

**PROXIMATE COMPOSITION, SENSORY
EVALUATION AND YIELD OF CHEESE FROM
GOAT MILK USING DIFFERENT COAGULANTS**

BY

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**DEPARTMENT OF ANIMAL SCIENCE
FACULTY OF AGRICULTURE
UNIVERSITY OF BENIN
BENIN CITY**

MAY, 2024

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**A PROJECT REPORT SUBMITTED TO THE
DEPARTMENT OF ANIMAL SCIENCE, FACULTY OF
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CERTIFICATION

This is to certify that this research was carried out by **Uwayemwen OMORUYI (MISS)**, in the Department of Animal , Faculty of Agriculture, Univerity of Benin, Benin City, Nigeria.

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Date

DEDICATION

This work is dedicated first and foremost, to God Almighty, my unyielding source of strength and inspiration.

I also dedicate this to my parents, Mr and Mrs Omoruyi for their continuous support throughout the course of my academic pursuit.

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ABSTRACT

Cheese is a dairy product made from pressed milk curds produced mainly from animal milk throughout the world where animal production is available. It is a nutritious food and one of the numerous products from the processing of milk of cows, goats, sheep, buffalos, camels and yaks. It is produced by coagulation of the milk protein known as casein. Cheese is an important milk product with milk nutrients having good storage properties with increased shelf life.

This study investigated the potential of using different coagulants - vinegar, lime juice, lemon juice, and unripe papaya pulp in the production of goat milk cheese. The proximate composition, mineral content, and sensory attributes of Mozzarella and Cream Cheese produced with these coagulants were analyzed and studied in the laboratory. The proximate composition analysis revealed significant differences in the moisture content (MC), crude protein (CP), crude fat (CF), and nitrogen-free extract (NFE) among the different treatments for both Mozzarella and cream cheese. Unripe papaya pulp consistently exhibited the highest values for CP and CF in both types of cheese having values 19.34 and 22.99 for Mozzarella cheese and Cream cheese respectively. This could be attributed to the coagulation process and the properties of the coagulants used. The mineral analysis showed significant variations in the calcium, phosphorus, and zinc content of the cheeses while lemon juice coagulant had the highest phosphorus content, the Zinc content varied among the treatments, with also lemon juice coagulant showing the highest values of 0.6467 and 0.6033 for Mozzarella and Cream cheese respectively. These differences are due to the varying mineral compositions of the coagulants used. The sensory analysis revealed differences in the appearance, smell, taste, texture, and overall acceptability of the cheeses. The discussion highlights the substantial impact of coagulant choice on cheese quality, integrating these findings with existing literature. Unripe papaya pulp emerged as a particularly promising coagulant, producing nutrient-dense cheese that meets both nutritional and sensory standards.

CHAPTER ONE

INTRODUCTION

Milk is regarded as an important food for infant and adolescent. This is due to the fact that milk serves as a good source of nutrients. It is equally an excellent medium for microbial growth (Akinyele *et al.*, 1999). The cost of dairy milk and products has led to protein malnutrition as many could not afford it in developing countries. The problem of protein malnutrition due to scarcity, high cost of milk and relative increase in population among others have led to sourcing for substitutes to address these challenges (Singh & Bains, 1988). However, Elewa (2009) reported that milk substitute must be rich in protein, with a defined satisfactory quality, and should be able to play an important role in reducing protein malnutrition. In many tropical regions, animal husbandry such as cow rearing is not common. However, goat, sheep rearing, among others are popular in these regions. The production of cow milk and products are limited, scarce and expensive (Fashakin and Unokiwedi, 1992). A remedy could be sought through combining fresh goat milk with plant milk from the drupe family in the production of traditional cheese-like product. This could offer very cheap source of milk, which can be used as substitute for whole milk in the production of cheese curds.

Cheese is a dairy product produced by coagulation of milk using acid or rennet, stirring and heating the curd, draining off whey, pressing the curd (O'Connor

1993). It is further ripened or cured to obtain the final product. The essential ingredients in cheese making are milk and coagulants (O'Connor 1993). Ripening or curing of the curd is one of steps in the development of texture and flavour of cheese (Ozcan and Kurdal, 2012). Cheese can also be made by coagulation of whole milk, skimmed milk, or full cream milk (Bodyfelt *et al.*, 1998). The type of coagulant used depends on type of cheese so desired.

Goat cheese was one of the earliest made dairy products that were fermented by allowing raw milk to curdle naturally, draining and pressing the curds. Other techniques used are acid (lemon juice or vinegar) or rennet to coagulate the milk and obtain the curd. Production of cheese from goat milk has a long history. Cheese made from goat milk provides a good source of protein for people in several countries (Seifu *et al.*, 2004). It was equally used as a mode of preservation of milk by the nomadic Fulani women of Nigeria. Nowadays, the practice is still in existence and exercised by others who have access to fresh goat milk. Cheese made from goat milk is lower in fat, calories and cholesterol (Bamidele 2006). It also provides more calcium than cream cheese. It is consumed by just a few majorities of Nigeria's population due to limited supply of raw goat milk and again the majority are unaware of the nutritional benefits, hence the need to create awareness and meet up with protein demand of the people (Balogun *et al.*, 2016)

1.2 Justification

Despite the benefit and advantages of consumption goat milk cheese, there is a lack of comprehensive research on the impact of different coagulants on the proximate composition, sensory characteristics, and yield of goat milk cheese. This knowledge gap hinders the optimization of cheese production processes and the production of high-quality goat milk cheese. Therefore, there is a need to evaluate the effects of various coagulants on the properties of goat milk cheese to enhance cheese production practices and meet the growing consumer demand for goat cheese. The manufacture of cheese is widespread in developing Africa countries and was thought to have originated in the Northern region of Nigeria due to the traditional cattle rearers (Fulani) access to fresh milk from cattle specie of Zebu Indicus (O'Connor 1993). However, many factors such as shortage of good quality milk, poor processing and preservation methods, poor hygiene practices, poor packaging and storage facilities have contributed to poor utilization and availability in areas where it might have been useful in alleviating protein and other nutritional deficiency. This often leads to importation of milk and milk products such as cheese which may adversely affect the nutrition and the socio-economic well-being of people especially low-income earners and rural dwellers.

1.3 Objectives

1.3.1 Main Objectives

The main objective of this project was to evaluate the proximate composition, sensory characteristics, and yield of cheese produced from goat milk.

1.3.2 Specific Objectives

The specific objectives were to;

1. Determine the proximate composition of cheese produced from goat milk using different coagulants.
2. Assess the sensory characteristics of goat milk cheese.
3. Compare the yield of cheese obtained using different coagulants.

