seed as shown on Figure 1. Respondents revealed that, watermelon seed can be used to develop watermelon seed tea, watermelon seed soup and roasted watermelon. Equally, other studies have revealed that, watermelon seeds can be used for watermelon seed protein bars, watermelon seed granola, watermelon seed snacks, watermelon seed flour, watermelon seed cooking oil and oil for production of cosmetics (Tabiri et al.2016; Ziyada, & Elhussien, 2008; Taiwo et al. 2008).

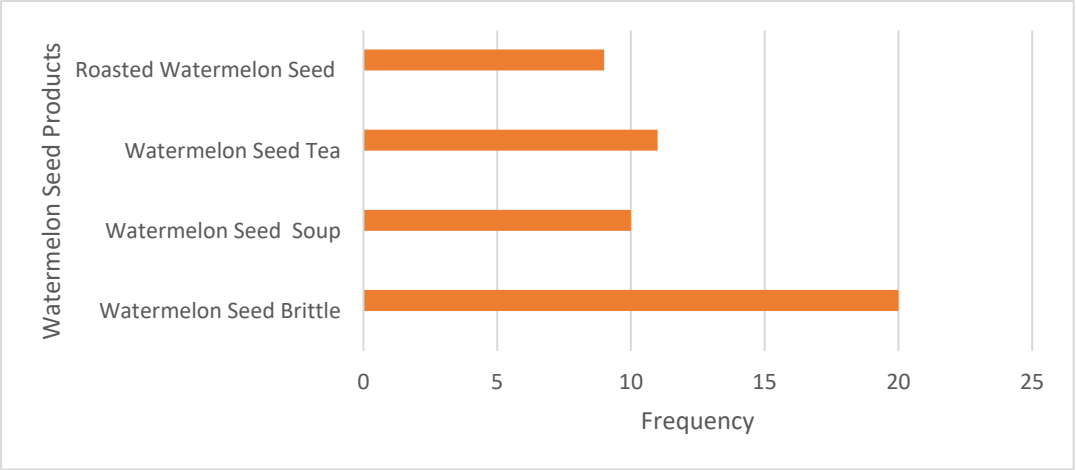


**Figure 4.1: Percentage of People Who Identified At least One Product made from Watermelon Seeds**

**Source:** Field Data, 2018.

### 4.3 Development of Watermelon Seed Brittle, Mixed Watermelon Seed and Groundnut Brittle and Groundnut Brittle

From the Figure 1 above, it was noted that, greater number of the respondents mentioned watermelon brittle. In order to make comparison in sensory analysis, three products were developed. These are watermelon seed brittle, mixed watermelon seed and groundnut brittle and groundnut brittle. Panel was formed to assess the sensory characteristics of each product. After this, the respondents were also made to taste and comment on the sensory. Samples of the products are shown below:

**Plate 4.1 Sample of Watermelon Seed Brittle**
**Source:** Field Data, 2018

**Plate 4.2 Samples of Mixed Watermelon Seed and Groundnut Brittle**
**Source:** Field Data, 2018

**Plate 4.3 Samples of Groundnut Brittle**
**Source:** Field Data, 2018

## 4.4 Sensory Comparison of Brittles made from only Watermelon Seed and Brittle made from Mixture of Watermelon Seed and Groundnut

The respondents were also made to taste the three products and assess the sensory characteristics made on the hedonic rating scales of points 9-1

**Table 4.8 Comparison of Sensory Characteristic by Respondents**

| **Type of Brittle** | **Colour** (Visual system) Average Score | **Appearance** (Visual system) Average Score | **Taste** (Gustatory system) Average Score | **Flavour** (Olfactory System) Average Score | **Texture** (Tactile & auditory system) Average Score | **Overall Acceptability** |
|---|---|---|---|---|---|---|
| TC-1 | 6.5 | 6.2 | 7.6 | 7.1 | 8.1 | **35.5** |
| DA-1 | 6.2 | 5.7 | 7.4 | 7.6 | 6.3 | **33.2** |
| BC-1 | 7.2 | 6.7 | 7.9 | 8.4 | 5.9 | **36.1** |

**Source:** Field Data, 2018.

TC-1= Watermelon seed brittle
DA-1= Mixed watermelon seed and groundnut brittle
BC-1= Groundnut brittle

The overall acceptability results in Table 4.8 shows that, respondents liked groundnut brittle most (36.1) and closely followed by watermelon seed brittle (35.5). In general, the respondent mentioned that, there were not much differences between the three products.

