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QUALITY CHARACTERISTICS OF SESAME SEED SPREAD

CHRISTINA ABI ATINGAH

(200026497)

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DECLARATION

Student's Declaration

I, **CHRISTINA ABI ATINGAH**, declare that this thesis with the exception of quotations and references contained in published works which have all been identified and duly acknowledged, is entirely my own original work, and it has not been submitted, either in part or whole, for another degree elsewhere.

Signature:.....

Date: .....

Supervisor's Declaration

I hereby declare that the preparation and presentation of this thesis was supervised in accordance with the guidelines for supervision of thesis as laid down by the University of Education, Winneba.

NAME OF SUPERVISOR: DR. GILBERT OWIAH SAMPSON

Signature: .....

Date:.....

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DEDICATION

This work is dedicated to the Almighty God and my mother MRS RUTH INGBING ALEBNA ATINGAH

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ABSTRACT

Sesame is recognized as one of the most important and oldest oil seed plants in the world and provides many nutrients to humans. Honey is one of the most digestible foods and contains a variety of nutritionally important balance factors. Most of the spreads used in the Ghanaian context are peanuts, butter and jam. However, despite the nutritional and health benefits of sesame, less attention has been paid to the use of sesame in the production of spreads. A study aimed at developing a recipe for making spreads from a mixture of sesame and honey was conducted. Water, ash, protein, fat, fiber, carbohydrates, free fatty acids, and total sugar were measured using standard methods. Sensory evaluation and shelf life analysis were also determined. In this study, five different variations of the sesame honey blend were created. According to the results of the study, the moisture content of the spread sample ranged from 3.64 + 0.01 to 6.87 + 0.12. The ash content of the spread samples ranges from 2.42 + 0.09 to 4.63 + 0.29 g / ml. The protein content varies from 9.64 + 0.04 to 16.47 + 1.60 g / ml. The fat content in the spread was found to be between 39.9 + 0.19 and 66.87 + 0.51 g / ml. The fiber content of the spread samples in this study ranged between 4.40 + 0.54 and 5.78 + 1.39 g / ml. Studies show that the carbohydrate content ranges from 2.61 + 0.85 to 39.9 + 0.20 g / ml. Sample ABC had the highest free fatty acid content and EFG had the highest total sugars. The HIZ sample (60g sesame seeds, 40g honey, 15 minute bake) was rated the highest in terms of ease. BDD (80g sesame seeds, 20g honey, 15 minute roast time) has the highest rating for spreadability. CFG (70g sesame seeds, 30g honey, 15 minute roast) has the highest rating for aroma, texture, smoothness, and general acceptance. No E. coli, Esure reis, or Salmonella typhi were found in the samples. However, total viable counts, total coliform counts, fermentation and mold were found, the number of which increased after 8 weeks of storage. Samples stored under refrigerated conditions had fewer microbes than those stored under ambient conditions. The study concludes that the ABC sample (90 g of sesame seeds, 10 g of honey, 15 minutes roast) has the lowest moisture and carbohydrate content.

CHAPTER ONE

INTRODUCTION

1.1 Background of the Study

Sesame (Basil Indicum L), usually identified as sesamum or benniseed, which is part of the pedicel family, is the most popular oil crop for humans. According to Germo et al., (2015), sesame plays a significant part in human nourishment. Sesame seeds are known as the most important and oldest basil crop in the world which provides many nutrients to mankind. It is a higher priced seed than popular bagged pulses such as soybean, rapeseed, canola, sunflower seeds and cotton seeds (Jeremy et al., 2012). The chemical composition of sesame indicates that the oil (44-58%), protein (18-25%), carbohydrates (13.5%) and ash (5%) in the seeds (Burchani et al., 2010) Included). Sesame seeds contain about 50% oil (35% monosaturated fatty acids and 44% polysaccharide fatty acids) and 45% food (containing 20% protein) (Gandhi, 2009; Hansen, 2011). Vegetable, sesame index is a crop of edible oil seeds. It is commonly called the "Queen of Oil Seeds" because of its high quality ethics. Sesame seeds are considered to be the most important oil substance in sesame crops in terms of shell nuts and soybeans and 50 to 60% oil (Ashri, 1998).

Oilseeds are known for their stability because they reverse oxidative volatility after prolonged contact with air. (Global Agri Systems, 2010). The oil section appears surprisingly solid for oxidation. This can be attributed to endogenous cancer prevention agents, particularly lignins and tocopherols (Ellech et al., 2007; Lee et al., 2008). The seed is sufficient in protein which provides good health to mankind compared to soy (NAERLS, 2010). In Ghana, the harvest is developing in some parts of northern Ghana, but production is declining due to low yields. The use of low-yielding local varieties by farmers is mainly responsible for this drift (FAOSTAT, 2000).

Sesame has been developed and stored in most African countries, including Ghana, that is, the three countries bordering Burkina Faso, Togo and the Ivory Coast (FAOSTAT, 2000). Information on the development and use of sesame in Ghana is insufficient until recently. The crop is not commercially developed within the country and is considered an exotic crop (FAOSTAT, 2000). Ghanaian farmers, due to mistrust or incompetence, regularly offer insignificant plots of their farmland to exotic crops, of which sunflower is an important case, and commercial development of sesame in Ghana is expected to increase. Currently, it is developed as a subsistence crop in the north of the country with its leaves or seeds cooked for food.

Honey is one of the easy-to-digest foods and is made up of several nutritionally important balancing elements. In addition to its high sugar content, there are also organic acids, amino acids, minerals, colorants, aromatics, and small amounts of fat (Redtke and Hadtke, 1998; Bogdanov et al., 1998). Honey contains very important unstable compounds such as enzymes, substances with hormonal properties, some vitamins and inappropriate insignificant compounds (Yilmaz and Yavuz, 1999; Qiu et al., 1999).). Honey from bees is a natural product, ingested for its wide range of nutritional value and its impact on humans, and has anti-inflammatory, antibacterial, antifungal, antiviral effects, as well as wound and burn healing (Alvarez-Suarez). al., 2010). Regarding its nutrient profile, it incorporates an interesting source of macronutrients and micronutrients, including saturated solutions of sugars in which fructose and glucose are important factors (Bogdanov, 2008).

Honey also contains enzymes, amino acids, vitamins, proteins, and minerals (Alvarez-Suarez et al., 2010). Today, honey is commonly used in foods, dietary supplements, and medicines known throughout the world, but compared to its use, the responsiveness of its function is

recognized in all regions. The combination of sesame and honey can help supplement other nutrients that may be less or less spread. In view of this, current research has been conducted to develop standard recipes for the production of spreads based on sesame and honey mixtures. Nevertheless, due to difficulties in coping with peanut production, including inadequate knowledge, the use of inferior raw materials has affected product quality and shelf life, as well as the general quality and safety of these foods (Mukantwali, 2014). It is against this background that the present study aims to evaluate the use of sesame seeds and other ingredients in the preparation of preaching.

1.2 Statement of the Problem

The periodic increase in population growth has definitely led to increased demand for food and increased consumption globally. Nowadays there is an increase in nutritional awareness, so buyers need a spread to meet their needs, but with better quality. This development has necessitated the study, development and production of alternative compound spreads from locally sourced staple crops to supplement the nutritional benefits of the spreads available in the market. The importance of sesame and honey in the production of spreads cannot be reduced because of their nutritional and health benefits. According to Kanu et al. (2007), these foods are a good source of protein, complex carbohydrates, and certain minerals that help reduce chronic diseases such as cancer, diabetes, and coronary artery disease (Maguire, 2004; Kanu et al., 2007). Most spreads used in the case of Ghana are peanuts, butter and jam. However, the use of sesame seeds for dispersal production has not received much attention despite its nutritional and health benefits. There are no obvious signs of mold in potentially contaminated peanut butter, so it cannot be said if the pieces used for propagation are damaged by mold or insects (Samuel et al., 2016). These problems are a real joy because of the high risk of microbial, physical and synthetic contamination during cooking, which does

not require proper control. These pollution problems can cause real medical problems for consumers.

1.3 Objectives of the study

1.3.1 Main Objective

The main aim of the study was to evaluate the quality characteristics of sesame seed spread.

1.3.2 Specific Objectives

The specific objectives of the current study were:

1. To determine the proximate composition of spread produced from sesame and honey.
2. To determine the free fatty acid and sugar content of the spreads
3. To analyse the sensory properties of the spreads.
4. To determine the shelf life of the spreads using microbial indicators.

1.4 Research questions

The study seeks out to answer the following questions:

1. What is the proximate composition of spread produced from sesame and honey?
2. What are the free fatty acid and sugar content of the spreads?
3. What are the sensory responses of the spreads?
4. What is the shelf life of the spreads produced?

1.5 Significance of the Study

The economy of any country, including Ghana, which imports jams, margarines and other fruits to spread, will improve if other staple foods, such as sesame seeds, are grown locally for food production. Therefore, efforts are being made to prepare spreads using sesame as an opportunity to increase the use of local crops grown in Ghana and equally contribute to

reducing the cost of spreads (Ayoola and Adeyeye, 2010). The development of sesame spread will increase the overall consumption of the spread in the country by offering consumers competitive products as well as improving the quality of the products offered.

CHAPTER TWO

LITERATURE REVIEW

2.1 The Biology of Sesame Crop

2.2 Composition and Nutritional quality of Sesame Seed

Sesame is a self-pollinating plant that has bulging, healthy, branched stems with a height of 0.60 to 1.20 m. Its leaves are spread or intertwined, but the lower leaves are triangular, sometimes triangular, and the upper leaves are seamless, unexpectedly serrated and pointed (Felter and Lloyd, 1898: Morris, 2002). The flowers form tubular, sagging, chimes, ranging from 1.9-2.5 cm with two pale purple or white roses. The flowers grow on short glandular stems, with flowers forming on the axis of each leaf, and the lower flowers are usually sprayed continuously for 2-3 months, mostly from top Moris (2002) and Garemu et al., (2016), Fruits are oval, radish, adolescent capsules, containing a variety of small, oval, yellow, white, reddish, brown, or dark seeds.

The natural composition and nutritional quality of sesame depend on several factors, such as the variety, origin, colour and size of the seed. Research by Hwang (2005) suggests that sesame seed is rich in fat and protein. In his research, he suggested that the fat content of sesame was around 50%, while the protein and ash components were 25% and 5%, respectively. Also, there is a variable amount of fiber and carbohydrates. Another analysis of the characterization and dynamics of oil degradation, seedling 5.7% humidity, 20% crude protein, 3.7% ash, 3.2% crude fiber and 54% fat, in the middle of heating seeds and oil (Sesamum indicum L.) Nzikou et al. 13.4% carbohydrates. The study recommends that the seeds are a decent spring of minerals, of which potassium is recorded as the most significant, after that magnesium, calcium and sodium come next.

According to research, the physical properties of the oil are improved at room temperature. High levels of unsaturated fatty acids were found in the oil, especially oleic (up to 38.84%) and linoleic (up to 46.26%). The seeds contained about 50% oil (35% of which are monounsaturated fatty acids and 44% polyunsaturated fatty acids and 45% from the diet (Ghandi, 2009; Hansen, 2011). A transitory movement appeared to oxidation of oil partition. Tocopherol (Yoshida et al., 1995; Abo-Gharbait al., 2000) can be well credited as endogenous cancer prevention agents (lignans). A study by L. Khiaret et al., (2008) of white mole seed (L. indicated from S. Sudan), provides more evidence of proximal composition, with fat as 52.24%, protein 25.97%, fiber 19.33% and ashes, 4.69 %.

The most mineral composition is potassium, magnesium and phosphorus followed by calcium. Other components were exhibited in lower concentrations. Similarly, Makinde and Akinoso (2014) found that the range of adjacent proteins was 15.4 to 26.5 g / 100 g, fat 52.4 to 62.8 g / 100 g, crude Fiber expanded to 3.34-3.89 g / 100 g, ash 3. 93- 6.78 g / 100 g, carbohydrates 11.7-13.4 g / 100 g and energy value 550.7- 593.7 kcal / g. Mineral composition of the seeds in comparison, calcium was considered the highest mineral after phosphorus, magnesium and potassium. Essential amino acids were found to be within the range of 26.66 to 32.73 mg / 100 g and these values exceeded the requirements of the FAO / WHO diet for new-borns and older. Sesame is uniquely named Queen of Oilseed Crop because of its rich oiliness, tenderness and appetizing taste (Johnson et al., 1979). Ogbonna and Ukaan (2013) elaborates on the major differences between sesame chemical composition and oil quality. The range of iodine peroxide, acidity, and free fatty acids ranged from 76.14 to 130.07 g / 100 g, 1.01 to 7.61 MAC (H2O2), 0.67 to 2.85 mg / g, and 0.34 to 1.43 mg / g, respectively.

2.3 Significance and Health Benefits of Sesame Seeds

Many seeds have been shown to have enormous health benefits and sesame seeds are no exception. Numerous studies have shown the beneficial health properties of sesame. This is consistent with Katsuzakiet et al., (1994), sesame contains essential fatty acids (EFAs) such as linoleic acid and is rich in lignans. Sesame is also recognized as an excellent source of B vitamins such as niacin, folate, thiamine (vitamin B1), pyridoxine (vitamin B6), and riboflavin. Additionally, the seeds are exceptionally rich in minerals such as calcium, iron, manganese, zinc, magnesium, selenium, and copper in concentrated amounts. Most of these minerals are essential for bone mineralization, red blood cell generation, enzyme synthesis, hormone generation, and cardiac and skeletal muscle exercise production. Furthermore, it has been recognized that the seed is rich in monounsaturated fatty acids, such as oleic acid, which comprises almost 50% fatty acids.

These seeds are excellent spring of high-quality amino acid, which is critical for growth, especially in children. Tunde-Akintunde (2016) acknowledges that sesame seeds contain many beneficial health compounds, such as sesame and sesaminol, which are phenolic cancer prevention agents and help the body release dangerous free radicals.

Several health benefits of sesame have been recognized. Weight gain control, cardiovascular disease anticipation, aging safety, skin smoothing, and withdrawal from Alzheimer's disease and cancer are some of the known benefits. Sismine from sesame seeds has been detailed for its in vivo hypocholesterolemic action and movement of suppressive symptoms against chemically active cancers, human lipopolysaccharides and low-density lipoproteins (LDL). Researchers and health professionals have indicated that consuming or adding sesame seeds to food might lessen the danger of heart ailment (Kang et al., 1999). Sesame is best known as

a healthy nutritional aid, helping to reduce various dangers and dangers in people, such as hypertension, hypercholesterolemia, and atherosclerosis. Foods containing 200 g / kg mole appear to increase hepatic mitochondrial and peroxisomal fatty acid oxidation rates in mice. However, sesame flour slowed down the proteins involved in fatty acid amalgam such as fatty acid synthase, glucose-6-phosphate dehydrogenase, ATP-citrate lysis, and pyruvate kinase (Sireto-Yasumotoet et al, 2001). Gandhi, et al., (2009) explain that sesame seeds mixed with sesame seeds and peanut flour are as strong as skim milk in controlling clinical signs of a healthy sustenance deficiency. Supplemented with sesame protein, fish molasses. Sesame has a nutritional value as animal protein. Sesame flour mixed with green chickpea is used for the remedy of 'cuasiocore', which is found in new-borns between 1 and 4 years of age and is produced by insufficiency of proteins in diets. Phosphorus substance extended between (540 to 640 mg/100g) in all the cultivars examined. Phosphorus is required for bone development, kidney work and cell development. Phosphorus helps keep up the body's acid-alkaline regulation. The distance of those minerals conjointly supports the actual point that sesame seed contains dietary complements to customers.