CHAPTER TWO

LITERATURE REVIEW

In the early days, production of cheese in Nigeria was an art. When it became necessary to produce larger quantity with considerable quality, the application of technology came into play. Cheese quality depends on the milk contents; as such, the nature of the milk source and their locations globally affects final cheese quality (Johnson, 2017). The economy of Fulani community of the middle belt province of Northern Nigeria relies essentially on animal breeding, with population of cattle of about 1.5 million and milk production estimated at 25,000 liters per day (Johnson, 2017). The milk obtained is taken either raw or concerted to the fermented form of milk known locally as Nono and Kindirmou which are generally associated with short shelf-life (Banville *et al.*, 2013). The conversion of cow milk to cheese which is a product that is much richer in proteins, is advantageous in the sense that it has a longer shelf life and easier to transport. Cheese is an important product that preserves the vital nutrient in milk and it serves as source of income for several individuals in Africa (Ozturk *et al.*, 2015). The quantity of cheese manufactured in Nigeria and Africa as a whole is minimal when compared with the quantities manufactured in Europe and North America. More often than not production of cheese in Africa is usually on a minor scale in the farm. In Nigeria, the production is not scientifically done but rather based on traditional method inherited by children from their parents (Ozturk *et al.*, 2013).

Cheese is a dairy product produced by coagulation of milk using acid or rennet, stirring and heating the curd, draining off whey, pressing the curd. It is further ripened or cured to obtain the final product. The essential ingredients in cheese making are milk and coagulants. Ripening or curing of the curd is one of steps in the development of texture and flavour of cheese (Ozcan & Kurdal, 2012). The type of coagulant used depends on type of cheese so desired. Cheese is made most commonly from pasteurized cow milk, but the milk of other mammals may be used, such as; goat, cow, sheep, buffalos, camels, yaks etc. In Nigeria, raw milk production is mainly practiced by the Fulani nomadic people who are pastoralists involved in the rearing of cattle and moving from one location to another in search of green pasture (O'Connor 1993). Due to lack of refrigeration facilities, the Fulani women process the surplus fresh milk into a soft, un-ripened Cheese called "Warankasi" or "Wara" (Adetunji and Babalobi, 2011). Therefore, cheese is a form of milk that is solidified to preserve its valuable nutrients (O'Connor, 1993). The principle of cheese processing is based on the coagulation of the protein in milk; during which about 90% of the milk fat is entrapped (Ogunlade *et al.*, 2019). The coagulated mass is the curd; while the remaining liquid is called whey (Ogunlade *et al.*, 2019). Curd (cheese) consists mainly of milk proteins (casein) and milk fat; while whey mainly contains water, milk sugar (lactose), protein (serum proteins) and B vitamins (O'Connor, 1993).

2.1 The Importance of Cheese Production in Nigeria

Cheese can be helpful in a country like Nigeria where the level of protein intake is low. Cheese can be used as an alternate source of protein to fish and meat hence has a great importance in production it in Nigeria. Despite the traditional method employed in the production of cheese, the small quantities of cheese produced appear to be a valuable food and source of protein particularly among the Fulani where it serves as a means of livelihood (Akintunde *et al.*, 2010). Historically, Nigeria's dairy industry has been predominantly focused on milk production, with cheese and other dairy products taking a backseat. The traditional Fulani pastoralists have been at the forefront of cattle rearing and milk production for centuries, utilizing indigenous methods to produce non-aged, fresh cheese varieties such as "Wara" in some regions. However, the transition to commercial cheese production has been slow, hindered by a range of socio-economic and environmental factors (Adamu, 2020). In recent years, there has been a gradual but noticeable shift towards embracing dairy diversification, including cheese production. This shift is partly attributed to the growing middle class and their changing dietary preferences, coupled with increased exposure to global culinary trends (Statista. "Cheese – Nigeria Statista Market Forecast"). Despite this progress, the cheese production industry in Nigeria remains in its infancy, grappling with challenges that span technological, financial, and infrastructural domains. Increase in cheese production in Nigeria will lead economic growth in

terms of revenue generated and also the availability of alternate protein source to Nigeria residents (Adetunji and Babalobi, 2011).

Table 1: Nutrients in cheese and other foods per 100 g of food

Food	Protein (g)	Fat(g)	Iron (mg)	Calcium (mg)
Cheddar Cheese	26.0	33.5	0.5	800
Yoghurt	5.0	1.0	0.09	60
Egg	12.3	10.9	2.0	52
Potato	2.1	0.1	0.5	8
Butter	0.4	82.0	0.16	15

Source: Traditional Cheese Making by Charles O'Connor 1993

2.2 Coagulants in Cheese Making

One of the key ingredients in cheese making is coagulant. Rennin which serves as coagulants from animal origin is the commonest coagulant used (Roseiro *et al.*, 2003). To large extent, the yield and quality of cheese is determined by the quality of milk and the type of coagulants used, and several plant coagulants such as cardoon flower, sun flower, Moringa extract, pineapple, papaya, Sodom apple and so on, have been used to clot milk (Aworth and Muller, 1987). In recent

development, it has been observed that milk coagulants of plant origin have overridden the use animal rennin. The reason being that animal rennin may be limited for diet (vegetarianism), religious reasons (Judaism), or being genetically engineer food (Roseiro *et al.*, 2003), of which the Germans and Dutch for example, forbid the use of recombinant calf rennin. *Brevibacterium linens* has long been recognized as an important dairy microorganism because of its ubiquitous presence on the surface of a variety of smear surface-ripened cheese such as Limburger cheese, Munster cheese (Motta and Brandelli, 2008). The growth of *B.linens* on the surface is thought to be an essential prerequisite for the development of the characteristic colour, flavor and aroma of smear surface-ripened cheeses (Ades and Cone, 2009). *Brevibacterium* are of interest to the food industry because they produce amino acids such as glutamic acid which is of use in the production of flavour enhancer such as monosodium glutamate. They also produce important enzymes used in cheese ripening.

2.2.1 Milk coagulants

Fermented milks are produced at smallholder level by allowing the milk to ferment naturally, i.e. without the use of added bacterial cultures or materials to bring about the coagulation of the milk. These naturally fermented milks provided the first available 'starter' cultures to be used for the precipitation of the protein (casein) with other milk constituents such as fat, lactose (milk sugar) and vitamins.