### 4.5 Reasons for Sensory Score of the three Products by Respondents

Respondents assigned various reasons for the sensory score of each of the three products under comparison. From the table below, respondents assessed the colour, appearance, taste, flavour and texture. The respondents asserted that, the colour of groundnut brittle is brighter than the other two products. They also mentioned that, watermelon brittle has good flavour and very fibrous. Others also mentioned that, the texture of watermelon brittle was hard when chewing. In terms of appearance, respondents mentioned that, the groundnut brittle has thee brightest colour. These are shown on Table 4.9.

**Table 4.9 Reasons for Sensory Score of the three Products**

| Type of Brittle | Colour | Appearance | Taste | Flavour | Texture |
|---|---|---|---|---|---|
| **Watermelon seed brittle** | *Darker than groundnut brittle<br>*Not bright like groundnut | *A bit shinny<br>* attractive | *Taste not so much good like groundnut brittle<br>* | *Has a good flavour | *Very fibrous<br><br>*Takes a bit of effort during mastication for the brittle to be soft in the mouth |
| **Watermelon seed and groundnut mix brittle** | *Mixed colours seen<br>*A bit darker than groundnut brittle | *Not shinny<br>*Less attractive | *Taste not so much good like groundnut brittle | * Has a good flavour | *Not so much fibrous |
| **Groundnut brittle** | *Colour brighter than the two other products | * Very shinny<br>* Very attractive | * Taste so sweet | * Has very good flavour than the two other products | *Not fibrous<br>* Very gummy when chewing |

**Source:** Field Data, 2018.

### 4.6: Sensory Evaluation of Watermelon Seed Brittle from the Perspectives of Respondents

The study then focused on assessing the sensory score of watermelon seed brittle alone based on the texture, the flavour, the taste, the sight appreciation and among others. On tasting watermelon seed brittle, respondents were asked to choose one sensory quality they like about the product. Figure 4.6 illustrates the sensory score of watermelon seed brittle. In assessing the sensory characteristics of watermelon seed brittle, it was noticed that, the texture was the highest (26%) as shown in Figure 4.6. Respondent mentioned that, the watermelon brittle was tough in masticating and takes a bit of efforts in becoming soft when chewing.

