EFFECTS OF THICKENER TYPE AND CONCENTRATION ON QUALITY PROPERTIES OF BAOBAB DRIED FRUIT PULP FORTIFIED LOW – FAT YOGHURT

BY

HASSAN MOHAMMED GWARZO

SPS/12/MAS/00007

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DECLARATION

I hereby declare that this dissertation is the product of my research efforts undertaken under the supervision of (Professor B.F. Muhammad) has not been presented and will not be presented elsewhere for the award of Degree or Certificate. All references made to published literature have been duly acknowledged.

Hassan Mohammed Gwarzo

SPS/12/MAS/00007

CERTIFICATION

This is to certify that the research work for this dissertation and subsequent write- up (Hassan Mohammed Gwarzo,SPS/12/MAS/00007) were carried out under my supervision.

Prof. B.F Muhammad Supervisor	Date
Dr. M. Baba The Head of Department	Date

APPROVAL PAGE

This Dissertation titled "Effects of Thickener type and Concentration on Quality Properties of Baobab Dried Fruits Pulp Fortified Low – Fat Yoghurt" has been examined and approved for the award of the Degree of MASTER OF SCIENCE IN ANIMAL SCIENCE

________________________ ________________________
External Examiner Date

________________________ ________________________
Prof. B.F. Muhammad Date
Supervisor

________________________ ________________________
Dr. M. Baba Date
Head of Department, Animal Science

____
Dr. Amina A. Mustapha
Faculty Postgraduate Representative ________________________
Date

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DEDICATION

This research work is dedicated to my Father Late Muhammad Abdullahi, My beloved Mother HajiaDaybat Muhammad, my wifeLubabatu Ibrahim andmy Brothers and Sisters.

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ABSTRACT

The study was carried out to determine chemical properties, sensory properties, mineral composition and microbiological quality of Baobab dried fruit pulp (BDFP) fortified low fat yoghurt stabilized with three (3) thickener type at varying concentration .Skimmed milk powder was processed into yoghurt, fortified with BDFP at 0, 10, 20 and 30% levels and Carbonxymethly Cellulose (CM), Corn starch (CS) and Gum Arabic (GA) were incorporated at 1,2 and 3% concentration levels.The results of chemical properties revealed that there were significant($p<0.05$ differences in protein and fat content of the yoghurt. However, no significant ($p>0.05$) differences in ash, total solid,titratable acidity and pH. But, interaction effects were found to be significant. The results further showed that ash content ranged between (0.35-1.5%) total solid (15-50%), fat (0.38- 1.53), titratable acidity (0.04-1.06%) protein (2.12 – 4.64%) and pH of 4.70 in all yoghurt samples was recorded. Sensory evaluation was conducted by a team of a 10 man panel of judges using 7 point hedonic scale sensory evaluation questionnaire to assesscolour, consistency, flavour, taste, and overall acceptability .The results showed that yoghurt fortified with 30%BDFP, stabilized with 3%sCS was the most generally accepted. The results further revealed that all yoghurt samples were accepted by taste panelists. Microbiological Analysis was conducted for the determination of *Staphylococcus aureus*, *Escherichia coli* and *Salmonella*. The results detected the presence of *Staphyloccocusaureus* in 3yoghsurt samples with high microbial load of 5.2×10^7cfu/ml. *E. coli* was detected in (2) yogurt samples with higher microbial count of 4.1×10^4cfu/ml while no growth with *Salmonella* in all yoghurt samples. The results also showed that all yoghurt samples fell within the acceptable range. Mineral composition of yoghurt samples were determined, the results showed that there were significant ($p<0.05$) differences in Ca, Cu, Zn, P and Fe.However, no significant ($P>0.05$) differences on Mg, Na and K observed, but, interaction effects were found to be significant. The results further indicated that yoghurt stabilized with GA at 3% concentration recorded significantly higher Ca, Mg, Na, K, P, Fe, Zn and Cu contents. It wasconcluded that the optimum thickener is the Cornstarch utilized at 3% concentration and recommended to use baobab fruit pulp at 30% level of inclusion.

CHAPTER ONE

1.0 INTRODUCTION

1.1 BACKGROUND INFORMATION.

In many cultures, especially in the Western world, humans continue to consume milk beyond infancy, using the milk of other animals such as cattle, sheep and goats (Gerosa and Skoet, 2012). The ability to digest milk was mainly limited to children, because adults not produce lactase enzymes. Thousands of years ago, a chance of mutation spread in human population in Europe that enabled the production of lactase in adulthood. This allowed milkto be used as a source of nutrition which could sustain population when other food sources failed. The term milk can be defined as lacteal secretion of mammary gland that is used to nourish the young ones Anonymous, (2016d).Milk is obtained by complete milking of one or more healthy cows and contains not less than 3.25% fat and 6.25% solid not- fat (Pearson,1976). It is a primary source of nutrition for young mammals before they are able to digest other type of food.

The female of all mammals can produce milk, but cow milk dominates commercial production; cow milk is produced on an industrial scale in Europe and is by far the most commonly consumed milk type.In 2011, FAO estimated that 85% of all milk worldwide was produced from the cow (Gerosa and Skeot, 2012). Other sources of milk beside that of cattle include buffalo, goats, sheep, camel, donkey, horse, reindeer and yak. The first four animals produced about 11%, 2%, 1.4% and 0.2% of all milk worldwide in 2011 (Gerosa and Skoet, 2012).It was reported that, worldwide dairy farms produced about 730 million tonnes of milk in 2011 (Anonymous, 2012). India is the largest producer and consumer of milk. However, other countries such as New Zealand, Australia and the United Stated are the world's leading exporters of milk and milk products. China and Russia are the world's largest importers of milk and milk product (Anonymous, 2010a). Milk is a key contributor to improved nutrition and food security particularly in developing countries. Improvement in livestock and dairy technology offers promise in reducing poverty and malnutrition in the world (Hemme and Otte, 2010).

For many centuries, milk has been processed into different fermented dairy products, yoghurt being the most widely distributed worldwide (Tarakci and Erdogan, 2003). Although, yoghurt has no single origin, but according to legend, it was first made by the ancient Turkish people in Asia (Kurt, 1981). Therefore, yoghurt was derived from Turkish word "yogurut" which means any fermented food with acidic taste. Its manufacture involves the use of mixed dairy starter cultures. According to Tamime, (2002) yoghurt is defined as product of lactic acid fermentation of milk by addition of starter culture which results in decreased pH of less than or equal to 4.6.

Yoghurt is a fermented milk product consumed by large segment of the population either as part of the diet or a refreshment beverage. It is nutritiously balanced food containing almost all the nutrients present in milk but in a more assimilable form. Yoghurt contains important nutrients such as amino acid, vitamins, minerals and fatty acid essential to good health Allen*et al*. (2006).

Yoghurt is consumed worldwide with a historical prevalence in the western world but a fast – growing foothold in emerging economy. The growth in yoghurt consumption was driven by growing consumer desire for convenient and health promoting product and functional foods- (GIA, 2013). Over the last two decades, per capita milk consumption decreased in Sub–Saharan Africa (FAO, 2004) as milk provide 3% of dietary energy supply in Asia and Africa compared to 8 to 9% in Europe.

The United State Department of Agriculture (USDA) Economic Research Services (2008) reported that for 2007, the United States annual *per capita* consumption of yoghurt, excluding frozen was 11.5 lbs. This represents 77% increase from 6.5lbs *per capita* in the year 2000. *Per capita* consumption of yoghurt is relatively high in developed countries such as Japan and Western Europe, and demand is unabated (USDA, 2006).

The variation in viscosity and syneresis are the most common defects especially in yoghurt with low fat content. They are the most frequent defects related to yoghurt texture that may lead to consumer rejection of the product. Some yoghurt types exhibit a heavy consistency that closely resembles custard of milk pudding. In contrast, others are purposely soft boiled and essentially drinkable,Cannolly *et al,* (1984). Texture is one of the most important properties that determine yoghurt quality and consumer satisfaction Crion *et al*.(2012).

Various studies have described the improvement of physical, textural, flavour and rheological properties of low fat yoghurt by incorporating stabilizers. (El Sayed *et al*. 2002; Paseephol *et al.* 2008; Sahan,*et al*.2008). Stabilizer and thickeners are important in different manufactured products such as dressing of milk drinks, ice cream and yoghurt. These substances prevent separation of various ingredients, increase viscosity and inhibit the formation of large crystals.

The most common stabilizers and thickeners use in yoghurt include starches, vegetable and pectin. Starches are the most common thickeners in food products, they are polysaccharide extracted from a number of different plants such as cereal, root and tubers and frequently used to thicken food and other dairy product such as yoghurt and ice cream. Examples Cornstarch, Arrow root, Tapioca starch and their derivatives, Vegetable gums are polysaccharide that have natural origin and use to increase the viscosity of solution or food even if used in a very small concentration. So, vegetable gum are actually food thickening agents, the gums come from various sources that can be on land or in a sea ,some of the sea weed are excellent sources of food gums like Guar gum, Locust bean gum, Gum Arabic, Aguar- aguar . Pectin is gelling agent that is usually extracted from dry citrus peels or the solid that remain when the juice is pressed from apples. It is a polysaccharide made by plant cell wall and being used to help jams and jellies to set, it is used as a stabilizer in milk drinks and fruits juices. Many thickeners are derived from plants and sea weeds, others are made by chemical modification of natural cellulose and some such as Xanthan gums made by fermentation.

Fortification is defined as the practice of deliberately increasing the content of essential micro nutrients (vitamins and minerals) in a food irrespective of whether the nutrients were originally in the food before processing or not, so as to improve the nutritional quality of the food supply and to provide a public health benefits with minimal risk to health WHO and FAO, (2006). Fortification acts as a means of delivering nutrients to vulnerable groups in the population who may be at much risk of deficiency FAO, (1997).

Baobab tree (*AdansoniaDigitataL)* is the species that MichealAdanson first examined in Senegal and described to the French Academy of Sciences; Linnaeus named the genus *Adansonia* in his honor. The English common names of the baobab include dead rat tree (from the appearance of fruit), monkey – bread tree (the soft, dry fruit is edible), upside down tree (the sparse branches resemble roots) and cream of tartar tree (cream tarter).

The baobab is large tree belonging to the genus *Adansonia*of the *Bombax* family. It is the most widespread species on the African continent, found in the hot, dry savannah of Sub-Saharan Africa (FAO, 1988). The tree has an exceedingly thick trunk with very large heavy white flowers. The showy flowers are pendulous with a very large number of stamen.

Researchers have shown that the flower appear to be primarily pollinated by fruits bat of the sub family *Pteropodinae,*Ebert *et al.*(2002).The tree also bear a gourd – like fruits, with hard hairy shell which is dried by nature, the pod cracks open to remove the fruit pulp, Sidibe and Williams, ((2002).

Nutritional analysis has shown that the baobab dried fruit pulp (BDFP) is an excellent source of potassium (240mg/100g), calcium (295mg/100g) and magnesium 190mg/100g Prentice *et al.*(1993). According to Magdi, (2004), baobab fruit pulp contains high amount of carbohydrate (76.2%) crude protein (8.2%) extremely low fat (0.3%) metabolizable energy (320kcal/100g) and crude fiber content (5.4%). Nour*et al.*(1980) reported that the baobab fruit pulp also contained ascorbic and tartaric acids, water soluble pectin's and the elements; calcium and iron.

This research work is designed to evaluate the effects of three thickeners type Carbonxymethyl cellulose, Corn starch and Gum Arabic on quality properties of Low- fat yoghurt fortified with baobab dried fruit pulp (BDFP).

1.2. STATEMENT OF THE PROBLEM.

Malnutrition has been a persistent problem for young children and account for about 54% death of children in developing countries in 2001 (WHO, 2013; Monica and Mercedes, 2005). Research has shown that out of the 800 million people suffering from hunger in the world, over 204 million come from Sub-Saharan Africa in 2002 (FAO, 2000). Hence, one of the effects of malnutrition on individual is that it creates and maintains poverty which hampers economic and social development (Monica and Mercedes, 2005). However, this indicates that children start life with low intellectual quotients and are unable later to offer the best of their expected intellectual abilities.

Africa is going through a rapid socio – demographic transition with increase in incidences of hypertension, *Diabetes mellitus* andcardiovascular diseases. The need for food products that do not only satisfy hunger and provide necessary nutrients but also prevent nutrition related diseases and improved physical and mental well – being cannot be over emphasized (Klaus, 2003). The development of yoghurt type with new flavour, improved nutrients and health benefits will help to minimize the problems posed by malnutrition. Yoghurt is accessible and convenient to consume by older population which makes consumption feasible for improved nutrition status.

Human consumption of yoghurt has been associated with drinks in Nigerian market. Yoghurt quality in a local market varies from one producer to another. The chemical composition and texture of yoghurt depend upon the type and milk sources, processing condition, use of poor quality milk, unhygienic practices associated with process involved in handling and processing and the use of wild type of starter culture by the local producers give rise to poor quality yoghurt Younus *et al*. (2002).

The taste, consistency and viscosity of yoghurt are some of the main factors involved in products' quality and acceptance. Viscosity is an important property for quality control especially for product expected to have a certain consistency in relation to sensory attributes such as mouth feel and appearance. Many parameters affects flavour, texture and consistency of yoghurt such as starter culture, incubation temperature, processing condition such as heat treatment and homogenization and compositional properties of the milk base Labropoulos *et al* .(1984).

Another important aspect of a milk gel is whey separation which refers to the appearance of a liquid (whey) on the surface of milk gel. It is common defect in fermented milk product such as yoghurt Lucey *et al.* (1999). Some possible causes of wheying off in acid gel are high incubation temperature, excessive treatment, low total solid (protein and/or fat of the mix) movement or agitation during or just after gel formation, and very low acid production Lucey *et al.* (1999).

1.3. JUSTIFICATION OF THE STUDY.

Recently, increased in consumer interest in food items recognized as beneficial to human health, posed the need for food low in fat, rich in bioactive compound considered to be of greater nutritional value (Roberfroid, 2007; Waijers,*et al.*2007). Fermented milk products particularly yoghurt is considered to have health promoting effects due to presence of probiotic bacteria that aid to improve immune system, control gastro-intestinal upset, enhance digestion of lactose by mal-digesters and help body to assimilate protein, calcium and iron Marona and Pedrigon, (2004).

The potential to increase consumer's satisfaction by development of yoghurt with new flavour, health benefits and good quality has increased Shori,*et al.*(2013). Trend of fortification of yoghurt with fruit is growing. The inclusion of baobab fruit pulp in low-fat yoghurt could offer additional protein, minerals and vitamins.

Studies have shown that fruit and vegetable intake is associated with improved health status, reduced risk of various types of cancer, cardiovascular diseases (CVD), hypertension and possibly delayed onset of age related indicators. Hence, fortification of low fat yoghurt with baobab dried fruits pulp extract will enhance the nutritional and therapeutic values to human diet Zahoor,*et al.* (2012).

Yoghurt quality characteristics depend on rheological and textural properties of the product; hydrocolloids are used in food product processing as thickeners and stabilizer to improve the texture of the product, increasing water retention and enhance low energy value. They are often employed in low–caloric food (Dickinson, 2003). Stabilizers are used to produce a thick, cohesive body, smooth texture and to prevent wheying off (Vedamuthu, 1993) and improve consistency and reduce syneresis Lucey, (2002).

The knowledge gained on rheological and textural properties of yoghurt can serve as an important factor to control the performance of various processing technologies in yoghurt processing plants, enhance the stability of product during storage, transportation and influence the appearance and appeal of products and impact on the mouth feel and other desirable quality properties among consumers.

1.4. OBJECTIVES OF THE STUDY.

The main objective of thepresent study is to develop yoghurt type with desirable quality properties and longer shelf life while the specific objectives are:-

I. To evaluate the effects of three thickener type, Carbonxymethyl cellulose, Corn starch and Gum Arabic on physico – chemical properties of BDFP fortified low fat yoghurt.

II. To determine the effects of thickener concentration on sensory properties of BDFP improve low fat yoghurt.

III. To determine the effects of thickener type and concentration on microbiological properties of BDFP enriched low fat yoghurt.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 MILK

Milk is often described as nature's most nearly perfect single food. It is the natural food of the new born mammals for which it provides the sole source of nourishment during the period directly after birth. Milk is the product of the total, full and un-interrupted milking of a dairy female in good health, also nourished and not over worked. It must be collected properly and not contain colostrum (Adib and Bertrand 2009; Lesseurand Melik, 1990).Milk can also be defined as lacteal secretion of mammary gland that is used to nourish young ones Anonymous, (2016d). Milk is obtained by complete milking of one or more healthy cows and contains not less than 3.5% fat and 6.5% solid not-fat (Pearson, 1976).

In physico – chemical sense, milk is an emulsion or colloid of butterfat globules within a water – based fluid that contains dissolved carbohydrates and protein aggregates with minerals (Rolf, 2002). Because, it is produced as a food sources for neonate, all its contents provide benefits to the growing young. Milk is a good source of protein which is of high biological value in promoting the growth of children. It is the best sources of calcium in the diet and consequently supports sound bone and teeth development. Milk contains a useful miscellany of vitamins such as vitamin A, thiamin, riboflavin, pyridoxine, biotin, niacin, panthothenic acid and vitamin D. Milk also serve as an excellent carrier products for extra nutrients and if fortified can satisfy the nutritional needs of the population Krupa*et al* .(2011).

In developing countries such as Nigeria where protein intake is generally low, milk is invaluable sources for supplementation. Milk is highly perishable product, thus necessitate its immediate consumption mostly as fresh (Yahuza, 2001). To minimize deterioration of milk quality, it has to be moved to consumers within 2-3 hours of milking or processed into products which will be kept without refrigeration or to add preservatives in the fresh milk Malcome, (1999).Milk is the primary ingredient in yoghurt manufacturing. Desai, (2012) reported that the choice of appropriate dairy ingredient used in yoghurt formulation has an impact in yoghurt quality characteristics such as acidification, flavour and texture.

2.2 SOURCES OF MILK.

The principal source of milk used for human consumption is the cow. However, many people obtains milk from other animals that are native to the environment or land, Russell, (2006). According FAO, (1995) cattle provide about 66% of tropical milk with buffaloes supplying 25%. While goats, sheep and camels supplying the rest. In Africa, milk is produced in most Agricultural systems. It is either consumed, sold fresh, as fermented milk or processed into products such as butter, cheese or yoghurt. Nigeria is the largest cow milk producers in West Africa and third in Africa, most of the milk is produced by the Fulani pastoralists who's accustomed to extensive system of production. However, the milk they produce is of low yield due to poor quality grass species especially during dry season, unsanitary methods of milking, low genetic potentials of the breed and poor managerial condition FAO,(1990)

In western countries, cow's milk is produce on an industrial scale and is by far the most commonly consumed milk type. In 2011, FAO estimated that 85% of all milk worldwide was produced from cow. (Gerosa and Skeot, 2012)Dairy cattle such as Holstein have been breed selectively for increased milk production. About 90% of the dairy cows in the United States and 85% in Great Britain are Holstein Mcgee, (2004). Other dairy cows in the United States includes Aryshire, Brown Swiss, Guernsey, Jersey and milking short horn. Holstein – Friesian is the dairy cow most common in the United Kingdom, Europe and the United State of America, the breed has been selected to produce the highest yield of any cow, about 22 liters per day is an average in the United Kingdom Anonymous,(2013a)

World cow's milk production in 2013 stood 636 million tonnes. The united states of America (USA) was leading cow's milk producer in the world in 2013, accounting for 14.4% of the world production, producing about 91 million tonnes, followed by India, accounting nearly 61 million tonnes in 2013,FAO, (2013).