2.4 Role of Sesame Seed in the Food Industry

In the food industry, sesame seeds are considered to be the most widely used and multi-purpose in the world (Vijjanands et al., 2007); the pertinent ones include:

2.4.1 Nutraceuticals and pharmaceutical uses

Sesame milk can be used as a nutritional benefit as well as a decorative substitute for certified ornamental sole seeds (Jihad et al, 2009). Is. Sesame seeds are a cancer-fighting agent and a health-promoting exercise (Nakai et al., 2003). When used in food preparation, sesame seeds increase plasma to coferol and improve vitamin E activity, which contributes to malignant growth and heart disease (Conney et al., 2001). Demonstrating its efficacy for meals and food

application, the sesame heat is stable and remains at 90% of the original level after baking. Total Phenolic Material (TPC), Trollox as Cancer Prevention Agent Limit, Free Radical Detection Limit, Low Fat Lipoprotein (LDL) Cholesterol Moderation and Metal Chelating Limit of Black and White Seeds Concentration and dissolution of its molds shows 80% extensive antioxidant activity Ethanol sesame food items, particularly black sesame seeds (Shahida et al., 2006) tested sesame products. The morbid choruses found in sesame seeds have the potential to inhibit malignant growth.

2.4.2 Medicinal properties and health concerns of Sesame seeds

For many years, spleen seeds have been used to lower or control cholesterol levels in humans. Fat metabolism is limited by the development of biochemical activity in both humans and animals by lignin sesame. Dietary sesamine and episphene have been shown to mitochondrial and peroxisomal unsaturated fat oxidation chemicals, such as carnitine palmethyl transferase, single-ca dehydrogenase, acyl-coa oxidase, 3-hydroxycase-quohydrogen What is it. ketoacyl-CoA thiolase which may lead to increased liver fat oxidation activity due to better production of ketone bodies. Alpha tocopherol, so to speak, complements the hypocholesterol activity of selenium. Sesame protects the liver from oxidative damage. It has been used to heal wounds since prehistoric times. It is antibacterial and antagonistic to infectious diseases of primary skin pathogens, such as Staphylococcus and Streptococcus and the organism of competitor's feet. It is against viruses and mitigation. In Ayurveda, the oil is used to treat some chronic diseases such as hepatitis, diabetes, and headaches. The analgesic process of sesame eggs has been experimented using a model of esteric acid stimulation in rats by Canal and Rocozinzaman (2009). Acidic acid causes Alzheimer's by releasing endogenous substances, which then triggers the nerve endings of pain (Raj, 1996) The development of malignant melanoma in vitro and the rupture of human

colon cancer cells in vitro melanoma and human colon Sesame oil inhibits the multiplication of disease cells (Smith and Salerno, 2001). It enters into the skin rapidly and enters the circulatory system through the vessels.

2.4.3 Food and modern application of sesame

Various products are made of sesame. Sesame oil is a great salad oil in the Japanese diet for cooking fish. The seeds play a major role in bread making. In Greece, tortillas are made from sesame oil, and in Africa the seeds are used as a thickener for soups. Peeled sesame seeds enrich baked goods and candles and serve as the basis for smoothies, sweet and healthy tahini. Sesame seeds contain many times more calcium than a similar amount in milk. Today the need for vitality is increasing, while the world's reserves of viability for fossil organisms are gradually being depleted. Perhaps vegetable oil will be ready to replace mineral oil in the future.

2.5 Uses of Sesame Seeds

Sesame seeds are commercialized in an exceedingly range. In most cases, the seeds are specially treated into oil by the farmer. However, it can be sold in numerous stages of process for various functions like dinner, pasta, pastries and food. Sesame seeds can also be consumed directly as a wholesome food (Naturland, 2002). The seeds have a fragile crazy taste. Their tastes can doubtless be a lot of noticeable if they are cooked for few minutes. Sesame seeds are primarily used to add texture, flavour, and appealing to different a spread of confectionery product, like bread, biscuits and as additives to cereal mixtures.

Sesame oil is odourless, has a straw-like colour and exceptional taste. Sesame oil can be a common source of salad oil, which is rarely needed in winter. Sesame oil a type of vegetable

oils used in cooking without much modification and is extensively used to prepare varieties of foods.

2.6 Sesame Seed Processing

Sesame seeds become brittle and do not harden when exposed to cooking. This may indicate that the surface is fresh. In Ghana and Africa, sesame peeling techniques are usually done by immersing the sesame in water for a while, letting it dry and rubbing a hard surface. The insulation frame is exhausted by Winnower. This method is tedious, tedious, and reasonable for preparing small quantities. So far, a progressively effective exfoliation strategy has been created by inflating and spraying with 3% NaCl (salt) (Chemonics, 2002).

Drenching and dehulling: Sesame preparation is mainly done to peel and peel the seeds and remove the oil from the seeds. Sesame can be cooked in several unique steps, including peeling and peeling, peeling / peeling / drying, peeling / peeling / drying / oil grinding. Roasting: Cooking sesame seeds is the main form of spreading sesame seeds. Sesame is roasted to improve flavour, colour and surface changes, ultimately improving the overall flavour of the product. When roasting sesame in the preparation of sesame paste, a mixture of several temperatures and times is considered. The optimum roasting temperature range for spreading sesame seeds to achieve the desired colour and texture is 20-40 minutes at 120-140° C (Mijena, 2015).

Grinding: The milling process is completed to reduce the portion size of the sesame paste preparation. This progress is focused on the preparation of sesame spread on the basis that molecular size and molecular circulation are important parameters affecting the overall distribution of sesame (Mijena, 2015).

Homogenization: This is considered the final process that allows the seed to spread. Thin and smooth surface. Before filling the paste into bottles, cooling is an important process, which involves lowering the temperature of the finished product from 32 to 43 ° C, depending on the stabilizer used. Tempering is the last step in which the finished pasta is kept aside for 72 hours at a temperature of 10-25 degrees, without spoiling until the best fat crystallization is achieved. This is a common progression that helps stabilize production (Woodroof, 1983; M. Cadonald et al., 1985).

2.7 Adverse effects of consuming sesame seeds

These seeds provide as much benefit as they provide a significant effect. While sesame has many health and commercial benefits, but it has some anti-nutritional properties. Sesame seeds are high in phytic acid, which is an anti-nutritional agent. Another obstacle to seeds is that they cause adverse reactions in some people. Sensitivity may be mild and present as hives, dermatitis and itching, or it may be excessive and can lead to serious physical side effects such as nausea, abdominal pain and swelling of lips and throat driving to breathing difficulties, chest congestion and further losing one's life. The purgative impact of sesame also shows that sesame oil ought to not be utilized by individuals who have diarrhoea.

2.8 Composition of Honey

2.8.1 Carbohydrates

Among the components of honey, sugar is the most popular, with 95% honey by dry weight. The primary sugars are monosaccharides, hexoses, fructose and glucose, which are the elements of the hydrolysis of the disaccharide sucrose. Apart from that, around 25 specific sugars have been identified (Donor, 1977). The main oligosaccharides in peacock honey are disaccharides: sucrose, maltose, turanose, elose. Honeydew honey contains trisaccharides

other than melyzite and refined. The addition of tetra and pentasaccharides is limited. The relative amounts of the two monosaccharides fructose and glucose are valuable for the classification of uniform molasses (Bogdanov et al., 2004). The sugar spectra of small sugars, on the other hand, are not very different in numerous pea honeys. This is often due to the fact that oligosaccharides are basically a melliferous vertebrate (White, 1975).

2.8.2 Proteins, enzymes and amino acids

The composition of honey is usually 0.5% protein, mainly enzymes and free amino acids. Protein matter is described in detail in honey from various plant sources, where it is considered that the rich protein content exceeds 1000 µg / g (Azardo et al., 2003). After all, its contribution to human protein intake is below average. The three basic proteins in honey are diastases (amylase), they break down starch or glycogen into small sugar units, invertase (sucrose, α-glucosidase), and break down sucrose into fructose and glucose and produce glucose oxidase and glucose oxidase (Bogdanov et al., 2008).

The amino acids in honey are 1% (w / w). The total amount of free amino acids in honey is between 10 and 200 mg / 100 g, with proline being its main carrier, compared to about 50% of the total amount of free amino acids (Iglesias et al., 2004). In addition to proline, honey has 26 amino acids, the relative content of which depends on its roots (nectar or honeydew). Since pollen is the primary source of honey's amino acids, honey's amino acid profile can be characteristic of its botanical root. Most of the amino acids recognized in honey based on various botanical and geological features: glutamic acid, aspartic acid, asparagine + serine, glutamine, histidine, glycine, threonine, b-alanine, arginine, a-alanine, g-aminobutyric acid, proline, tyrosine, Valine ammonium particles, methionine, cysteine, isoleucine, leucine, tryptophan, phenylalanine, ornithine and lysine (Perez et al., 2007).

2.8.3 Vitamins, minerals and trace compounds

It is obvious that the characteristic concentrations of trace elements and mineral components in honey depend on its botanical and geographical origin. Trace components play a key role in biomedical exercise related to this diet because these components have many known and opaque natural properties. Vitamins such as phylloquinone, thiamine, riboflavin, pyridoxine and niacin are described in detail in nectar, but in particular the sum of vitamins and minerals is low and the contribution of honey to the RDI of various trace elements is low (Bogdanov, 2017).

2.8.4 Aroma compounds, taste-building compounds and polyphenols

Honey is well characterized and evaluated for its variety of tastes and colors, depending on the roots of its plant. Sugar is the main compound that greatly explains its taste. Overall, high fructose honey (eg acacia) is sweeter than high glucose honey (eg rapeseed). Besides sugar, the scent of honey depends on the quantity and quality of acids and amino acids contained in honey. Over the last few decades, several studies have been conducted on the odour of honey compounds, and over 500 unique and unstable compounds have been completely distinguished by different types of honey. Undoubtedly, most odour-producing compounds vary in different types of honey, depending on the roots of the plant (Bogdanov, 2007). Honey flavour is an essential quality for use in the nutrition industry and is a measure of consumer satisfaction. Polyphenols are another essential group of compounds in terms of appearance and useful properties. Total polyphenols of 56-500 mg / kg have been completely detected in different types of honey, depending on the type of honey (Gheldolf and Engeseth, 2002). The polyphenols contained in honey are mainly flavonoids (quercetin, luteolin, caffeferol, apigenin, chrysin, galazine, etc.), phenolic acids, and phenolic acid derivatives (Tomas-Barberan and Espin, 2001). Flavonoid content could vary between 2 and 46 mg / kg

of honey, with higher samples available at higher temperatures during the dry season. The antioxidant properties of honey are the result of the polyphenols present.

2.9 Nutritional Function of Honey

2.9.1 For athletic performance and infant nutrition

Ernest etc. (2004) investigated gel and honey powder-type physical activity as a source of carbohydrates for competitive performance. The use of products that energize before, during, and after the frame of physical work affects a person's performance and promotes muscle regeneration. Usually this is associated with bee dietary supplements, providing 17 grams of carbohydrates per tablespoon and highly needed energy, providing a commercially available sports enhancement assistant serves as a cheap alternative ((Kreider et al., 2002).

2.10 Increase digestion and absorption

2.10.1 Medicinal uses of Honey

Bee honey contains some chemicals that improve the absorption of nutrients, especially carbohydrates such as sugar and starch (Bogdano et al., 2008). The main particles of honey sugar are in a pre-digested form and can be eaten exclusively by the human system. In most cases, honey helps in digestion in the body (Bogdanov et al., 2008). The gastrointestinal tract (GIT) contains some basic and beneficial microbes, especially bifidobacteria, that support life and well-being. It is recommended that the population of these microorganisms within GIT be increased by providing abundant prebiotics such as natural honey and nutritious nutrients. Prebiotics are substances that promote the upgrade growth and organic process of these active and useful microorganisms. Numerous sample studies, including both in vitro and in vivo studies, have highlighted the importance of natural honey dietary supplements to the

development of beneficial microorganisms (Bifidobacterium and Lactobacillus) and their prebiotic effects within GIT. Archives (Shin and Austonol, 2005).

2.10.2 Anti-Viral Effects

Honey has been shown to have antiviral activity and is used in many fruits to treat diseases that prevent the spread of infection. Honey has antiviral activity against rubella infection and is used to cure persistent herpes wounds ((Al-Waili, 2004). The antiviral effects of honey have been described in detail, suppressing rubella virus and herpes infections in vitro and counteracting the transmission of HIV-1 due to methylglycosol (Behbahani, 2014). Manuka honey has been described in detail for its highly preventive action against influenza infections from various sources (Watanabe et al., 2014). Grass honey is mostly used for anti-infective (especially antiviral) purposes due to hydrogen peroxide. Untreated honey can cure herpes compared to acyclovir. Honey is thought to attack the infection and suppress its replication, neutralizing the infection even at appropriate concentrations (Zeina et al., 1996).

2.10.3 Anti-Fungal Effects

Several fungal species have been tried, but the bactericidal action of honey cannot be ignored. It has antifungal activity against mycosis (tinea), epidermal phytane, microsporum, and dermatophytes, which are three crophytons. Simple treatment of infections is constrained, some of which is due to the recent range of antifungal drugs and expensive treatments, especially due to the need for longer treatments. In modern times, some studies on the in vitro defense of superficial mycoses against honey antifungal agents (Jessup et al., 2000). Therefore, many recent studies have focused on the therapeutic properties of pure honey and its antifungal activity (Ji et al., 2009). Recently, a multi-flower honey test was assessed for its capability to manage the development of 40 yeast strains. Some of them include Candida

albicans. Kurushi, c. Glabreta and Tricosoporan (koc et al., 2009). Unilateral honey antifungal activity against Penicillium species often occurs at concentrations above 10% (Kakaniova et al, 2011).

2.10.4 Anti- Parasite Effects

The antiparasitic properties of honey have been examined for anthelmintic action using beetles (Pheretima posthumous), tapeworms (Raillietina spiralis) and roundworms (Ascaridia galli). Different concentrations (100–300 mg / ml) of sweeteners were tested in BioSay.

2.10.5 Wound healing purpose

The history of honey and its distinctive wound healing properties date back to 2000 BC. Various reports support the effectiveness of honey in wound healing, and some researchers show that honey dominates many advanced treatment strategies. Honey has been used for centuries to purify and speed up wound healing; Be that as it may, the scientific facts of their conquest have not been explained until the twentieth century. Nowadays, honey is used all over the world to treat people with stains or wounded body cavities (Fasika et al., 1996). Honey is an effective treatment for wounds because it is more beneficial than irritating, non-toxic, sterile, antibacterial, nutritive and other dressings. Simple, easy and safe to apply.