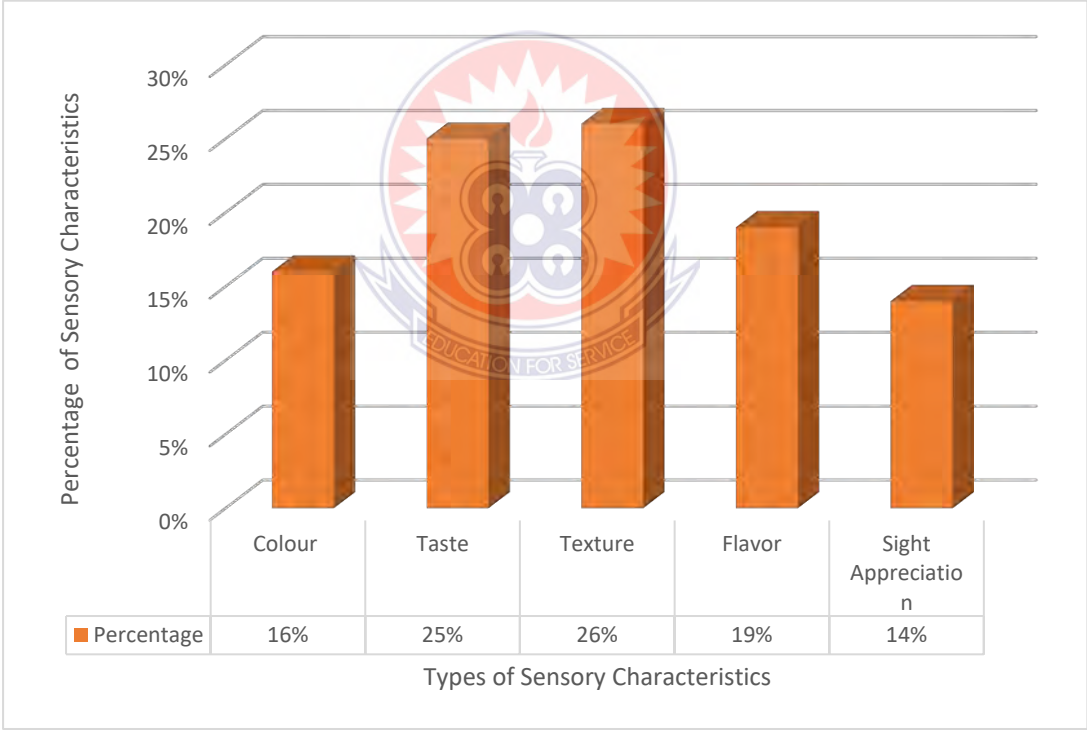


**Figure 4.2: Nature of Sensory Characteristics of Watermelon Seed Brittle**

**Source:** Field Data, 2018

The qualitative impression of the respondents were also assessed. Respondents gave many reasons for their score of sensory characteristics of watermelon seed brittle. Among the comments were:

> ‘*The watermelon seed brittle is hard, the colour is appealing and appetizing. The flavour to me is better than groundnut brittle. It’s very nice and I wish I knew how to prepare it……* ***{Respondent 4_Female_Tanoso_Kumasi}***
>
> *‘In terms of colour, it is very appealing, shining and looks like groundnut brittle….. {Respondent 2_Male_ Kwadaso_Kumasi}*
>
> *Wow! That is nice. You made it? I like the texture. It is very nice and smells good. Hhmmmmm. We have food products in Ghana oooo, my Sister. People eat watermelon and throw the seed away just like that. The Whiteman does not waste food resources like us’……..* ***{Respondent 7_Female_Tanoso_Kumasi}***

# CHAPTER FIVE

# MAJOR FINDINGS, CONCLUSION AND RECOMMENDATIONS

## 5.0 Introduction

This chapter is divided into three sections. The first section highlights the major findings based on the objectives of the study. The second section focuses on the conclusions drawn from the study. The final section gives the various recommendations meriting the findings of the study.

## 5.1 Major findings

- The average age of the respondent were 31years.
- The age cohort 34-45years dominated the interviews.
- 40 out of the 50 respondents were of the females.
- About 70% of the respondents were married.
- About 80% of the respondents were Christians.
- The study found that about 50% of respondents have completed SHS.
- About 70% of the respondents were Akans.
- About 53% of the respondents were in the informal sector category and traders (16) formed the highest.
- 70% of the respondents asserted that, they were aware of the use of fruit seed for other products.
- 50% of the people asserted they have actually used fruit seeds before.
- Respondents asserted that, the fruit seeds were used as medicinal and to prepare food product.

- About 70% of the respondents agreed that, the fruit seeds contribute positively to health outcome of people.
- 33 out of the 50 respondents are aware that, watermelon seed can be used to develop edible products.
- 37 out of the 50 respondents said they have not used watermelon seed before
- About 40% of the respondent were able to mention that, watermelon seed can be used for brittle.
- Respondents appreciated the watermelon seed brittle so much
- The texture of Watermelon seed brittle was adjudged to be the highest sensory quality.
- About 66% of the respondents had positive perception before tasting watermelon seed brittle.
- About 82% of the respondents were impressed about the watermelon seed brittle.
- The respondents stated that, the sensory characteristics (colour, taste, flavour, texture) were better in watermelon seed brittle than brittle made from mixture of watermelon seed and groundnut.
- In overall acceptability by the panel, groundnut brittle was the most liked product, followed by watermelon brittle. Equally, the respondents also liked groundnut brittle more than the watermelon seed brittle and the mixed watermelon seed and groundnut brittle.