Table 2.1.1: World Top Ten Cow Milk Producers from 2011 – 2013. (Tonnes)

Country	2011	2012	2013
United states	89,015,235	90,865,000	91,271,058
India	57,770,000	59,805,250	60,600,00
China	36,925,896	3s7,784,491	35,670,002
Brazil	32,096,214	32,304,421	34,255,236
Germany	30,323,465	30,506,929	31,122,000
Russian federation	31,385,732	31,500,972	30,255,969
French	24,361,096	23,998,422	23,714,357
New Zealand	17,339,000	19,129,000	18,883,000
Turkey	13,802,428	15,977,837	16,655,009
United kingdom	13,849,000	13,843,000	13,941,000
World	616,956,092	630,183,853	635,575,895

Source: FAO,(2000) Related Link Publication Download Historical Data in Excel for World Milk Production

2.3 OTHER SIGNIFICANCE SOURCES OF MILK.

Although cow's milk is the most popular in many countries but Goat and sheep make a substantial contribution to the total milk produced in countries of eastern and southern Europe, Malawi and Barbados. In Russia and Sweden, small moose dairies serve as an important milk source Anonymous, (2004). Whereas water Buffalo is the common sources of milk much in Asia and considered the second world largest sources of milk in the world in 2004, according to statistics from the United Nations food and agricultural organization FAO, (2013) the world production of Buffalo milk was 75.8 million tones. Trend in world milk production over five years to 2004 indicated that the volume of Buffalo milk is increasing steadily to about three percent (3%) per year.

According to the United States National Bison Association, American bison also called American buffalo are not milked commercially (NBA, 2009). However, various sources reported cows resulting from cross – breed bison and domestic cattle are good milk producers and have been used both during European settlement of north American (Allen, 1977) and during development of commercial beefalo in the 1970s and 1980s O'Connor, (1981).

Table 2.1.2: Top Ten Buffalo Milk Producers in 2010.

Country	Production (Tones)
India	62,400,000
Pakistan	22,279,000
China	3,100,000
Egypt	2,725,000
Nepal	1,066,870
Iran	279,800
Myanmar	284,400
Italy	210,200
Srilanka	46,990
Bangladesh	36,000
World	92,517,217

Source: FAOSTAT, 2010

2.4 COMPOSITION OF MILK

There has been an increased interest in milk composition in the last 20 to 30 years, prior to this period, attention has been focused mainly on the fat content, a good' cream line" being considered as a measure of milk quality. However, the solid not fat of milk is now regarded as of equal if not greater value than the fat content. Milk is a considerable resource of product whose composition varies, the four components are dominant in quantitative term; water, fat, protein and lactose while the minor constituents are vitamins, minerals, enzymes and gases Mcgee,(2004).

Lactose is the main carbohydrate in milk, it is disaccharide consisting of glucose and galactose. Lactose gives milk its sweat taste and contribute approximately 40% of the whole cow's milk calories. It exist in true solution in milk and as such is readily assimilated as a food, being hydrolyzed into glucose and galactose by the enzymes "Lactase". Medical studies have shown that more than 70% of adult Africans, Indians and American exhibit lactose deficiency leading to condition known as "lactose intolerance" Babu*, et al.*(2009) lactose prevent infection by stimulating bifido bacteria in the colon, thus improving colon health Adolfsson*et al.*(2004). Lactose also helps in absorption of calcium and magnesium and is less carcinogenic compared to other sugars. Active bacterial culture in yoghurt helps to digest lactose there by making it suitable for lactose intolerance people Kolar*et al,*(1984)

Protein of animal origin ranked highest in quality rating as a food source. Milk protein contain a good proportion of all essentials Amino acid for body growth and maintenance Konte, (1999) and has roughly the same composition as in egg's except for the amount of Matheonine and Cystine. The two most important components of milk protein are the Casein and whey protein (Desai, 2012) Casein is the principal protein of milk representing about 80% of total milk protein. Whey protein representing about 20% of total milk protein, whey protein digest more rapidly compared to casein thus provides greater quantity of essential Amino acid (Hoffman and Flavo, 2004; Haug*et al.*(2007). Research has shown that whey protein found naturally in milk increase muscle protein synthesis which in combination with physical activities can enhance skeletal muscle Tipton*et al.*(2004) While, casein is used an ingredient in different manufactured products such as cheese, bakery products, glue and paints.

Milk fat is composed of a complex mixture of lipid. Triglycerides are the major types of lipid in milk fat, milk fat exist in the form of fat globules and each globules is composed almost or entirely triglycerol surrounded by membrane Fox, (1995) consisting of complex lipid such as phospholipids along with protein. Milk fat is the major sources of lipid used by the neonate mammals for accumulation of body adipose tissue in the initial days after birth, few days later neonate begins to be able to metabolism milk fat as an energy sources.

Milk fat is a carrier of fat – soluble vitamins A.D.E and K along with essential fattyacids such as linoleic, linolenic and Arachidonic found within the fat – portion of the milk Mcgee,(2004). Milk fat provide useful quantity of Vitamin A (retinol) and (beta – carotene) which plays an important roles in vision, protection of skin and cell membrane, resistance to infection and vitamin D which has an importance role in calcium metabolism and bone growth, it also provide to a lesser extent vitamin E (Anti-oxidant) and vitamin K (Anti hemorrhagic).

Milk water, water is the principal component of milk, on average, water constitutes about 80-92% of the fluid milk Belewu, (2008). Cow milk is about 87% water, milk water is the only source of water to neonate and milk water provide the aqueous medium for suspension of various organic components of milk, water content of milk is depend upon the synthesis of lactose, without water in the milk, milk would not be a viscous secretion composed mostly lipid and protein and would be extremely difficult to remove from the mammary gland.

Table2.1.3: Milk Composition of Various Mammals' Species

Species	Water	Protein	Fat	Total	Lactose	Ash
Human	87.43	1.63	3.75	12.57	6.98	0.21
Cow	87.80	3.20	3.90	13.19	4.96	0.71
Goat	88.90	3.52	4.25	7.75	4.40	0.86
Sheep	83.00	5.40	7.90	19.29	4.81	0.90
Camel	87.61	2.98	5.38	12.39	3.29	0.70
Buffalo	82.76	3.60	7.38	17.24	5.48	0.78

Source: Jenness and Show (1970) Compilation fundamental of dairy chemistry, edited by Web and Johnson

USDA (2010) Nation Nutrient Database for standard reference (http://www.ars.usda.gov/nutrientdata).Ars. Usd.gov.Retrieved on 2011-11-24

2.5 FACTORS AFFECTING MILK COMPOSITION.

Variations in milk composition exist. However, the composition of milk marketed nationally has been rather constant over the last 15 years, averaging 3.5% fat, 3.2% protein, 4.7% lactose Younus*et al.*(2002). Milk composition is affected by a number of factors including both genetic (breed, Age, individuality) and environmental (feed, season, Temperature, health management practices) (O" Connor, 1981).

2.5.1 Health

Both fat and solid – not – fat (SNF) can be reduced by disease, particularly mastitis. Mastitis generally causes a decline in milk fat percentage and change in milk composition (Kitchen, 1981; Needs and Anderson, 1984; Schultz, 1977). Milk from mastitis infected quarter are usually watery and has a lower total solid when compared with normal milk from healthy quarter

2.5.2 Breeds

Between and within the breeds, fat varies the most and lactose the least Woodford, Jorgense and Barrington, (1986). Both milk yield and composition vary considerably among breed of dairy cattle. Jersey and Guernsey breed of cattle give milk with 5% fat content, shorthorns and Friesian givemilk with about 3.5% fat while zebu breed of cow milk may contain up to 7% fat.

2.5.3 Seasonal Variation

Seasonal in milk fat percentage are well recognized with summer months averaging 0.4% unit less than winter month (Jennes, 1985). In summer, milk fat tend to be lower in palmetic acid of that milk fat from the same cows during winter Christie, (1979).

2.5.4 Stage of Lactation

Milk fat, protein and solid-not-fat varies, milk composition varies with stage of lactation lactose, fat and protein content are usually higher during the first two to three week, after which it decrease slowly during the first two to three month of lactation after which tends to increase as lactation progresses until the end of the period. Devies*et al.* (1983) reported distinct changes in fatty acid content of milk over the lactation period.

2.5.5 Physiological Condition of the Animal

Milk from individual cow may show a day to day variation on quality and quantity of milk produced such fluctuation may influenced by the mental and physical condition. Excitement, worry or discomfort are liable to have adverse effect on yield and composition of milk produced Pearson, (1976)

2.6 HEALTH AND NUTRITIONAL SIGNIFICANCE OF MILK.

Milk is often regarded as being nature most balanced or complete food. It earn his reputation by providing many nutrients which are essential for healthy growth. Being an excellent sources of protein, vitamins and minerals particularly calcium, milk can make a positive contribution to health of the nation. The two most available protein types in milk are whey protein (20%) and casein (80%) Desai,(2012). Both are high quality protein. According to science – based rating scale, both contained all essential amino acid in amount sufficient to support the multiple roles in the body (Phillips *et al.*2009; Bosch *et al.*2004). Protein Digestibility – Corrected Amino Acid Score (PDCAAS). A method of measuring protein quality based on availability, milk provide high quality protein and used as a standard reference protein Miller, (2007).

Milk is an important component of DASH (Dietary Approach to Stop Hypertension), diet design to reduce the risk of high blood pressure, these diet include three serving a day of low – fat and fat –free milk yoghurt and cheese and 8-10 daily serving of fruits and vegetables, has also shown to reduce risk of heart disease and strokes (NHLBI, 2006). People suffers from a condition known as lactose intolerance for their unable to digest the milk sugar (Lactose) can however, tolerate milk, if it is fermented to produce food such as yoghurt.Various studies have found that Conjugated Linoliec acid found mainly in milk, meat and dairy product provide several health benefits in prevention hypertension and improving immune function (Clement, Scimeca, and Thompson, 1994; Kritchevsky, 2000). Recent evidence suggested consumption of milk as an effective way of promoting muscle growth and improving post exercise muscle recovery Roy, (2008).

2.7 MILK PROCESSING TECHNIQUES.

Milk is a valuable nutrition's food that has a short shelf life and requires careful handing. Milk is highly perishable product; its low acidity and high nutrients content make it the perfect breeding ground for bacteria pathogen that can cause food poisoning and disease in consumer. Milk processing allows the preservation of milk for days, weeks or month and help to reduced food bone illness. The useful shelf- life of milk can be extended for several days through the following:

2.7.1 Pasteurization**:**

In 1963, French chemist and biologist Luis Pasteur invent "pasteurization" as a method of killing harmful bacteria in beverage and food products (Anonymous. 2010b). Pasteurization is a process of heating fluid milk to render it safe for human consumption by destroying most if not all pathogenic organisms (Frye, 2006; Juffs and Deeth, 2007). The effectiveness of heat treatment depend on three main factors; temperature to which milk is raised, length of time milk is held at the temperature and resistance of micro organisms in milk to thermal destruction (Hayes and Boor, 2001).

Pasteurization as a heat treatment methods aimed to reduce microbial load to such level that infectious does not occur, it also help to improve milk keeping quality and proper heat treatment for specific time followed by proper packaging and storage extend shelf life of the products considerably Ashrat*et al.* (2003). The two most common pasteurization techniques are Batch or Holder Method and High Temperature Short Time Method (HTST) and both involves heat treatment.(Gillis and Singh, 2005; Frye, 2006).

Batch or Holder method.

This is also called low temperature long time methods. The batch process not common to modern dairy industries. In the batch or holder method, the entire batch of milk is heated to a definite temperature for a given time, the usual time and temperature is 30minutes at 65^{o}C. The temperature above 65^{o}C causes a cooked flavour in milk and phospholipids membrane around the fat globules may be destroyed, reducing the tendency of the milk to form cream layer.

High temperature short time methods (HTST)

This is a continuous process of the holder method called high temperature short time method, in this technique,milk is heated for 15/16 seconds at temperature between 71 – 72^{o}C and 75^{o}C through the use of plate type heat exchanger and to prevent the growth of surviving bacteria in pasteurized milk. HTST process reduced up to 99. 000% reduction in the number of bacteria in milk, rendering it safe to drink for up to three weeks if continually refrigerated. Other new pasteurization method includes.

Ultra high temperature methods (UHT).

This is a new pasteurization method which has been developed. The technique involves, heating of milk at 125^{o}C for 15 seconds or 131^{o}C for 0.5seconds. UHT, milk may have shelf life of up 12 months, although, it's usually consumed much earlier to this period. The basis of Ultra high temperature (UHT) as stated by Gedam *et al.* (2007),is the sterilization of food prior to packaging, then filling into pre – sterilized environment. UHT – treated milk is commercially steriled with a shelf – life of 40 -45 days at 40^{o}F when aseptically packed in a sterile container (Bodnaruk, 1998).

2.7.2 Powdered Milk Processing.

Milk can be processed into powder in order to preserve it by removing the water content of the milk to a product of 2.5 – 5% moisture content. The basic operation in the powdered milk production are the evaporation and drying Henning, *et al.*(2006). Milk can be processed for future use by various methods, the two most common methods are spray – drying process and roller drum process.In spray drying process, the milk is first evaporated to a dry mass (DM) content of 45-55% prior,it is pumped through a nozzleunder high pressure through heated chamber "Spray drier" Dairy Technology, (2014), thus evaporating the moisture in the milk droplet which settle at a bottom of the chamber, this process is more efficient in term of energy and scale Keogh *et al.*(2004). Spray drying involves atomizing condense milk into a lot air stream at 180-200^{o}C, the atomizer may be either pressure nozzle or centrifugal disc. By controlling the size of a droplet, the air temperature and theair flow evaporates almost all moisture content of the droplet to a relatively low temperature (Chandan and O'Rell,2006).

While in roller drum process, a thin of the concentrated milk is spread on a rotating heated drum either single or double. A scraper then removes the dried milk film and then ground into powder. Roller dried powder does not require evaporation and occur in a single step Dairy Technology, (2014). Depending on the types of finished milk powder, this determine the raw milk to be used, either skimmed,full cream or butter milk. Hence, two main type of milk powder has been produced "the skimmed milk powder and whole milk powder, with skimmed milk being the most common worldwide.

2.7.3 MilkFermentation.

Before the scientific revolution and industrial development in Europe during 19th century, the technology of fermenting milk, butter, cheese already had a considerable importance in human lifeKonte, (1999). Historically,fermentation can be traced back around 10,000BC.It is likely that fermentation arose spontaneously from indigenous microflorafound in milk. Fortunately, the bacteria were *Lactococci*and*Lactobacillus thermophillus*which typically suppress spoilage and pathogenic organism effectively. Today, specific symbiotic bacterial culture (Lactic acid producing bacteria) are added to milk, under controlled conditions to decreased pH and produce many different fermented milk products Guarner *et al.*(2005). Fermentation enriches food substrate biologically with protein, vitamin, essential Amino and Fatty acid beneficial to human health Cook, (1994). The primary aims of milk fermentation is to extend the shelf life, improve taste and desirable flavor, prevent the growth of putrefactive and or pathogenic organism and to enhance digestibilityBystron and Molenda, (2004). While end product of milk fermentation is the production of lactic acid, acetic acid, carbon dioxide, diacetyl and several other components given the characteristics flavour to yoghurt Tamime and Robinson, (2004).

In general, the milk is fermented at 40-45^{o}C that is, the optimum growth condition for the mixed cultures, the short incubation methods which could also be as short as 2 hours 30 minutes (Tamime and Robinson, 2000). However, the longer incubation methods (Overnight) can be used and the incubation conditions are 30°C for around 16-18hours or until the desired acidity is reached (Hrabova and Hylmar, 1987). Thus, the success of milk fermentation relies most often the synergy between the cultured species *Lactobaccilusbulgaricus* and *Streptococcus thermophillus* because both are able to grow alone in milk, this indirect positive interaction is called proto – cooperation (Courtin and Rul, 2004). Fermented dairy products Chandan,(2006) have constituted a vital part of human diet in many region of the world, these products probably results from the needs to extend the shelf life of milk in the absence of refrigeration Kosikowski and Mistry,(1997).

2.8 FERMENTED MILK PRODUCTS

Milk and milk products have been considered as the most satisfactory and perfect single food substance elaborated by nature. It is one of the most valuable foods containing virtually all nutrients. Milk has been used to produce fermented products as far back as 10,000 BC in different regions of the world. Fermented milk products often contain "Probiotic" as the process of fermentation involved the use of lactic – acid producing bacteria that convert lactose (Milk sugar) to lactic acid results to rise in acidity, which allows the production of Kefir, yoghurt, cheese, sour cream among others. The benefits of these products includes: enhance digestibility, new and unique flavour, added probiotic, vitamins and minerals and preservation for a food that normally has a very short shelf - life.

2.8.1 Cheese

Cheese is a dairy product that was borne around 4000 years ago, when people started to breed animals and process their milk. Cheese is nutrition's food made mostly from the cow's milk but can also be made from milk of other animals such as goat, sheep, buffalo, and camel. Cheese is an important dairy product(Jibrin and Garba,2009) and a popular fermented product made throughout the world in many varieties(Henning *et al*,2006). It is a concentrated source of nutrients(O, Connor 1981; Ebing and Rugers,1996) that may be limiting in the average diet of under developed countries.

The general process of manufacture of cheese consist of the two important steps (1) milk preparation and inoculated with appropriate starter culture (2) the curd is shrunk and pressed, followed by salting and in case of ripened cheese, allowed to ripen under condition appropriate to the type of cheese to be prepared Jay *et al.*(2005*).* The starter culture for cheese production may differ depending on the amount of heat applied to the curd *Streptococcussalivariussubspeciesthermophillus* is mainly employed for acid production in cooked curd because it is more heat tolerant than either commonly used starter culture or mixed strain. According to Henning*et al.* (2006) the main step in cheese making is coagulation of casein by(3) possible methods: limited proteolysis using enzymes, acidification by the starter culture or combination of the 3 methods. This coagulation result in the formation of weak gel mass that is subjected to various treatment (Cutting, cooking, salting and chedding) to form a curd. The food value of cheese is particularly high. An average whole milk cheese consist of protein, fat and water in an approximate proportion 2:3:3, there are also appreciable quantities of minerals among which calcium is most abundant.

2.8.2 Kefir

Kefir is a fermented milk product that originates centuries ago in the Caucasus Mountain.The product was unknown outside the Caucasus,for a long time until 19^{th} century when the information spread of its successful use for the treatment of tuberculosis, intestinal and chronic diseases. Kefir is now consumed in many cultures of the world particularly in Europe and Asia. Kefir is yoghurt - like drink Anonymous, ($2016a_2$), which can be made from milk of any ruminant animals such as cow’s goats, sheep, Buffalo.

Kefir is made with starter culture known as "kefir grain" which contain active microorganism consisting of about 85 – 90% lactic acid producing bacteria and 10-17% yeast, kefir grains are complex symbiotic colony containing more than 35probiotic bacteria proven highly beneficial to human health. The benefit of this product is said to provide to those who consumed it. Kefir contains various essential vitamins, amino acid, enzymes and minerals, particularly phosphorous, magnesium and calcium. Consumption of kefir regulates body's immune system and improves resistance to diseases Anonymous, ($2016a_1$). Kefir help to regulate the blood pressure, blood sugar and cures diabetes, it also help to heals the lungs, bronchitis, tuberculosis, asthma, allergies and migraine Anonymous, ($2016a_1$)

In kefir production, different microorganism has been found,mainly lactic acid producing bacteria followed by yeast and acetic acid bacteria. The *Lactobacillus species* ferment lactose and other sugar to lactic acid, this give kefir it sourness leading to drop in pH and denature some of its protein. In kefir manufacturing process , raw milk is pasteurized at 85^{o}C and allowed the mixture to cooled to 22^{o}C inoculate with kefir grain and incubated for 12hr to ferment but full time fermentation occur at about 24hr, kefir is ready to use when coagulated bottom is firm as a thick jelly, not much moving.

2.8.3 Sour Cream

Sour cream is a fermented dairy product obtained by fermenting a regular cream with certain kind of lactic acid producing bacteria, it is a semi fluid cream result from souring by lactic acid bacteria or similar culture of pasteurized cream Anonymous, (2013b),which contains not less than 0.2% acid expressed as lactic acid, the sour cream has mild and tangy flavour with thick and smooth texture. The product contains 8.5% milk fat and 8.5% solid not fat and composed various ingredients such as emulsifier's stabilizers, skim powder milk and water Anonymous, (2016b)

Sour cream is produce by mixing cream with bacterial culture containing milk as well as live, active cultures mainly *Lactococcus lactis subspecies.cremoris, Lactocccuslactic biovar, Diacetyllactis* and *Leuconostosmesenteriodes subspecies Cremoris.* In sour cream production, the cream is heated at correct temperature, candy thermometer is used to monitor the temperature and ensure it reaches 145^{o}F. During sour cream culturing, the need of ventilated cover to allow air flow through the container while keeping out bugs and other contaminants. Heating the creamkills'bacteria so that beneficial bugs thrives in the cream, it also result in flavour and texture of the product Anonymous, (2016b).