2.11 Effects and Precautions for the use of Honey

According to Bogdanov (2006), honey can be contaminated by the environment just like any other natural food, for example, from pesticides, antimicrobial agents and plant poisons. Some plants produce honey that contains harmful substances. Dieterpenoids and pyrazolidine alkaloids are the two major toxic groups associated with honey. Some plants of the Ericaceae family, belonging to the rhododendron subfamily, such as rhododendron ponticum, contain

harmful polyhydroxylated cyclic hydrocarbons or diterpenoids, as claimed by De Bodt (1996). Swallowing excess contaminated nectar can cause dizziness, nausea, sweating, vomiting, vision loss, seizures and loss of consciousness, irritation of the limbs, excessive sweating, migraines, abdominal pain, numbness, weak eyesight and skin rashes. Rural beekeepers know that honey, which contains harmful substances, cannot be sold (Boston et al., 2010). Furthermore, toxicity of honey has been documented by other plants: Datura, Belladonna, Hyosmus niger, Serzania lethalis, Gelsium sempervirens, Kalmia latifolia, Tripetalia paniculata and Ledum palustre (Islam et al., 2014). Due to the proximity of Clostridium botulinum in honey, the health disorders of newborns should not be overlooked. The spores of this bacterium multiply well in honey, but cannot produce toxins. Therefore, in the belly of new-borns within a year, microscopic spores from honey continue to poison and can turn into poison in the unknown intestinal tract, which pose greater risks to health and even death (Tanzi, & Gabby, 2002). To reduce the risk of honey poisoning when plants with poisonous nectar are developed, consumers are encouraged to buy honey as it is on the market, and not from individual beekeepers (Edgar et al., 2002).

2.12 Production of Spread

The spreading or pasting method involves removing the shell from the dry pieces, roasting, cooling, blanching and removing foreign particles (including the skin of the seeds), cutting, cooling and packaging. Sometimes salt and other substances, such as fat, sugar and other antioxidants, are also added to enhance shelf life and improve quality (Woodruff, 1989). The color of the peanut butter can be described as deep fried, and can be lightly fried depending on the type that some customers prefer, as there are variations in roasting (Settaluri et al., 2012).

CHAPTER THREE

MATERIALS AND METHODS

3.1 Source of Raw Materials

Sesame seeds and pure honey were purchased from the Bawku Market and the Damongo Catholic Diocese Secretariat in the Upper East and Northern Regions respectively.

3.2 Preparation Method of Sesame Seed for Spread

Roasting of seeds: Dehulled sesame seeds were sorted, washed and dried. 400g of different sesame seeds samples were measured and spread in each of the five baking sheets with sized (36 x46 cm) and roasted in a high temperature oven (Technico, TLPPL-130, Chennai, India) for at a temperature of 120º C using different time intervals. Roasting was performed in the Food laboratory using a high temperature oven (Technico, TLPPL-130, Chennai, India). Roasted sesame seeds were coded according to the roasting time used as seen in

Table 1.

Table 1: Proportions of Sesame and Honey for the spread

Sample code	RSS (g)	Honey (ml)	SFL oil (ML)	Salt (g)	PT	RT
ABC	90	10	50	0.5	1	15
BDE	80	20	50	0.5	2	15
CFG	70	30	50	0.5	3	15
HIJ	60	40	50	0.5	4	15
KLM	50	50	50	0.5	5	15

RSS- Roasted Sesame Seed, SFL- Sunflower Oil, PT-processing time, RT- roasting time

ABC (90% Roasted sesame seed, 10% Honey), BDE (80% Roasted sesame seed, 20% Honey), CFG(70% Roasted sesame seed, 30% Honey), HIJ (60% Roasted sesame seed, 40% Honey), KLM (50% Roasted sesame seed, 50% Honey),

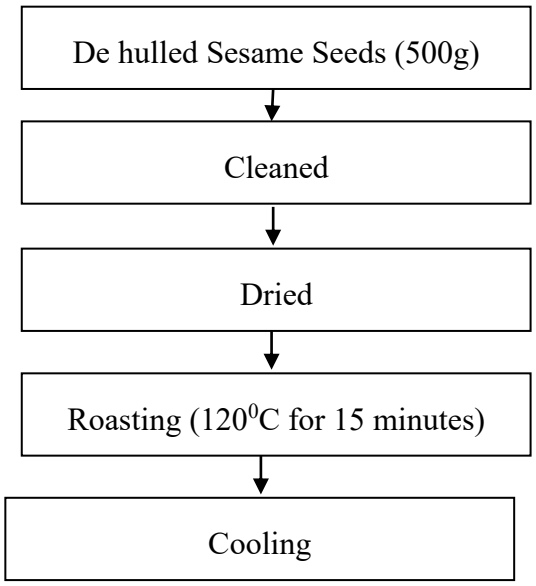
3.3 Method of Preparation of sesame-honey spread

The method of preparing Sesame spread described by Woodroof (1983) was used. The sesame spread was prepared according to the designated formulations in

Table 1. The roasted sesame seed was ground using a size reduction machine. The following ingredients were added to the ground Sesame by weight according to the formulation in

Table 1: sesame seeds, sunflower oil, honey and salt.

The mixture was well blended in a food processor machine. One hundred millilitres (50ml) of sunflower oil, 1g of salt was added to each of the samples and were completely mixed with a blender until the mixture formed a creamy thick and fairly smooth paste as desired. 10, 20, 30, 40 and 50g of honey was measured into the sample and blended again until it was uniformly mixed to a smooth consistency using the research laboratory food processor (Prestige Hand Blender PHB 5.0, Bangalore, India). The formulated Sesame spread was filled into sterilized plastic jars and sealed with aluminium foil for evaluation through sensory analysis.



[Figure 1: **Process flow chart of sesame spread**]

3.4 Physicochemical properties of the sesame spread

The proximate composition of the spread was determined using the AOAC (2005) method.

3.4.1 Moisture content and total solids: Oven Drying Method

About 5g of sample was transferred to a dry and heavy plate. The dish was placed in a thermostat controlled oven at 105 ° C for 5 hours. It was then removed and placed in a desiccator to cool and weigh at room temperature. The plate was dried again, cooled and weighed for 30 minutes. Drying, cooling, and weighing are repeated until a stable weight is reached.

Calculations

$$\%\ Moisture\ (wt/wt) = \frac{wt\ H_2O\ in\ sample}{wt\ of\ wet\ sample} \times 100$$

$$\%\ Moisture\ (wt/wt) = \frac{wt\ wet\ sample\ -\ wt\ of\ dry\ sample}{wt\ of\ wet\ sample} \times 100$$

$$\%\ Total\ solids\ (wt/wt) = \frac{wt\ of\ dried\ sample}{wt\ of\ wet\ sample} \times 100$$

Where wt = Weight of sample/spread

3.4.2 Ash Content

About 5g sample was weighed into a tarred crucible. Pre-dried if the sample was too wet. The crucibles were placed in a cold muffle furnace. A protective gear such eyewear, gloves and tong wore gloves were used when the muffle furnace was hot. Ignited for 2 hours at about 600 ^{0}C. Muffle furnace was turned off and waited to open when the temperature had dropped to at least 250 ^{0}C preferably lower. Door was opened carefully to avoid losing ash that may be fluffy. Safety tongs was quickly used to transfer crucibles to a desiccator with a

porcelain plate and desiccant. Desiccator was closed to allow crucibles to cool prior to weighing.

Calculations

$$\%Ash = \frac{wt\ of\ ash}{wt\ of\ sample} \times 100$$

$$\%Ash = \frac{(wt\ of\ crucible\ +\ ash) - (wt\ of\ empty\ crucible)}{(wt\ of\ crucible\ +\ sample) - (wt\ of\ empty\ crucible)} \times 100$$

Where wt= Weight of sample/spread

3.4.3 Fat content: soxhlet extraction

250 ml Round Bottom Flask with Exhaust (air oven at 100°C) was accurately weighed. 5g dry sample to 22 × 80 mm paper thimble was weighed. A small of cotton or glass was placed into the thimble to prevent loss of the sample. 150 ml of petroleum spirit bp 40-60 ° C was added to the round bottom flask and the device was attached. The condenser on the hanging robe was connected to the soxhlet extractor and reflux for 4 - 6 hours. After extraction, the thimble was removed and the solvent was obtained by distillation.

The flask and fat/oil were heated in an oven at about 103°C to evaporate the solvent. The flask and contents were cooled to room temperature in a desiccator. The flask was weighed to determine weight of fat/oil collected.

$$\%\ Fat\ (dry\ basis)\ =\ \frac{fat/oil\ collected}{weight\ of\ sample} \times 100$$

$$\%\ Fat\ (dry\ basis) = \frac{(weight\ of\ flask\ +\ oil) - weight\ of\ flask}{weight\ of\ sample} \times 100$$

3.4.4 Crude fibre determination

Two grams (2 g) of the crude fat sample was weighed into a 750 ml Erlenmeyer flask. Two hundred milliliters (200 mL) of 1.25% H2SO4 was added and immediately the flask was placed on a hotplate and connected to a condenser. The contents were boiled for 1 minute after contact with the solution. After 30 minutes the flask was removed and immediately filtered through a linen cloth in a funnel and rinsed with copious amounts of water.

Filtrate (containing sample from acid hydrolysis) was washed and returned into the flask with 200ml 1.25% NaOH solutions. Flask was connected to the condenser and was boiled for exactly 30 minutes. It was then filtered through Fischer's crucible and washed thoroughly with water and added 15ml 96% alcohol. Crucible and contents was dried for 2 hour at 105 °C and cooled in desiccator and it was weighed. Crucible was ignited in a furnace for 30 minutes and after that it was cooled and reweighed.

$$\%\ Crude\ fibre\ = \frac{weight\ of\ \ Crude\ fibre}{weight\ of\ \ sample} \times 100$$

$$\%\ Crude\ fibre = \frac{(weight\ of\ \ Crude\ fibre) + sample\left(before - after\right)\ ashing}{weight\ of\ \ sample} \times 100$$

3.5.5 Protein Determination

Digestion Method: Two grams (2g) of sample and a half of selenium –based catalyst tablets and a few anti-bumping agents were added to the digestion flask. Twenty-five mililitres (25ml) of concentrated H_2SO_4 was incorporated and the flask was dazed for the entire sample to become thoroughly wet. Flask was positioned on digestion burner and heated gradually till boiling stopped and the subsequent solution was clear. The sample was allowed to cool to room temperature and digested sample solution was moved into a 100ml volumetric flask and made up to the mark.

Distillation Method: To rinse the equipment before use, water was heated within the steam generator of the distillation equipment, with connections organized to flow through the condenser for a minimum of ten minutes. The receiving flask was lowered and continued to heat for thirty seconds to deliver all the liquid to the condenser. Twenty five (25ml) milliliter of two percent (2%) boric acid was pipetted into a 250 milliliter conical flask and two drops of mixed indicator were added. The conical flask and its substances were placed underneath the condenser in such a way that the tip of the condenser is totally immersed in the solution. Ten milliliter (10ml) of the digested sample solution was measured into the decomposition flask of the Kejdahl unit, fixed it and add excess of 40% NaOH (about 15-20ml) to it. The ammonia produced was distilled into the collection flask with the condenser tip immersed in the receiving flask till a volume of about 150ml– 200ml is collected. Before distilling another sample and on completion of all distillations, the apparatus was flushed as in step 1 above. Steam was allowed to pass only until 5ml of the distillate is obtained.

Titration Method: The Distillate with 0.1N HCL solution was titrated. The acid was added until the solution became colourless. Any additional acid added made the two solutions become pink. The nitrogen content was determined in duplicate, and a blank determination was run using the same amount of all reagents as used for the sample. The blank was meant to correct for traces of nitrogen in the reagents and included digestion as well as distillation methods.

Calculation

$$\%\ Total\ nitrogen\ =\ \frac{100\times(V_a - V_b)\times NA\times 0.01401\times 100}{W\times 10}$$

where

V_a = *Volume in ml of standard acid used in titration*

V_b = *Volume in ml of standard acid used in blank*

NA = *normality of acid*

W = *weight of sample taken*

3.4.6 Carbohydrate content

The obtainable carbohydrates (nitrogen-free extract-NFE) were calculated once finishing the analysis of ash, crude fiber, ether extract, and crude protein. The calculations were created by adding proportion values supported by the dry matter of those analyzed materials and subtracting them from 100%.

Calculation:

$$Carbohydrate\ (\%) = \%\ Crude\ fibre\ +\ \%\ NFE$$

Or

$$Carbohydrate\ (\%) = 100 - (\%\ moisture\ +\ \%\ fat\ +\ \%\ protein\ +\ \%\ ash)$$

$$Calculation\ for\ dry\ basis\ =\ \frac{(100 - \%\ moisture) \times wet\ basis}{100}$$

3.5 Total Sugar

Anthrone reagent was prepared by dissolving 2 g anthrone in 100 mL conc. H_2SO_4 and also a stock solution of glucose of a concentration of 100 µg/mL. was prepared. A range of serial dilutions of glucose of 10-100 µg/mL in a volume of 1 mililtre each was set up, as described in the observation table given later. Similarly, a blank with 1 mL distilled water only was set up. 1 mililitre of serial dilutions of the unknown sugar sample (undiluted, 2 µg/mL, 5 µg/mL, l0 µg/mL, 100 µg/mL) was transfer into separate test tubes. Four mililitres (4 ml) of the anthrone reagent was added to each tube, mixed, and covered with glass marbles. This was incubated in a boiling water bath for 10 min. Tubes were cooled to room temperature andwas used to measure the absorbance of the analyte at 620 nm (a red filter was alternatively used) after setting to zero absorbance (i.e., 100% transmittance) using the blank. A standard curve was drawn by means of absorbance values of typical glucose tubes, that is, by taking the sugar concentration on the X -axis and also the corresponding absorbance value at 620 nm on

the Y-axis. The amount of glucose was calculated within the unknown sample from this curve and also the observation recorded.

3.6 Microbial Analysis

3.6.1 Determination of Total Aerobic Count (TAC)

The total aerobic counting was performed by the plate spread method on plate count agar (PCA). A 100 microliter (100 µl) aliquot of each diluent was inoculated into a Petri dish containing PCA. The inoculum was evenly distributed with a sterile angled rod and dried at room temperature for 15 minutes. The plate was turned upside down and incubated at 37 ° C for 24 hours.

3.6.2 Determination of Total Coliform Count (TCC)

Aliquots of one hundred microliters (100µl) from each of the dilution were injected into Petri dishes containing MacConkey agar. The inoculum was spread evenly on a sterile bent rod and dried at room temperature for 15 minutes. The plate was turned upside down and incubated at 37 ° C for 24 hours.