## 5.2 Conclusion

The study noted that, greater numbers of people are aware of the use of watermelon seeds.

However, only few people had actually used water melon seeds to prepare a product before. The sensory analysis by the respondents showed that, groundnut brittle is the most liked product. The 2nd most liked product is watermelon seed brittle. The overall acceptability ratings for groundnut brittle and watermelon seed brittle by the respondents were too close portraying that, respondents did not notice much differences between the two products. However, there was a bit of sensory differences of mixed groundnut and watermelon seed brittle from the other two products. Even though the two products aside the groundnut brittle were not known to the public, they were accepted as very good in terms of taste, flavour, appearance, texture and colour. The acceptability of the watermelon seed brittle was also noticed by the nature of comments given by respondents after the qualitative analysis.

## 5.3 Recommendations

The study recommended the following:

1. Watermelon seed products should be made known to people through education. It is believed that, the product will be patronised if education is high.
2. The nutritional and health benefits of watermelon should be made known.
3. Training should be offered for people to learn how to make the watermelon seed products. This may serve as income generating activity for a section of the population.
4. Watermelon seed products should be recommended for consumption because of its nutritional values.

5. For those who would want to produce watermelon seed on larger scale and for lack of capital, producer co-operatives societies can be formed and soft loans advanced to them to commence production.

### 5.4 Areas for Further Studies

It is recommended that further studies should be carried on nutritional analysis, microbial analysis and the shelf life of watermelon seed brittle.

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## APPENDIX A: Sample Questionnaire (Semi-Structured)

**UNIVERSITY COLLEGE OF EDUCATION**
**DEPARTMENT OF CATERING AND HOSPITALITY MANAGEMENT**
**MTEC CATERING AND HOSPITALITY**

**TOPIC: ASSESSING CONSUMER ACCEPTABILITY OF WATERMELON SEED BRITTLE**

**Households Semi-Structured Questionnaire**

I am a student of University College of Education pursuing Mtech (Catering and Hospitality). This questionnaire is intended to collect data on awareness of uses of fruit seeds, and watermelon seeds in particular for my MTech Thesis. I would be grateful if you could spend a few minutes with me to answer the questions below.

The Questionnaire covers the three (3) objectives of the study as stated below:

1. To ascertain people's awareness of the use of watermelon seeds.
2. To develop watermelon seed brittle.
3. To ascertain consumer acceptability of watermelon seed brittle.

**- SECTION A: Bio- Data**

**SECTION 1: DEMOGRAPHIC CHARACTERISTICS OF RESPONDENTS**

1. Name of the Community……
2. Respondent Code: [ ][ ]
3. Telephone Number of Respondent [ ][ ][ ][ ][ ][ ][ ][ ][ ][ ]
4. Current Occupation……..
5. Employer:……
6. Years of employment:…….
7. Fruit Seller [ ] Yes [ ] No

| 8 Gender | 9. Place of Birth | 10. Age | 11 Marital Status | 12. Religious Affiliation | 13 Ethnicity | 14. Level of Education | 15. Ability to read and write | 16. Occupational status |
|---|---|---|---|---|---|---|---|---|
| 1=Male 2= Female | | | 1=Married 2=Separated 3=Divorced 4.Widowed | 1=Christian 2=Moslem 3=Traditional | 1=Akan 2=Ga 3=Northerner 4=Others…. | 1=None 2=Basic 3=SHS 4=Tertiary | 1=Yes 2=No | 1=Formal Specify work …… 2=Informal Specify work ……... |

**Status of Fruits and Watermelon Seeds in Ghana**

17. Are you are fruit seeds can be used for something?

( ) I am aware

( ) I am not aware

18. Have you used fruit seed before for anything?

( ) I have used fruit seed before

( ) I have not used fruit seeds before.