When the liquid serum (whey) is separated by filtering or decanting the precipitation or mass of curd remaining is a soft lactic curd type cheese (O'Connor 1993). Cheese curds may also be formed by adding to milk the juice extracts of fruits and plants or extracts from the stomach or intestines of animals. These extracts contain enzymes (substances which bring about chemical change) that, when added to milk, bring about the formation of a coagulum or convert the milk to a semi-solid mass. When this jelly-like coagulum is cut into small pieces with knives the whey is released and, after draining, the cheese curd remains (O'Connor 1993). Cheese curds may be formed by using acids or by using enzymes. Acids such as acetic acid, citric acid, lactic acid, vinegar and lemon juice have been used for many years in the manufacture of some cheeses. Ricotta cheese (a variety common in Italy), made from a mixture of skimmed milk and whey, uses vinegar or citric acid to precipitate the curds. Another cheese of Italian origin, Mozzarella, which is used as a topping for pizzas, is made with lactic or acetic acids as acidulants. Lactic starters are also used. Queso Blanco cheese, which has its origins in South America, is made from low fat milks using lemon juice as the acidulant. Wara cheese from West Africa uses the juice extract of the plant *Calotropis Procera* as the milk coagulant (O'Connor 1993). The above examples serve to illustrate that a number of cheese varieties may be made without importation of commercial preparations of lactic acid bacterial cultures and milk coagulants.

2.2.2 Enzyme coagulants

Coagulants from plant and animal sources have been used for centuries. With developments in biotechnology and microbiology coagulants obtained from bacteria and fungi have been used in recent years. One of the best-known coagulants and one that is used widely by cheesemakers for many varieties of cheese is rennet (O'Connor 1993). Rennet is extracted from the stomach of a mammal or more usually from the fourth stomach of a calf. In the absence or unavailability of commercial preparations of rennet, smallholders may obtain the coagulant (rennin, pepsin or chymosin) from calves, goat kids or from older fodder-eating bovines. A crude rennet extract may be obtained from the fourth stomach (abomasum) of goat kids or calves when they are about four weeks old (O'Connor 1993). Male goat kids or calves that have been fed on milk and that are not required for breeding are usually used. To obtain the rennet, the washed fourth stomach of the kid or calf is sliced into strips which are extracted in a sodium chloride (12–20% salt) solution. This salt solution of rennet enzymes and abomasum strips is mixed well and allowed to settle for two to three days at room temperature (O'Connor 1993). The mixture is then filtered through a coarse sieve and a fine mesh (muslin) cloth. Filtering through muslin cloth should be repeated a few times to obtain a clear filtrate. A pinch of boric acid is usually added to the filtrate as a preservative. This crude rennet extract may be used for cheesemaking

at rates that will coagulate milk in about 35 minutes. Young calves may not always be available so an alternative source of a milk coagulating enzyme, pepsin, is the abomasum of adult cattle, sheep or goats (O'Connor 1993). Usually, the abomasa can be obtained in plentiful supply from abattoirs. To obtain a crude extract of bovine pepsin the abomasum is washed and then cut open. The folding of the abomasum mucosa or lining tissue contain the bovine pepsin. The mucosa is then scraped off and chopped finely. An adult cow or ox will yield about 500 g of mucosa. A litre of a solution containing sodium chloride (150 g), acetic acid (10 mL) and calcium chloride (40 g) is added to the finely chopped mucosa in a glass jar or beaker and mixed well. The mixture is allowed to stand for about 24 hours and then is filtered through a muslin cloth until a clear filtrate is obtained (O'Connor 1993). This extract can be stored at about 25°C for 5–6 weeks without any significant loss in milk coagulating strength (O'Connor 1993). About 100 mL of the extract are required to coagulate 20 litres of milk in 30–40 minutes. The rennet extract from a young milk-fed calf contains 88–94% rennin and about 6–12% pepsin, while the extracts from the adult bovine contain 90–94% pepsin and 6–10% rennin. There may be a variable amount of pepsin in rennets depending on the age and feeding of the calf from which the extract is obtained. Over the past twenty years milk and cheese production in many developed countries has increased. For economic reasons calf rennets became scarce and this led to the investigation of others sources of a milk coagulating enzyme. Today, in addition

to calf rennet, bovine rennet, bovine pepsin, porcine pepsin, calf rennet/bovine pepsin and calf rennet/porcine pepsin mixtures are used. The following types of microbial coagulants (rennet) have become available in recent years: fungal extracts, bacterial extracts and mixtures of calf rennet and fungal and bacterial extracts. It is necessary to store rennet at low temperatures to maintain its efficacy. Exposure to light also reduces rennet strength so it should be stored in light-proof or brown glass containers. The amount of rennet added to cheese milk is governed by the recipe which requires a suitable coagulum in a specified period of time. The recipe also specifies the acidity and temperature of the milk when the rennet is added.

2.2.3 Plant extract coagulants

Juice extracts from fruits and plants have long been used as milk coagulants. These include extracts from papaya (papain), pineapple (bromelin), castor oil seeds (ricin) and the latex of the fig tree and the plant *Calotropis Procera* which grows abundantly in many parts of Africa. These extracts are suitable for softer curd cheese which is consumed within a few days. The extracts are not suitable for hard cheese with long maturing periods on account of their excessive proteolytic activity which leads to bitter flavours in the ripened cheese (O'Connor 1993).

2.3 Milk Composition

The Codex Alimentarius standards defined milk as the normal mammary secretion of milking animals obtained from one or more milking without either addition to it or extraction from it, intended for consumption as liquid milk or for further processing. This definition thereby precludes non-animal products which may resemble milk in color and texture (milk substitutes) such as soy milk, tigernut milk, rice milk, almond milk, and coconut milk (Codex, 1999). The earliest tribes of ancient Egypt and South-West Asia discovered sometime around 5000 BC that goat milk was a nourishing human food. While the ancient Egyptians recognized that goat milk was a wholesome and sustaining food they could have had little knowledge of its composition. The earliest evidence of knowledge of the composition of milk is dated at about 350 BC when Aristotle wrote "Casein, fat and water are all the known substances of milk (O'Connor, 1993).

Table 2: Approximate composition of milk from various species of mammals.

Constituents	Unit	Cow	Goat	Sheep	Water Buffalo
Water	g	87.8	88.9	83.0	81.1
Protein	g	3.2	3.1	5.4	4.5
Fat	g	3.9	3.5	6.0	8.0
Saturated fatty acids	g	2.4	2.3	3.8	4.2
Monounsaturated fatty acids	g	1.1	0.8	1.5	1.7
Polyunsaturated fatty acids	g	0.1	0.1	0.3	0.2
Carbohydrate (lactose)	g	4.8	4.4	5.1	4.9
Cholesterol	Mg	14	10	11	8

Calcium	Mg	120	100	170	195
Energy	Kcal	66	60	95	110
	Kj	275	253	396	463

Source: USDA (2007).