Sour cream is among cultured dairy product which contain probiotic that affect a long list of health benefits, sour cream is an important source of essential nutrients such carbohydrate, protein, fats and minerals (Nicki, 2011) such as calcium, a mineral that body needs to boost bone health. Each half cup of sour cream provides 13% of the daily recommended intake of calcium, sour cream also serve as sources of B vitamins especial vitamin B_2, B_6 and B_{12} that help to keep normal physiological functions.

2.8.4 Dahi(Curd)

Dahi (Curd) is well known fermented milk product consumed in India. Curd is the dairy product obtained by coagulating milk by the process called "curdling" with harmless lactic acid bacterial culture which convert milk sugar (lactose) to lactic acid by means of fermentation Anonymous, ($2016c_1$). There are three types of Dahi in India: Sweet mildy sour Dahi, Sour Dahi and Sweetened Dahi. Like other fermented dairy products, Dahi contains calcium and phosphorus that play an important roles in strengthening of bone and teeth, consumption of Dahi product regularly help to boost body immunity due to the presence of beneficial culture, daily intake of curd help to prevent diseases such as arthritis and osteoporosis in addition to its use in preventing vaginal yeast infection Anonymous, ($2016c_2$)

In manufacture of Dahi, milk is boil or pasteurize for about 5- 10minutes, allowed the milk to cool to room temperature,then inoculate with mixed culture or previous day's mild acidic curd at rate of 0.5-1%, fill the milk in container and then remove the container and store at low temperature to check further fermentation. Dahi is carbonated to increase the keeping quality up to 15-30days without refrigerator Anonymous, (2016c).

2.9 ROLES OF BAOBAB TREEIN HEALTH AND NUTRITION.

Baobab tree *(AdansoniaDigitata L.)* is a member of Bambacaceae family which consist at least 20genera with about 180 species (Heywood, 1993). This deciduous tree was originated from South Africa, Botswana, Namibia, Mozambique and Zimbabwe (Keith and palgrave, 2000), but can be found in most countries within the African continent (Watson, 2007). Export by trader means. The baobab tree is also common in America, India, Srilanka, Malaysia, China, Jamaica and Holland Sidibe and williams, (2012).The tree has an exceedingly thick truck with very large, heavy white flowers that appear to be primarily pollinated by fruit bat of the sub-family*Pteropodinae,*Ebert *et al*, (2002), the tree spend only four (4) mouth of the year in leaf and eight months leafless Gebeuer *at al.* (2002). This is possible because photosynthesis take place in the trunk and branches during the 8 months of leafless period using water stored in the trunk Gebeuer*et al.* (2002). The large green or brownish fruits resemble gourd – like capsules contain a soft whitish fruits pulp that has the appearance of powdery bread and kidney beans seed. The fruit is wild harvested by collecting from the tree or from the ground, the hard shell is crack open and the powdery fruit pulp is separated from the seed and shell before used.

Research has shown that all part of baobab trees are absolutely useful and either be used as food, beverage, treatment of illness or as ingredient for food preparation. Baobab part such as fruits, seed, leaves and bark contributed to the lively hood of many people in Africa as source of food, fibre, medicine (Sidibe and Williams, 2002; Chadare*et al.*2009; Decaluwa*et al.*2009).

The baobab fruit pulp is reported to have many uses to the indigenous people of Africa, the pulp is used as a beverage and in food preparation (Qbizoba and Amaechi, 1983) (Bosch *et al.* 2004) reported that the fruits is eaten as a sweet and used to make refreshing drinks and ice cream. In Sudan a refreshing drink called 'gubdi' is made from the pulp and cold water to preserve the vitamins (Bosch *et al.,*2004) the fruit pulp is used by Fulani to adulterate and curd milk. (Bosch, *et al.*2004; Diop, *et al.*1988) reported that the pulp is rich in calcium and it is was the main reason that the baobab was largely consumed by pregnant women and children in Senegal. Burning of baobab fruit pulp produces an acid smokes used to dater insects troublesome to livestock Orwa *et al.* (2009).

Nutritional analysis has shown that Baobab leaves contains about 11% Dry matter with a crude protein of 5 – 17% (Feedipedia, 2013; Belewu*et al.* 2008) the leaves can be used either fresh or a that all part of baobab tree are characterized to have medicinal properties according to traditional Folklorecooked vegetable or dried and powered as a functional ingredient (Thickener) of soup and Sauces Watt and Beyer – Brand Wijk, (1962) reported that the leaves of baobab were used against excessive sweating and as astringent. The dried leaves are used in many West African as an insect repellent Denloye*et al.*(2006). Watt and Beyer – Brandwijk, (1962) reported, of particular interest is the used of baobab fruits and seed to treat dysentery Ramadan *et al.*(1994) showed that whilst baobab fruit pulp may lower elevated body temperature, normal body temperature is not affected.The oil extracted from the seed is used against diarrhea and hiccough Decaluwa*et al.*(2009). In dairy cows, baobab oil meal partially replacing soybeans mealand included at 5-15% in the diet, decrease milk yield and butter fat solid. Overall baobab oil meals has potential in dairy ration for replacing conventional and expensive protein sources provided its content of Anti nutritional factors is reduced Madzimure *et al.* (2011).

In Africa, people infected with malaria parasite consumed a mash containing dried baobab bark as febrifuge in order to treat the fever associated with this illness

2.10POLYSACCHARIDE THICKENERS IN FOOD AND DAIRY PRODUCTS.

The use of starch extract from wide variety of available and affordable dietary staple such as cereals, roots and tubers in the stabilization of yoghurt has elicited the interest of nutritionist and food scientists in most sub Saharan African countries in recent times. This is because, the starches produced form of these staple food crops, give body of bulk and improved the texture and nutritional values of yoghurt (Ikenebome and Omogbai, 2001). Polysaccharides thickeners are the most commonly used hydrocolloid thickeners being relatively cheap,abundant and possibly they does not impart any noticeable taste if used at a low concentration of 2-5% and are used both in native and modified form Babic*et al.*(2009). According to Glicksman, (1982), thickeners give high viscosity at concentration below 1%.The thickening effects produce by these thickeners depend on the type of the thickener use, its concentration level, the food system in which it is used and also the temperature and the pH of the food(Glicksman 1982; Sahin and Ozdemir, 2004). Thickening occur above critical concentration known as critical overlap concentration and is donated as C* below this, the polymer disperse exhibit Newtonian behavior but non Newtonian above the concentration (Phillips and Williams, 2001).

In Acidic product such as yoghurt, Arrowroot is a batter than cornstarch which loses potency in acid mixture. At pH level below 4.5, guar gum has sharply reduced aqueous solubility, thus also reduce its thickening capability. In frozendessert, tapioca or arrowroot are preferable over the cornstarch which becomes spongy when frozen.Yoghurt fortified with xanthan gum and pectin become more viscous when severe heat treatment is applied

Soukoulis*et al.*(2007). The maximum amounts of pectin that can be added to yoghurt is 0.20% as high concentration result in chalky or sandy texture and reduce viscosity in stirred yoghurt (Hoefler, 2004).

Gum Arabic *(Acacia gum)* is widely used to impart desirable qualities because of its influence over viscosity and texture. It is used mainly as an emulsifier in beverage emulsion Buffo *et al.*(2001). It is a low viscosity gum and has been found to produce low viscosity at 30% concentration compared to 1% xanthan gum and carbonxymethyl cellulose(CMC) at low shear rates (Williams and Philips,2000). Monthe and Roe (1999) in their study on rheological behavior of aqueous dispersion of Gum Arabic have found that dispersion of the gum (4. 50% w/v) exhibit shear thinning characteristic at low shear rate<100s-1 and Newtonian plateaus at shear rate above<100s-1.The infinite shear rate viscosity, however, is found to increase with increasing concentration of the Gum.Polysaccharide thickeners comprised the starch such as tapioca starch, cornstarch, arrowroot, vegetable gum such as guar gum, gum Arabic, cellulose gum and the pectin, these thickeners are obtain from plants and seaweed, others are made by chemical modification of natural cellulose and some such as xanthan gums are made by fermentation.

2.10.1 <u>Tapioca Starch</u>

Tapioca is a tapi word that means the process through which starch is made edible. Tapioca starch also called cassava flour is a starch extracted from the cassava roots (*Manihotesculenta*). This species is a native of north region of Brazil, but spread throughout the South American continent, the plant was carried by Portuguese and Spanish explorer in most part of Africa and Asia including Philippines and Taiwan. It is now cultivated worldwide FAO,(1990).

Tapioca is predominantly consist a carbohydrates with each cup containing 23.9g for a total of 105 calories, it is low in saturated fat, protein and sodium. It has no significant essential vitamins and dietary minerals Conder, (1995). Tapioca starch is not widely use in Europe, but many countries make use of it. In Belgium, small amount of tapioca pearls are added to clear soups Clark, (1990). Tapioca starch is used as thickener and stabilizer in pudding bread, sauces, fruit pies and meat products.

2.10.2Cornstarch

Cornstarch is sometimes referred to as Corn flour, is a carbohydrate extracted from the endosperm of the Corn. This white powdery starch is used in many culinary and house hold Gottlieb and Capella, (2005). Corn starch was discovered in 1840 by Thomas Kingsford while he was a superintendent of a wheat starch factory in jersey city, New jersey, corn starch is used as a thickening agent in liquid –based food such as soup, sauces, gravies, custard and other dessert, usually mixed with a lower temperature liquid to form paste or slurry. It is also used supply glucose to human who have glycogen storage disease (GSD)

2.10.3Carbonxymethyl Cellulose (CMC E466)

Cellulose gum is a tough carbohydrate that obtains from the cell wall of plant, cellulose gum is made by reacting cellulose from wood pulp or cotton lint with an acid. CMC is cost effective, versatile, and easy to use. It is one of the most common thickening, stabilized protein which retain moisture in a vast array of processed products. It has the ability to impart viscosity to aqueous solution; it is Pseudo plastic by nature and has thixotropic properties

2.10.4LocustBean Gum (E410)

Locust beans gum is also known as carob beans gum, it is like guar gum a galactomannan polysaccharide and is extracted from the seed of carob tree. It is water soluble and used as a thickener and stabilizer in variety of product including Sauces, fruit filling, ice cream and other dairy products.

2.10.5 Guar Gum (E412)

This is a carbohydrate based – vegetable gum extracted primarily from the grounded endosperm of guar beans, milled, screened to obtains the guar gum GWT, (2013). Gum is water soluble polysaccharide called mannan. In dairy products, guar gum use to thicken milk yoghurt, Kefir, cottage cheese and help to maintain homogeneity and texture of ice cream and other frozen dessert. Guar gum is also a good source of fiber with 80% soluble dietary fibre on a dry weight bases Martin, (2012). Guar gum has been considered of interest with regard to both weight loss and diabetic diet Daumerie and Henguin, (2013).

2.10.6Gum Arabic

Gum Arabic also known as acacia gum, chear gum or meska, is a natural gum made of hardening sap obtains from species of Acacia tree. The tree is well adopted to Sudan and Sahelian agro ecological zone of Africa notably among species is *Acacia seneglensis* because, it produce quality grade gum FAO, (1995). In the past, the hardened sap tears, serves as a major source of acacia gum, but today, commercial acacia gum is derived by tapping tree periodically to collect the resin. Gum Arabic is the complex mixture of glycoprotein and polysaccharide and is the original sources of sugar ribose and arabinose. Gum Arabic is used primarily in the food industry as emulsifies, stabilizer and a thickening agent in icing, filling, chewing gum and other confectionary treats Laura and Glenn, (2009). It is also a key ingredient in traditional lithography and used in printing, paint production, glue, cosmetics and various industrial application.

2.11YOGHURT.

In the early years of milk fermentation, milk was simply allowed to ferment by its normal micro biota, but the actual process was not completely understood. Today, a wide variety of fermented milk product including liquid drinks such as Kefir and Semi solid or firm product like yoghurt and cheese best used of illustrious microbial culture to convert milk sugar (lactose) to lactic acid.

Yoghurt is a fermented milk product which originated in Mesopotaniathousands of years ago. Evidence has shown that these people had domesticated goats and sheep around 5000 BC. The milk from these animals was stored in gourds, which was an early form of yoghurt Beel, (1994). One legend tells that yoghurt was born by a miracle of nature. Microorganism of various kind happened to land in a pitcher of milk that belong to Turkish nomad. The result was what the Turks called "Yogurut". The name yoghurt was supposedly introduced in the 8th century and was change in the 11th century to the current version "yoghurt" Bylund, (1995).

Yoghurt is defined as a fermented milk product produced with lactic acid producing bacteria (LAB) usually *Streptococcus thermophillus*and *Lactobacillus bulgaricus*Mottar*et, al,*(2002). Industrially, yoghurt can be divided into two types: A set – style yoghurt is made in retails containers given a continuous undisturbed gel structure in the final product Tamime and Robinson, (1999). On the other hand, stirred yoghurt has a delicate protein gel structure that develops during fermentation Benezech and Maingonnat, (1994). In stirred yoghurt manufacture, the gels are disrupted by stirring before mixing the fruits and then it is packaged. Most fruit - flavoured yoghurt are stirred yoghurt because flavour and fruits added after fermentation needs to be properly disperse in the yoghurt matrix (Tamime and Robinson 1999; Chandan, 2006; Tamime, 2006).

The two illustrious microbial culture in yoghurt manufacture are *Lactobacillus bulgaricus* (rod) and *Streptococcus thermophiles* (coccus) added to yoghurt at a level of around 2% by volume and incubated at 45^{o}C for 3-6 hrs followed by cooling at 42^{o}C, these bacteria grow best at approximately 45^{o}C. The *S. thermophiles* grow faster than *L. bulgaricus*and is primarily responsible for the initial acid production at higher rate than that produce by either growing along. The *S. thermophillus* can produce 0.5% lactic acid and the *L. bulgqricus* of about 0.6 - 0.8%. These genera ferment lactose in the milk to lactic acid, causing the milk to curdle and form yoghurt. If the product is not pasteurized, the result is yoghurt with “active culture Sahan*et al.*(2009). The lactic acid bacteria are fastidious microorganism and their growth is often restricted in milk because of its paucity in essential nutrients.Impact, it is the fermentation of lactose (Milk sugar) into lactic acid that give yoghurt its gel like texture and characteristics tang Fiszman*et al.*(2010). Preservation of milk by lactic acid bacteria through acidification process is being practiced since centuries and use of different starter culture, manufacturing techniques and milk types considerably change the characteristics of fermented milk products (Thapa, 2000)

The composition of yoghurt is dependent on the type and sources of milk and a range of seasonal factors (Blance, 1986; Adolfsson*et al.,* 2004) and the effect of mammalian species affect yoghurt properties. Food and drug administration FDA,(2008) standard of identify for yoghurt drinks specify all yoghurt must contain at least 8.25% milk –solid-not-fat and fat level to satisfy nonfat yoghurt not less than 0.5%, low fat yoghurt not more than (2%) milk fat and full fat yoghurt must contain not less than3.25%) milk fat before the addition of other ingredientsChandan*et al.*(2006). Typical plain yoghurt contained about 3.0% fat, 12.06% total solid, 3.60% protein, 18.94% moisture, 0.7% Ash and 4.2% Anther, (1986).

In term of health, although technology has been applied with almost complete success to produce low-fat, low-calories and functional yoghurt with sufficient rheological properties. Fermented milk products such as yoghurt have been known for their functional value, particularly in managing intestinal disorder such as lactose intolerance or acute gastroenteritis Marona and pedrigon, (2004). Yoghurt can be a good sources of essential nutrient such as mineral in the human diet and could significantly contribute to the recommended daily requirement for calcium and magnesium to maintain the physiological processes Tarakci and

Dag, (2013). Yoghurt is also a good dietary sources of phosphorus (beside calcium considered the most important nutrient for bone health) and its contribution to total phosphorus intake has been reported as 30-45% in western countries Tarakci and Dag, (2013) Yoghurt is one of the most popular fermented dairy products widely consumed all over the world Lacey *et al.* (1999), it is a complete food product, which possess some biochemical and bacteriological characteristics that make it extremely useful to human diet Everett and McLeod, (2000).

In order to make yoghurt processing attractive and the product affordable, quite a number of process manipulations have been adopted including evaporation or concentration, addition of milk solid, use of high temperature processing to denature whey proteins to modify their water binding capacity and selection of appropriate starter culture to make yoghurt thick and free from whey separation Bille and Keya, (2002).

2.12NUTRITION AND HEALTH BENEFITS OF YOGHURT.

Although, fermented milk product such as yoghurt were originally developed simply as a means of preserving nutrients present in milk and yoghurt is more nutritious than other fermented milk products because it contains a high level of milk solid in addition to nutrients developed during fermentation process and its sensory attributes have large effects on consumer acceptability Saint eve *et al.*(2008).Yoghurt is one of the oldest fermented milk product, tremendously popular all over the world. It's widespread and popularity marked from its health promoting potentials due to presence of probiotic culture. The health promoting attributes of consuming probiotic yoghurt containing live and active culture are well documented (Chandan,1989;Chandan and Shahani,1993;Frenandes *et al.*1992).

Yoghurt contained live and active bacterial culture (Probiotics). These beneficial bugs live in digestive tract and help to crowd out harmful microorganism that causes intestinal infection, they regulate digestion and strengthen immune system of the body De-simone*et al.*

(1993). Probiotic have been reported to be useful in the treatment of cystitis, candidiasis, colitis rheumatic and arthritic conditions and some forms of cancer Shah, (2001). Probiotic also assist in preventing and or treatment of diarrhea and irritable bowel syndrome Mcfarland , (2006) Most of bacterial culture in yoghurt are acid tolerant that survive stomach acidity and secrets lactic acid in the human intestine Tamime and Robinson, (1999),to regulate digestive tract and prevent stomach upsets.

Yoghurt is nutritionally rich in protein, vitamins and minerals such as calcium, zinc, iodine, the vitamins present in yoghurt especially vitamin B_{12} maintained red blood cells and help to keep nervous system functioning, while the protein is an essential nutrient the body needs to build and maintained muscles. Yoghurt is believe to promote good gum health, facilitate the absorption of calcium, thus prevent osteoporosis possibly because of the probiotic effect of lactic acid present Kerry*et al.* (2001). In general, yoghurt is not just seen as a diet food but also as health food because of its therapeutic value and it is consumed both as a food and thirst quenching beverage (Alfa-Lawal,1984). Consumption ofdairy products such as yoghurt help to improve the overall quality of diet and increase the chances of achieving nutritional recommendation.

CHAPTER THREE

3.0 MATERIALS AND METHODS

3.1 THE STUDY AREA

The experiment was conducted at Department of Animal Science. BayeroUniversity, Kano. Kano lies betweenLatitude 9°30'and 12°30'North and Longitude 9°30' and 8°42'East. Kano receives annual precipitation ranges between 600 to 1000mm (KNARDA, 2006). The bulk of which falls from June to September, the area is typically hot throughout the year, though from December to February is noticeably cooler period with an average temperature of about 11°C.

Kano state has total landmass of 21,276.9 km^2 with a totalpopulation of 9,401.288, mainly of Hausa and Fulani by tribe (NPC, 2006). Kano metropolitan population makes it the second largest city in Nigeria. Agriculture is one of the most important pillars of the state's economy with about 75% of the total working population engaged directly or indirectly in this activity. The principal food crops cultivated are sorghum, millet, maize, cowpea, rice (for local consumption) while groundnut and cotton are produced for export and industrial purposes. Other economic activities of the people in the area include processing of hide and skin into leather, processing and marketing of dairy products such as yoghurt and ice cream and small scale poultry production.

3.2 SOURCES OFEXPERIMENTALMATERIALS AND SAMPLE PREPARATION.

A baobab fruit was obtained at Dayi local market in Malumfashi local government area of Katsina State. The fruit pulp was manually separated from the seed using mortar and pestle which was made into powdered form. The creamy white powder was sifted to remove impurities and other fibrous materials using 0.2mm sieves. The yogourmet (freezed driedyoghurt starter), Corn starch (CS), Carbonxymethyl Cellulose (CM), Sodium benzoate (preservatives), flavouring were obtained at Bello Muhammad Dandago Shop, Singa Market Kano. While milk powder and Gum Arabic were obtained at SabonGari and Kurmi market in Kano City. A sample(50g) of Corn starch, Carbonxymethyl cellulose, Baobab dried fruit pulp each and 5g of Gum Arabic were soaked in 500ml of distilled water for 24hours.