3.6.3 Determination of Staphylococcus aureus

Species of Staphylococcus were counted by isolation and dispersion plate method and cultured on mannitol salt agar (SMA). One milliliter of each of these was made into an MSA petri dish. The inoculum was spread evenly with a sterile curved rod and allowed to dry for 15 minutes at room temperature. The plates were inverted and incubated at 35 ºC for 24 hours. After incubation, yellow colonies were counted and recorded as *Staphylococcus* counts.

3.6.4 Determination of E. coli

The presence of E. coli was determined by dispensing an aliquot of 0.1 ml of the original dilution of the sample onto a sterile plate containing selective Brilliant E. coli agar medium and incubating at 37 ° C for 24 hours. The presence of Escherichia coli was established by noticing purple colonies.

3.6.5 Determination of Salmonella typhi

The presence of Salmonella species was elucidated by following a three-step assay; pre-enrichment, enrichment and culture. The food sample (5g) was inoculated into 45ml of 1% peptone and incubated overnight at 37^0C. An aliquot of 100µl of the pre-enriched sample was transferred into 9ml sterile Rappaport Vassiliadis broth and further incubated for 24 hours. Aliquots of 10µl was transferred unto plates of XLD and BGA and incubated for another 24 hours at 37^0C. The plates were observed for the appearance of colonies with black spots on XLD and red colonies on BGA for Salmonella species.

3.7 Determination of Shelf life

The shelf life of the product was determined using both microbiological and physicochemical indicators. The microbiological parameters used include the total aerobic count, total Coliform count, yeast count and mould count. The physicochemical parameters used include the moisture and Free Fatty Acid (FFA%) of the oil.

The samples were stored at room temperature (25^0C) and elevated temperature (45^0C) for 8 weeks and sampled on 14 days interval for analysis following the standard protocols as described. The data obtained was used in the shelf-life estimation using the Statgraphics Centurion software under simple and multiple regression analysis.

3.8 Sensory Evaluation

For sensory analysis of the sesame spread, 50 assessors (untrained food taster) received a portion of the sample (10g) white disposable plastic cups, accompanied by disposable spoons. Then, the assessors answered a sensory ballot sheet where the result was used to evaluate the attributes of Colour, Aroma, Texture, Smoothness, Spreadability, Taste and Overall Acceptability of the spread. For each sample, 10 g of spread was served in white disposable plate with a piece of Jacob's cracker biscuit based on the Resurreccion (1998) modified parameters where 9 represents (liked extremely) and 1 (disliked extremely) on 9-point hedonic scale

3.9 Statistical Analysis

The data were analysed by means of Analysis of Variance (ANOVA). The Turkey test was employed to determine the significant differences between the different simulations. Software, Statistical Package for Social Sciences (SPSS) Version 22.00 (SPSS Inc., Chicago), IL, USA at a significant level of 0.05.

CHAPTER FOUR

RESULTS AND DISCUSSIONS

4.1 Proximate Analysis

This aspect of the study entails the physicochemical analysis namely moisture (amount of free water present), ash (the inorganic components), fat (oils), protein (nitrogenous compounds), crude fibre (roughages) and carbohydrate using AOAC methods.

Table 2 show the results of the proximate analysis of the spreads.

Table 2: Proximate Composition of spread

Sample	Moisture(%)	Ash(%)	Protein(%)	Fat(%)	Fibre(%)	CHO(%)
ABC	3.64±0.01^{a}	4.63±0.29^{d}	16.47±1.60^{e}	66.87±0.51^{c}	5.78±1.39^{e}	2.61±0.85^{d}
BDE	4.54±0.17^{d}	3.38±0.09^{b}	12.17±0.16^{a}	64.69±0.06^{a}	5.39±0.26^{a}	9.83±0.04^{a}
CEF	5.84±0.28^{c}	2.91±0.09^{c}	11.45±0.48^{d}	53.92±0.71^{d}	5.30±0.86^{d}	20.56±0.70^{e}
HIJ	6.29±0.12^{e}	2.95±0.01^{a}	6.57±0.26^{c}	39.90±0.19^{b}	4.40±0.54^{b}	39.90±0.20^{b}
KLM	6.87±0.12^{b}	2.42±0.09^{c}	9.64±0.04^{b}	51.10±1.09^{e}	4.73±0.69^{c}	25.23±1.95^{e}

Values represent means and standard deviation replicate readings for various parameters. Values in the same column with different superscripts are significantly different (p>0.05). Keys: ABC = (90g Sesame seed, 10g honey, 5mins roasting time), BDE = (80g Sesame seed, 20g honey,10mins roasting time) CFG = (70g Sesame seed, 30g honey, 15mins roasting time) HIJ = (60g Sesame seed, 40g honey, 20mins roasting time) and KLM = (50g Sesame seed, 50g honey,25mins roasting time)

4.1.1 Moisture content of the spread

The moisture content of the spread samples ranged from 3.64±0.01 to 6.87±0.12. Sample ABC had a very low moisture content. This was followed by BDE, CEF, HIJ and KLM respectively. There were significant differences in the moisture content for all samples. Results show that the sample with the lowest amount of honey had an extremely low

moisture content. There was significant ($p<0.05$) difference between the moisture content of all the spread formulations. Moisture content however increased with an increase in roasting time and honey content.

The moisture contents observed in the spread may make them possess a shorter storage capability and thus rapid deterioration (Enyoh *et al*., 2017: Enyoh *et al*., 2018). The current study results are almost similar to the range 3.71% for banana flour-sesame paste blends reported by Zebib *et al*. (2015). Results showed that moisture content of all paste blends increased with an increase in honey concentration. This increase in the moisture content of blends is due to higher moisture content in the honey. This happens because honey has a higher moisture content.

4.1.2 Ash content of the spread

The Ash content of the spread samples ranged from 2.42±0.09 to 4.63±0.29. The lowest ash content of the samples was recorded by sample KLM (highest roasting time). The highest ash content was recorded by sample ABC. Ash content of the samples decreased with an increase in roasting time and a decrease in the amount of sesame from sample to sample. There was significant ($p<0.05$) difference between the ash contents.

Ash denotes to the mineral deposit remaining once either ignition or complete oxidation of organic matter in a food sample. The inorganic residue consists mainly of the minerals present in the food sample. Conferring to Bowmen and Russell (2001), values of ash and crude fibre content are significant in terms of the appropriateness of food digestibility.

Results show that as percentage of sesame paste increases, the ash content of the blended pastes increases. Steve *et al*. (2009) reported that ash contents of 2.3-3.4% for banana-groundnut flour paste and the range 4.06-4.20 for apricot-date bars by Rehman *et al*. (2012)

which are much lower than this result. Ash content of all formulated paste was significantly higher than the control (3.28%) due to the contribution of ash content by the ripe banana flour (Abbas *et al*. 2009) to the blended products.

4.1.3 Protein content of the spread

Proteins were found to be contained in the samples evaluated. The study showed that the protein content ranged from 9.64±0.04 to 16.47±1.60. The highest amount of protein was found in sample ABC and the lowest in sample KLM. Increasing roasting time decreased the amount of protein in the samples studied. There was significant ($p<0.05$) difference between the protein content of all the spread formulations.

Crude protein is the amount of protein of animal feed or specific food. Crude protein depends on the nitrogen content of the food proteins

Zebib *et al*., (2015) in their work on banana-sesame blend reported that with increasing of sesame paste ratios, protein content in the blended products was increased from 11.96% to 15.89%. The results obtained are significantly higher than the range 6.7-13.8% reported by Steve *et al*. (2009) for banana-groundnut flour blends and the value 7.42% for pestil with hazelnuts mulberry product reported by Yildiz (2013). The protein content of two paste blends was significantly higher than control (11.76%) however with no significant ($p>0.05$) differences between BfBR1. This is due to the high amount of crude protein in sesame paste (Orrun and Morgan, 2005; El-Khier *et al*. 2008) and partly also contribution from the protein content of honey (Emag *et al*. 2007; Abbas *et al*. 2009). The decrease in protein with an increase in roasting time could be as a result of the proteins being denatured as time of roasting increases.

4.1.4 Fat content of the spread

Fat content in the spread were found to be between 39.9±0.19 to 66.87±0.51. This variation corresponded to a decrease in the amount of sesame seeds used in the study. From the study, the highest amount of fat was recorded in sample ABC and the lowest in HIJ. There was a decrease in fat content when the roasting time was increased. There was significant ($p<0.05$) difference between the fat content of the spread formulations.

In the study by Zebib *et al*., (2015), they reported highest crude fat content of 33.56% while the lowest was 23.42%. These values are lower than the results of the current study. The crude fat contents found in this work are higher than the values 16.08%, 13.78% and 13.24% for pestil with hazelnuts, pestil with walnuts and Kome mulberry products, respectively reported by Yildiz (2013).

4.1.5 Fibre content of the spread

The fibre content of the spread samples in this study ranged from 4.40±0.54 to 5.78±1.39. The highest fibre content was recorded in sample ABC and the lowest in HIJ. Results from the study showed a decrease in fibre content with an increase in roasting time and a reduction in the amount of sesame seeds added. There was significant ($p<0.05$) difference between the fibre content of all the spread formulations

Crude fibre is a measure of the amount of cellulose, pentoxifylline, lignin and other such components present in existing foods. These ingredients are of low food value but provide the bulk needed for proper peristaltic action in the intestinal tract (Mbaeie *et al*., 2010). Furthermore, the National Research Council (1975) recommended that the raw fibre content of sesame indium L may also help in the daily requirement of fibre. Recently, interest in fibre has grown due to its ability to prevent chronic diseases such as heart disease, cancer, and

diabetes mellitus. However, consuming more or less fibre can lead to bowel irritation and potentially colon cancer.

These finding results are much higher than 1.48% by Yildiz (2013) for Turkish traditional mulberry product (pestil with hazelnuts) but lower than the range 5.66-6.14% by Rehman *et al*. (2012) for apricot-date bars containing skim milk powder, roasted gram flour and peanuts. In this study, it was also observed that fiber content of all paste products decreased with a decrease in the amount of sesame seeds. This is due to high amount of fiber in sesame (Abu-Jdayil *et al*. 2002; Gharehyakheh and Tavakolipour, 2013) and some amount of fiber in ripe banana flour (Abbas *et al*. 2009) that contributed to high crude fiber contents in the blended products.

4.1.6 Carbohydrate content of the spread

The study showed that the carbohydrate content varied from 2.61±0.85 to 39.9±0.20. Sample HIJ and ABC had the highest and lowest amount of carbohydrates respectively. Carbohydrate content increased with a reduction in the amount of sesame added. It however increased with an increase in the roasting time. Analysis of variance showed significant ($p<0.05$) difference between the carbohydrate contents of the spread formulations.

Zebib *et al* (2015) found the highest carbohydrate content of 49.05% and the lowest (34.03%) for banana-sesame paste. The total carbohydrates found in this work are significantly lower than the range 68.9-77.8% reported for banana-bambara groundnut paste by Steve *et al*. (2009) and 52.28-55.67% for apricot-date bars by Rehman *et al*. (2012). Carbohydrate content increased with an increase in roasting time and a decrease in the amount of sesame seeds.

4.2 Free fatty acid and total sugar content

This aspect of the study entails the free fatty acid and sugar content of the spreads. Results are presented in Table 3.

Table 3: Free fatty acid and total sugar content of spread

Sample	Free fatty Acid (Mg(KOH)/g	Total Sugars ($100\mu g/mL$)
ABC	0.19 ± 0.09^{d}	8.06 ± 0.19^{d}
BDE	0.12 ± 0.01^{a}	9.27 ± 0.09^{c}
CFG	0.12 ± 0.00^{a}	8.56 ± 0.00^{a}
HIJ	0.16 ± 0.02^{c}	10.19 ± 0.05^{b}
KLM	0.15 ± 0.03^{b}	8.64 ± 0.06^{c}

Values represent means and standard deviation replicate readings for various parameters. Values in the same column with different superscripts are significantly different ($p>0.05$). Keys: ABC = (90g Sesame seed, 10g honey, 15mins roasting time), BDE = (80g Sesame seed, 20g honey,15mins roasting time) CFG = (70g Sesame seed, 30g honey, 15mins roasting time) HIJ = (60g Sesame seed, 40g honey, 15mins roasting time) and KLM = (50g Sesame seed, 50g honey,15mins roasting time)

4.2.1 Free fatty acid content of the spread

The free fatty acid content of the spread samples ranged from 0.12 ± 0.01 to 0.19 ± 0.09. Spread sample ABC had the highest amount of free fatty acid. Samples BDE and CEF also recorded the lowest amount of free fatty acid. There was a reduction in free fatty acid with an increase in roasting time.

A decreasing trend of free fatty acids with a decrease in roasting time could be attributed to the discovery of Hunziker (1948) who stated that the value of free fatty acids improved during blending and decreased with decreasing temperature. A high fat content results in a higher content of free fatty acids, therefore the increase in the percentage of fat of the free

fatty acids of the cream in the final product also increased. These results were closely associated with the results of Walstra et al. (1999) who concluded that high fat cream rich in fat increases the content of free fatty acids. The changes in fatty acid composition of lipids provide an indirect measure of susceptibility to lipid oxidation. Fat content alone is not a good indicator of storage stability (Pershen *et al*., 1995) but the degree of unsaturation or polyunsaturation (Labuza and Dugan, 1971), tocopherols, chlorophyll and beta carotene, moisture content and temperature (Hasenhuetti *et al*., 1992; Reynhout, 1991) affect primary lipid oxidation and oxidative stability of intermediate moisture foods during storage.

4.2.2 Total sugar content of the spread

The total sugar content of the samples was between 8.06±0.19 to 10.19±0.05. The highest amount of sugar was recorded in sample HIJ and the lowest in sample ABC. Increasing the roasting time and honey content increased the total sugar content of the spread. The study revealed significant ($p<0.05$) difference in the total sugar content of the spread formulations.

4.3 Sensory properties

The sensory properties of the spread are presented in Table 4. According to McNeill *et al*. (2002) among important qualities butter include texture, colour, flavour and nutritive value.