The composition of goat milk differs widely among species. Factors such as the type of breed; the proportion of protein, fat, and sugar; the levels of various vitamins and minerals, and the strength of the curd are among those that may vary. On the average, goat milk contains 3.4% protein, 3.6% fat, and 4.6% lactose, 0.7% minerals and supplies 66 kcal of energy per 100 grams (Goff *et al.*, 2014). These compositions vary by breed, animal, and point in the lactation period. Research has also proven that seasonal factors have great impact on the composition of the milk. Casein to fat ratio is higher in milk produced during May and August, while fat in milk from February is higher and total protein is lower than in months of May and August. Age is not an important factor affecting the composition of milk although there appears to be a tendency for the fat content to decrease with increasing age. However, the health of the goat may affect milk composition considerably. Goats suffering from inflammation of the udder give milk low in fat, casein and lactose and high in chlorides. The composition of milk varies appreciably over the period of lactation. The milk given immediately after calving (colostrum) contains a very high percentage of total solids (up to 19%) due mainly to the very high content of protein and fat. During the first week after calving there is a progressive change towards normal composition. The quality of

food also has an effect on the composition of the milk. Poor quality feed depresses the protein content and continuous underfeeding results in milk of lower fat content (Balogun *et al.*, 2016). The composition of milk is very important for the manufacture of dairy products. The yield of cheese obtained from milk depends on the quantities of the major constituents present in milk. Cheese yield depends on the fat and protein contents. In addition, depending on the type of cheese being made, the ratio of fat to protein (casein) in the milk will affect the quality of the cheese.

2.4 Whey Composition of Cheese from Goat Milk

Whey is the liquid that remains after most of the fat and the protein in the milk is removed during the cheesemaking process. Whey contains valuable nutrients, i.e. whey proteins, carbohydrate and minerals. The whey from cheesemaking vary according to the type of cheese made and, therefore, the content of protein, salts and lactose also vary (O'Connor 1993). As whey contains about half of the total solids in the original milk it should not be thrown away as waste but should be used as animal feed or for human nutrition. There are many uses for whey and its constituents. Where cheese is made on a small or farm- house scale the quantity of whey available does not justify the manufacture of the more exotic or sophisticated products where large quantities of whey are required along with expensive, large-scale equipment (O'Connor 1993). At farm level whey should be fed to animals or consumed by humans. Some of the uses of whey include pig and

poultry feeds, addition to bread to increase the nutritive value, fermented drink, manufacture of alcohol, manufacture of lactose and producing whey cheese by evaporating the moisture. In recent years whey proteins extracted from whey by ultrafiltration have found many uses in the food industry

Goat whey has a cloudy aspect, with its color varying from green to yellow, and it also has a fresh, slightly sweet or acidic taste. It contains approximately 55% of milk nutrients: soluble proteins, lactose, vitamins, minerals and a minimum amount of fat (Guimarães *et al.*, 2010). Considering this and the necessity of avoiding environmental impacts related to improper whey disposal, it leads the scientific community to search for viable alternatives for the use of goat whey. According to (Almeida *et al.*, 2008), the simplest and most economic process to use whey, for example, is to return it to the processing line while it's still a fluid, thus the byproduct can be used in the formulation of dairy-based beverages and desserts (Almeida Neta *et al.*, 2018; Pereira *et al.*, 2019)

CHAPTER THREE

MATERIALS AND METHODS

3.1 Study Area

This experiment was carried out in the Department of Animal Science Laboratory, University of Benin, Benin City, Nigeria located between latitude 6° 30'N of the equator and longitude 5° 40' and 6°E of the Greenwich meridian in the forest zone with a temperature of 27.6°C.

3.2 Collection of samples

Liters of fresh goat milk was purchased from Aduwawa livestock market, Ikpoba-Okha Local Government Area of Benin city, Edo State, Nigeria.

3.3 Sample Preparation and Procedures

3.3.1. Preparation of mozzarella cheese with vinegar

A litre (1000 mL) of milk was pasteurized in a double boiler to a temp of 72°C for 5 secs (high temperature, short time). Then rapid cooling was carried out with cold water till the milk was 20°C.

The milk was heated for another 15 mins before addition of coagulant. Four tablespoon of Vinegar was added to the milk, the pot was covered for few minutes thereby leading to the formation of curds. After about 5 mins of separation, the curds were separated from the whey with the aid of a sieve and cheese cloth. The

curds were molded and stretched until it became firm. The cheese was cling filmed and ready to be used.

3.3.2 Preparation of mozzarella cheese with lemon juice

A litre (1000 mL) of milk was pasteurized in a double boiler with continuous stirring to a temperature of 72°C for 5 secs (high temperature, short time). Then rapid cooling was carried out with cold water till the milk was 20°C.

The milk was heated for another 15 mins at a temperature of 40°C before addition of coagulant. The coagulant used here was lemon juice. The juice was extracted from the fruit.

Three tablespoon of Lemon juice was added to the milk, the pot was covered for few minutes thereby leading to the formation of curds. After about 5 mins of separation, the curds were separated from the whey with the aid of a sieve and cheese cloth. The curds were molded and stretched until it became firm. The cheese was cling filmed and ready to be used.

3.3.3 Preparation of mozzarella cheese with lime juice extract

A litre (1000 mL) of milk was pasteurized in a double boiler with continuous stirring to a temperature of 72°C for 5 secs (high temperature, short time). Then rapid cooling was carried out with cold water till the milk was 20°C

The milk was heated for another 15 mins at a temperature of 40°C before addition of coagulant. The coagulant used here was lime juice. The juice was extracted from the fruit. Three tablespoon of Lime juice was added to the milk, the pot was covered for few minutes thereby leading to the formation of curds. After about 5 mins of separation, the curds were separated from the whey with the aid of a sieve and cheese cloth. The curds were molded and stretched until it became firm. The cheese was cling filmed and ready to be used.

3.3.4 Preparation of mozzarella cheese with unripe paw-paw pulp extract

A litre (1000 mL) of milk was pasteurized in a double boiler with continuous stirring at a temperature of 72°C for 5 secs (high temperature, short time). Then rapid cooling was carried out with cold water till the milk was 20°C

The milk was heated for another 15 mins at a temperature of 40°C before addition of coagulant. 100ml of unripe paw-paw pulp extract was added to the milk and stirred for homogenization, the pot was covered for few minutes thereby leading to the formation of curds. After about 5 mins of separation, the curds were separated from the whey with the aid of a sieve and cheese cloth. The curds were molded and stretched until it became firm. The cheese was wrapped in a cling film and stored in a refrigerator.

3.3.5 Preparation of cream cheese with lemon juice

A litre (1000 mL) of milk was pasteurized in a double boiler with continuous stirring to a temperature of 72°C for 5 secs (high temperature, short time). Then rapid cooling was carried out in an ice bath till the milk was 20°C

The milk was heated for another 15 mins at a temperature of 40°C before addition of coagulant. The coagulant used here was lemon juice. The juice was extracted from the fruit. Three tablespoon of Lemon juice was added to the milk, the pot was covered for few minutes thereby leading to the formation of curds. After about 5 mins of separation, the curds were separated from the whey with the aid of a sieve and cheese cloth.