**Specific Items Developed from Fruit Seeds**

19. Mentioned what you used the following Fruit Seeds for?

| **Fruit Seed** | **No of People Who have used specific fruit seed for specific item** | | | **Fruit Seed was used for** |
|---|---|---|---|---|
| | Less than 10 respondents | Between 11-20 respondents | Over 21 respondents | |
| Orange Seed | | | | |
| Pawpaw Seed | | | | |
| Watermelon Seed | | | | |
| Guava Seed | | | | |
| Apple Seed | | | | |

20. Do you agree that fruit seeds contribute to health outcome of people?

( ) I Agree ( ) I Strongly Agree ( ) Neutral ( ) I don't Agree

21. What are some of the health benefits of fruit seeds?

……
……..

**Awareness of Developing Edible Product from Watermelon Seed**

22. Are you aware watermelon fruit seed can be used for something edible?

( ) Watermelon Seeds can be used for something edible.
( ) Watermelon Seeds can be used for something edible.

23: Have you used watermelon seed for before for anything edible (internal) or anything not edible (external)?

( ) I have used watermelon seeds for something edible (internal) or anything not edible (External)?

( ) I have used watermelon seeds for something edible (internal) or anything not edible (External)?

24. Mention some products that can be prepared from watermelon seeds

1…… 2…… 3…….. 4…….

25. Can you identify which of these products (Researcher shows sample to respondents) that has been developed from watermelon seed products?.....

26. What are the possible health benefits of watermelon seeds?

……
……..
……

27. What else can you can you say about the uses of watermelon seed?

……
……

28. What recommendations can you make in relation to the watermelon seed products study?.....

THE END

## APPENDIX A: Sample Questionnaire (Semi-Structured)

**UNIVERSITY COLLEGE OF EDUCATION**
**DEPARTMENT OF CATERING AND HOSPITALITY MANAGEMENT**
**MTEC CATERING AND HOSPITALITY**

**Assessment of Sensory Characteristics (Panellist and Respondents)**

**TOPIC: ASSESSING CONSUMER ACCEPTABILITY OF WATERMELON SEED BRITTLE**

1 Describe the sensory characteristics of each of the products

- Watermelon seed brittle (TC-1)
  ……
  ……..
  ……..
- Mixture of watermelon seed and groundnut seed brittle (DA-1)
  ……..
  ……
  ……..
- Mixture of watermelon seed and groundnut seed brittle (BC-1)
  ……
  ……

2. Did you have any perception about watermelon seed product?

( ) Yes I had perception

( ) No. I did not have any perception

3. Are you impressed about watermelon seed brittle after tasting it?

( ) I am impressed

( ) I am not impressed

4. After tasting the mixture of watermelon seed and groundnut seed brittle, please make a comparative sensory characteristics of these two products' below using these Hendonic rating scales /scores:

Liked extremely 9/ Liked very much 8/ Liked moderately 7/ Liked slightly 6/ Neither liked nor disliked 5/ Disliked slightly 4/ Disliked moderately 3/ Disliked very much 2/ Disliked extremely 1

| | Colour | Appearance | Taste | Flavour | Texture | Overall Acceptability |
|---|---|---|---|---|---|---|
| TC-1 | | | | | | |
| DA-1 | | | | | | |
| BC-1 | | | | | | |

Where TC-1=Watermelon Brittle, DA-1=Mixed watermelon seed and Groundnut Brittle, BC-1= Groundnut Brittle

5. What are the reasons for the scoring of each sensory characteristics above?.
…….
……

6. What are the possible health benefits of watermelon seeds?
……
……..
……

7. What else can you can you say about the uses of watermelon seed?

……
……

8. What recommendations can you make in relation to the watermelon seed products study?.....

THE END