Table 4: Sensory properties of the spread

Sample	Colour	Aroma	Appearance	Taste	Softness	Spreadability	Smoothness	Overall acceptability
ABC	6.92±1.48[a]	7.08±1.35[a]	7.32±1.33[c]	7.40±1.41[c]	7.66±1.081[c]	7.30±1.62[c]	7.38±1.11[c]	7.48±1.50[a]
BDE	7.04±1.44[a]	7.10±1.36[b]	7.08±1.28[a]	7.35±1.45[a]	7.29±1.30[a]	7.67±1.08[a]	7.25±1.61[a]	7.19±2.06[a]
CFG	6.92±1.53[a]	7.57±1.39[c]	7.55±1.25[b]	7.43±1.46[b]	7.98±1.21[b]	7.53±1.69[b]	7.45±1.47[b]	7.86±1.18[b]
HIJ	7.47±1.31[a]	7.18±1.72[c]	7.27±1.46[b]	7.35±1.35[b]	7.25±1.53[b]	7.59±1.19[b]	7.49±1.10[b]	7.16±1.30[a]
KLM	7.39±1.44[a]	7.27±1.34[c]	7.49±1.26[b]	7.67±1.03[b]	7.37±1.34[b]	7.39±1.20[b]	7.25±1.32[b]	7.25±1.67[a]

Values represent means and standard deviation replicate readings for various parameters. Values in the same column with different superscripts are significantly different (p>0.05). Keys: ABC = (90g Sesame seed, 10g honey, 15mins roasting time), BDE = (80g Sesame seed, 20g honey,15mins roasting time) CFG = (70g Sesame seed, 30g honey, 15mins roasting time) HIJ = (60g Sesame seed, 40g honey, 15mins roasting time) and KLM = (50g Sesame seed, 50g honey, 15mins roasting time). 1=Dislike extremely, 2=dislike very much, 3=Dislike moderately, 4=Dislike slightly, 5=Neither like nor dislike, 6=Like slightly, 7=Like moderately, 8=Like very much, 9=Like extremely.

4.3.1 Colour of the spread

The colour of the spread samples were evaluated and results presented in Table 4. The colour readings were rated on a 9-point hedonic scale. The sensory panellists rated colour from 6.92±1.48 to 7.47±1.31. From the scale colour of all samples were rated as being liked moderately. Analysis of variance found no significant ($p>0.05$) differences in the colour rating of the samples. The study showed that processing time had no effect on the colour of the spreads.

In the case of roasted nuts colour change arise as a result of Maillard reaction, Strecker degradation, and caramelization of sugars (Lima *et al*., 2012). Colour is another important attribute used by consumers to judge the acceptability of food products (Riha and Wendorff, 1993). These reactions could have led to the changes in colour of the various spreads produced. This is because of the different volumes of honey contained in each spread.

4.3.2 Aroma of the spread

The Aroma of the samples are presented in Table 4. The aroma ranged from 7.08±1.35 to 7.57±1.39. The study showed that there were no significant ($p>0.05$) differences in the aroma of samples CEF, HIJ and KLM. These however differed from the rest of the samples. Samples ABC and BDE also differed significantly ($p<0.05$) among themselves. Thus, the aroma of the spread was affected by the processing time.

Beside textural attributes, overall liking of spreads such as hazelnut spread is related to the flavor of the product (Di Monaco *et al*., 2008). Flavor liking cannot be measured directly by instruments; it is an interaction of consumer and product (Rohm, 1990). With a wide range of materials and processing methods in peanut butter manufacturing, processors may not have a

clear understanding of the most desirable roasting or storage conditions that contribute to the flavour of their product (Crippen *et al*., 1992). These conditions are linked to the time of processing. Increasing processing time increases the production of aroma compounds (Rehman et al., 2012). Pattee *et al*. (1991) showed that the peanut flavor (nutty, sweet, salty, roasted and rancidity) from sensory analysis is related to the roasted peanut.

4.3.3 Appearance of the spread

The result for Appearance of the samples are presented in Table 4. The appearance of the samples ranged from 7.08±1.28 to 7.55±1.25. The study showed that there were no significant ($p>0.05$) differences in the aroma of samples CEF, HIJ and KLM. These however differed from the rest of the samples. There were significance ($p<0.05$) between the control and composite samples ABC and BDE. Increasing processing time increased the appearance rating of the samples.

Regarding the presence of spread samples made of 35% fat, the results of this study scored the highest with the highest percentage fat, minimum moisture content, maximum total solids and less non-fats solids, which contributed to the good appearance of the spread. . The results of this work were confirmed by Douglas (2006), who concluded that spread gives a good appearance with a good percentage of fat, moisture, hard and non-greasy solids, colour, texture, and taste.

These are also affected by the processing time. Increasing processing time enables the compounds to interact and present a desirable appearance (Rall et al., 2003).

4.3.4 Taste of the spread

The result for Taste of the spread samples are presented in Table 4. These were within the ranges of 7.35±1.45 and 7.67±1.03. From the study there were no significant ($p>0.05$) differences in the taste of samples CEF, HIJ and KLM. These however differed from the rest of the samples. Samples ABC and BDE also differed significantly ($p<0.05$) among themselves. Increasing processing time resulted in an increase in the taste of the samples.

The findings of the present study showed that the spread sample that obtained good texture scores (as seen in the current study) obtained good taste scores. These results are buttressed by the outcomes of Bayer et al (2001), who specified that the taste of any spread is attributed to the texture and the way it tastes within the mouth. When processing time is increased the samples attain the desirable taste. Work by Popa et al. (2009) confirm results of this study.

4.3.5 Softness of the spread

The sensory score for Softness of the spread samples are presented in Table 4. The scores ranged between 7.25±1.53 and 7.98±1.21. Sample CEF was the sample with the most preferred softness. From the study there were no significant ($p>0.05$) differences in the softness of samples CEF, HIJ and KLM. These however differed from the rest of the samples. Samples ABC and BDE also differed significantly ($p<0.05$) among themselves. The processing time was affected by the softness of the samples.

Estimation of butter composition may be associated with low iodine number in the range 25-27, as low iodine value is attributed to oxidation and good texture. These findings are also supported by the facts cited by Burns (1993), which established that the use of spread composition is at a low iodine number (25-27). In addition, spread with a high fat content give a good texture rating. This result is also buttressed by Beer et al., (2001) that the fatty

acid content in spread affects the consistency of spread samples, and 80% of the structural variability is credited to fatty acids, resulting in the desired softness. Increasing processing time results in an increase in water removal and thus affect the softness of the product (Rehman and Nadeem, 2012).

4.3.6 Spreadability of the spread

The sensory score for spreadability of the spread samples are presented in Table 4. The scores ranged between 7.39±1.20 and 7.67±1.08. Sample BDE was the sample with the most preferred spreadability. From the study there were no significant ($p>0.05$) differences in the spreadability of samples CEF, HIJ and KLM. These however differed from the rest of the samples. Samples ABC and BDE also differed significantly ($p<0.05$) among themselves. The spreadability was also affected by the processing time of the products. Increasing the processing time increased the spreadability rating of the samples developed.

Spreadability, one of the sensory attributes of foods that influence market demand, buying choices, and ultimate depletion is spreadability. It was discovered to be the single most important factor in food among consumers (Gills, 2000). Spreadability is a crucial characteristic of semi-solid food textures. Spreadability is a concept that refers to how simple it is to dilute a sample uniformly. The spreadability of descriptive characteristics was found to be strongly associated with the spreadability of user attributes (Rohm, 1990). Increasing processing times enables the products to attain their desired cooking temperature and thus a perfect product.

4.3.7 Smoothness of the spread

Results for smoothness of the spread are presented in Table 4. The scores ranged between 7.25±1.32 and 7.49±1.10. Sample HIJ was the sample with the most preferred smoothness. From the study there were no significant ($p>0.05$) differences in the smoothness of samples CEF, HIJ and KLM. These however differed from the rest of the samples. Samples ABC and BDE also differed significantly ($p<0.05$) among themselves. The smoothness was affected by the processing time of the products.

The higher the score, the easier it is to spread. This conclusion is also supported by Jinjarek *et al*. (2006) the fatty acid content of the spread or butter affects the softness of the sample, and 80% of the change in smoothness is due to the fatty acid, which gives the desired softness. Increasing processing times causes a change in the configuration of the fatty acids. These tend to vary for the smoothness of the products (Rehman and Nadeem, 2012).

4.3.8 Overall acceptability of the spread

Results for the overall acceptability of the samples are presented in Table 4. The aroma ranged from 7.16±1.30 to 7.86±1.18. From the study sample CEF was accepted by the consumers. Consumers liked the product very much. The study showed that there were no significant ($p>0.05$) differences in the aroma of samples ABC, BDE, CEF, HIJ and KLM. Sample CEF however differed from the rest of the samples.

4.4 Purchasing Decision of Consumers

The purchasing decision of the consumers presented in

Table 5: Purchasing decision of spread

Sample	Yes (%)	No (%)
ABC	96	4
BDE	80	20
CFF	84	16
HIJ	74	26
KLM	80	20

Keys: ABC = (90g Sesame seed, 10g honey, 5mins roasting time), BDE = (80g Sesame seed, 20g honey,10mins roasting time) CFG = (70g Sesame seed, 30g honey, 15mins roasting time) HIJ = (60g Sesame seed, 40g honey, 20mins roasting time) and KLM = (50g Sesame seed, 50g honey,25mins roasting time)

Purchasing decision of the samples was between 74% to 96%. About 96% of the consumers chose sample ABC. Sample CEF was also chosen by 84% of the consumers. The study revealed that samples BDE and KLM were chosen by 80% of the consumers. The least sample chosen by the consumers was HIJ. This was chosen by 74% of the consumers. Purchasing decisions are made by consumers per certain criteria. These include colour, appearance, flavour, taste and texture (Owiredu and Barima, 2013).

4.5 Ratings for most important Attribute

The most important sensory attribute to the consumers when making purchasing decisions were also rated. The results are presented in Table 6. The study revealed that Aroma (24%) was highly rated by the consumers. This was followed by smoothness (22%) of the product. Colour, spreadability and overall acceptability were all rated by the consumers at 10%. The least important sensory attribute was taste (4%).

Table 6: Most important sensory attribute of spread to consumers

Sensory attribute	Frequency	Percentage (%)
Colour	5	10
Aroma	12	24
Appearance	6	12
Taste	2	4
Softness	4	8
Spreadability	5	10
Smoothness	11	22
Overall acceptability	5	10

It comes to infer that all the panellist in making decisions were more used to the Aroma and smoothness of spread in relations to non-volatile compounds combining to create a special combination of salty, soft, and smooth notes associated with spread (Treuille and Ferrigno, 2008); hence the preference for the Aroma and smoothness.

4.6 Shelf Life Using Microbiological Indicators

Results for microbial safety and quality of the sesame-honey spread are shown in Table 7. From the results *E. coli, S. aureus* and *salmonella typhi* were not detected in the product. There were also zero (0) counts for yeats and mold. The study however sound that the total viable count was less than 30cfu/ml. the total coliform count was also found to be less than 10cfu/ml.

Table 7: Microbiological safety and quality of sesame-honey spread

Test	Unit	Results	Specification
Total viable count	Cfu/g	< 30	1.0×10^4
Total Coliform count	Cfu/g	< 10	1.0×10^2
E. coli	Cfu/g	Not detected	0.00
S. aureus	Cfu/g	Not detected	0.00
Salmonella typhi	Cfu/g	Not detected	0.00
Yeast	Cfu/g	0.00	1.0×10^2
Molds	Cfu/g	0.00	1.0×10^1

The results from the quality assessment of the product indicate a highly hygienic and safe product with no food pathogen detected. The microbial counts factoring the total viable, Coliform, yeast and mold counts were all within specification, further highlighting the quality and safety of the product. The detailed product safety assessment is provided in table 4.6. These observations are lower than the 10cfu/g reported in Algeria (Adjlane *et al*, 2014) and the 100CFU·g^{-1} in Romania (Popa *et al*., 2009) Nigeria (Omafuvbe and Akanbi, 2009) and Cameroon (Tatsadjieu *et al*., 2005). Total coliforms are lower than 10 in our analysed samples. This indicates good hygienic practice by the manufacturers. The absence offecal coliforms was also served in some honeysamples in Spain (Rall *et al*., 2003), Argentina (Jurlina and Fritz, 2005), and Morocco (Naman *et al*., 2005). However, total coliforms were reported (between1cfu/gand3.10cfu/g) in Nigeria (Omafuvbe and Akanbi, 2009).

4.7 Total Aerobic Count

The data obtained from the study showed a very steady rise in aerobic count of the samples over the storage period with the final counts still within the safe limit after the 8 weeks of storage duration. The product stored at elevated temperature (42°C) recorded relatively higher counts than those stored at room temperature (25°C), however the statistical analysis of the data shows the variation to be not significant (P>0.05:P=0.6380). The statistics again show some significant difference (P<0.05:P=0.0007) in the aerobic counts over the storage weeks. All the samples were however, below the maximum acceptable limit of 10^4 (Council, 2009). Good Manufacturing Practices (GMP) such as the addition of filtered and clean water during processing may destroy favourable medium for microbial proliferation (Copetti *et al*., 2011).

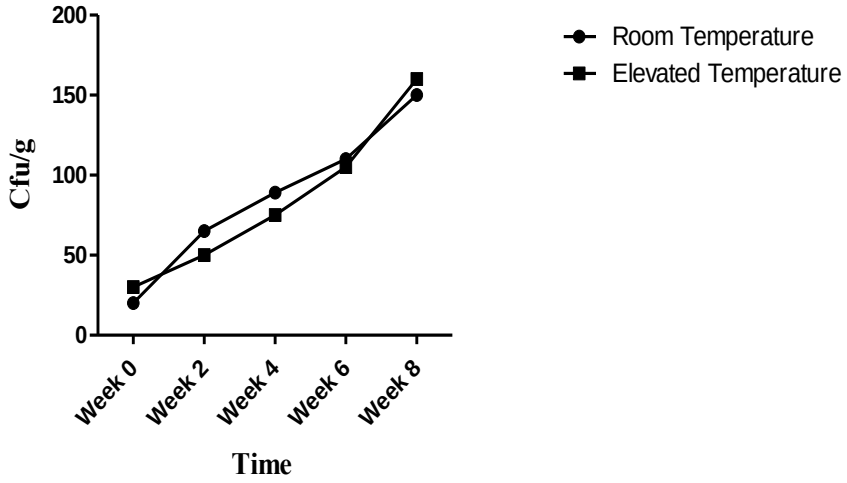


Figure 1: Total aerobic count of Sesame-honey spread over storage period

The data obtained from the storage growth kinetics and dynamics was used in a simulation using mathematical modelling to forecast the shelf life of the product using the aerobic count as predictor. The best model selected for the prediction was the Square root-Y logarithmic-X model: $Y = \left[a + b \ln\left(x \right) \right]^2$. The finding of the analysis and prediction estimates the shelf life of the sesame spread to be 81 weeks when stored at room temperature (25^0C) and 72 weeks when stored at elevated temperature (45^0C). These findings are well buttressed by Sun et al., (2008) who stated that the low temperature blending gives a speedy thickening to the spread and this leads to an extension of the shelf life.