3.3 YOGHURT PROCESSING PROCEDURE

Skimmed milk powder of Dano brand was reconstituted and processed into yoghurt as described by Tamime and Robinson, (2004). The milk was pasteurized at 65^{o}C for 30minute. The mixture then cooled to 42^{o}C and inoculated with yogourmet$^{(R)}$ (freezed dried starter) which contain mixture of *Lactobaccilusbulgaricus* and *Streptococcus thermophilus*. The yoghurt was enriched with baobab fruit pulp at inclusion level of 0% (control), 10%, 20% and 30%.

The thickeners were added at varying concentration level of 1%, 2% and 3% at room temperaturethenwas added sugar and Sodium benzoate (Preservative) at 12.5g and 1.4g to the yoghurt samples before blending. The percentage of baobab fruit pulp and thickener concentration levels were removed before replacement, the yoghurt samples were then labeled and packed in 240ml containers and stored at the refrigeration temperature of 4-7^{o}C for analysis, Muhammad and Abdulkadeer (2011).

3.4 DETERMINATION OF PHYSICO – CHEMICAL PROPERTIES OFYOGHURT.

Physico - chemical analysis were carried out according to the method of Association of Official Analytical Chemist AOAC, (1990).

3.4.1 Determination of pH and Titratable Acidity

The pH of the yoghurt samples was determined using Labtech pH meter with a glass electrode. The tip of the electrode was dipped into the sample solution and allowed to stand for about five (5) minutes before the reading is taken displayed on the pH meter. While the titratable acidity was determined by the methods of AOAC, (1990).

3.4.2 Ash and Total Solid Determination

Ash content of the yoghurt samples was determined by incineration method as contained in AOAC,(1990) , 2g of each sample was measured into crucible of known weight, the sample was burnt to ash in a muffle furnace for about three hours at 550^{o}C, it was then cooled in a desiccator and the weight of the Ash was finally determined. Total solid content of the yoghurt samples was determined by gravimetric method by drying the samples in an electric oven at 105^{o}C for 24 hours as described by methods of analysis AOAC,(1990).

3.4.3 Fat and Protein Determination.

Fat content of the yoghurt samples was determined by Gerber method with the aid of Van Gulicbutyrometer to enhance the sensitivity reading on the readout system (Pearson, 1976). The protein content of the sample was determined by formol titration as described by AOAC, (1990).

3.5 DETERMINATION OF MINERALS.

For minerals determination, 10mls of yoghurt samples was measured into 50mls beakers, and then 10mls of 1% HCL was added in the samples; digested the samples on a hot plate for 30 minutes. The sample digested solution was filtered through to what man no 40 filter paper to remove the waxy and undissolved materials, the filtrate was then analyzed with aid of atomizer after appropriate dilution against single element aqueous standard. For Iron (Fe), Zinc (Zn), Magnesium (Mg), Calcium (Ca) and Cupper (Cu) by atomic absorption spectrophotometer, Sodium (Na) and Potassium (K) Using flame photometer while phosphorous by using spectrophotometer.

3.6MICROBIOLOGICALANALYSIS

Microbiological quality of the yoghurt samples was conducted for the determination of total bacterial count (TBC), *Staphyloccocusaureus, Escherichia coli* and *Salmonella* as described by Harrigan and MCcane,(1976). *Escherichia coli* was determined using eosin methylene blue (EMB Agar) at 35^{o}C for 24 hours, Baird Parker Agar was used for *Staphyloccocusaureus* at 35^{o}C for 24 hours while for *Salmonella* deoxychollate citrate Agar was used after enrichment with selenite cysteine media at 28^{o}C for 48 hours. The positive test colonies were then counted as a colony forming unit per mililitre samples (Cfu/ml) as described by Harrigan and MCcane, (1976).

3.7 SENSORY EVALUATION OF YOGHURT

Sensory evaluation was conducted by taste panelist which comprised often judges (staff and students) from the Department of Animal Science. Bayero University, Kano. A 10minutes briefing was held for the product evaluation. Yoghurt samples were coded with two different letters and a digit number and served in disposable cups. The panelists were given a hedonic scale questionnaire to evaluate the yoghurt samples for colour, consistency, flavour, texture, taste, and overall acceptability and water was served to panelists to rinse mouth between the samples presented, International Dairy Federation (IDF,2002) . Yoghurt samples were evaluated on a scale 1 to 7 (1 likes extremely and 7 likes moderately).

3.8 EXPERIMENTAL DESIGN AND STATISTICAL ANALYSIS

The experiment was conducted in a 4x3x3 factorial arrangement in a completely randomized design (CRD). The factors were four (4) level of baobab fruits pulp 0%, 10%, 20% and 30%, three (3) thickener types Cornstarch (CS), Gum Arabic (GA) and Carbonxymethyl Cellulose (CM) and three(3) thickener concentration levels of 1%, (Low) 2% (Medium) and 3% (High). Each was repeated three times. The data collected on chemical properties, mineral composition and sensory evaluation were analyzed for variance (analysis of variance)using statistical package for social science (SPSS) version 16 of 2007, and the differences among means were separated by Duncan's multiple range test.

CHAPTER FOUR

4.0 RESULTS AND DISCUSSION

4.1.RESULTS

4.1.1 Physico–Chemical Properties of Low fat Yoghurt Fortified with Baobab dried Fruit Pulp (BDFP) at Different Concentration Levels.

Table: 4.1.4 Effects of Level of Baobab (LB) on Proximate Composition of the BDFP Fortified Low-fat Yoghurt.

	Levels of Baobab (LB) (%)				
ChemicalParameters	0	10	20	30	S.E
Ash	0.85^{a}	0.70^{b}	0.71^{b}	0.61^{b}	0.036
TS	28.33^{c}	30.94^{c}	41.67^{b}	46.39^{a}	0.956
Protein	2.43^{d}	3.75^{b}	4.01^{a}	3.59^{c}	0.031
Fat	2.95	2.86	2.95	2.91	0.28
TA	0.09	0.30	0.07	0.06	0.036
pH	4.70	4.70	4.70	4.70	0.000

abc means with different Superscripts within a row differed significantly ($P < 0.05$), S.E means Standard Error, TS = Total Solid, TA = Titratable acidity.

From the results of this study (Table 4.1.4), levels of baobab (LB) Showed only significant ($P>0.05$) differences between 0% levels and the rests of the levels.However, increase of LB from 10-30% had not shown any significant ($p<0.05$) difference on the ash contents of all the treatments. The total solid (TS) was however higher ($p<0.05$) for LB with 30% compared to the other treatments. Similarly, LB of 20% was significantly better ($p<0.05$) compared to those of 0% and 10% .The results on TS for 0% and 10% did not showed any significant ($p>0.05$) difference. The protein contents of the yoghurt with 20% LB had the best ($p<0.05$)contents followed by 10 and 30% LB. The least ($p>0.05$) protein contents of the yoghurt wasrecorded by 0% LB. Fat, titratable acidity and pH of yoghurt enriched with the all levels of baobab were similar ($p>0.05$) with pH of all yoghurt showing the same concentration of 4.70.

Table 4.1.5: Effects of Thickener Type (TT) on Chemical Composition (%) of the Low-fat Yoghurt

Thickener Type(%) ChemicalParameters	CM	CS	GA	SE
Ash	0.69	0.76	0.71	0.031
TS	36.54	36.47	36.50	0.828
Protein	3.18^{c}	3.49^{b}	3.73^{a}	0.032
Fat	2.84^{b}	2.89^{b}	3.10^{a}	0.033
TA	0.14	0.17	0.7	0.055
pH	4.70	4.70	4.70	0.000

abc means with different Superscripts within a row differed significantly ($P < 0.05$), S.E means standard error, CM = Carboxymethyl Cellulose, CS = Corn Starch, GA = Gum Arabic,TA = Titratable Acidity and TS = Total Solid.

From the results,(Table4.1.5) of this trail, only protein and fat contents were affected (p>0.05) by the thickener type. Protein contents of yoghurt improved with GA recorded significantly (p>0.05) higher protein value followed by yoghurt stabilized with CS. The least protein contents was observed in yoghurt stabilized with CM. Higher fat content was observed with GA stabilized yoghurt while the least content was recorded in CM treated yoghurt which was similar with yoghurt stabilized with CS. Ash, total solid, titratable acidity and pH were observed to showed no significant (p>0.05) effects when different thickener were added to the yoghurt samples.

Table: 4.1.6 Effects of Thickener Concentration (TC) on Chemical Composition (%) of BDFP Fortified Low-fat Yoghurt

	Thickener Concentration (%)			
ChemicalParameter	1	2	3	S.E
Ash	0.70	0.69	0.77	0.036
TS	37.39	37.48	36.36	0.901
Protein	3.50^{a}	3.35^{b}	3.45^{ab}	0.033
Fat	2.97^{a}	2.92^{ab}	2.85^{b}	0.036
TA	0.13	0.11	0.11	0.063
pH	4.70	4.70	4.70	0.000

abc means with different Superscripts within a row differed significantly P (<0.05), S.E means standard error. CM = Carbonxymethyl Cellulose, CS = Corn Starch, GA = Gum Arabic, TA = Titratable Acidity and TS = Total Solid.

The effects of the thickener concentration, presented the same pattern with the thickener type. From the results in (Table 4.1.6) only protein and fat contents were affected by the thickener concentration. Unlike the case of thickener type, 1% and 3% concentration levels were similar ($p>0.05$). Similarly, concentration of 2% and that of 3% were also observed to show no significant ($p>0.05$) difference between them. Ash, total solid, titratable acidity and pH of all the yoghurt were not affected ($p>0.05$) by the thickener concentration.

Table 4.1.7: Effects of Level of Baobab (LB) and Thickener Type (TT) on Proximate Composition of BDFP Fortified Low-fat Yoghurt

Factors	Proximate Composition low-fat yoghurt (%)					
LB x TT	Ash	TS	Protein	Fat	TA	PH
CM-0	1.01	40.00	2.41 [b]	3.04 [b]	0.08 [b]	4.70
10	0.71	24.50	3.51 [a]	2.70 [d]	0.36 [a]	4.70
20	0.53	36.67	3.63 [a]	2.88 [c]	0.06 [b]	4.70
30	0.51	45.00	3.19 [a]	2.73 [d]	0.06 [b]	4.70
CS-0	0.75	20.00	2.31 [b]	2.88 [c]	0.11 [a]	4.70
10	0.84	33.33	3.75 [a]	2.77 [c]	0.41 [a]	4.70
20	0.84	45.00	3.90 [a]	3.77 [c]	0.09 [a]	4.70
30	0.59	47.50	3.48 [a]	2.87 [c]	0.07 [a]	4.70
GA-0	0.79	25.00	2.58 [b]	2.92 [b]	0.07 [b]	4.70
10	0.54	35.00	3.10 [a]	3.10 [a]	0.08 [b]	4.70
20	0.77	43.33	4.49 [a]	3.20 [a]	0.07 [b]	4.70
30	0.73	46.67	4.11 [a]	3.12 [a]	0.06 [b]	4.70
SE	0.071	1.766	0.054	0.049	0.110	0.000

abcd means with different superscripts within a column differed significantly ($P<0.05$),SE=Standard Error, CM = Carbonxymelthyl Celluse, CS=Corn starch, GA=Gum Arabic,TS=total solid, TA = titratable acidity.

The findings in (Table 4.1.7) showed the interaction effects of Level of Baobab (LB) and Thickener Type (TT) on Proximate Composition of low- fat Yoghurt.The results indicated that ash, protein, fat, total solid and titratable acidity were affected ($p<0.05$) by LB and TC. From the results 10-30% LB significantly ($p<0.05$) observed higher protein contents with yoghurt stabilized with GA,CS and CM,whereas the least protein contents was recorded in 0% LB with all thickener type. With fat contents 10-30% LB were similar and significantly ($p<0.05$) better with GA while the least fat contents was observed with 10 and 30% LB in CM treated yoghurts. In case of TA contents, 10 and 0-30% LBwere similar with CM and GA stabilized yoghurt with least fat contents at 0- 30% and 20-30%LB in GA and CM stabilized yoghurts. However, Ash, TS and pH were not affected ($P>0.05$) by level of baobab and thickener type.

Table4.1 8: Effects of LB and TC Interaction on Proximate Composition of BDFP Fortified Low-fat Yoghurt.

	Proximate CompositionLow-fat Yoghurt(%)					
LBxTC	Ash	TS	Protein	Fat	TA	PH
0-1	0.94^{a}	28.33^{d}	2.54^{e}	3.05^{a}	0.18^{b}	4.70
2	0.76^{b}	31.67^{d}	2.22^{f}	2.90^{b}	0.10^{a}	4.70
3	0.85^{c}	25.00^{e}	2.53^{e}	2.90^{b}	0.08^{b}	4.70
10-1	0.61^{c}	30.83^{d}	3.77^{c}	2.89^{b}	0.42^{a}	4.70
2	0.72^{b}	25.33^{e}	3.70^{c}	2.88^{b}	0.22^{a}	4.70
3	0.77^{b}	36.67^{c}	3.79^{c}	2.80^{b}	0.21^{a}	4.70
20-1	0.66^{c}	42.50^{b}	4.06^{a}	2.95^{a}	0.08^{b}	4.70
2	0.64^{c}	41.67^{b}	4.02^{b}	3.00^{a}	0.06^{b}	4.70
3	0.83^{c}	40.83^{b}	3.95^{b}	2.92^{a}	0.08^{b}	4.70
30-1	0.54^{c}	46.67^{a}	3.63^{c}	3.00^{a}	0.08^{b}	4.70
2	0.66^{c}	48.33^{a}	3.59^{d}	2.92^{a}	0.05^{b}	4.70
3	0.62^{c}	44.17^{a}	3.56^{d}	2.80^{b}	0.06^{b}	4.70
SE	0.071	1.766	0.64	0.071	0.124	0.00

abc–fmeans with different superscripts within a column differed significantly ($P<0.05$),SE=Standard Error, CM= Carbonxymethyl Cellulose, CS=Corn starch, GA=Gum Arabic, LB=Level of Baobab, TC=Thickener Concentration.

The results in (Table 4.1.8) significant ($p<0.05$) differences were observed in ash, protein, fat, total solidand titratable acidity in all the yoghurt samples. From the results, at 0% LB and 1% concentration, ash contents was significantly ($p<0.05$) higher compared to the other treatments whereas the least ash contents were similar in 0-10% LB at 3 and 1% concentration levels. Meanwhile, with 30% LB at all concentration, TS contents were significantly ($p<0.05$) higher compared to the other treatments followed by 20% LB at 1-3% concentration while the least TS contents was recorded with 0 and 10% LB at 2 and 1% concentration. With protein contents, yoghurt fortified with 20% LB stabilized at 1% concentration showed higher ($p<0.05$) protein contents when compared with rest of the samples whereas the least protein contents was recorded with 0% LB at 1 and 3% concentration. At 0% LB and 1% concentration significantly ($p<0.05$)higher fat contents and was similar to fat contents recorded with 20 and 30% at 1-3% and 1-2% concentration. The least fat contents was observed with 10% LB at 3% concentration which was similar to fat contents recorded with 0, 20 and 30% LB at 2-3,1-2 and 3% concentration. In case of TA contents, higher content was observed with 10% LB at 1% concentration and was same to TA contents recorded with 2-3 % of the same LB and1% at 0% LB. However, pH values were not affected ($p>0.05$) by LB and TC in all the treatments.

Table 4.1. 9: Effects of TT and TC Interaction on Proximate Composition ofLow-fat Yoghurt.

Factors	Proximate CompositionLow-fat Yoghurt(%)					
TT x TC	Ash	TS	Protein	Fat	TA	PH
CM-1	0.84 [a]	38.75 [a]	3.41 [b]	2.88 [b]	0.08	4.70
2	0.61 [b]	37.13 [a]	3.02 [d]	2.80 [b]	0.17	4.70
3	0.61 [b]	33.75 [b]	3.12 [c]	2.75 [c]	0.16	4.70
CS-1	0.60 [b]	34.75 [a]	3.25 [c]	2.88 [b]	0.33	4.70
2	0.73 [b]	38.13 [a]	3.34 [c]	2.80 [b]	0.33	4.70
3	0.94 [a]	37.50 [a]	3.49 [b]	2.79 [b]	0.09	4.70
GA-1	0.62 [b]	38.75 [a]	3.83 [a]	3.15 [a]	0.07	4.70
2	0.74 [b]	35.00 [a]	3.78 [a]	3.08 [a]	0.06	4.70
3	0.76 [b]	38.75 [a]	3.76 [ab]	3.03 [ab]	0.07	4.70
SE	0.054	1.434	0.046	0.043	0.124	0.00

abcd means with different superscripts within a column differed significantly ($P<0.05$),SE=Standard Error, CM= Carbonxymethyl Cellulose, CS=Corn starch, GA=GumArabic,TS= total solid, TA= Titratable Acidity, TT= Thickener Type, TC= thickener concentration.

From the results in (Table 4.1.9). Ash, TS, protein and fat were affected ($p<0.05$) thickener type and thickener concentration. The results showed that with CS stabilized yoghurt at 1% concentration, ash contents was significantly ($p>0.05$) higher and similar to that of CM at 1% concentration, the least ash contents was observed with CM at 2-3% and were the same to the ash contents observed with CS and GA at 1-2 and 1-3% concentration. Similarly, concentration of 1-3 with CS, GA and CM at 1-2% concentration have better ($p<0.05$) TS contents, with least TS values recorded at 3% CM. With respect to protein and fat contents, yoghurt stabilized with GA at 1-3% concentration were similar and showed significantly ($p<0.05$) higher protein and fat contents. The least protein and fat contents were recorded at 2 and 3% CM. However, TA and pH were not affected by thickener type and concentration while same pH values of 4.70 in all the yoghurt samples were recorded

Table:4.1.10 Interaction Effect of LB, TT and TC onChemical Properties(%) of Low-fat Yoghurt.

Factors	Chemical properties of low-fat yoghurt (%)				
LBxTTxTC	Ash	TS	Protein	Fat	TA
CM 0 – 1	1.53^{a}	45.00^{a}	2.60^{f}	2.98^{b}	0.07^{c}
2	0.80^{b}	40.00^{b}	2.16^{g}	3.16^{a}	0.08^{c}
3	0.70^{b}	35.00^{b}	2.46^{f}	3.00^{b}	0.10^{c}
CM 10 – 1	0.68^{c}	25.00^{b}	3.68^{c}	2.75^{c}	0.12^{c}
2	0.58^{c}	18.00^{c}	3.52^{d}	2.80^{b}	0.51^{a}
3	0.68^{b}	30.00^{c}	3.34^{e}	2.55^{c}	0.44^{b}
CM 20 – 1	0.68^{c}	40.00^{b}	4.17^{a}	3.10^{a}	0.07^{a}
2	0.53^{c}	40.00^{b}	3.24^{e}	2.70^{c}	0.05^{c}
3	0.38^{c}	30.00^{c}	3.47^{d}	2.85^{b}	0.06^{c}
CM 30 – 1	0.50^{c}	45.00^{a}	3.21^{e}	2.70^{c}	0.08^{c}
2	0.55^{c}	50.00^{a}	3.16^{e}	2.90^{b}	0.05^{c}
3	0.48^{c}	40.00^{b}	3.21^{e}	2.60^{c}	0.05^{c}
CS 0 – 1	0.48^{c}	20.00^{b}	2.32^{g}	3.16^{a}	0.12^{c}
2	0.78^{b}	25.00^{c}	2.12^{g}	2.79^{b}	0.14^{b}
3	1.00^{b}	15.00^{d}	2.15^{f}	2.70^{c}	0.08^{c}
CS 10-1	0.58^{c}	30.00^{c}	3.65^{d}	2.80^{b}	0.06^{c}
2	0.70^{b}	32.00^{b}	3.55^{d}	2.93^{b}	1.05^{c}
3	0.71^{b}	37.00^{b}	4.06^{a}	2.93^{b}	0.12^{c}
CS 20 – 1	0.73^{b}	40.50^{b}	3.37^{c}	2.55^{c}	0.08^{c}
2	0.68^{b}	45.00^{b}	4.23^{a}	3.05^{a}	0.07^{c}
3	1.00^{b}	50.00^{a}	4.12^{a}	2.70^{c}	0.12^{c}
CS 30 –1	0.53^{c}	45.00^{a}	3.68^{c}	3.00^{b}	0.08^{c}
2	0.58^{c}	50.00^{a}	3.49^{d}	2.80^{b}	0.06^{c}
3	0.73^{b}	47.50^{a}	3.49^{c}	2.80^{b}	0.06^{c}
GA 0 – 1	0.83^{b}	20.00^{c}	2.70^{f}	3.00^{b}	0.05^{c}
2	0.70^{b}	30.00^{c}	2.39^{f}	2.76^{b}	0.07^{c}
3	0.85^{b}	25.00^{c}	2.64^{f}	3.00^{b}	0.08^{c}
GA 10 –1	0.60^{c}	37.50^{b}	3.98^{b}	3.10^{a}	0.08^{c}
2	0.85^{b}	25.00^{c}	4.03^{a}	3.30^{a}	0.09^{c}
3	0.73^{b}	42.09^{a}	3.98^{b}	2.90^{b}	0.07^{c}
GA 20 – 1	0.58^{c}	47.50^{b}	4.64^{a}	3.20^{a}	0.08^{c}
2	0.73^{b}	40.00^{b}	4.58^{a}	3.20^{a}	0.07^{c}
3	1.00^{b}	42.50^{a}	4.25^{a}	3.20^{a}	0.06^{c}
GA 30 – 1	0.60^{c}	50.00^{a}	4.02^{a}	3.30^{a}	0.07^{c}
2	0.85^{b}	45.00^{a}	4.13^{a}	3.05^{a}	0.04^{c}
3	0.73^{b}	45.09^{a}	4.18^{a}	3.01^{b}	0.07^{c}
SE	0.108	2.867	0.093	0.085	0.190

abc-f means with different superscripts within a column differed significantly ($P<0.05$) ,S.E = Standard Error, CM = Carbonxymethyl Cellulose, CS = Corn starch, GA = Gum Arabic, TS = Total solid, TA = Titratable Acidity, pH = 4.70, LB=Level of Baobab, TT= Thickener Type, TC= Thickener Concentration.