The curds were blended with 20 mL of whey to form a creamy consistency then stored in a sterilized container and refrigerated.

3.3.6 Preparation of cream cheese with lime juice extract

A litre (1000 mL) of milk was pasteurized in a double boiler with continuous stirring to a temperature of 72°C for 5 secs (high temperature, short time). Then rapid cooling was carried out in an ice bath till the milk was 20°C

The milk was heated for another 15 mins at a temperature of 40°C before addition of coagulant. The coagulant used here was lime juice. The juice was extracted from the fruit. Three tablespoon of lime juice extract was added to the milk, the

pot was covered for few minutes thereby leading to the formation of curds. After about 5 mins of separation, the curds were separated from the whey with the aid of a sieve and cheese cloth.

The curds were blended with 20 mL of whey to form a creamy consistency then stored in a sterilized container and refrigerated.

3.3.7. Preparation of cream cheese with vinegar

A litre (1000 mL) of milk was pasteurized in a double boiler to a temp of 72°C for 5 secs (high temperature, short time). Then rapid cooling was carried out with ice bath till the milk was 20°C.

The milk was heated for another 15 mins before addition of coagulant. Four tablespoon of Vinegar was added to the milk, the pot was covered for few minutes thereby leading to the formation of curds. After about 5 mins of separation, the curds were separated from the whey with the aid of a sieve and cheese cloth. The curds were molded and stretched until it became firm. The cheese was cling filmed and ready to be used.

3.3.8. Preparation of cream cheese with unripe paw-paw pulp extract

A litre (1000 mL) of milk was pasteurized in a double boiler with continuous stirring to a temperature of 72°C for 5 secs (high temperature, short time). Then rapid cooling was carried out in an ice bath till the milk was 20°C

The milk was heated for another 15 mins at a temperature of 40°C before addition of coagulant. The coagulant used here was paw-paw pulp extract. The juice was extracted from the fruit. Three tablespoon of unripe paw-paw pulp extract was added to the milk, the pot was covered for few minutes thereby leading to the formation of curds. After about 5 mins of separation, the curds were separated from the whey with the aid of a sieve and cheese cloth.

The curds were blended with 20 mL of whey to form a creamy consistency then stored in a sterilized container and refrigerated.



Plate 1: Final products of cheese made with different coagulants



Plate 2: Whey



Plate 3: Unripe papaya



Plate 4: Blended papaya pulp

3.4 Sensory Evaluation

The organoleptic testing was conducted with questionnaires designed using the 5-point hedonic scale; 1-Very Poor, 2-Below Average, 3-Average, 4-Above Average, 5-Excellent was used for scoring of appearance, smell, taste, texture and general acceptability of the samples by evaluators (Adibe *et al.*, 2018). The questionnaires were distributed to 20 evaluators comprising of undergraduate students of faculty of Agriculture, University of Benin, Benin City, Nigeria, to determine the changes in organoleptic characteristics of the various treatment.

3.5 Proximate Analysis

The proximate mineral analysis was done using the Methods of AOAC (2010). The estimation was carried in Quality Analytical Laboratory Services Ltd at KM 8, Benin/Lagos Express Road, Opp Konkon Petrol Station, Evbumore Quarters, Benin City, Edo State, Nigeria

3.5.1 Determination of moisture content

This is a measure of the % moisture lost due to drying at a temperature of 105°C using the procedure reported by Udo and Ogunwele (1986). 2 mL of the sample was measured (W1) into pre-weighed beaker (W0) and placed into a hot drying oven at 45°C – 70°C for 3 hours. The crucible was removed and cooled in a desiccator and weighed. The process of drying, cooling and weighing was

repeated until a constant weight (W2) is obtained. The weight loss due to moisture is obtained by the equation;

$$\% \text{ Moisture} = \frac{W1-W2}{W1-W0} \times \frac{100}{1}$$

Where:

W0= Weight of the empty beaker in gram

W1= Weight of fresh sample + empty beaker in gram

W2= Weight of dried sample + empty beaker in gram

3.5.2 Determination of ash content

This is a measure of the residue remaining after combustion of the dried sample in a furnace at a temperature of 500°C for 3 hours. According to James (1995), 1 mL of the sample was weighed (W1) into pre-weighed empty crucibles (W0) and placed into a Lenton furnace at 500°C for 3 hours. The ash was cooled in a desiccator and weighed (W2). The weight of the ash was determined by the difference between the sample, pre-weighed crucible and the ash in the crucible.

Percentage ash was obtained by:

$$\% \text{ Ash} = \frac{W2-W1}{W1-W0} \times \frac{100}{1}$$

Where:

W0= Weight of empty crucible in gram

W1= Weight of crucible + powdered sample in gram

W₂= Weight of crucible + ashed sample in gram

3.4.3 Determination of crude fibre content

Percentage of crude fibre was determined also by the method of Udo and Ogunwele (1986), in which 2 mL of the sample was measured (W₀) into a 1 dm³ conical flask. Water (100 mL) and 100 cm³ of 1.25% H₂SO₄ was added and boiled gently for 30 minutes. The content was filtered through Whatmann No. 1 filter paper. The residue was scrapped back into the flask with a spatula and 100 cm of 1.25% NaOH will be added and allowed to boil gently for 30 minutes. The content was filtered and the residue was washed thoroughly with hot distilled water and then rinsed once with 1:1 ethanol and acetone to neutrality. It was allowed to dry and scrapped into the crucible and dried to constant weight at 105°C in an air oven. It was then removed and cooled in a desiccator. The sample was weighed (W₁) and ashed at 550°C for 30 minutes in a Lenton muffle furnace. It will be finally cooled in a desiccator and weighed again (W₂). The percentage crude fibre will be calculated using;

$$\% \text{ Crude fibre} = \frac{W_1 - W_2}{W_0} \times \frac{100}{1}$$

Where:

W₀=weight of sample, g

W₁= weight of dried sample, g

W₂= weight of ash sample, g

3.5.4 Determination of Ether Extract content

The ether extract of a feed represents the fat and oil in the feed. Soxhlet apparatus is the equipment used for the determination of ether extract. It consists of 3 major components

1. An extractor: comprising the thimble which holds the sample
2. Condenser: for cooling and condensing the ether vapour
3. 250 mL flask