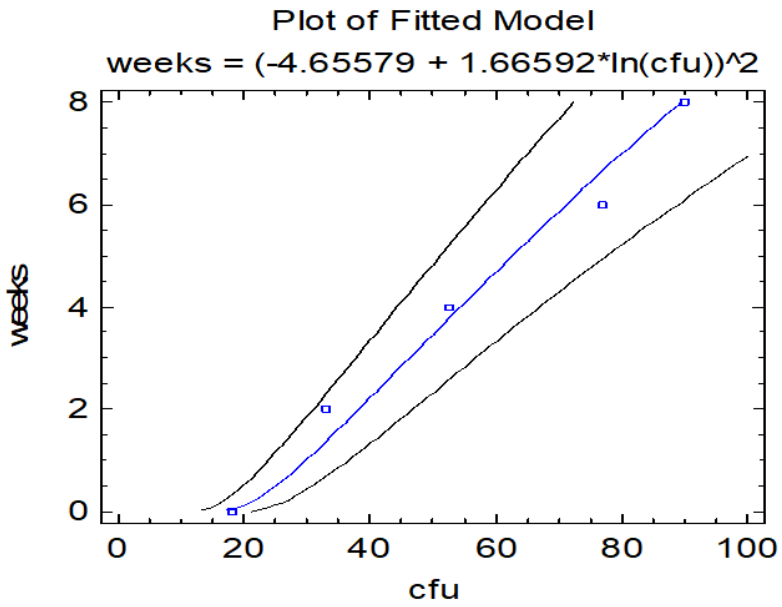


Figure 2: Shelf life of sesame spread using total aerobic count as predictor

4.8 Total Coliform Count

The Coliform profile of the product over the storage period shows a trend quite similar to what was observed for the aerobic count with a gradual and steady increase in population over the storage period. The counts recorded from the product stored at elevated temperature was relatively higher with some statistically significant difference ($P<0.05:P=0.0196$) in the counts at the two storage temperatures as well as significant difference in the counts ($P<0.05:P=0.0005$) recorded over the weeks.

The differences may be attributed to variations in hygienic conditions, as total coliform counts in food samples are indications of poor hygienic practices during and after production on the part of the producer (Reij & Den Aantrekker, 2004). According to the United States Drug Administration indicated that, total coliform levels above 10 cfu/g may be a sign of high contamination which could lead to diarrhoea and other foodborne diseases (Council,

2009). The presence of coliform in the paste samples may be an indication of faecal contamination, which may also have resulted from direct contact of the product with faecal matter, through packaging to storage since most of the coliforms are likely to have been killed during processing (Smith and Stratton, 2007).

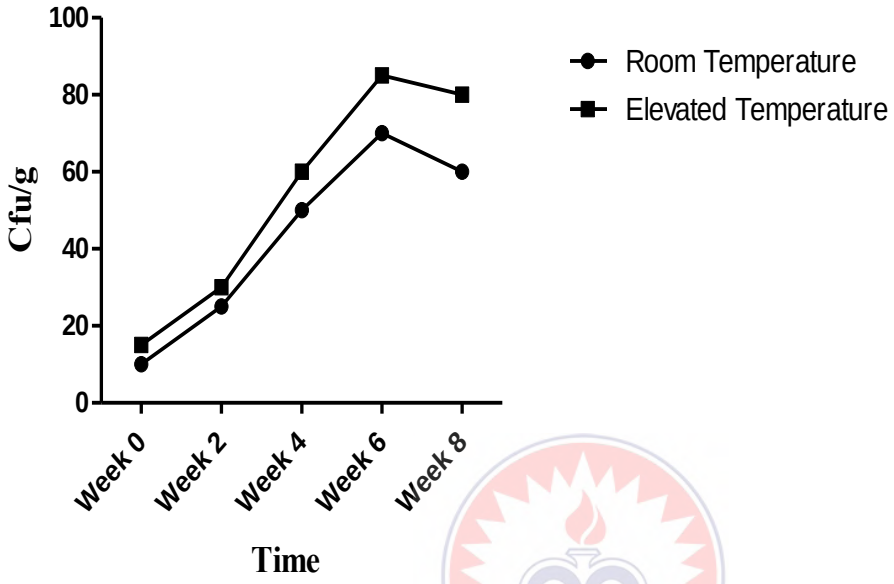


Figure 3: Total Coliform count of Sesame-honey spread over storage period

At higher temperatures microbial action is high and therefore the product spoils quicker. In the case of a product at room temperature, there is less microbial activity. Thus, microorganisms are not able to proliferate in the product (Bornaz *et al*., 1995).

The shelf life that was estimated for the product using the total Coliform count was relatively shorter as compared to the predictions using the aerobic count. The shelf life was obtained using the Square root-Y logarithmic-X model: $Y = \left[a + b\ln\left(x\right)\right]^2$ for the product stored at room temperature and the Squared-X model: $Y = a + bx^2$ for the product stored at elevated temperature.

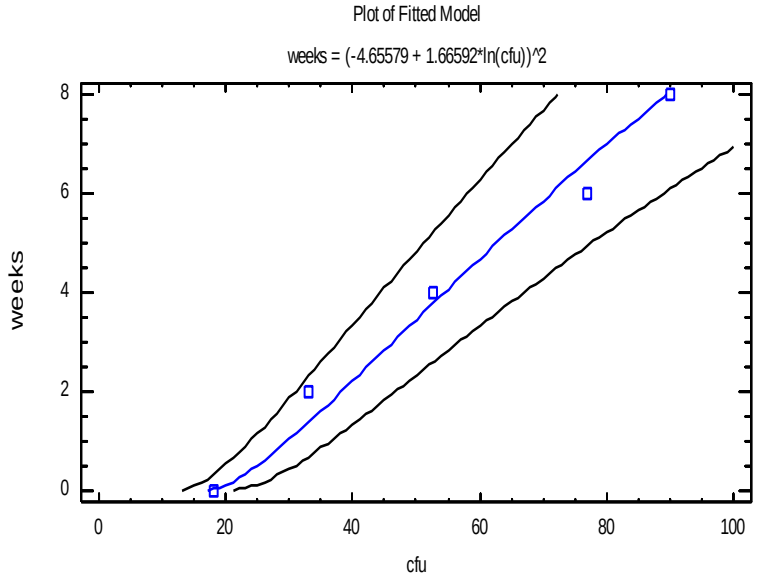


Figure 4: Shelf life of Sesame spread using total Coliform count as predictor

The finding shows the shelf life of the sesame spread to be 9 weeks when stored at room temperature and 10 weeks when stored at elevated temperature (42ºC). The details of the microbial loads of the products at the various storage conditions are provided in

Table 8. The table shows that for all microorganisms studied, the microbial loads increased with an increase in storage time. The rate of increase was however slower in products kept under room temperature (25ºC) than those stored under elevated temperature (47ºC).

Table 8: Microbial loads of sesame-honey spread over time of storage

Weeks	TAC	TCC	Mold
Room Temperature (25°C)			
Week 0	$2.1\times10^{1}\pm1.41$	$1.1\times10^{1}\pm0.71$	0.00
Week 2	$5.3\times10^{1}\pm4.24$	$2.3\times10^{1}\pm2.83$	0.00
Week 4	$7.3\times10^{1}\pm2.83$	$5.6\times10^{1}\pm5.66$	$0.7\times10^{1}\pm3.53$
Week 6	$1.1\times10^{2}\pm4.95$	$6.3\times10^{1}\pm3.54$	$1.0\times10^{1}\pm4.24$
Week 8	$1.6\times10^{2}\pm8.49$	$7.5\times10^{1}\pm4.24$	$1.6\times10^{1}\pm8.49$
Elevated Temperature (47°C)			
Week 2	$6.9\times10^{1}\pm5.66$	$3.3\times10^{1}\pm4.24$	0.00
Week 4	$8.4\times10^{1}\pm7.07$	$5.2\times10^{1}\pm3.53$	$1.1\times10^{1}\pm5.65$
Week 6	$1.2\times10^{2}\pm5.66$	$7.7\times10^{1}\pm4.24$	$1.6\times10^{1}\pm7.07$
Week 8	$1.7\times10^{2}\pm9.19$	$9.0\times10^{1}\pm7.07$	$2.1\times10^{1}\pm8.48$

The overall shelf life of the product using all microbiological predictors featuring the total aerobic count, mold count and total coliform count in a multiple regression modeling gave a linear model of weeks = -1.70563 + 0.0460193*TAC + 0.060447*TCC - 0.124857*MOLDS which when computed gave an ultimate shelf life of 49 weeks when stored at room temperature and 48 weeks when stored at elevated temperature using the model: weeks = -2.16549 + 0.047473*tac + 0.0577516*tcc - 0.0980034*molds.

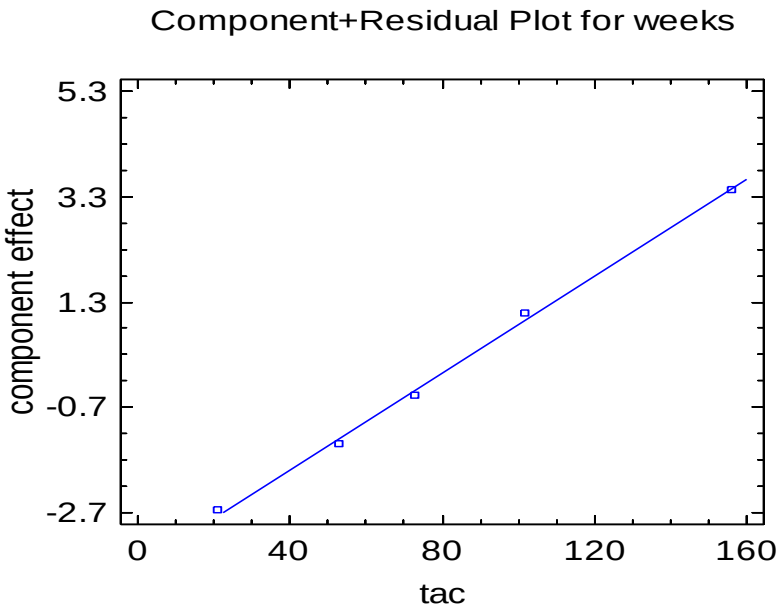


Figure 5: Overall shelf-life determination using microbiological predictors

Although the number of microbes is higher in products with a shelf life of more than six weeks, products with a shelf life of more than six weeks have shown a sharp decline in microbial quality. The fresh samples also appeared to have lower microbial properties than the older samples, but were similar to the values achieved by the ten month samples. However, in a similar study, the microbial numbers of tahini decreased significantly after four months of storage (Yamani and Isa, 2006). Deviations in our results could be due to the fact that it was not the same fresh sample, but samples from different batches that were examined regardless of the assignment to the same manufacturer. In both cases it is evident that fresh and aged samples are susceptible to microbial contamination. In addition, the results of the current study agree with the results of the study by Torlak et al. (2013), in which the existence of dangerous microbes in sesame paste products was proven even after prolonged storage. Al-Holy et al. (2017) observed a decrease in the number of Salmonella in halva with increasing storage time. The decrease in microbial levels could be due to bacterial

competition for resources that are limited in vacuum-sealed packaging. However, the microbe was still present in dangerous amounts even after a long time, possibly due to the protective effects of foods high in fat and moisture on certain bacteria.

Bacteria usually do not survive in dry environments, but some can survive dormantly and, as in the case of Salmonella, reactivate when conditions return to normal. Similar studies have shown that Salmonella survived in tahini after 16 weeks of storage (Torlak et al 2013). Salmonella also survived in tahini for up to 8 months. Meanwhile, Al-Holy et al. (2013) E. coli was found to have survived in tahini after 28 days of storage. In Halva, Staphylococcus aureus was still present in the sample after 9 months (Kotzekidon, 1998). Tahini has low water activity, and foods with low water activity are considered free of microbial contamination. However, that is not the case. In the United States, between 2007 and 2012, 5,141 foods with low water activity due to pathogens were recalled (USDA, 2012). Food and water-based pathogens adversely affect food quality, can adversely affect human health, and are the leading cause of illness worldwide (USDA, 2012). In general, contamination can result from the use of contaminated water during cleaning, soaking, or brining, or mutual contamination during outdoor processes such as crushing and filling, or improper storage conditions in the factory (UNIDO). , 2003). More specifically, Staphylococcus aureus often invades food through the skin surface of employees (Atlas, 2006). Bacteria can freeze in the air and can be exposed to the environment for a long time. This is a large number of S. Can lead to Ure Res. Major Health Effects This may be due to the high microbial numbers of Ure Res, which involves the production of toxins. Yeast and mold are widespread in the environment as air, water, soil and dust pollutants and are at risk from mycotoxin production and allergic reactions (Jarvis et al., 1983). During the study, worms appeared in SDA agar, indicating the presence of insect eggs in their respective samples. Insect eggs can result from

improper handling and storage and can have a negative impact on a person's health. On the other hand, coliforms, mainly E. coli, are often used as indicators of human feces. Coliforms can cause gastrointestinal infections, and some E. coli strains can cause severe kidney disease and can be fatal (Atlas, 2006). The presence of high coliform numbers in food has led to the use of contaminated water during production (UNIDO, 2003). Salmonella is another deadly germ when ingested. Various Salmonella species are usually etiological agents of salmonellosis, bacteremia, and typhoid, requiring a small amount of salmonella typhi. The most commonly recognized sources of Salmonella infection are birds and domestic poultry, including their eggs (Atlas, 2006). Handling contaminated water and food products from individuals infected with this bacterium can also lead to the spread of microorganisms (UNIDO, 2003). Insects are also capable of transferring salmonella to intake or physical contact (Soto-Arias et al. 2017). Inadequate roasting temperatures can lead to insufficient clearance of salmonella (UNIDI, 2003). The results indicate that some tahini made in Lebanon can have dangerous and even fatal effects. In addition, about 35 percent of the production of tahini in the country is exported, mainly to the United States, the European Union, Australia and the GCC.

4.9 Shelf Life Using Physicochemical Indicator

The parameter considered for the shelf-life prediction is the Free Fatty Acid (FFA) content of the surrounding oil which gives an index of the oxidation and rancidity of the oil and impacts the taste and smell thus affecting consumer acceptability.

The free fatty acid content for the product was 0.12 after production. This value increased for products stored under both room and elevated temperatures. At the end of the 8 weeks of storage, the product stored under room temperature (25^{o}C) had a free fatty acid content of

0.28. However, a free fatty acid content of 0.30 was recorded for the product stored under elevated temperature (45°C).

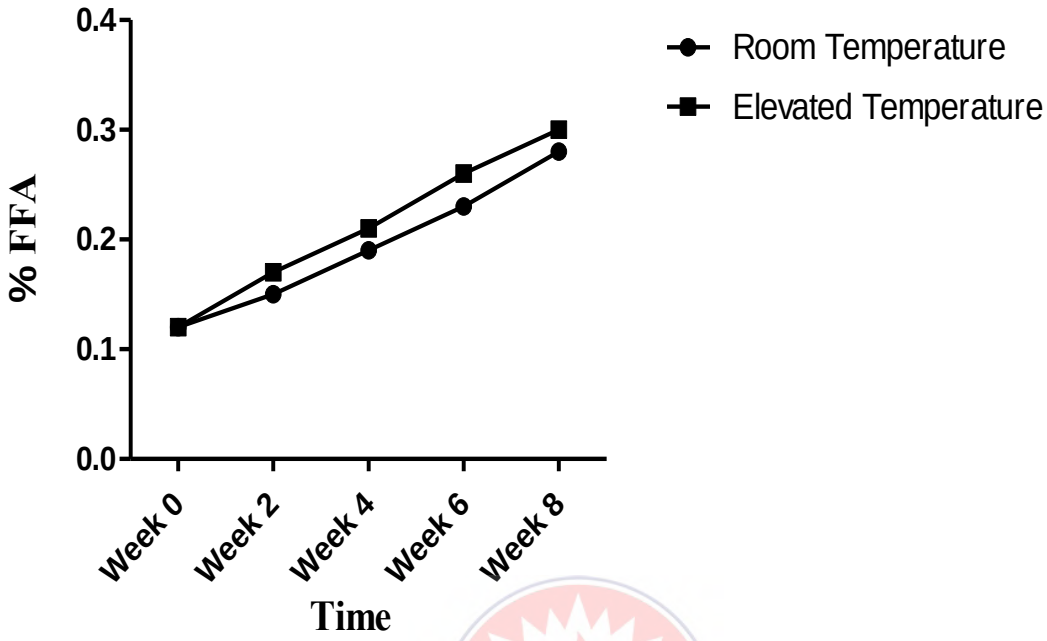


Figure 6: Free Fatty Acid content of sesame spread over storage period

The finding of the assay using the FFA as predictor indicates the shelf life of the spread stored at room temperature to be 44 weeks using the Linear model: $Y = a + bx$ and 39 weeks when stored at elevated temperature using same model.