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From the results in(Table 4.1.10), it could be seen that no significant ($p>0.05$) difference in pH of all the yoghurt samples.However, the significant ($P<0.05$) differences were observed in ash, total solid, protein, fats and tritratable Acidity. The results indicated that ash content value of 1.53% was obtained in yoghurt fortified at 0%LB stabilized at 1% CM, the value was significantly ($p>0.05$) higher than the rests of the treatments while the lowest ash contents of 0.38% was obtained in yoghurt fortified with 20%LB stabilized at 3%concentrtion which was similar to those recorded at 1-3concentration in yoghurtenriched with 0%LB, 10%LB at 1%CM, 0-30%LB stabilized at 1-3, 2-3 and 2-3%GA and those fortified with 0 and 20%LBat 2% and 1-3% CS. All thickeners showed higher TS contents between concentration 1-3% with yoghurt fortified with 30% LB at CS 1-3% and 0 and 30% LB at 1% CM while the lowest TS value of 15.00 was observed with yoghurt enriched with 0% LB at 3% CS. Yoghurt improved with 20 and 10 – 20% LB at 1% CM and 3 and 2 – 3% CS with those fortified with 10, 20 and 30% LB stabilized at 2 and 1- 3% GAhave better protein contents and were significantly ($p>0.05$) higher than the other samples while the least protein contents was recorded in yoghurt fortified with 0% LB stabilized at CM 2% and 1-2% CS concentration. Similarly, yoghurt improved with 10-30% LB at 1-2,2-3 and1-3% GA concentration observed similar fat contents with that fortified with 0 - 10% LB at 2 and 1%CM and 0% LB at 1% CS and were significantly higher than the rest of the treatments. With respects of TA, yoghurt fortifiedwith 10 and 20% LB stabilized at 2 and 1% CM were the same and better in TA contents. However, pH was not affected by LB, TT and TC as all the yoghurt samples showed the same concentration of pH 4.70.

4.1.2 Sensory Properties BDFP Fortified Low –fat Yoghurt Stabilized with Different Thickeners

Table 4.1.11: Effects of Level of Baobab (LB) on Sensory Properties (%) ofBDFP Fortified Low-fat Yoghurt

	Level of Baobab (%)				
Sensory properties	0	10	20	30	SE
Colour	2.00^{ab}	1.79^{b}	1.96^{ab}	2.18^{a}	0.088
Consistency	2.60	2.69	2.72	2.57	0.070
Texture	2.21^{ab}	1.91^{c}	2.36^{a}	2.61^{a}	0.106
Taste	2.32^{b}	2.37^{ab}	2.67^{ab}	2.70^{a}	0.123
Flavour	2.69^{ab}	2.41^{b}	2.88^{a}	2.66^{ab}	0.115
O/Accept.	2.40^{bc}	2.16^{c}	2.51^{b}	2.80^{a}	0.099

abcmeans with different Superscripts within a row differed significantly ($P < 0.05$), S.E means Standard Error, O/ Accept= overall acceptability.

In (Table 4.1.11), the results indicated that no significant ($p>0.05$) difference with respect to consistency of all the yoghurt samples. However,significant ($P<0.05$) differences were recorded in Colour, Texture, Taste, Flavour and overall acceptability. The results further revealed that colour, texture, and flavor were similar and better ($p<0.05$) at0, 20 and 30% LB.Similarly, taste and overall acceptability were the best at 10-30% and 30% LB. However, consistency was not affected by all levels of baobab (0-30%). Hence, increase in level of baobab between 0-30% has no effects in consistency of the yoghurt samples.

Table 4.1.12: Effects of Thickener type (TT) on Sensory Properties (%) of BDFP Fortified Low-fat Yoghurt

	Thickener Type (%)			
Sensory properties	CM	CS	GA	SE
Colour	1.83^{b}	1.95^{ab}	2.16^{a}	0.070
Consistency	2.18^{b}	2.81^{a}	2.95^{a}	0.070
Texture	2.00^{b}	2.30^{a}	2.52^{a}	0.091
Taste	2.29^{b}	2.53^{ab}	2.72^{a}	0.106
Flavour	2.51	2.74	2.73	0.100
O/Accept.	2.19^{b}	2.63^{a}	2.58^{a}	0.086

ab means with different Superscripts within a row differed significantly ($P < 0.05$), S.E means Standard Error, O/Accept = Overall Acceptability CM = Carbonxymethyl Cellulose, CS = Cornstarch, GA = Gum Arabic.

From the results of this study (Table 4.1.12).It could be seen that no significant ($p>0.05$) difference was recorded in flavour of the yoghurt samples, but significant ($p<0.05$) differences were observed in colour, consistency, texture, taste and overall acceptability of the all the yoghurt samples. The results also indicated that both CS and GA showed the same effects and better in colour, consistency, texture, taste and overall acceptability. However, flavour was not influenced by thickener type.

Table 4.1.13: Effects of Thickener Concentration (TC) on Sensory Properties (%) BDFP Fortified of Low- fat Yoghurt

	Thickener Concentration (%)			
Sensory properties	1	2	3	SE
Colour	1.83^{b}	2.01^{ab}	2.10^{a}	0.076
Consistency	2.43^{b}	2.60^{b}	2.90^{a}	0.070
Texture	2.18^{b}	2.30^{a}	2.52^{a}	0.091
Taste	2.47^{ab}	2.35^{b}	2.75^{a}	0.106
Flavour	2.60	2.54	2.83	0.100
O/Acceptability	2.41^{b}	2.25^{b}	2.74^{a}	0.086

abc means with different Superscripts within a row differed significantly ($P < 0.05$), S.E means Standard Error, O/Acceptability = Overall Acceptability .

The results in (Table 4.1.13) showed no significant ($p>0.05$) difference was observed with regard to flavour content of the yoghurt samples. However, the significant ($P<0.05$) differences were recorded in Colour, Consistency, Texture, Taste and overall acceptability. The resultsrevealed that colour, texture, consistency, taste and overall acceptability were influenced by the thickener concentration, from the results 3% concentration levels significantly affects all the sensory attributes. With respects to colour and texture, 2 and 3% concentration levels were the same.Similarly, concentration 1 and 3% levels were similar in taste contents. However, flavour was not affected by thickener concentration in all the yoghurt samples.

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Table 4.1.14: Effects of LB and TTInteractionon Sensory Properties of BDFP Fortified Low fat Yoghurt.

LB x TT	Sensory Properties (%)					
	Colour	Consistency	Texture	Taste	Flavour	Overall/accept.
sCM-0	1.47[a]	1.77[f]	1.67[c]	1.77 [b]	2.23[b]	1.70 [c]
10	1.83[b]	2.27[e]	1.73[c]	2.33 [b]	2.40 [b]	2.23 [b]
20	2.03[a]	2.47[d]	2.33[b]	2.57[a]	2.90 [a]	2.37 [b]
30	2.00[b]	2.20[e]	2.27 [b]	2.50 [a]	2.50 [b]	2.47 [b]
CS-0	2.10 [a]	2.87[b]	2.53 [b]	2.30 [a]	2.63 [a]	2.60 [a]
10	1.63[b]	2.77[c]	1.97 [b]	2.50 [a]	2.60 [b]	2.17 [b]
20	1.97 [b]	2.97[b]	2.30 [b]	2.73 [a]	3.00 [a]	2.70 [a]
30	2.10[a]	2.63[cd]	2.40 [b]	2.60 [a]	2.73 [a]	3.03 [a]
GA-0	2.43 [a]	3.17 [a]	2.43 [b]	2.90 [a]	3.20 [a]	2.90 [a]
10	1.90[b]	3.03 [a]	2.03 [b]	2.27 [b]	2.23 [b]	2.07 [b]
20	1.87[b]	2.73[c]	2.43 [b]	2.70 [a]	2.73 [a]	2.47 [b]
30	1.43 [a]	2.87[b]	3.17[a]	3.00 [a]	2.73 [a]	2.90 [a]
SE	0.152	0.141	0.183	0.213	0.199	0.177

abc-f means with different superscripts within a column differed significantly ($p<0.05$), SE= Standard Error, CM=Carbonxymethyl Cellulose, CS= Cornstarch, GA=Gum Arabic, LB = Level of Baobab, TT = Thickener Type ,O/ Accept. = Overall Acceptability.

In (Table 4.1.14), the results of the findings indicated the significant ($p<0.05$) differences in all the sensory attributes. The results further showed that yoghurt stabilized with CM at 0 and 20% LB, 0 and 30% LB stabilized with both CS and GA showed better and significantly ($p<0.05$) higher colour contents than the other treatments. Also, at 0 and 10 % LB, yoghurt improved with GA recorded good consistency while the least consistency value was observed with yoghurt fortified with 10 and 30% BDFP stabilized with CM. Similarly, good texture contents was recorded in yoghurt enriched with 30% LB in GA treated yoghurt whereas, yoghurt improved 0 and 10 % LB stabilized with CM showed the same lower texture content. However, GA improved yoghurt fortified with 30% LB observed better and higher taste content which was similar to CM stabilized yoghurt fortified at 20 and 30% LB, 0 – 30% LB with CS and GA stabilized yoghurt fortified with 0, 20 and 30% LB. For flavour, yoghurt fortified with 20, 20 and 30 % LB and 0, 10 and 30% LB stabilized with CM, CS and GA concentration showed the same flavor concentration than the other treatments. With overall Acceptability,yoghurt fortified with 30% LB stabilized withCS observed similar acceptability values with treatments improved with 0 and 20% LB in CS treated yoghurt and 0 and 30% LB enriched yoghurt stabilized with GA concentration.

Table 4.1.15: Effects of LB and TCInteractionon Sensory Properties(%) of BDFP Fortified Low-fat Yoghurt.

	Sensory Properties					
LB x TC	Colour	Consistency	Texture	Taste	Flavour	O/Accept
0-1	1.67 ^{b}	2.57 ^{b}	1.90 ^{b}	2.20 ^{b}	2.53 ^{b}	2.27 ^{b}
2	2.03 ^{a}	2.67 ^{b}	2.18 ^{b}	2.33 ^{b}	2.53 ^{b}	2.40 ^{b}
3	2.30 ^{a}	2.57 ^{b}	2.57 ^{a}	2.43 ^{b}	3.00 ^{a}	2.53 ^{b}
10-1	1.73 ^{a}	2.33 ^{b}	1.70 ^{b}	2.00 ^{b}	2.20 ^{b}	2.07 ^{b}
2	1.70 ^{b}	2.63 ^{b}	1.93 ^{b}	2.57 ^{b}	2.57 ^{b}	2.07 ^{b}
3	1.93 ^{a}	3.10 ^{a}	2.10 ^{b}	2.53 ^{b}	2.47 ^{b}	2.33 ^{b}
20-1	1.83 ^{b}	2.57 ^{b}	2.23 ^{b}	2.83 ^{a}	3.00 ^{a}	2.57 ^{b}
2	2.07 ^{a}	2.67 ^{b}	2.97 ^{a}	1.90 ^{c}	2.27 ^{b}	1.77 ^{c}
3	1.97 ^{a}	2.93 ^{a}	2.87 ^{a}	3.27 ^{a}	3.37 ^{a}	3.20 ^{a}
30-1	2.10 ^{a}	2.27 ^{b}	2.83 ^{a}	2.83 ^{a}	2.67 ^{b}	2.73 ^{a}
2	2.23 ^{a}	2.43 ^{b}	2.27 ^{a}	2.60 ^{b}	2.80 ^{a}	2.77 ^{a}
3	2.20 ^{a}	3.00 ^{a}	2.53 ^{a}	2.67 ^{a}	2.50 ^{b}	2.90 ^{a}
SE	0.152	0.183	0.183	0.213	0.199	0.191

abc means with different superscripts within a column differed significantly ($p<0.05$), SE=Standard Error ,O/ Accept. = Overall Acceptability, LB = Level Baobab, TC = Thickener Concentration.

The results in (table 4.1.15) showed the significant ($p<0.05$) differences in all the sensory attributes tested (colour, consistency, texture, taste, flavour and Overall Acceptability).The results also indicated that yoghurt fortified with 0-30%LB stabilized at 1-2%,1 and 3%, 2and 3% and 1-3 % concentration showed better colour and significantly ($p<0.05$) higher than the rest of the yoghurt samples. Similarly, higher consistency contents of 3.10%was recorded in yoghurt fortified with 10 % LB at 3% concentration which was the same to the contents observed with yoghurt improved with 20 and 30% LB at 3% concentration and were significantly ($p<0.05$) higher compared to the other treatments. Yoghurt fortified with 0% LB at 3% concentration, 20 and 30% LB at 2-3 and 1-3% concentration showed similar texture concentration and were similar better than the rest. For taste contents, yoghurt enriched with 20 and 30% LB A at 1 and 3% showed the best concentration of 2.83%and were the same to that obtained at 30% LB at 3% concentration, while the least taste value of 1.90was recorded with yoghurt improved with 20 % LB at 3% TCwhich was similar to those fortified with 10%LB stabilized at 2%TC and 20%LB at 1%TC. Similarly, yoghurt fortified with 10%LB stabilized at 3%TC had highest consistency value of 3.10 which was similar to those enriched with 20%LB stabilized at 3%TC while the lowest value of 2.27% was obtained in yoghurt fortified with 30%LB stabilized at 1%TC. Higher flavour contents of 3.37% was recorded in 3% TC at 20% LB was the same to those recorded with 20 and 30% LB at 1and 3% concentration. However, yoghurt stabilized at 3%, fortified with 20%LB was the better and highly accepted and was observed to be the same with those fortified with 30% LB stabilized at 1-3% concentration while lowest acceptability was obtained in sample enriched with 20% LB at 2% thickener concentration.

Table 4.1.16:The Interaction Effects of TT and TC on Sensory Properties (%) of Low-fat Yoghurt

	CM			CS			GA			
Sensory prop.	1	2	3	1	2	3	1	2	3	SE
Color	1.60^{b}	1.80^{b}	2.10^{a}	1.76^{b}	1.98^{a}	2.10^{a}	2.13^{a}	2.25^{a}	2.10^{a}	0.132
Consistency	1.65^{c}	2.03^{b}	2.85^{a}	2.70^{a}	2.75^{a}	2.98^{a}	2.95^{a}	3.03^{a}	2.88^{a}	0.122
Texture	1.88^{b}	1.88^{b}	2.25^{b}	2.28^{b}	2.10^{b}	2.53^{a}	2.35^{a}	2.43^{a}	2.78^{a}	0.158
Taste	2.00^{b}	2.05^{b}	2.83^{a}	2.43^{a}	2.35^{b}	2.83^{a}	2.98^{a}	2.65^{a}	2.53^{a}	0.184
Flavour	2.28^{b}	2.43^{b}	2.83^{a}	2.68^{a}	2.50^{b}	3.05^{a}	2.85^{a}	2.70^{a}	2.63^{a}	0.173
O/Accept.	2.00^{c}	1.95^{c}	2.63^{b}	2.50^{b}	2.48^{b}	2.90^{b}	2.73^{b}	2.33^{c}	4.70^{a}	0.148

abcmeans with different Superscripts within a row differed significantly ($P < 0.05$),S.E means Standard Error, O/Accept. = Overall Acceptability, TT = Thickener Type, TC = Thickener Concentration, CM = Carbonxymethyl Cellulose, CS = Corn starch, GA = Gum Arabic.

From (Table 4.1.16), the results revealed significant ($p<0.05$) differences in all the sensory properties of the yoghurt samples. However, the results indicated that all thickeners (CM, CS and GA) showed the same colour contents at concentration of 3, 2-3 and 1-3% levels and were significantly ($p<0.05$) higher than the other samples. Good consistency contents was observed with yoghurt stabilized with GA at concentration of 1% which was the same to consistency content recorded with yoghurt stabilized with 3% CM, 1-3 % CS and 1 and 3 % GA. Similarly, yoghurt stabilized with 3% GA concentration recorded better texture contents of 2.78%, the value was similar to those obtained in yoghurt improved with GA at concentration of 1-2% and 3% CS. Concentration of 3%, 1 and 3% with CM, CS and GA showed similar taste content and were higher than the other treatments. With flavour, yoghurt stabilized at 1% GA was observed to have the same flavour content with yoghurt improved with 2-3, 1and 3 and 3% with GA, CM and CS respectively. However, yoghurt stabilized with GA at concentration of 3 % showed higher acceptability value while the lower acceptability value was observed with yoghurt stabilized with 2% GA concentration which was similar to those recorded at 1-2 % CM concentration.

Table 4.1.17: Interaction Effects LB,TT and TC on Sensory Properties of BDFP Fortified Low-fat Yoghurt.