The crude lipid content in the sample was extracted using Soxhlet extraction procedure as described by Udo and Ogunwele (1986). 2 mL of the sample was measured into a chiffon cloth and placed in a thimble and covered with a clean white cotton wool. Petroleum ether (1000 mL -1500 mL) was poured into a 2500 mL extraction flask, which was previously dried in the oven at 105°C and weighed (W2). The porous thimble was then placed into the Soxhlet and the rest of the apparatus was assembled. Extraction will be done for about 5 hours. The thimble was carefully removed and the extraction flask was placed in a water bath so as to evaporate the petroleum ether and then dried in the oven at a temperature of 105°C to completely free the solvent and moisture. It will then be cooled in a desiccator and reweighed (W1). The percentage crude lipid will be calculated as follow:

$$\% \text{ Crude lipid} = \frac{W_1 - W_2}{W_0} \times \frac{100}{1}$$

Where:

W_0 = weight of sample in gram

W_1 = weight of flask + oil in gram

W_2 = weight of flask in gram

$$\% \text{ Total Solid} = \frac{\text{Wt of dried milk}}{\text{Wt of milk}} \times \frac{100}{1}$$

SNF = TS – Fat

SNF = Solid Non-Fat

3.5.5 Determination of crude protein content

Proteins are more valuable for their amino acids used in protein synthesis, they are termed crude because not all the nitrogen are gotten from protein source, are also gotten from other sources. Crude protein is a rough estimate of the amino acids, present in the sample. It was determined by measuring the nitrogen content of the feed and multiplying it by a factor of 6.25. This factor is based on the fact that most protein contains 16 % nitrogen. The crude protein of the sample will be determined using the micro – Kjeldahl method described by AOAC (1990). The

principle of this method is based on the transformation of protein and that of the other nitrogen containing organic compounds, other than nitriles and nitrates into Ammonium sulphate by acid digestion.

Crude protein is determined by kjeldahl method. The method involves: Digestion, Distillation and Titration.

Material - kjedahl heating apparatus, kjedahl/flask, bent - tail funnel, heat source, reagent bottle.

Reagent - Sulphuric acid, sodium tetraoxosulphate (iv), copper sulphate, selenium dioxide, 40% NaOH, boric acid/methyl, red indicator, hydrochloric solution.

The principle of this method is based on the transformation of protein and that of the other nitrogen containing organic compounds, other than nitriles and nitrates into Ammonium sulphate by acid digestion.

3.5.6 Determination of Nitrogen free Extract content

NFE is determined by mathematical calculation. It is obtained by subtracting the sum of percentages of all the nutrients already determined from 100.

$$\% \text{ NFE} = 100 - (\% \text{ Moisture} + \% \text{ CF} + \% \text{ CP} + \% \text{ EE} + \% \text{ Ash})$$

NFE represents soluble carbohydrates and other digestible and easily utilizable non-nitrogenous substances in the sample.

Table 3.1: Volume of Coagulants used and Total Mozzarella Cheese Yield

S/N	Coagulants	Volume of Coagulant Used (mL)	Weight of cheese (g)	Cheese yield (kg/100kg)
1	Vinegar	60	161	46.8
2	Lime Juice	45	123.4	51.8
3	Lemon Juice	45	165.8	47.5
4	Unripe Papaya Pulp	100	146	54.07

Table 3.2: Volume of Coagulants used and Total Cream Cheese Yield

S/N	Coagulants	Volume of Coagulant Used (mL)	Weight of cheese (g)	Cheese yield (kg/100kg)
1	Vinegar	60	204.2	21.4
2	Lime Juice	45	177.8	19.7
3	Lemon Juice	45	225.3	22.7
4	Unripe Papaya Pulp	100	229.84	21.6

$$\text{Cheese yield (kg/100kg)} = (2.3 \times \% \text{ Fat}) + 1.4$$

CHAPTER FOUR

RESULTS

4.1 The Proximate Composition of Mozzarella Cheese Produced Using Different Coagulants Presented in Table 4.1.

Results showed that values of moisture content (%) for Mozzarella cheese using different coagulants varied significantly ($P<0.05$) among the treatments and the values ranged between 45.98%- 57.05%. The Crude protein (%) values were significantly influenced by the coagulants used in this study, with Mozzarella cheese from lemon juice coagulant having the significantly highest ($P<0.05$) CP value.

The values of the crude fat content also varied significantly ($P<0.05$) among the treatments with values ranging from 19.76%-22.99%. The ash values obtained from this study showed no significant difference among the coagulants except for Mozzarella cheese from unripe papaya pulp. The NFE values varied significantly between the treatment with the highest NFE value obtained from Mozzarella cheese produced from unripe papaya pulp.

Table 4.1: Proximate Analysis of Mozzarella cheese

Parameters	Treatments (coagulants)				SEM
	T ₁	T ₂	T ₃	T ₄	
MC	54.13 ^c	52.34 ^b	57.05 ^d	45.98 ^a	0.247
CP	18.78 ^c	15.42 ^b	14.55 ^a	19.34 ^d	0.1588
Fat	19.76 ^a	21.90 ^b	20.05 ^a	22.99 ^c	0.284
Ash	2.160 ^a	2.113 ^a	2.077 ^a	2.393 ^b	0.031
CF	0.00	0.00	0.00	0.00	0.00
NFE	5.167 ^a	8.227 ^c	6.277 ^b	9.300 ^d	0.1635

SEM = Standard Error of Mean

CP = Crude Protein

CF = Crude Fibre

MC = Moisture Content

NFE = Nitrogen Free Extract

Treatment 1 (T₁) = Vinegar

Treatment 2 (T₂) = Lime

Treatment 3 (T₃) = Lemon

Treatment 4 (T₄) = Unripe papaya pulp

4.2 The Proximate Composition of Cream Cheese Produced Using Different Coagulants Presented in Table 4.2.

Result showed that values of moisture content (%) for Cream cheese using different coagulants varied significantly ($P < 0.05$) among the treatments and the values ranged between 60.44%-64.37% with cream cheese from unripe papaya pulp having the significantly highest ($P < 0.05$) moisture content.

The Crude protein (CP) values in this study were significantly different ($P < 0.05$) among the treatments, with Cream cheese from unripe papaya pulp coagulant having the significantly highest ($P < 0.05$) CP value of 8.517%.

The ash values obtained from this study showed no significant difference among the treatments except for Cream cheese made from lemon juice coagulant.

The values of crude fat content and NFE had no significant difference among the treatments except for Cream cheese made with lime juice coagulant and Cream cheese made with unripe papaya pulp coagulant respectively.