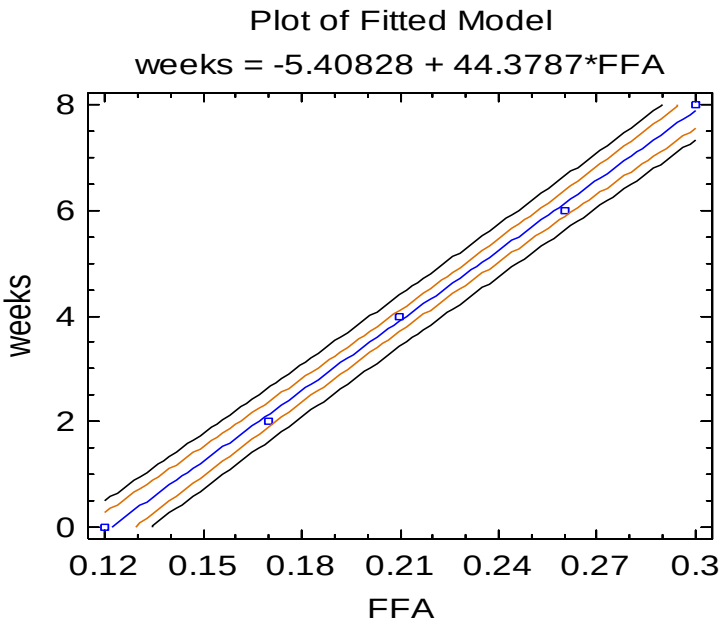


Figure 7: Shelf-life of sesame spread using FFA as predictor

Considering all the data gathered the shelf life of the Sesame-honey spread is 46 weeks when stored at room temperature and 44 weeks when stored at elevated temperature. This thus puts the shelf life of the spread as 12 months when stored at room temperature (25^0C) and 11 months when stored at elevated temperature (45^0C).

Table 9: Free Fatty Acid content of sesame spread oil over duration of storage

Time	Room Temperature	Elevated Temperature
Week 0	0.12	0.12
Week 2	0.15	0.17
Week 4	0.19	0.21
Week 6	0.23	0.26
Week 8	0.28	0.30

Lipid fatty acid composition variations serve as an indirect indicator of susceptibility to lipid oxidation. Seeds can be stored for up to 25 years in ideal conditions, but they become inedible within a month due to insects, mold, absorption of foreign flavors, discoloration, staleness, or rancidity in unsuitable storage conditions.

The fat content only is not a reliable predictor of storage stability. (Pershen *et al*., 1995) but the degree of unsaturation or polyunsaturation (Labuza and Dugan, 1971), tocopherols, chlorophyll and beta carotene , moisture content and temperature (Hasenhuetti *et al*., 1992; Reynhout, 1991) disturb main fat oxidation and oxidative steadiness of intermediate moisture foods during storage. In the occurrence of oxygen, oxidative reactions take precedence, and therefore the storage life of the food product is restricted by the production of oxidative rancidity of fat (Maskan and Karatas, 1998; Bremmer *et al*., 1976). The effects of various antioxidants on the oxidative stability of plant-derived oils and fats have been extensively studied, with promising results in terms of protecting oils and fats from oxidation. Several researchers have looked into the use of natural antioxidants and natural products Azizkhani *et al*., 2011; Nahm *et al*., 2012). Judde et al. (2003) discovered that adding 1 percent (w/w) soy lecithin to rapeseed, soy, walnut, and palm oils delayed oxidation by increasing induction time by 1.7–1.8 times when measured at 110 °C and reducing peroxide values by 2.2–4.6 folds when heated at 40 °C for 35 days. Pecan and pistachio oils were the most stable, while sesame and walnut oils were the least stable due to unsaturated fatty acid levels, according to Miraliakbari & Shahidi (2008). Antioxidants can be used to regulate the oxidation of oils and fats, as well as processing methods that reduce tocopherol and other natural antioxidant losses (Allen and Hamilton, 1994).

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1 Introduction

The study developed a standard recipe for the production of spread using sesame seed and honey blends. It also summarizes the key findings of the study, as well as conclusion based on the findings of the research. Finally, suggestions for further studies and recommendation were made.

5.2 Summary of Findings

Samples of Fifty (50) untrained respondents who consume spread were selected for the study. A sensory evaluation test was used to collect the data from respondents. Data were analyzed into frequencies, percentages and cross-tabulation tables and one-way analysis of variance using Statistical Package for Social Solutions (SPSS 22).

Sesame-Honey blends was produced using varying proportion of roasted sesame, honey and processing time in the proportion of 90g: 10ml :1minute, 80g: 20ml :2minutes, 70g: 30ml :3minutes, 60g: 40ml :4minutes and 50g: 50ml :5minutes and then analysed for proximate composition and shelf life test. All data generated in the studies were analysed statistically with SPSS. The results of proximate composition of the various flour indicated increasing level of moisture and carbohydrate while there was decrease in levels of ash, protein, fat and fibre as the proportion of the honey and processing time increased. Sensory evaluation of the spread showed that the sample produced from the 70g sesame, 30ml honey and 3 minutes roasting time was much more preferred to that from the rest of the spreads in terms of overall acceptability.

5.3 Conclusion

Five types of spread were produced from the blends. They had various percentages of Sesame seed, honey and varying roasting time.

The study concludes that sample ABC (*90g Sesame seed, 10g honey, 15 mins roasting time*) had the least moisture content and carbohydrate. It again had the highest content of Ash, Protein, Fat, Free fatty acid and Fibre. Sample HIJ (*60g Sesame seed, 40g honey, 20mins roasting time*) however had the highest content of total sugars. Sample HIJ (*60g Sesame seed, 40g honey, 20mins roasting time*) was again rated highest in relation to colour and smoothness. BDE *(80g Sesame seed, 20g honey, 15 mins roasting time)* was rated highest for spreadability. CFF *(70g Sesame seed, 30g honey, 15mins roasting time)* had the highest rating for Aroma, appearance, softness and overall acceptability.

No *E. coli, S. aureus* and *salmonella typhi* were detected in the samples. Total viable count, total coliform count, yeast and mold were however detected. Upon storage their numbers increased. Samples stored in refrigerated conditions had lower microbial numbers compared to those stored in ambient conditions

5.4 Recommendations

In view of these research findings, further research must be undertaken to examine the likelihood of using roasted Sesame seed and honey as ingredients in other food products in order to increase the usage of such key food ingredients.

The mineral components should also be ascertained to know the benefits associated with the product in that aspect.

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APPENDIX 1

SCORE SHEET FOR SENSORY EVALUATION DATA

University of Education, Winneba, Kumasi Campus

College of Technology Education

Department of Hospitality and Tourism Education

Sample: sesame spread

Age …… **Sex: …….**

You have been provided with sesame spread and you are expected to make a fair assessment based on a 9-point hedonic scale. That is;

9 = like extremely, 8 = like very much, 7 = like moderately, 6 = like slightly, 5 = neither like nor dislike, 4 = dislike slightly, 3 = dislike moderately, 2 = dislike very much, 1 = dislike extremely

Sample codes	**SENSORY QUALITY ATTRIBUTES**							
	Colour	Aroma	Appearance	Taste	Softness	Spreadability	Smoothness	Overall Acceptability
A								
B								
C								
D								
E								

Purchasing decision:

Please indicate if you will be willing to buy the product on the market

Sample Code	Purchasing decision	
	Yes	No
A		
B		
C		
D		
E		

What is the most important sensory attribute for spreads? Please **circle only one**

[ ] Colour [ ] Aroma [ ] Appearance

[ ] Taste [ ] Softness [ ] Spreadability

[ ] Smoothness [ ] Overall Acceptability

Additional comment (if any)

……..

……..

……..

……..

APPENDIX 2: RAW DATA

Table 10: Statistical analysis of microbiological indicators for shelf-life determination

Parameter				
Table Analyzed				
Two-way ANOVA				
Source of Variation	% of total variation	P value		
Interaction	14.21	< 0.0001		
Column Factor	53.38	< 0.0001		
Row Factor	31.06	< 0.0001		
Source of Variation	P value summary	Significant?		
Interaction	***	Yes		
Column Factor	***	Yes		
Row Factor	***	Yes		
Source of Variation	Df	Sum-of-squares	Mean square	F
Interaction	8	8189	1024	19.55
Column Factor	2	30768	15384	293.8
Row Factor	4	17902	4476	85.47
Residual	15	785.5	52.37	
Number of missing values	0			
Bonferroni posttests				

Total aerobic count vs Total Coliform count				
Row Factor	Total aerobic count	Total Coliform count	Difference	95% CI of diff.
Week 0	25.00	12.50	-12.50	-36.28 to 11.28
Week 2	57.50	27.50	-30.00	-53.78 to -6.221
Week 4	82.00	55.00	-27.00	-50.78 to -3.221
Week 6	107.5	77.50	-30.00	-53.78 to -6.221
Week 8	155.0	70.00	-85.00	-108.8 to -61.22
Row Factor	Difference	t	P value	Summary
Week 0	-12.50	1.727	P > 0.05	ns
Week 2	-30.00	4.146	P<0.01	**
Week 4	-27.00	3.731	P < 0.05	*
Week 6	-30.00	4.146	P<0.01	**
Week 8	-85.00	11.75	P<0.001	***
Total aerobic count vs mold				
Row Factor	Total aerobic count	mold	Difference	95% CI of diff.
Week 0	25.00	0.0	-25.00	-48.78 to -

				1.221
Week 2	57.50	0.0	-57.50	-81.28 to -33.72
Week 4	82.00	7.500	-74.50	-98.28 to -50.72
Week 6	107.5	12.50	-95.00	-118.8 to -71.22
Week 8	155.0	15.00	-140.0	-163.8 to -116.2
Row Factor	Difference	t	P value	Summary
Week 0	-25.00	3.455	P < 0.05	*
Week 2	-57.50	7.946	P<0.001	***
Week 4	-74.50	10.30	P<0.001	***
Week 6	-95.00	13.13	P<0.001	***
Week 8	-140.0	19.35	P<0.001	***

Table 11: Statistical analysis of the total aerobic count of sesame spread over time

Parameter				
Table Analyzed	TAC			
Two-way ANOVA				
Source of Variation	% of total variation	P value		
Column Factor	0.10	0.6380		
Row Factor	98.37	0.0007		
Source of Variation	P value summary	Significant?		
Column Factor	ns	No		
Row Factor	***	Yes		
Source of Variation	Df	Sum-of-squares	Mean square	F
Column Factor	1	19.60	19.60	0.2584
Row Factor	4	19541	4885	64.41
Residual	4	303.4	75.85	
Number of missing values	0			

Table 12: Statistical analysis of total Coliform count of Sesame spread

Parameter				
Table Analyzed	TCC			
Two-way ANOVA				
Source of Variation	% of total variation	P value		
Column Factor	4.62	0.0196		
Row Factor	94.09	0.0005		
Source of Variation	P value summary	Significant?		
Column Factor	*	Yes		
Row Factor	***	Yes		
Source of Variation	Df	Sum-of-squares	Mean square	F
Column Factor	1	302.5	302.5	14.24
Row Factor	4	6165	1541	72.53
Residual	4	85.00	21.25	
Number of missing values	0			

Table 13: Statistical analysis of Free Fatty Acid content of sesame spread oil

Parameter				
Table Analyzed	FFA			
Two-way ANOVA				
Source of Variation	% of total variation	P value		
Column Factor	4.62	0.0196		
Row Factor	94.09	0.0005		
Source of Variation	P value summary	Significant?		
Column Factor	*	Yes		
Row Factor	***	Yes		
Source of Variation	Df	Sum-of-squares	Mean square	F
Column Factor	1	302.5	302.5	14.24
Row Factor	4	6165	1541	72.53
Residual	4	85.00	21.25	
Number of missing values	0			

Descriptive Statistics

Dependent Variable: scores

attribute	Product	Mean	Std. Deviation	N
colour	ABC	6.92	1.481	51
	BDE	7.04	1.442	51
	CFG	6.92	1.534	51
	HIJ	7.47	1.362	51
	KLM	7.39	1.313	51
	Total	7.15	1.437	255
aroma	ABC	7.08	1.353	50
	BDE	7.10	1.361	52
	CFG	7.57	1.389	51
	HIJ	7.18	1.717	51
	KLM	7.27	1.343	51
	Total	7.24	1.440	255
appearance	ABC	7.32	1.332	50
	BDE	7.08	1.281	52
	CFG	7.55	1.254	51
	HIJ	7.27	1.457	51
	KLM	7.49	1.255	51
	Total	7.34	1.318	255
taste	ABC	7.40	1.414	50

	BDE	7.35	1.454	52
	CFG	7.43	1.460	51
	HIJ	7.35	1.354	51
	KLM	7.67	1.033	51
	Total	7.44	1.347	255
softness	ABC	7.66	1.081	50
	BDE	7.29	1.304	52
	CFG	7.98	1.208	51
	HIJ	7.25	1.534	51
	KLM	7.37	1.341	51
	Total	7.51	1.322	255
spreadability	ABC	7.30	1.619	50
	BDE	7.67	1.080	52
	CFG	7.53	1.689	51
	HIJ	7.59	1.186	51
	KLM	7.39	1.201	51
	Total	7.50	1.371	255
smoothness	ABC	7.38	1.105	50
	BDE	7.25	1.607	52
	CFG	7.45	1.474	51
	HIJ	7.49	1.102	51
	KLM	7.25	1.324	51