Factors	Sensory properties (%)					
LBxTTxTC	Colour	Consistency	Texture	Taste	Flavour	O/Accept
CM 0 – 1	1.20^{c}	1.50^{d}	1.50^{c}	1.70^{b}	1.90^{d}	1.50^{c}
2	1.50^{c}	2.00^{b}	1.70^{b}	1.80^{b}	2.30^{c}	1.60^{b}
3	1.70^{c}	1.80^{c}	1.80^{b}	1.80^{b}	2.50^{c}	2.00^{b}
CM 10 – 1	1.80^{b}	1.70^{d}	1.40^{c}	1.90^{b}	2.10^{d}	2.10^{b}
2	1.60^{c}	2.00^{b}	1.60^{b}	2.00^{b}	2.20^{d}	2.10^{b}
3	2.10^{a}	3.10^{a}	2.20^{b}	3.10^{a}	2.90^{c}	2.50^{a}
CM 20 – 1	1.80^{b}	1.90^{b}	1.90^{b}	2.00^{b}	2.40^{c}	2.20^{b}
2	2.00^{a}	2.20^{b}	2.20^{b}	2.10^{b}	2.70^{c}	1.60^{b}
3	2.30^{a}	3.30^{a}	2.90^{a}	3.60^{a}	3.60^{a}	3.30^{a}
CM 30 – 1	1.60^{c}	1.50^{d}	2.70^{a}	2.40^{a}	2.70^{c}	2.20^{b}
2	2.10^{a}	1.90^{b}	2.00^{a}	2.00^{a}	2.50^{c}	2.50^{a}
3	2.30^{a}	3.20^{a}	2.10^{b}	2.80^{a}	2.30^{c}	2.70^{a}
CS 0 – 1	1.40^{c}	2.10^{a}	1.60^{b}	1.70^{b}	2.30^{c}	2.10^{b}
2	2.30^{a}	2.80^{a}	2.50^{b}	2.30^{a}	2.30^{c}	2.80^{a}
3	2.60^{a}	2.70^{a}	3.50^{a}	2.90^{a}	3.30^{b}	2.90^{a}
CS 10 – 1	1.60^{c}	2.40^{d}	2.10^{b}	2.00^{b}	2.40^{c}	2.20^{b}
2	1.50^{c}	2.80^{a}	1.80^{b}	2.50^{a}	2.50^{c}	1.90^{b}
3	1.80^{b}	3.10^{a}	2.00^{b}	3.00^{a}	2.90^{c}	2.40^{b}
CS 20 – 1	1.90^{a}	2.90^{a}	2.80^{b}	3.20^{a}	3.20^{b}	2.70^{a}
2	2.00^{a}	2.90^{a}	1.80^{b}	2.00^{b}	2.20^{d}	2.10^{b}
3	2.00^{a}	3.10^{a}	2.30^{b}	3.00^{b}	3.60^{a}	3.30^{a}
CS 30 – 1	2.20^{a}	2.40^{b}	2.60^{a}	2.80^{a}	2.80^{c}	3.00^{a}
2	2.10^{a}	2.50^{b}	2.30^{b}	2.60^{a}	3.00^{c}	3.10^{a}
3	2.00^{a}	3.00^{a}	2.30^{b}	2.40^{a}	2.40^{c}	3.00^{a}
GA 0 – 1	2.40^{a}	3.10^{a}	2.60^{a}	3.20^{a}	3.40^{b}	3.20^{a}
2	2.30^{a}	3.20^{a}	2.30^{b}	2.90^{a}	3.00^{c}	2.80^{a}
3	2.60^{a}	3.20^{a}	2.40^{b}	2.60^{a}	3.20	2.70^{a}
GA 10 – 1	1.80^{b}	2.90^{a}	1.60^{b}	2.10^{b}	2.10^{d}	1.90^{b}
2	2.00^{a}	3.10^{a}	2.40^{b}	3.20^{a}	3.00^{c}	2.20^{b}
3	1.90^{a}	3.10^{a}	2.10^{b}	1.50^{b}	1.60^{d}	2.10^{b}
GA 20 – 1	1.80^{b}	2.90^{a}	2.00^{b}	3.30^{a}	3.40^{b}	2.80^{a}
2	2.20^{b}	2.90^{a}	1.90^{b}	1.60^{b}	1.90^{d}	1.60^{b}
3	1.60^{c}	2.40^{a}	3.40^{a}	3.20^{a}	2.90^{c}	3.00^{a}
GA 30 – 1	2.50^{a}	2.90^{b}	3.20^{a}	3.30^{a}	2.50^{c}	3.00^{a}
2	2.50^{a}	2.90^{b}	3.10^{a}	2.90^{a}	2.90^{c}	2.70^{a}
3	2.30^{a}	2.30^{a}	3.20^{a}	3.30^{a}	2.80^{c}	3.00^{a}
SE	0.264	0.224	0.317	0.369	0.345	0.296

abcd means with different superscripts within a column differed significantly ($P<0.05$), S.E = Standard Error, O/Accept. = Overall Acceptability, LB = Level of Baobab, TT = Thickener Type, TC = Thickener Concentration. CM = Carbonxymethyl Cellulose, CS = Cornstarch, GA = Gum Arabic.

The results showed significant (P<0.05) differences in all the sensory Properties of the Yoghurt. The results further indicated that yoghurt fortified with 10-30 % LB stabilized at 3 and 2-3% CM, 0- 30% LB at 2-3 and 1-3% CS and 0,10 and 30 % LB at 1-3, 2-3 and 1-3% GA concentration showed better and similar colour contents and were significantly (p<0.05) higher than the other samples. Similarly, yoghurt enriched with 20 % LB stabilized at 3 % CM observed higher consistency contents of 3.30% which was the same with consistency contents recorded in yoghurt improved with 10-30% LB at 3% CM, 10- 30% LB at 2-3 % and 3% CS and 0-20 and 30% LB at 1-2 and 3% GA. Similarly, yoghurt fortified with 0% LB at 3% CS showed good texture content of 3.50% which was observed similar texture contents with yoghurt enriched with 20 and 30% LB at 3 and 1-2 % CM and 0,10 and 30% LB at 1,3 and 1-3% GA concentration. However, yoghurt improved with 20% LB stabilized with 3% CM and those fortified with 10 and 30% LB, 0-30%LB at concentration of 3 and 1-3% CM, 1-3, 2-3, 3% and 1-3% CS and 1-3, 2, 1 and 3, and 1-3 % GA showed better taste when compared with other yoghurt samples. With respects to flavour, yoghurt enriched with 20% LB stabilized at 3% CM recorded suitable flavour and was significantly (p<0.05) better than the rest of the treatments. However, yoghurt fortified with 10 and 30 % LB, 0- 20 and 30%LB stabilized at concentration of 3 and 1-2 % CM, 1-2 ,1 and 3 and 1-3 % CS and 1-3 ,1 and concentration of 2 and 1-3% GA were the same in acceptability values and were higher (p<0.05) than the other samples while the least acceptability value was recorded at concentration of 1% CM in the control yoghurt (0% LB).

4.1.3 Minerals Composition of BDFP Fortified Low-fat Yoghurt Stabilized with Different Thickeners.

Table 4.1.18: Effects of Level of Baobab (LB) on Minerals composition of low-fat yoghurt fortified with BDFP at different concentration.

	Level of Baobab (LB) %				
Minerals (Mg/kg)	0	10	20	30	S.E.
Ca	920.97^{c}	1182.00^{b}	1429.00^{b}	1214.00^{a}	41.094
Mg	247.45	374.26	407.60	448.12	10.968
Na	68.40	112.78	99.99	105.18	2.755
K	275.62^{b}	389.22^{a}	353.37^{a}	350.50^{a}	17.89
P	6.94^{d}	6.60^{c}	9.36^{b}	10.46^{a}	0.133
Fe	6.25c	7.56^{b}	9.40a	7.24^{b}	0.310
Zn	4.40^{d}	6.68^{b}	9.01^{a}	6.18^{c}	0.067
Cu	5.92^{c}	11.04^{a}	8.43^{b}	8.40^{b}	0.044

abcd means with different Superscripts within a row differed significantly ($P < 0.05$), S.E means Standard Error, Ca = calcium, Mg = Magnesium, Na = Sodium, K = Potassium, P = Phosphorus, Fe = Iron, Zn = Zinc .

The results in (Table 4.1.18) revealed no significant (p>0.05) differences with respect to Mg and Na. However, significant (p<0.05) differences was recorded in Ca, K, P, Fe, Zn and Cu contents of the yoghurt samples.The results indicated that yoghurt fortified with 20% LB had highest calcium content value of 1429.00mg/kg while the lowest value of 920.97mg/kg was obtained on that enriched with 0% LB, the results further showed that Ca content of the yoghurt increased with increase in the LB at 0 -20% while decrease at 30%LB. The highest K value of 389.22mg/kg was obtained in yoghurt improved with 10%LB which was similar to that obtained at 20 and 30%LB while the lowest value of 275.62mg/kg was recorded in yoghurt fortified with 0% LB. Yoghurt enriched with 30% LB recorded highest P content value of 10.46mg/kg while lowest value of 6.60mg/kg was obtained on yoghurt fortified with 10%LB. Similarly, the highest Fe value of 9.40mg/kg was recorded in yoghurt improved with 20% LB while the lowest value of 6.25% LB was recorded at 0% LB, the result also showed that the Fe content increased with increase in LB at (0 – 20%) while decreased at 30%LB. For Zinc (Zn), yoghurt fortified with 20% LB recorded highest value of 9.01mg/kg while the lowest value of 4.40mg/kg was obtained in that fortified at 0% LB. Also,the highest Cu value content of 5.92mg/kg was recorded in yoghurt enriched with 20% LB which was the same to those obtained at 30% LB while the lowest value of 5.92mg/kg was recorded in yoghurt fortified at 0%LB. For Mg and Na, no significant difference (p>0.05) were recorded.

Table 4.1.19: Effects of Thickener Type (TT) on Mineral Composition of BDFP Fortified Low Fat-Yoghurt

	Thickener Type (TT)			
Mineral Mg/kg	CM	CS	GA	S.E.
Calcium	1096.00[b]	1131.00[ab]	1332.00[a]	35.588
Magnesium	318.55[b]	386.22[a]	403.30[a]	9.499
Sodium	93.93	98.73	97.10	2.386
Potassium	357.47	330.27	338.80	15.493
Phosphorus	7.84[c]	8.81[b]	9.87[a]	0.115
Iron	7.12[b]	7.63[ab]	8.08[a]	0.269
Zinc	6.28[b]	6.88[a]	6.40[b]	0.058
Cupper	8.10[b]	7.36[c]	9.92[a]	0.038

abcd means with different Superscripts within a row differed significantly ($P < 0.05$), SE means Standard Error, CM = Carbonxymethyl Cellulose, CS = Cornstarch, GA= Gum Arabic.

From the findings (Table 4.1.19), the results indicated that no significant ($p>0.05$) differences in Sodium and Potassium contents of the yoghurt samples. However, significant ($P<0.05$) differences were observed in Ca,M, P, Fe, Zn and Cu. The results also indicated that yoghurt stabilized with GA had highest Ca contents of 1332.00mg/kg which was similar to that improved with CS while the lowest value of 1096.00mg/kg was recorded in that treated with CM. Similarly, higher Mg content value of 403.30mg/kg was recorded in yoghurt improved with GA and was the same to that stabilized with CS while the lowest value of 318.55mg/kg had with yoghurt improved with CM. For Phosphorus (P), the highest contents of 9.87mg/kg was obtained in yoghurt stabilized with GA, followed by that stabilized with CS while the lowest value of 7.84mg/kg was recorded in yoghurt improved with CM. However, yoghurt stabilized with GA and CS showed similar Fe contents while the lowest contentswas obtained in yoghurt stabilized with CM. Also, yoghurt improved with CS was observed with highest Zn contents of 6.88mg/kg, followed by the sample stabilized withCM recorded lower contents. For the Cu, the highest value of 9.92mg/kg was obtained with GA treated yoghurt followed by that stabilized with CM while the lowest value of 7.36mg/kg was obtained in yoghurt improved with CS. However, SodiumandPotassium, were not affected by thickener type and therefore no significant ($p>0.05$) differences were recorded.

Table 4.1.20: Effects of Thickener Concentration (TC) on Mineral Composition(%) of BDFP Fortified Low-fatYoghurt

	Thickener Concentration (%)			
Mineral Mg/kg	1	2	3	SE
Calcium	330.21^{b}	344.71^{b}	351.60^{a}	61.640
Magnesium	321.67^{c}	373.11^{b}	413.29^{a}	9.499
Sodium	85.12^{b}	99.10^{a}	105.53^{a}	2.386
Potassium	320.22	344.71	351.60	15.493
Phosphorus	8.41^{c}	8.87^{b}	9.46^{a}	0.269
Iron	5.91^{c}	7.46^{b}	9.46^{a}	0.269
Zinc	6.29^{b}	6.32^{b}	6.94^{a}	0.058
Cupper	7.13^{c}	8.42^{b}	9.82^{a}	0.038

abcd means with different Superscripts within a row differed significantly ($P < 0.05$), S.E means Standard Error, In (Table 4.1.20), the results revealed no significant (P>0.05) difference with respect topotassium contents in all levels of thickener concentration. However, significant (P<0.05) differences were recorded in calcium, Magnesium, Sodium,Phosphorous, Iron. Zinc and Cupper. The results indicated that yoghurt stabilized at 3% concentration recorded higher Ca contents of 351.60 mg/kg, Mg (413.29mg/kg) Na (105.53mg/kg), P (9.46mg/kg), Fe (9.46mg/kg) Zn (6.94mg/kg) and Cu (9.82mg/kg) whereasthe Na contents was similar to that obtained in 2% concentration while the lowest values was obtained at 1% concentration, the results further revealed that mineral contents of the yoghurt increased with increase in thickener concentration. For Potassium (K), increase in thickener concentration from1 -3% does not affects (K) contents of the yoghurt samples.

Table 4.1.21: Effects of LB and TT Interaction on Mineral Composition (%) of BDFP Fortified Low- fat Yoghurt.

Factor	Mineral (mg/kg)						
LB x TT	Calcium	Magnesium	Sodium	Potassium	Phosphorous	Iron	Zinc
0-CM	780.67 ^{d}	182.12 ^{f}	50.06 ^{d}	230.56 ^{d}	6.22 ^{d}	4.33 ^{d}	4.18 ^{f}
CS	964.40 ^{d}	287.22 ^{e}	71.23 ^{c}	295.17 ^{c}	7.02 ^{d}	5.98 ^{c}	4.40 ^{g}
GA	1018.00 ^{c}	274.00 ^{e}	83.90 ^{c}	308.14 ^{c}	7.59 ^{c}	8.43 ^{b}	4.61 ^{g}
10-CM	1034.00 ^{c}	358.08 ^{d}	138.15 ^{a}	517.99 ^{a}	6.47 ^{d}	6.53 ^{c}	5.91 ^{e}
CS	1238.00 ^{b}	397.08 ^{b}	98.40 ^{b}	341.45 ^{b}	8.99 ^{bc}	8.05 ^{b}	6.65 ^{a}
GA	1276.00 ^{b}	366.95 ^{c}	101.78 ^{b}	308.23 ^{c}	10.38 ^{a}	8.08 ^{b}	6.89 ^{d}
20-CM	1236.00 ^{b}	328.12 ^{d}	85.46 ^{c}	333.13 ^{b}	7.78 ^{c}	7.16 ^{c}	8.16 ^{b}
CS	1514.00 ^{a}	448.68 ^{b}	135.97 ^{b}	390.73 ^{b}	9.64 ^{b}	8.70 ^{b}	5.52 ^{e}
GA	1536.00 ^{a}	446.00 ^{b}	78.55 ^{c}	336.25 ^{b}	10.66 ^{a}	12.34 ^{a}	10.37 ^{a}
30-CM	1335.00 ^{a}	406.88 ^{b}	102.04 ^{ab}	348.21 ^{b}	10.91 ^{a}	5.60 ^{c}	6.91 ^{d}
CS	807.74 ^{d}	411.23 ^{b}	89.32 ^{b}	393.74 ^{b}	9.60 ^{b}	7.11 ^{c}	5.72 ^{e}
GA	1500.00 ^{a}	526.25 ^{a}	124.18 ^{a}	409.57 ^{b}	10.85 ^{a}	9.00 ^{b}	7.64 ^{c}
SE	71.176	18.998	4.773	30.985	0.230	0.538	0.116

abc-g means with different superscripts within a row differ significantly (P<0.05), SE=Standard Error, CM= Carbonxymethyl Cellulose, CS=Corn starch, GA=Gum Arabic, LB = Level of Baobab, TT = Thickener Type.

The results of the finding in (Table 4.1.21), showed significant ($p<0.05$) differences in all the mineral contents of the yoghurt samples.The results further revealed that yoghurt fortified with 20% LB stabilized with GA recorded better Calcium contents of 1536.00mg/kg which was similar to those improved with 20and 30 % LB stabilized with the all thickeners while the lowest value of 780.67mg/kg was recorded in control (0%LB) stabilized with CM which was same to the samples improved with CS at 0% and 30%LB. The highest Magnesium content of 526.25mg/kg was observed in yoghurt stabilizedwith GA at 30%LB while the lowest value of 182.12 mg/kg was obtained in yoghurt fortified with 0%LB stabilized with CM. Similarly, yoghurt enriched with 10%LB stabilized with CM had higher Sodium content of 138.15mg/kg which was similar to the yoghurt fortified with 20% and 30% LB stabilized with CS and GA while the lowest value of 50.06mg/kg was obtained in those improved with 0%LB stabilized with CM. Furthermore, CM stabilized yoghurt fortified with 10% LB had better potassium content of 517.99 mg/k while the lowest value of 230.56mg/kg was recorded with CM treated yoghurt fortified at 30%LB. Whereas, yoghurt improved at 10- 30%LB stabilized with GA and CM have the same and higher Phosphorous content than the other samples. However, for Iron and Zinc, yoghurt fortified with 20 %LB stabilized with CM showed better contents of 12.54 and 10.37mg/kg and were significantly ($p<0.05$) higher than the other yoghurt samples.

Table 4.1.22: Effects of LB and TC Interaction on Mineral Composition of BDFP Fortified Low-fat Yoghurt.

Factors	Minerals mg/kg							
LB x TC	Calcium	Magnesium	Potassium	Sodium	Phosphorous	Iron	Cupper	Zinc
0-1	869.20 [h]	232.32 [g]	246.48 [b]	59.50 [e]	6.00 [f]	4.33 [d]	7.01 [d]	4.18 [f]
2	895.03 [h]	221.68 [g]	273.98 [b]	68.62 [d]	6.67 [e]	5.98 [c]	8.22 [c]	4.40 [f]
3	998.63 [g]	288.34 [f]	306.41 [b]	77.07 [d]	8.16 [d]	8.43 [c]	7.43[d]	4.61 [f]
10-1	1069.00 [f]	298.88 [d]	379.60 [a]	100.01 [b]	8.16 [d]	6.53 [c]	6.88[e]	5.91 [d]
2	1204.00 [d]	361.94 [d]	426.53 [a]	112.16 [a]	8.75 [d]	8.05 [b]	7.23 [d]	6.65 [d]
3	1274.00 [d]	461.97 [d]	361.53 [a]	126.15 [a]	8.90 [c]	8.08 [b]	8.40 [c]	6.89 [c]
20-1	1322.00 [c]	529.72 [a]	349.72 [a]	89.01 [c]	9.20 [c]	7.16 [c]	7.36 [d]	8.16 [b]
2	1444.00 [b]	401.00 [d]	335.99 [a]	101.78 [b]	9.72 [c]	8.70 [b]	9.56 [b]	5.52 [e]
3	1520.00 [a]	393.08 [e]	374.40 [a]	109.17 [b]	9.16 [b]	12.34 [a]	12.42 [a]	10.37 [a]
30-1	1081.00 [e]	325.76 [f]	345.90 [a]	19.62 [c]	10.29 [a]	5.60 [c]	7.10 [d]	6.91 [c]
2	1199.00 [e]	507.80 [c]	342.36 [a]	113.85 [a]	10.33 [a]	7.11 [c]	6.92 [e]	5.71 [d]
3	1362.00 [c]	510.79 [b]	364.07 [a]	109.78 [a]	10.74 [b]	9.00 [b]	8.10 [c]	5.92 [d]
SE	71.176	18.998	30.985	4.773	0.230	0.538	0.123	0.116

abc-gmeans with different superscripts within a column differed significantly (P<0.05), SE= Standard Error, LB= Level of Baobab andTC= Thickener Concentration.

The results in (Table 4.1.22), revealed significant ($p<0.05$) differences in all the analyzed mineral contents in the yoghurt samples. The findings indicated that yoghurt fortified with 20%LB stabilized at 3%TC had higher Calcium contents of 1520mg/kg while the lowest value of 869.20mg/kg was obtained in yoghurt enriched with 0%LB stabilized at 1%TC which were the same to the contents observed in yoghurt fortified with 0%LB at 2%TC. However,yoghurt fortified with 20% LB at 1% concentration showed better and higher magnesium contentswhile the least was observed with control yoghurt stabilized at 1 and 2 % concentration .For Potassium (K), yoghurt improved with 10%LBat 2% concentration recorded higher potassium contents of 426.53mg/kg which was the same to the values obtained in yoghurt fortified with 10-30 % LB at 1 and 3, and 1-3 % concentration. The results further revealed that yoghurt fortified with 30%LB stabilized at 1-3% have similar Phosphorous contents than the other treatments. The higher Iron content of 12.34mg/kg was recorded in yoghurt fortified with 20%LB stabilized at 3%TC while the lowest value content of 4.33mg/kg had with yoghurt enriched with 0%LB at 1%TC. Similarly, concentration of3% in 20% LB fortified yoghurt showed better and higher copper contents while the least copper contents was observed in control yoghurt (0%LB) at 1-3 % levels.