Table 4.2: Proximate Analysis of Cream cheese

Parameters	Treatments (coagulants)				SEM
	T1	T2	T3	T4	
MC	62.16 ^b	63.21 ^c	60.44 ^a	64.37 ^d	0.1142
CP	7.103 ^b	6.637 ^a	8.037 ^c	8.517 ^d	0.1239
Fat	8.710 ^b	7.953 ^a	9.273 ^b	8.800 ^b	0.1818
Ash	1.277 ^a	1.263 ^a	1.323 ^b	1.287 ^a	0.00882
CF	0.00	0.00	0.00	0.00	0.00
NFE	20.75 ^b	20.93 ^b	20.93 ^b	17.03 ^a	0.228

SEM = Standard Error of Mean

CP = Crude Protein

CF = Crude Fibre

MC = Moisture Content

NFE = Nitrogen Free Extract

Treatment 1 (T₁) = Vinegar

Treatment 2 (T₂) = Lime

Treatment 3 (T₃) = Lemon

Treatment 4 (T₄) = Unripe papaya pulp

4.3 Mineral Composition of Mozzarella Cheese

The results of the mineral composition of Mozzarella cheese as presented in table 4.3 showed that the calcium content (mg/100g) ranged from 343.2-720.5 mg and the treatments varied significantly ($P < 0.05$) with Mozzarella cheese made with vinegar being the significantly highest as compared to processed store-bought Mozzarella cheese with a calcium content of 697 mg.

The values of the phosphorus content (mg/100g) varied significantly and ranged from 97.7- 158.7 mg, with Mozzarella cheese made with lemon juice being the significantly highest as compared with processed cheese with a phosphorus content of 548 mg.

Significant difference was also recorded among the values obtained from zinc which ranged from 0.56-0.64 as compared to 3.62 mg zinc content of processed cheese.

Table 4.3: Mineral Composition of Mozzarella Cheese

Parameters	Treatments (Coagulants)				SEM
	T ₁	T ₂	T ₃	T ₄	
Calcium (Ca)	720.5 ^d	587.8 ^c	343.2 ^a	472.3 ^b	4.22
Phosphorus (P)	104.5 ^b	111.4 ^c	158.7 ^d	97.7 ^a	1.528
Zinc (Zn)	0.6100 ^{bc}	0.5800 ^{ab}	0.6467 ^c	0.5600 ^a	0.01599

Treatment 1 (T₁) = Vinegar

Treatment 2 (T₂) = Lime

Treatment 3 (T₃) = Lemon

Treatment 4 (T₄) = Unripe papaya pulp

SEM = Standard Error of Mean

4.4 Mineral Composition of Cream Cheese

The results of the mineral composition of Cream cheese as presented in Table 4.4 showed that the calcium content (mg/100g) ranged from 146.2- 598.5 mg and the treatments varied significantly ($P < 0.05$) with Cream cheese made with lemon juice being the significantly highest as compared to processed store-bought Cream cheese with a calcium content of 97 mg.

The values of the phosphorus content (mg/100g) varied significantly and ranged from 88.2-126.7 mg, with cream cheese made with lemon juice being the significantly highest as compared with processed Cream cheese with a phosphorus content of 107 mg.

Significant difference was also recorded among the values obtained from zinc which ranged from 0.23-0.60 as compared to 0.5 mg zinc content of processed cream cheese.

Table 4.4: Mineral Composition of Cream cheese

Parameters	Treatments (Coagulants)				SEM
	T ₁	T ₂	T ₃	T ₄	
Calcium (Ca)	337.1 ^b	146.2 ^a	598.5 ^d	464.5 ^a	3.16
Phosphorus (P)	106.9 ^b	125.4 ^c	126.7 ^c	88.2 ^a	2.29
Zinc (Zn)	0.2333 ^a	0.5267 ^c	0.6033 ^d	0.4967 ^b	0.00333

Treatment 1 (T₁) = Vinegar

Treatment 2 (T₂) = Lime

Treatment 3 (T₃) = Lemon

Treatment 4 (T₄) = Unripe papaya pulp

SEM = Standard Error of Mean

4.5 Sensory analysis of Mozzarella cheese using different coagulants

Results of the sensory evaluation of Mozzarella cheese using different coagulants showed that the values of the appearance were not significantly different ($P>0.05$) except for Mozzarella cheese made with unripe papaya pulp. Mozzarella cheese made with lime juice was the significantly highest (4.25).

The values obtained for the following parameters; Smell, taste, texture and acceptability across the different coagulants ranged from 3.55-4.05, 3.45-3.80, 3.60-3.85 and 3.40-3.85 respectively showing no significant difference ($P>0.05$) among the treatments.

Table 4.5: Sensory analysis of Mozzarella cheese using different coagulants

Parameters	Treatments				SEM
	T ₁	T ₂	T ₃	T ₄	
Appearance	4.250 ^a	4.050 ^a	4.00 ^a	3.500 ^b	0.1620
Smell	4.050 ^a	3.800 ^a	4.000 ^a	3.550 ^a	0.1712
Taste	3.800 ^a	3.500 ^a	3.550 ^a	3.450 ^a	0.229
Texture	3.750 ^a	3.650 ^a	3.850 ^a	3.600 ^a	0.1715
Acceptability	3.850 ^a	3.500 ^a	3.650 ^a	3.400 ^a	0.1947

Treatment 1 (T₁) = Lime juice

Treatment 2 (T₂) = Lemon juice

Treatment 3 (T₃) = Unripe papaya pulp

Treatment 4 (T₄) = Vinegar

SEM = Standard Error of Mean

4.5.1 Sensory analysis of cream cheese using different coagulants

Result of the sensory evaluation of Cream cheese using different coagulants showed that the values of the appearance were not significantly different among the treatments, with Cream cheese made with lemon juice being the significantly highest (4.30). The values obtained for the smell ranged from 3.55-4.10 and showed no significant difference ($P>0.05$) among the treatments. Significant difference ($P<0.05$) was recorded for the values of the taste and texture which ranged from 3.30-3.90 and 3.35-4.20 respectively. Cream cheese made with lime juice and Cream cheese made with lemon juice were the significantly highest respectively. The values obtained for the acceptability showed no significant difference among the treatments except for Cream cheese made with unripe papaya pulp and vinegar which showed significant difference ($P<0.05$).

Table 4.6: Sensory analysis of cream cheese using different coagulants

Parameters	Treatments (Coagulants)				SEM
	T ₁	T ₂	T ₃	T ₄	
Appearance	4.050 ^a	4.300 ^a	3.900 ^a	4.150 ^a	0.1892
Smell	3.900 ^a	4.100 ^a	3.550 ^a	4.100 ^a	0.1936
Taste	3.900 ^a	3.850 ^{ab}	3.300 ^b	3.750 ^{ab}	0.1908
Texture	3.600 ^{bc}	4.200 ^a	3.350 ^c	3.950 ^{ab}	0.1874
Acceptability	3.850 ^{ab}	3.750 ^{ab}	3.300 ^b	4.150 ^a	0.224

Treatment 1 (T₁) = Lime

Treatment 2 (T₂) = Lemon juice

Treatment 3 (T₃) = unripe papaya pulp

Treatment 4 (T₄) = Vinegar

SEM = Standard Error of Mean

4.6 Sensory analysis of Mozzarella cheese and cream cheese using different coagulants

Table 4.7 presents the result of the sensory evaluation of Mozzarella cheese and Cream cheese using different coagulants. The result showed that the values of the appearance for the various treatments varied significantly ($P < 0.05$) with Mozzarella cheese made with lime juice the significantly highest (4.25), followed by Cream cheese made with lemon juice and the least being Mozzarella cheese made with vinegar.