	Total	7.36	1.333	255
overall acceptability	ABC	7.48	1.502	50
	BDE	7.19	2.058	52
	CFG	7.86	1.184	51
	HIJ	7.16	1.302	51
	KLM	7.25	1.671	51
	Total	7.39	1.586	255
Total	ABC	7.32	1.377	401
	BDE	7.25	1.474	415
	CFG	7.54	1.428	408
	HIJ	7.35	1.385	408
	KLM	7.39	1.316	408
	Total	7.37	1.399	2040

scores						
	N	Mean	Std. Deviation	Std. Error	Minimum	Maximum
colour	255	7.15	1.437	.090	1	9
aroma	255	7.24	1.440	.090	2	9
appearance	255	7.34	1.318	.083	2	9
taste	255	7.44	1.347	.084	2	9

softness	255	7.51	1.322	.083	2	9
spreadability	255	7.50	1.371	.086	1	9
smoothness	255	7.36	1.333	.083	2	9
overall acceptability	255	7.39	1.586	.099	1	9
Total	2040	7.37	1.399	.031	1	9

Test of Homogeneity of Variances

scores

Levene Statistic	df1	df2	Sig.
1.465	7	2032	0.175

ANOVA

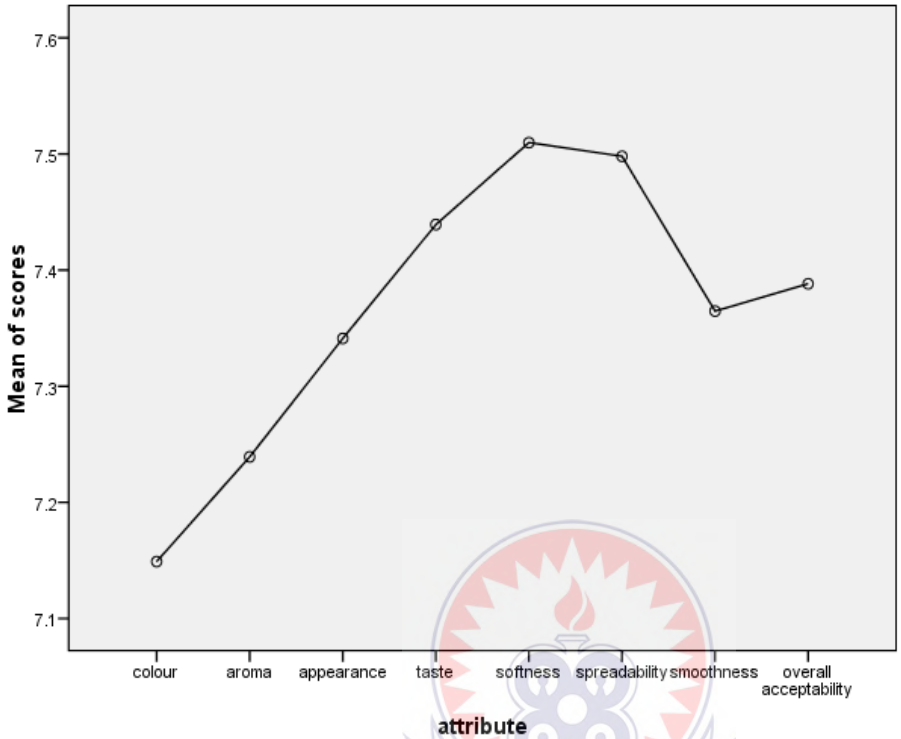
scores					
	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	27.474	7	3.925	2.012	0.050
Within Groups	3963.992	2032	1.951		
Total	3991.466	2039			

Dependent Variable: scores					
	(I) attribute	(J) attribute	Mean Difference (I-J)	Std. Error	Sig.
LSD	colour	aroma	-.090	.124	.466
		appearance	-.192	.124	.120
		taste	-.290*	.124	.019
		softness	-.361*	.124	.004
		spreadability	-.349*	.124	.005
		smoothness	-.216	.124	.081
		overall acceptability	-.239	.124	.053
	aroma	colour	.090	.124	.466
		appearance	-.102	.124	.410
		taste	-.200	.124	.106
		softness	-.271*	.124	.029
		spreadability	-.259*	.124	.037
		smoothness	-.125	.124	.310
		overall acceptability	-.149	.124	.228
	appearance	colour	.192	.124	.120
		aroma	.102	.124	.410
		taste	-.098	.124	.428

		softness	-.169	.124	.173
		spreadability	-.157	.124	.205
		smoothness	-.024	.124	.849
		overall acceptability	-.047	.124	.704
	taste	colour	.290*	.124	.019
		aroma	.200	.124	.106
		appearance	.098	.124	.428
		softness	-.071	.124	.568
		spreadability	-.059	.124	.634
		smoothness	.075	.124	.547
		overall acceptability	.051	.124	.680
	softness	colour	.361*	.124	.004
		aroma	.271*	.124	.029
		appearance	.169	.124	.173
		taste	.071	.124	.568
		spreadability	.012	.124	.924
		smoothness	.145	.124	.241
		overall acceptability	.122	.124	.326
	spreadability	colour	.349*	.124	.005

		aroma	.259*	.124	.037
		appearance	.157	.124	.205
		taste	.059	.124	.634
		softness	-.012	.124	.924
		smoothness	.133	.124	.281
		overall acceptability	.110	.124	.375
	smoothness	colour	.216	.124	.081
		aroma	.125	.124	.310
		appearance	.024	.124	.849
		taste	-.075	.124	.547
		softness	-.145	.124	.241
		spreadability	-.133	.124	.281
		overall acceptability	-.024	.124	.849
	overall acceptability	colour	.239	.124	.053
		aroma	.149	.124	.228
		appearance	.047	.124	.704
		taste	-.051	.124	.680
		softness	-.122	.124	.326
		spreadability	-.110	.124	.375
		smoothness	.024	.124	.849

*. The mean difference is significant at the 0.05 level.		



scores						
	N	Mean	Std. Deviation	Std. Error	Minimum	Maximum
ABC	401	7.32	1.377	.069	1	9
BDE	415	7.25	1.474	.072	1	9
CFG	408	7.54	1.428	.071	1	9
HIJ	408	7.35	1.385	.069	2	9
KLM	408	7.39	1.316	.065	1	9
Total	2040	7.37	1.399	.031	1	9

Test of Homogeneity of Variances

scores

Levene Statistic	df1	df2	Sig.
1.127	4	2035	.342

ANOVA

scores

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	19.224	4	4.806	2.462	.043
Within Groups	3972.242	2035	1.952		
Total	3991.466	2039			

Dependent Variable:scores

	(I) product	(J) product	Mean Difference (I-J)	Std. Error	Sig.
LSD	Product A	BDE	.071	.098	.469
		CFG	-.220*	.098	.025
		HIJ	-.029	.098	.769
		KLM	-.071	.098	.473
	Product B	ABC	-.071	.098	.469
		CFG	-.291*	.097	.003
		HIJ	-.100	.097	.306
		KLM	-.141	.097	.147
	Product C	ABC	.220*	.098	.025
		BDE	.291*	.097	.003
		HIJ	.191	.098	.051
		KLM	.150	.098	.127
	Product D	ABC	.029	.098	.769
		BDE	.100	.097	.306
		CFG	-.191	.098	.051
		KLM	-.042	.098	.670
	Product E	ABC	.071	.098	.473
		BDE	.141	.097	.147

	CFG	-.150	.098	.127
	HIJ	.042	.098	.670

*. The mean difference is significant at the 0.05 level.

TWO-WAY ANOVA

Levene's Test of Equality of Error Variances[a]

Dependent Variable:scores

F	df1	df2	Sig.
1.655	39	2000	.007

Tests the null hypothesis that the error variance of the dependent variable is equal across groups.

a. Design: Intercept + attribute + product + attribute * product

Dependent Variable:scores

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	104.415[a]	39	2.677	1.378	.061
Intercept	110686.901	1	110686.901	5.695E4	.000

attribute	27.494	7	3.928	2.021	.049
product	19.234	4	4.809	2.474	.043
attribute * product	57.686	28	2.060	1.060	.380
Error	3887.051	2000	1.944		
Total	114683.000	2040			

a. R Squared = .026 (Adjusted R Squared = .007)

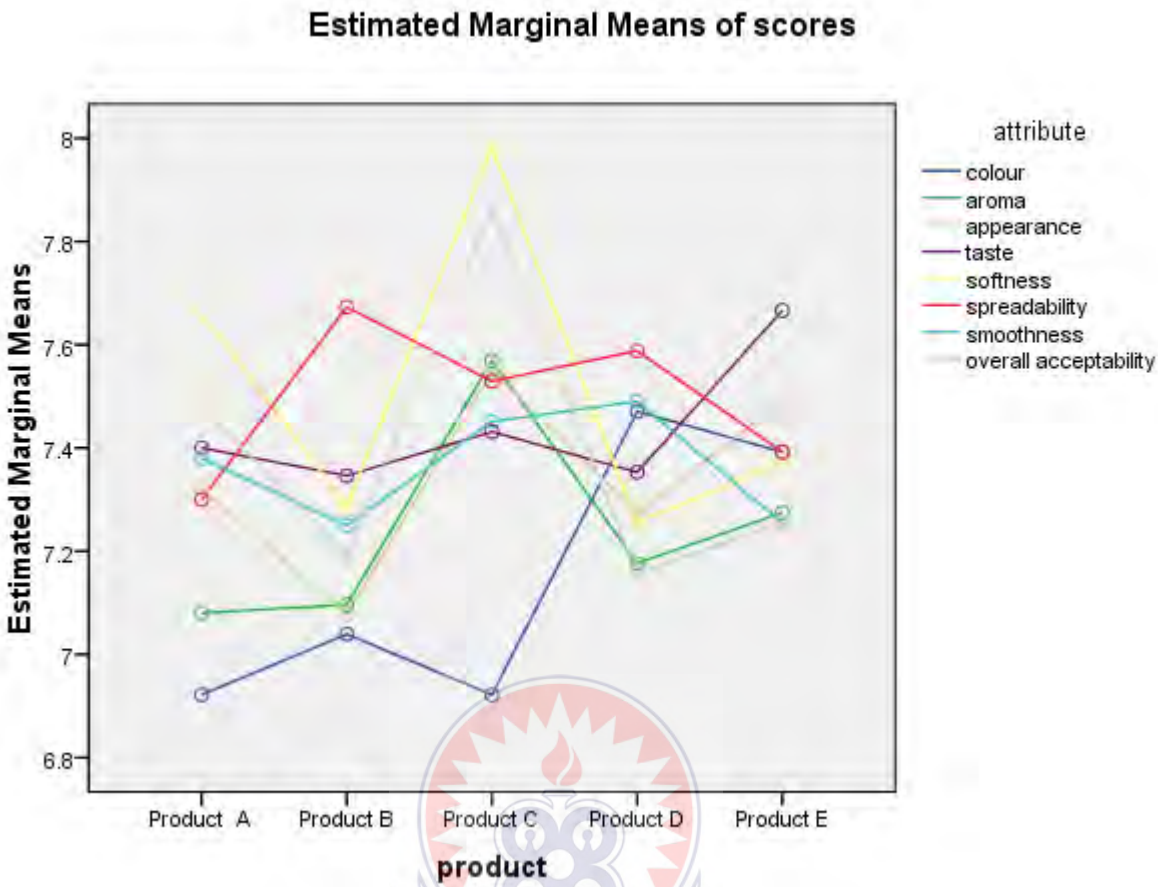
3. attribute * product

Dependent Variable:scores

attribute	product	Mean	Std. Error	95% Confidence Interval	
				Lower Bound	Upper Bound
colour	ABC	6.922	.195	6.539	7.304
	BDE	7.039	.195	6.656	7.422
	CFG	6.922	.195	6.539	7.304
	HIJ	7.471	.195	7.088	7.853
	KLM	7.392	.195	7.009	7.775
aroma	ABC	7.080	.197	6.693	7.467
	BDE	7.096	.193	6.717	7.475
	CFG	7.569	.195	7.186	7.951

	HIJ	7.176	.195	6.794	7.559
	KLM	7.275	.195	6.892	7.657
appearance	ABC	7.320	.197	6.933	7.707
	BDE	7.077	.193	6.698	7.456
	CFG	7.549	.195	7.166	7.932
	HIJ	7.275	.195	6.892	7.657
	KLM	7.490	.195	7.107	7.873
taste	ABC	7.400	.197	7.013	7.787
	BDE	7.346	.193	6.967	7.725
	CFG	7.431	.195	7.049	7.814
	HIJ	7.353	.195	6.970	7.736
	KLM	7.667	.195	7.284	8.050
softness	ABC	7.660	.197	7.273	8.047
	BDE	7.288	.193	6.909	7.668
	CFG	7.980	.195	7.598	8.363
	HIJ	7.255	.195	6.872	7.638
	KLM	7.373	.195	6.990	7.755
spreadability	ABC	7.300	.197	6.913	7.687
	BDE	7.673	.193	7.294	8.052
	CFG	7.529	.195	7.147	7.912
	HIJ	7.588	.195	7.205	7.971
	KLM	7.392	.195	7.009	7.775

smoothness	ABC	7.380	.197	6.993	7.767
	BDE	7.250	.193	6.871	7.629
	CFG	7.451	.195	7.068	7.834
	HIJ	7.490	.195	7.107	7.873
	KLM	7.255	.195	6.872	7.638
overall acceptability	ABC	7.480	.197	7.093	7.867
	BDE	7.192	.193	6.813	7.571
	CFG	7.863	.195	7.480	8.246
	HIJ	7.157	.195	6.774	7.540
	KLM	7.255	.195	6.872	7.638



PURCHASING DECISION BY CONSUMERS

PRODUCT	YES%	NO%	TOTAL%
A	96.0	4.0	100
B	80.0	20.0	100
C	**84.0**	**16.0**	**100**
D	74.0	26.0	100
E	80.0	20.0	100

ProductA

	ProductA	Frequency	Percent	Cumulative Percent
	no	2	4.0	4.0
	yes	48	96.0	100.0
	Total	50	100.0	

ProductB

	Product B	Frequency	Percent	Cumulative Percent
	no	10	20.0	20.0
	yes	40	80.0	100.0
	Total	50	100.0	

Product C

	ProductC	Frequency	Valid Percent	Cumulative Percent
	no	8	16.0	16.0
	yes	42	84.0	100.0
	Total	50	100.0	
Total		2382		

Product D					
	Product D	Frequency	Percent	Valid Percent	Cumulative Percent
	no	13	.5	26.0	26.0
	yes	37	1.6	74.0	100.0
	Total	50	2.1	100.0	

Product E

	Product E	Frequency	Valid Percent	Cumulative Percent
	No	10	20.0	20.0
	yes	40	80.0	100.0
	Total	50	100.0	

Most importance sensory attribute for spread

	Sensory Attributes	Frequency	Percent	Cumulative Percent
	Colour	5	10.0	10.0
	Aroma	12	24.0	34.0
	appearance	6	12.0	46.0
	Taste	2	4.0	50.0
	Softness	4	8.0	58.0
	spreadability	5	10.0	68.0

	smoothness	11	22.0	90.0
	overall acceptability	5	10.0	100.0
	Total	50	100.0	

APPENDIX 3

Sesame Plant

Raw and Roasted Sesame Seed

Finished Sesame Spread