With Zinc, contents of 10.37mg/kg had with yoghurt fortified with 20%LB stabilized at 3% and was significantly higher than the other yoghurt samples while the lowest content of 4.18mg/kg was recorded in that fortified with 0% LB stabilized at 1%TC which was the same to those improved at2 and 3%TC. For Magnesium, the yoghurt fortified with 20%BDFP stabilized at 3%TC recorded highestcontent value of 529.72mg/kg while the lowest value of 221.68mg/kg was recorded in yoghurt enriched with 0% LB at 2%TC which is statistically similar to control yoghurt (0%LB) stabilizedat 1%TC .So also, concentration of 3% in yoghurt fortified with 20% LB showed better and higher copper contents of 12.42% than the rest of the samples

Table 4.1.23:Effects of TT and TC Interaction on Mineral Composition of BDFP Fortified Low-fat Yoghurt.

	Mineral Composition mg/kg							
TTxTC	Calcium	Magnesium	Potassium	Sodium	Phosphorous	Iron	Cupper	zinc
CM-1	1116.00^{b}	232.50^{d}	356.85	84.78^{c}	7.78^{c}	6.26^{b}	6.97^{e}	5.72^{c}
2	1136.00^{b}	343.71^{c}	365.31	97.09^{b}	7.63^{d}	7.46^{b}	8.22^{c}	6.29^{c}
3	1136.00^{b}	379.44^{b}	353.24	99.99^{a}	8.13^{c}	7.63^{b}	9.12^{b}	6.83^{ab}
CS-1	1007.00^{b}	358.14^{b}	313.28	87.75^{b}	8.26^{c}	5.60^{c}	6.48^{e}	6.07^{a}
2	1105.00^{b}	402.18^{ab}	336.03	97.20^{b}	8.94^{b}	7.50^{b}	7.23^{d}	6.62^{b}
3	1181.00^{b}	398.34^{b}	341.49	111.23^{a}	9.25^{ab}	9.78^{ab}	8.35^{c}	6.04^{c}
GA-1	1233.00^{b}	374.37^{b}	320.53	82.92^{c}	9.20^{b}	5.85^{c}	7.94^{d}	6.17^{c}
2	1315.00^{a}	373.43^{a}	335.79	103.01^{a}	10.05^{a}	7.42^{b}	9.83^{b}	6.06^{c}
3	1449.00^{a}	462.10^{a}	360.07	105.37^{a}	10.34^{a}	10.98^{a}	12.00^{a}	6.97^{a}
SE	61.640	16.452	26.834	4.133	0.199	0.446	0.066	0.100

Abc-e means with different superscripts within a column differedsignificantly ($P<0.05$), SE=Standard Error, CM= Carbonxymethyl Cellulose, CS= Cornstarch, GA= Gum Arabic, LB = Level of Baobab, TC = Thickener Concentration.

From (Table 4.1.23), it could be seen that significant ($p<0.05$) differences were observed in all the mineral contents of the yoghurt samples. The results further showed that yoghurt stabilized with 2 and 3%GA concentration showed similar andbetter Calcium (Ca) contents than the other treatments. Higher magnesium contents of 462.10 mg/kg was observed in yoghurt stabilized with 3% concentration of GA, this value was the same to magnesium contents recorded in yoghurt improved with 2% of both CS and GA concentration while the least magnesium contents of 462.10mg/kg was recorded in 2% CM stabilized yoghurt. The results also showed that yoghurt improved with 3%CS had highest Sodium contents of 11.23mg/kg which was similar to those stabilized with 3% CM, 3% CS and 2 and 3% GA respectively. For Magnesium, yoghurt treated with GA at 3%TC had highest value content of 462.10mg/kg which was the same to that obtained in yoghurt stabilized with GA at 2% concentration while the lowest value of 232.50 mg/kg was obtained in that improved with 1% CM. For Phosphorous, yoghurt extended with 3% GA concentration recorded highest value content of 10.34mg/kg, the value was similar to that obtained at 2% GA and 3% CS concentration while the lowest value of 7.63 mg/kg was recorded in yoghurt improved with CM at 3% concentration.

Concentration of 3% in yoghurt stabilized with both CS and GA revealed the same and higher Iron value contentsthan the rest of the samples, while the lowest content of 5.85%mg/kg was obtained in yoghurt stabilized with 1% GA which was similar to that stabilized at 1%CS. Yoghurt treated with GA at 3% concentration had highest Copper contents of 12.00mg/kg while the lowest value of 6.48mg/kg was obtained inyoghurt improved with 1%CS. Yoghurt extended with 3% GA concentration had highest Zinc contents of 6.97mg/kg which wasthe same to the contentsobtained with 1% CSstabilized yoghurt.While the lowest value of 5.72 mg//kg was obtained in yoghurt treated with 1% CM. However, potassium, was not affected by thickener types and concentration

Table 4.1.24: Interaction Effects of Level of Baobab (LB), Thickener Type (TT) and Thickener Concentration (TC) on Mineral Composition of BDFP Fortified Low-fat Yoghurt.

Factors	Mineral Composition (mg/kg)							
LB xTTxTC	Calcium	Magnesium	Sodium	Potassium	Phosphorus	Iron	Copper	Zinc
CM 0 – 1	727.40^{d}	146.28^{f}	43.13^{d}	208.85^{c}	5.76^{d}	4.58^{d}	7.04^{l}	2.86^{m}
2	757.80^{d}	197.16^{e}	47.84^{d}	228.15^{c}	4.33^{d}	5.65^{c}	7.74^{k}	3.61^{i}
3	111.00^{c}	199.92^{e}	59.23^{d}	254.15^{b}	8.56^{b}	6.33^{c}	9.19^{j}	4.41^{k}
CM 10 – 1	922.20^{c}	263.40^{d}	122.06^{b}	525.16^{a}	6.58^{c}	8.38^{b}	10.05^{h}	3.41^{l}
2	1034.00^{c}	308.52^{c}	143.06^{a}	585.39^{a}	7.43^{c}	10.24^{b}	11.41^{f}	8.10^{f}
3	1144.00^{c}	502.32^{a}	149.09^{a}	443.43^{a}	5.39^{d}	6.58^{c}	10.76^{g}	9.56^{d}
CM 20 – 1	1190.00^{b}	263.52^{e}	68.89^{b}	393.67^{b}	7.80^{c}	8.39^{b}	6.46^{m}	7.39^{g}
2	1203.00^{b}	416.16^{c}	85.68^{c}	326.04^{b}	8.17^{b}	9.34^{b}	7.91^{k}	8.89^{c}
3	1315.00^{b}	304.68^{d}	502.32^{b}	379.43^{b}	7.36^{c}	12.01^{a}	13.50^{c}	9.6^{c}
CM 30 – 1	1227.00^{b}	256.80^{e}	104.77^{b}	399.75^{b}	10.96^{a}	3.70^{d}	4.32^{p}	5.23^{j}
2	1512.00^{b}	453.00^{c}	111.78^{b}	309.66^{b}	10.58^{a}	4.63^{d}	5.76^{n}	4.53^{k}
3	1265.00^{b}	510.84^{b}	89.59^{c}	335.21^{b}	11.21^{a}	3.70^{d}	7.18^{l}	3.69^{l}
CS 0 – 1	860.00^{c}	292.92^{e}	59.92^{d}	257.79^{b}	7.12^{c}	3.68^{d}	3.57^{z}	5.82^{i}
2	970.00^{c}	258.20^{e}	68.08^{c}	292.11^{b}	7.41^{c}	5.80^{c}	4.30^{p}	5.09^{j}
3	1063.00^{c}	310.98^{d}	85.68^{c}	335.60^{b}	7.53^{c}	8.39^{b}	5.06^{o}	5.51^{i}
CS 10 – 1	1181.00^{c}	301.00^{d}	88.09^{c}	298.55^{b}	6.91^{c}	5.58^{c}	12.76^{d}	5.78^{i}
2	1267.00^{b}	414.00^{c}	93.06^{c}	391.76^{b}	9.59^{b}	7.41^{c}	12.07^{e}	5.18^{j}
3	1267.00^{b}	417.48^{c}	114.08^{c}	334.04^{b}	10.46^{a}	8.36^{b}	13.28^{c}	5.17^{j}
CS 20 – 1	1357.00^{b}	462.60^{c}	361.00^{d}	455.97^{a}	9.66^{b}	7.53^{c}	4.31^{p}	8.15^{f}
2	1576.00^{a}	372.12^{d}	414.00^{c}	348.27^{b}	10.20^{a}	10.23^{b}	5.76^{n}	10.31^{b}
3	1610.00^{a}	511.32^{a}	417.48^{c}	367.97^{b}	9.06^{b}	13.94^{a}	7.18^{l}	11.83^{a}
CS 30 – 1	629.00^{d}	315.72^{d}	73.26^{c}	240.83^{b}	9.33^{b}	5.59^{c}	3.79^{q}	8.13^{f}
2	607.68^{d}	564.35^{b}	90.05^{c}	313.00^{b}	9.54^{b}	6.52^{c}	5.05^{o}	5.91^{i}
3	1186.00^{b}	353.12^{d}	104.65^{d}	328.38^{b}	9.92^{b}	8.43^{b}	6.46^{m}	5.19^{i}
GA 0 – 1	1020.00^{c}	258.24^{d}	75.44^{c}	272.10^{b}	5.12^{c}	4.72^{d}	4.41^{p}	3.45^{l}
2	919.00^{c}	209.64^{e}	89.93^{c}	301.67^{b}	9.28^{b}	6.49^{c}	5.11^{o}	4.51^{k}
3	1114.00^{c}	354.12^{d}	86.32^{c}	328.97^{b}	8.38^{b}	10.56^{c}	7.27^{l}	3.40^{l}
GA 10 – 1	1105.00^{c}	271.44^{e}	89.93^{c}	315.12^{b}	10.99^{a}	5.64^{c}	8.59^{j}	4.52^{k}
2	1310.00^{b}	363.30^{d}	100.40^{b}	302.45^{b}	9.22^{b}	6.50^{c}	9.31^{i}	6.68^{h}
3	141.00^{b}	466.10^{b}	115.00^{b}	307.13^{b}	10.85^{a}	9.30^{b}	11.10^{f}	5.95^{i}
GA 20 – 1	1420.00^{b}	563.04^{a}	271.44^{e}	299.52^{b}	10.12^{a}	5.56^{c}	12.14^{e}	8.94^{e}
2	1552.00^{b}	363.30^{d}	363.30^{d}	333.65^{b}	10.80^{a}	6.51^{c}	14.84^{b}	6.35^{h}
3	1635.00^{a}	466.10^{b}	466.10^{b}	375.75^{b}	10.04^{a}	11.06^{b}	16.15^{a}	9.60^{c}
GA 30 – 1	1388.00^{b}	404.77^{c}	97.87^{b}	394.68^{b}	10.58^{a}	7.50^{c}	12.14^{e}	6.35^{h}
2	1478.00^{b}	506.04^{b}	139.73^{a}	405.41^{b}	10.88^{a}	10.19^{b}	14.84^{b}	6.70^{h}
3	1634.00^{a}	667.94^{a}	134.96^{a}	428.61^{a}	10.10^{a}	12.98^{a}	16.15^{a}	8.87^{e}
SE	123.281	32.905	8.266	53.668	0.399	0.931	0.133	0.201

abc-q means with different superscripts within a column differed significantly ($P<0.05$), S.E = Standard Error, CM = Carbonxymethyl Cellulose, CS = Corn starch, GA = Gum Arabic, TS = total solid, TA = Titratable Acidity, LB = Level of Baobab, TT = Thickener Type, TC = Thickener Concentration.

From the results (Table 4.1.24), the significant ($P<0.05$) differences were observed in all the mineral compositions of yoghurt. The results further revealed that yoghurt enriched with 20 and 30 % LB stabilized at 3% GA and 20 %LB at 2 and 3 %CS showed the same calcium (Ca) contents and were significantly ($p<0.05$) higher than the rest while the lowest Ca contents were recorded in samples fortified with 0 and 30% LB stabilized with 1-2 and 2-3% CS concentration. Similarly, yoghurt improved with 10 and 30% LB at 3 and 2 % CS and 20 and 30% LB at 1 and 2-3 % GA have similar and better magnesium (Mg) contents when compared with rest of the samples, whereas the least Mg contents was observed at 1% CM in control yoghurt sample. The higher sodium (Na) contents were recorded in yoghurt improved with 30% LB at 1-3% CM and 3% GA and were better than the other treatments. Yoghurt fortified with 10 and 30% LB at 1-3% CM and 3% GA observed the same potassium contents, the values were significantly higher than the other samples.Similarly, yoghurt fortified with 30% LB at 1-3% CM, 10 and 20% LB at 2 and 3% CS and 20 and 30% LB at 1-3% GA showed similar and higher phosphorus (p) contents than the rest, while the least p contentswere recorded with 0 and10% LB at 1-2 and 3% CM.

However, higher Iron (Fe) content of 13.94mg/kg was recorded in yoghurt with 30% LB stabilized at 3% GA which was the same to the Fe content observed with the samples fortified with 20% LB at CS and CM 3%. So also, yoghurt fortified with 20 and 30% LB at 3% GA had higher copper (Cu) content of 16.15mg/kg while the least Cu content was obtained in 30% LB fortified yoghurt stabilized at 1% CS. With Zinc (Zn), yoghurt improved with 20% LB stabilized at 3% CS had better and higher ($p<0.05$) Zn content than the other samples, while the least Zn content was recorded in control yoghurt sample (0% LB) stabilized at 1 % CM concentration.

4.1.4 Microbiological Quality of Low- fat Yoghurt Fortified with BDFP Stabilized with Different Thickeners.

Table 4.1.25: Microbiological Analysis of Yoghurt Samples

LBxTT x TC	*S.aureus* (cfu/ml)	*E.coli* (cfu/ml)	*Salmonella*
CM 0-1	-	-	-
2	-	-	-
3	-	-	-
CS - 1	-	-	-
2	-	-	-
3	-	-	-
GA - 1	-	-	-
2	-	-	-
3	-	-	-
CM 10-1	-	-	-
2	-	4.1×10^4	-
3	-	3.7×10^4	-
CS - 1	-	-	-
2	-	-	-
3	-	-	-
GA - 1	-	-	-
2	-	-	-
3	-	-	-
CM 20-1	-	-	-
2	-	-	-
3	-	-	-
CS - 1	-	-	-
2	-	-	-
3	-	-	-
GA - 1	-	-	-
2	-	-	-
3	6.3×10^4	-	-
CM 30-1	-	-	-
2	-	-	-
3	-	-	-
CS - 1	-	-	-
2	7.9×10^4	-	-
3	5.2×10^7	-	-
GA - 1	-	-	-
2	-	-	-
3	-	-	-

CM = Carbonxymethyl cellulose, (-) No Growth, CS = Cornstarch, GA = Gum Arabic, TBC = Total bacterial count <10cfu/ml = Level at which Organism cannot be detected, LB = level of baobab, TT = Thickener Type, TC = Thickener Concentration.

The results of microbiological analysis indicated that (3) yoghurt samples detected the presence of *Staphylococcus aureus*, *Escherichia coli* was detected in (2) yoghurt samples while *Salmonella species* was not detected in any of the yoghurt samples. The results revealed that the higher microbial load of 5.2 x 10^7cfu/ml was recorded with *Staphylococcus aureus* in yoghurt fortified with 30% LB stabilized with 3% CS, followed by 7.9 x 10^4cfu/ml obtained in yoghurt enriched with 30% BDFP stabilized with 2% CS while least microbial count of 6.3 x 10^4cfu/ml was obtained in yoghurt improved with 20% LB stabilized with 3% GA , *E. coli* was detected with higher microbial count of 4.1 x 10^4cfu/ml, followed by microbial load of 3.7x10^4cfu/ml recorded in yoghurt enriched with 10% LB stabilized at 2 and 3% CM. No growth with *Salmonella species* in all the yoghurt samples.

4.2 Discussion

4.2.1 Physico-Chemical Properties of Low-fat Yoghurt Stabilized with different Thickeners.

The results on table 4.1.4, 4.1.5 and 4.1.6 of the main effects on proximate composition, showed no significance difference ($P<0.05$) in fat, titratable acidity, total solid and ash. However, interaction effects were found to be significant ($P>0.05$).The results were in contrast to that of Alkali *et al.* (2008)who reported TS values of 24.50%, 23.90% and 25.40% recorded in yoghurt stabilized with CM, CS and gelatin at 1% concentration. Results of the total solid contents inthe presents study were higher compared to the value of21.8% reported by Obugboyiro and Oseh, (2011) in Mr cream yoghurt in Nigeria and 17.11% value reported by Muhammad *et al*. (2009). According to Weaver, (1993) low percentage of total solid could lead to malfunction of the starter culture. The higher total solid content obtained in the current study could be attributed to addition of stabilizer in yoghurt manufacture. This agreed with finding of Mekana and Mehanna, (1990) and Monay, (1987) who reported that addition of stabilizer increase the total solid content of yoghurt.

Alkali *et al*. (2008) reported fat content value of 2.40% obtained in thermized yoghurt at 1% CS concentration which was lower than the value of 3.30%obtained in the current study. However, Jonhol and Micheal, (2006) reported the average fat content range between 0.3 to 3.5% for low-fat stirred yoghurt which fall within the range of the current findings. The higher fat content obtained in the present study could be attributed to higher percentage of total solid in the yoghurt. The results in the present finding also revealed that fat content increased with thickener type while decreased with increase in the thickener concentration as shown in table 4.1.5 and 4.1.6. The results further showed that at 1% concentration, the maximum fat content value was achieved. According to FAO standard fat content of yoghurt between 0.5-10 is good but being the best at 3.0%. The higher fat content of 3.30% in the present study was almost similar to that of FAO minimum standard (FAO 1979), in the same vein the value of the current finding falls within the standard of low-fat yoghurt (<3.50%) as reported by Saint Eve *et al.* (2008).

The protein content of yoghurt in the present study range between 2.12 – 4.64%, with highest value of 4.64% obtained in yoghurt enriched with 20%BDFP at 1%GA concentration, the values were in contrast with findings of Alkali *et al.,* (2008) who reported lower protein content of 3.50% in physico-chemical and sensory attributes of thermized yoghurt. However, Chinbas and Yazici, (2008) reported protein contents of 37.5% obtained in yoghurt fortified with blueberry, these values were lower than the reported value obtained in the current study. The higher protein contents obtained in the present study could be due to the fact that the milk used for the experiment was pasteurized at 65^{o}C for 30minutes, as high pasteurization temperature of 75^{o}C or above can significantly denature milk protein Gillis and Singh, (2005).Milk protein have high nutritive value due to favorable balance of essential amino acid that are in good proportion.

(Atherton and Newlander, 1992; Rodrigues *et al.*2010) remarked that, the pH of the yoghurt is between4.30–5.08.Chowdhurry *et al.*(2011) in the study of quality assessment of curd (Dahi) reported pH ranges from 3.55 – 4.80. However, the results of the present study fells within the ranges reported by proceeding authors. Zaker Hossain *et al.*(2015) in a study of Bangladesh, Mistannan Vander yoghurt reported pH value of 4.80; the value was slightly higher than the value recorded in the current study while Sarkar *et al.*(2012) in chemical and bacteriological quality of curd (Dahi) reported pH value of 4.66 which is in close agreement with the value of the current finding. The results revealed no significant difference (P>0.05) in pH of all the yoghurt samples, hence BDFP, thickener type and concentration had no effect in pH of the yoghurt samples. The pH is the parameter that determined the sample acidity strength, is an important factor in yoghurt production and responsible for its characteristic taste.

The titratable acidity (TS) value ranged between 0.04% to 1.06%, with highest value of 1.06% obtained in yoghurt improved with 10%BDFP stabilized with 1% CS concentration, this value agreed with the finding of Alkali *et al.* (2008) who reported maximum TA value of 1.09% at 0.5% CS concentration obtained in thermized yoghurt. However, the highest TA value recorded in the current study may be as the result of less inhibitory effect of Corn starch (CS) on the Lactic acid production as compared to CM which depressed it production.

The Ash content ranged between 0.38 to 1.53% with highest value of 1.53% obtained in control (0% BDFP) stabilized at 1% CM concentration, this value was contrary and significantly higher than the finding of Alkali *et al.*(2008) who reported fat content value of 0.72% in yoghurt stabilized with 1%CM in effect of stabilizer on physico chemical and sensory attributes of thermized yoghurt. However, Muhammad *et al,(*2009) and Aryana *et al.* (2006) reported ash values ranging from 1.03 to 1.06 and 0.66 to 0.99% in fruit flavoured yoghurt, the results of the current finding is higher than the reported values of the proceeding authors. The results of the present finding revealed that BDFP has significant effects on the ash content of the yoghurt samples. The higher Ash content is an index of major mineral which is needed for bone development, teeth formation and body functions (Trachoo and Mistry 1998).

4.2.2 Sensory Properties of Baobab Dried Fruit Pulp Enriched Low-fat Yoghurt Stabilized with Different Thickeners.

The results in table 4.1.11, 4.1.12 and 4.1.13 of the main effects revealed no significant difference ($p > 0.05$) in consistency and flavour but interaction effects were found to be significance ($p < 0.05$).The results of the current study revealed that yoghurt fortified with 0% Level of Baobab (control) stabilized at 1% CS recorded highest colour score of 2.60%. The results was in agreement with finding of Olurunnisomo *et al*. (2015) who reported that yoghurt stabilized with 1%CS concentration attracted the most desirable colour. However, in fruit flavoured yoghurt, Kadam *et al.*(2010) on effect of different varieties of Date Palm Paste reported that yoghurt stabilized with Safri date palm paste at 10% concentration showed attractive colour. The same author opined that consumer preferred light than dark colour product.

The best colour recorded in yoghurt stabilized with Corn starch in the current study may be due to colour of stabilizer and appropriate level of concentration used. Colour serves as a visual criteria for justifying product quality, it is an important food attribute and directly related to consumer acceptance of the product (Pomeranz and Meleon, 1990; Redinger, 1993; Hendrick, Forest, Judge and Merka,1994).

The results of the present study indicated that yoghurt produce with addition of 20% BDFP stabilized with 3% CM concentration was also liked by respondents, this was in agreement with finding of Alkali *et al*. (2008) in effects of stabilizer on physico-chemical and sensory evaluation of thermized yoghurt who reported that the most desirable flavour was obtained in sample stabilized with 1% CM, 1% CS and 0.5% (GL), while Olurunnisomo *et al.* (2015) on influence of stabilizers in yoghurt composition and sensory properties reported that yoghurt enriched with Baobab fruit and milk powder at 2% concentration recorded the best flavour, the higher flavour contents obtained in the current study could be attributed to inclusion of Baobab fruit pulp. According to Tribby, (2001) the presence of other volatile matter in the pulp in addition to Aromatic compound such as tartaric acid, diacetyl and acetaldehyde developed during fermentation. Flavour of contributed to the flavour in the yoghurt. This agreed with view of Olurunnisomo *et al.* (2015) who reported that addition of stabilizer with Baobab fruit pulp generally improved the sensory properties of yoghurtthe product is generally considered the most critical and important indicator of consumer acceptance of the product as reported by Body felt *et al.*(1988).

With regard to overall acceptability, the result of sensory evaluation showed that yoghurt enriched with 20%LB stabilized at 3%CS recorded higher acceptability scores of 2.63% was preferred by the taste panelists and recorded as the yoghurt with good quality attributes. This is in line with finding of Kumar and Mishra (2004) and Kadam *et al*. (2010) in fruit flavoured yoghurt who reported that the quality and acceptable yoghurt was produced with fortified mango-Soymilk yoghurt and Safri date palm powder at 2% concentration. The results of the current finding also agrees with view of Okoth *et al*. (2011) who reported that skimmed milk powder with modified starch produced high quality yoghurt. However, the high acceptability score obtained in the current study could be attributed to various additives and stabilizer used at appropriate concentration. This support the view of Aryana *et al*. (2006) who opined that sensory acceptability of yoghurt is affected by the type of milk used, the culture species, additives and stabilizer and production technique employed.

Consistency is the resistance of fluid to flow, it is described as the thickness of the product. The consistency value range between 1.50 to 3.30% with highest value of 3.30% obtained with yoghurt enriched with 20% LB stabilized at 3% CM followed by yoghurt obtained at 3% GA while the least value was recorded on 3% GA. Alkali *et al.,* (2008) in thermized yoghurt obtained highest consistency value of 4.20% in yoghurt stabilized with Gelatin (GL) at 0.05% concentration which is higher than the value recorded in the present study. The same author reported higher consistency value of 2.70% with CS at 0.50% than the reported value in the current study. The higher consistency value obtained in the current study could be attributed to the higher total solid content of the yoghurt. This agrees with view of Robinson and Tamime, (1990) who observed that, consistency of the yoghurt improved when the total solid content of the yoghurt is reasonably high. O'Neil *et al.*(1979) concluded that the consistency of the yoghurt is influence by the composition milk, storage time and acidity.

Alkali *et al.* (2008) and Kumar and Mishra (2004) stated that the use of stabilizer in low-fat yoghurt improved the body, texture, appearance and delays whey separation, this agrees with findings of (Vedamuthu, 1993; Lucey, 2002) who stated that different stabilizer are used to produce thick, cohesive body, smooth texture, prevent wheying off and improve consistency and reduce syneresis. The texture values ranges between 1.40% to 3.50% with highest score of 3.50% obtained in control yoghurt(0% LB) stabilized at 3% CS followed by yoghurt enriched with 20% LB stabilized at 3% GA concentration while CMC recorded least texture value of 1.40% in yoghurt fortified with 0 and 10% LB stabilized at 1% concentration. The results of the present study were higher than the findings of Nima *et al.*(2012) in effect of Guar gum on yoghurt characteristic who reported higher texture value 34% with Xanthan gum (XG) at 0.005% concentration.

Alkali *et al*., (2008) in thermized yoghurt reported higher Taste value of 3.30% in yoghurt stabilized with 1% CS concentration respectively. The results of the finding were lower than the value of 3.60 obtained in the present study. However, Desilva and Rathnayaka, (2013) in physico-chemical, sensory and Microbiological evaluation of set-type fruited yoghurt, reported higher taste value of 5.16% which is higher than the reported value obtained in the current study. The highest taste score obtained in the present study could be due to addition of flavouring agent and Baobab fruit pulp in the mix. This support the view of Deeth and Timame, (1981) who reported that fruit added to flavoured yoghurt significantly determined the taste of the products.

4.2.3 Minerals Composition of BDFP Fortified low fat Yoghurt Stabilized with Different Thickener

The results of the main effects in minerals' composition indicated that there were no significant differences ($p<0.05$) in Mg, Na and K. However, interaction effects were found to be significant ($P>0.05$).The higher Calcium (Ca) content of 1635.00 mg/kg was obtained in yoghurt enriched with 20% LB stabilized at 3% GA concentration which was significantly higher than the finding of Sanchez-Segarra *et al.*(2000) who reported Ca content between the range of 964 to 1056mg/kg in yoghurt fortified with different fruits and fruits extract respectively. However Swang and Singh (1978) reported Ca value of 1525 mg/kg which is in close agreement with present finding while Morena Rojas *et al.* (1993) and Garcia-Martinez *et al.* (1998) Reported higher Ca value of 1355 mg/kg and 112 mg/kg comparatively the values were lower to the finding obtained in present study. The higher Ca value recorded in the present study could be due to fortification of yoghurt with Baobab Dried fruit pulp which is as importance source of calcium. Yoghurt is a good source of calcium which is essential for healthy growth and maintenance of teeth and bones.

The Sodium (Na) content of 956.36mg/kg reported by Sanchez- Segarra *et al*, (2000) in yoghurt enriched with Degla- Beida date powder was significantly higher than maximum value of 149.53mg/kg obtained in the present study. The Na contents reported in the present study was lower compared to the values of 303-392 mg/kg reported by Sanchez- Segarra *et al*,(2000) who enriched yoghurt with different fortifiers. The higher Na content recorded in the current study could be attributed to the use of CM as stabilizer which is known to be a good source of sodium (Na).

The higher magnesium (Mg) contents of 526.25mg/kg obtained in the present study was significantly higher and in contrasts with the valuesof 98.3 – 122.6 mg/kg reported by Tarakci and Dag (2013). However, Sanchez *et al.* (2000) reported lower magnesium contents of 84-105mg/kg. The higher mg contents obtained in the present study could be due to addition of Baobab dried fruit pulp in addition to others additives in the mixed. Magnesium is one of the six essential minerals that body need in relatively large quantitieswhich is required for normal bone structure and treatment of osteoporosis.

The Phosphorus (P) content ranges between (4.35 -11. 20 mg/kg), with higher content of 11.21mg/kg obtained in yoghurt improved with 30% LB stabilized with 1% CM concentration. The results was observed to be lower than the value of 1002 mg/kg reported by Gad *et al.* (2010) in evaluation of nutrients value of functional yoghurt. The lowest P value obtained in the current study may be attributed to the milk type and various additives in yoghurt matrix. Phosphorus is necessary for healthy bones and teeth as well as energy production, it also help in cell membrane structure, tissue growth and regulation of pH level in the body.

Sanchez *et al*., (2000) reported Potassium (K) content value of 1337 mg/kg and 1191 mg/kg in yoghurt with added fruit mixture and strawberries yoghurt. These values are significantly higher than the value reported in the current study. The same authors also reported higher K contents of 209 mg/kg and 921 mg/kg in yoghurt enriched with blackberries and pineapple. While Amella – Chibane and Benamera, (2011) reported potassium content of 771.77 mg/kg in yoghourt fortified with Mech-Degla date powder, which favorably compared to the present values contrasts with current findings. Potassium is one of the main blood minerals called "electrolytes" which play a vital roles in proper function of cell, tissue and organs in human body.

Sanchez *et al.* (2000) reported higher iron (Fe) contents of 11.52 mg/kg in yoghurt enriched with Mech-Degla date powder, the results was comparably with reported value of 13.95 mg/kg in the present study. The same authors reported Fe contents between the ranges of 0.62-3.46mg/kg in yoghurt fortified with different fruits which are comparatively lower than the values obtained in the present study.The higher value recorded in the current study could be attributed to the addition of Baobab dried fruit pulp. According to Mccane et Widdowson, (1993), addition of fruit and fruit extract such as raspberries, fruit pieces and blackberries could increase mineral contents.

The higher Zinc (Zn) content of 11.80mg/kg obtained in the present study was higher than the reported values of Sanchez – Segarra *et al*. (2000) who reported Zinc content of 7.93 mg/kg. However, Fiszman *et al.*(1999) also reported Zn contents between the ranges of 2.8-3.4mg/kg for yoghourt fortified with different additives which were lower than the values obtained in the present study.

4.2.4 Microbiological Quality of Yow fat yoghurt Fortified with BDFP and Stabilized with Different Thickeners.

The Microbiological quality of yoghurt is mainly concern with protection of the consumer against health hazard and ensuring that the products are not suffering any microbiological deterioration during it anticipated shelf-life (Caballero, 2003). According to microbiological data on table 25, the study detected the presence of *Escherichia coli* in (2) yoghurt samples, yoghurt fortified with 10% BDFP stabilized at 2% CM with higher microbial load of 4.1×10^4 cfu/ml and yoghurt enriched with 10% BDFP stabilized with 3% CMC. The results were in conformity with findings of Eissa *et al.*(2010) in physico-chemical, microbiological and sensory characteristic of yoghurt produced from Goat milk who reported the presence of *Eschericia coli*. The presence of *E. coli* is commonly used as surrogate and must be negative to be safe for consumers based on European regulations. Its presence in food generally indicates direct or indirect fecal contamination. The presence of *E. coli* in the present study may be due to in-adequate storage facility, lack of constant electric power as well as weak hygienic practices in handling processing and storage of the product, this support the finding of Shojaei and Yodollah, (2008),who stated that substantial number of *E. coli* in food suggest a general lack of cleanliness in handling and improper storage before analysis. However, the current study also detected the presence of *Staphylococcus aureus (S.aureus)* in (3) yoghurt samples with higher microbial count of 5.2×10^7cfu/ml obtained in yoghurt enriched with 30%LB stabilizedwith 2% CS,yoghurt with microbial load of 7.9×10^4cfu/ml fortified with 30%LB stabilized at 2% CS and microbial load of 6.3×10^7cfu/ml was recorded in yoghurt enriched with 20% BDFP stabilized with 3% GA. The results was consistent with finding of Farinde *et al,*(2009) who reported the presence of *S. aureus* while contradict the finding of Egwaikhide and Faremi, (2010) who reported the absence of *S. aureus* due to use of preservatives which prevent the growth of pathogens. The presence of *S. aureus* in current study could be attributed to production and handling process. The pathogen has been identify as the causative agent in many food poisoning outbreak.

Dardashti *et al.*(2001) and Eissa *et al*.(2010) in physico-chemical, microbiological and sensory characteristic of yoghurt reported that *Salmonella species* was not detected in any of the yoghurt sample, the result was affirmed with current finding. The absence of salmonella in the present study could be attributed to the used of preservative in manufactured yoghurt, this prevented the growth of pathogen. The sample was considered safe when*Salmonella* is not detected in food, FAO, (1979). Any sample analyzed not exceed microbiological count of 10cfu/ml is considered to be safe to consumers FAO, (1979).

CHAPTER FIVE

5.0 SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1 SUMMARY

The study was conducted at the Department of Animal Science. Bayero University Kano to determine physico- chemical, sensory, minerals and microbiological quality of low fat yoghurt enriched with Baobab Dried Fruit Pulp (BDFP) stabilized with (3) thickeners at varying concentration. The experiment was conducted in a 4 x 3 x 3 factorial arrangement ina completelyrandomized design (CRD). The factors were four (4) levelsof Baobab (LB) 0%, 10%, 20% and 30%, three (3) thickener type; Carboxymethyl cellulose (CM), Corn starch (CS) and Gum Arabic (GA) and three (3) thickeners concentration levels 1%, 2% and 3% respectively.

The results in Table 4.1.4, 4.1.5 and 4.1.6 of the main effects on proximate composition, showed there were no significant differences ($P > 0.05$) in Ash, fat, total solid, titratable acidity and pH. However, interaction effects were found to be significant. The results revealed fat content to range between (2.55-3.30%), protein (2.12-4.64%), ash (0.38-1.53%), total solid (20-50%), titratable acidity (0.04-1.06). On the interaction effects, the results showed significantly higher contents in chemical composition. While pH value of 4.70 in all the yoghurt samples were recorded. The results further revealed that fortification of yoghurt with BDFP had significant ($P > 0.05$) effects in ash content as higher value was recorded in control yoghurt (0% BDFP).

Sensory evaluation was conducted by a team of a ten man panel of judges that assessed the yoghurt on the basis of colour, consistency, texture, flavour, taste and Overall acceptability using 7 point hedonic scale (1-like extremely to 7-Dislike moderately). The results in Table 4.1.11, 4.1.12 and 4.1.13 of the main effects on sensory properties revealed no significant differences ($p < 0.05$) with respect to consistency and flavour. However, interaction effects were found to be significant. The results showed the colour score ranged between (1.20-2.60%), consistency (1.50-3.30%),texture (1.40-3.50%), taste (1.50-3.60%), flavour (1.60-3.60%) and overall acceptability (1.50-3.30%). From the results the yoghurt enriched with 30% BDFP Stabilized with 3% CS attracted higher acceptability score of 2.63% and was the preferred by taste panels, followed by yoghurt fortified with 30% BDFP stabilized at 3% GA. Higher values in sensory attributes were also recorded on interaction effects .The result further revealed that all yoghurt samples were accepted by taste panelists.

The data in Table 4.1.18, 4.1.19 and 4.1.20 of the main effects in minerals' composition showed no significant differences ($P > 0.05$) with respect to Mg, Na and K. However, significant differences were recorded on the interaction effects. The results showed the Ca value range between (107.68-1635mg/kg), Mg (146.28-667.94mg/kg), Na (43.13-149.09mg/kg),K (208.85-585.39mg/kg),P (4.33-11.21mg/kg), Fe (3.68-13.94mg/kg),Zn (2.86-11.83mg/kg) and Cu (3.57-16.15mg/kg) .The interaction effects also recorded higher values on mineral composition.

Microbiological analysis was conducted for the determination of *Escherichia coli, Staphylococcus aureus*, *Salmonella spp* and total bacterial count in all the yoghurt samples produced. The results presented revealed that *Staphylococcus aureus* was detected in (3) yoghurt samples with higher microbial load of 5.2×10^7cfu /ml in yoghurt fortified with 30 % BDFP stabilized with 3 % CS, followed by yoghurt with microbial count of 7.9×10^4cfu/ ml while the least value of 6.3×10^4 recorded in yoghurt improved with 20 % LB stabilized at 3 % GA, *Escherichia coli* was detected in (2) yoghurt samples with higher microbial load of 4.1×10^4cfu/ml, followed by 3.7×10^4cfu/ml microbial count obtained in yoghurt fortified with 10 % BDFP stabilized at 2 and 3 % CM Concentration. However, *Salmonella spp* was not detected in any of the yoghurt samples. The results also revealed that all the yoghurt fell within the acceptable range.

5.2 CONCLUSION

Based on the present findings, it was concluded that inclusion of Baobab dried fruit pulp at 30 % concentration produced yoghurt with good chemical and sensory attributes preferred by most respondents. Meanwhile, Corn starch was recorded as the optimum thickener followed by Gum Arabic while CM had least acceptable score. It was also concluded that the inclusion of 30% BDFP and thickeners at 3% concentration levels yield quality and acceptable yoghurt with Cornstarch and Gum Arabic while 1% concentration is appropriate for the use of Carbonxymethyl cellulose in yoghurt.

5.3 RECOMMENDATIONS

In line with the present findings, the following recommendations were offered:

(1) Low- fat yoghurt could be fortified with 30% BDFP to improve physico-chemical properties ofthe yoghurt.

(2) Cornstarch and Gum Arabic could be used to improve sensory attributes of low-fat yoghurt at 3% concentration while carbonxymethyl cellulose should be used at 1% concentration.

(3) Although, the overall picture of yoghurt quality assessment is fair, but additional emphasis on quality control should be employed during processing.

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APPENDIX

DEPARTMENT OF ANIMAL SCIENCE

FACULTY OF AGRICULTURE

BAYERO UNIVERSITY, KANO

SENSORY EVALUATION QUESTIONNIARE

Please, kindly score the following yoghurt samples based on seven (7)points' hedonic scales

A	PARAMETERS					
Sample	Colour	Consistency	Texture	Taste	Flavor	Overall Acceptability
Ac1						
Ac2						
Ac3						
As1						
As 2						
As3						
AG1						
AG2						
AG3						

Hedonic scale:

1- Like extremely
2- Like very much
3- Like moderately
4- Like slightly
5- Neither like dislike
6- Dislike slightly
7- Dislike moderately

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SENSORY EVALUATION QUESTIONNIARE

Please, kindly score the following yoghurt samples based on seven (7) points' hedonic scales

B	PARAMETERS					
Sample	Colour	Consistency	Texture	Taste	Flavour	Overall Acceptability
Bc1						
Bc2						
Bc3						
Bs1						
Bs 2						
Bs3						
BG1						
BG2						
BG3						

Hedonic scale:

1- Like extremely
2- Like very much
3- Like moderately
4- Like slightly
5- Neither like dislike
6- Dislike slightly
7- Dislike moderately

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SENSORY EVALUATION QUESTIONNIARE

Please, kindly score the following yoghurt samples based on seven (7) points' hedonic scales

C	PARAMETERS					
Sample	Colour	Consistency	Texture	Taste	Flavour	Overall Acceptability
Cc1						
Cc2						
Cc3						
Cs1						
Cs 2						
Cs3						
CG1						
CG2						
CG3						

Hedonic scale:

1- Like extremely
2- Like very much
3- Like moderately
4- Like slightly
5- Neither like dislike
6- Dislike slightly
7- Dislike moderately

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SENSORY EVALUATION QUESTIONNIARE

Please, kindly score the following yoghurt samples based on seven (7) points' hedonic scales

D	PARAMETERS					
Sample	Colour	Consistency	Texture	Taste	Flavour	Overall Acceptability
Dc1						
Dc2						
Dc3						
Ds1						
Ds 2						
Ds3						
DG1						
DG2						
DG3						

Hedonic scale:

1- Like extremely
2- Like very much
3- Like moderately
4- Like slightly
5- Neither like dislike
6- Dislike slightly
7- Dislike moderately