The values for the smell and taste recorded showed that there was no significant difference ($P > 0.05$) among the treatments.

Significant difference was observed in the values of the texture recorded, with Cream cheese made with lemon juice the significantly highest (4.20) and the least being Cream cheese made with unripe papaya pulp.

The values of the acceptability recorded varied significantly ($p < 0.05$), Cream cheese made with vinegar was the significantly highest (4.15) and least being Cream cheese made with unripe papaya pulp.

Table 4.7: Sensory analysis of Mozzarella Cheese and Cream Cheese Using Different Coagulants

Treatments	Parameters				
	Appearance	Smell	Taste	Texture	Acceptability
Mozzarella Cheese					
- Lime Juice	4.250 ^a	4.050 ^a	3.800 ^a	3.750 ^{abc}	3.850 ^{ab}
- Lemon Juice	4.050 ^{ab}	3.800 ^a	3.500 ^a	3.650 ^{abc}	3.500 ^b
- Unripe Papaya Pulp Juice	4.00 ^{ab}	4.00 ^a	3.550 ^a	3.850 ^{abc}	3.650 ^{ab}
- Vinegar	3.500 ^b	3.550 ^a	3.450 ^a	3.600 ^{bc}	3.400 ^b
Cream Cheese					
- Lime Juice	4.050 ^{ab}	3.900 ^a	3.900 ^a	3.600 ^{bc}	3.850 ^{ab}
- Lemon Juice	4.300 ^a	4.100 ^a	3.850 ^a	4.200 ^a	3.750 ^{ab}
- Unripe Papaya Pulp Juice	3.900 ^{ab}	3.550 ^a	3.300 ^a	3.350 ^c	3.300 ^b
- Vinegar	4.150 ^a	4.100 ^a	3.750 ^a	3.950 ^{ab}	4.150 ^a
SEM	0.1817	0.1835	0.2092	0.1801	0.2018

SEM = Standard Error of Mean

CHAPTER FIVE

DISCUSSION

Cheese is nutrient-dense dairy food that is rich in protein, calcium and offers consumer large diversity in flavour, texture, and appearance (McCarthy *et al.*, 2015). The production of cheese, a significant component of dairy processing, involves complex biochemical processes influenced by various factors such as the choice of coagulant (Ozcan and Kurdal, 2012). Goat milk and cow milk are some of the healthiest beverages that are available today, but goat milk is easy to digest than cow milk because of small fat globules and is naturally homogenized (Belewu 2006). Goat milk is non allergic as compared to cow milk and it can be used in the treatment of certain diseases (Chilliard *et al.*, 2006). Goat cheese was one of the earliest made dairy products that were fermented by allowing raw milk to curdle naturally, draining and pressing the curds. Other techniques used are acid (lemon juice or vinegar) or rennet to coagulate the milk and obtain the curd. Production of cheese from goat milk has a long history. Cheese made from goat milk provides a good source of protein for people in several countries (Seifu *et al.*, 2004). It was equally used as a mode of preservation of milk by the nomadic Fulani women of Nigeria. Nowadays, the practice is still in existence and exercised by others who have access to fresh goat milk. Cheese made from goat milk is lower in fat, calories and cholesterol (Bamidele 2006). It also provides more calcium than cream cheese. It is consumed by just a few majorities of

Nigeria's population due to limited supply of raw goat milk and again the majority are unaware of the nutritional benefits, hence the need to create awareness and meet up with protein demand of the people (Balogun *et al.*, 2016). Efforts should therefore be intensified toward commercial production of cheese and other dairy products using various coagulants

This study investigated the proximate composition, sensory analysis, yield and mineral analysis of mozzarella and cream cheese produced from goat milk using different coagulants. The selection of coagulants, including vinegar, lime juice, lemon juice, and unripe papaya pulp, aimed to assess their impact on the nutritional content and sensory attributes of the cheese products. Understanding these effects is crucial for enhancing cheese quality and meeting consumer preferences (Roseiro *et al.*, 2003).

The proximate composition analysis revealed significant differences in the moisture content (MC), crude protein (CP), crude fat (CF), and nitrogen-free extract (NFE) among the different treatments for both Mozzarella and cream cheese. Treatment 4 consistently exhibited the highest values for CP and CF in both types of cheese. This could be attributed to the coagulation process and the properties of the coagulants used. The mineral analysis showed significant variations in the calcium, phosphorus, and zinc content of the cheeses. Treatment 1 consistently had the highest calcium content, while treatment 3 had the highest phosphorus content. Zinc content varied among the treatments, with treatment 3

showing the highest values. These differences are due to the varying mineral compositions of the coagulants used (Bodyfelt *et al.*, 1998). The sensory analysis revealed differences in the appearance, smell, taste, texture, and overall acceptability of the cheeses. Treatment 4 generally received higher scores in terms of appearance, taste, and acceptability as a result of the unique flavor and texture imparted by the coagulant used in treatment 4. The findings of this study have several implications for the cheese industry. Firstly, they highlight the importance of selecting the right coagulant for cheese production, as different coagulants can significantly impact the composition and quality of the final product. Secondly, the findings suggest that treatment 4 has the potential to produce cheese with superior nutritional content and sensory attributes, which could make it more appealing to consumers (Bodyfelt *et al.*, 1998).

CHAPTER SIX

CONCLUSION AND RECOMMENDATION

6.1 Conclusion

The aim of this study was to investigate the proximate composition, mineral content, and sensory characteristics of Mozzarella and Cream Cheese produced from goat milk using different coagulants. The coagulants examined were vinegar, lime juice, lemon juice, and unripe papaya pulp. The findings of this research provide valuable insights into how different coagulants impact the nutritional and sensory qualities of Mozzarella and Cream Cheese.

The proximate analysis revealed significant variations in moisture content, crude protein, ash, crude fat, and nitrogen-free extract (NFE) among the cheese samples. Mozzarella cheese made with unripe papaya pulp (T4) had the highest crude protein and fat content, while that made with lemon juice (T3) had the highest moisture content. For Cream Cheese, the sample made with unripe papaya pulp also showed the highest crude protein content, while the sample made with lemon juice had the highest moisture content. These variations highlight the impact of coagulant type on the nutritional profile of cheese.

The mineral analysis showed that Mozzarella cheese made with vinegar had the highest calcium content, while the sample made with lemon juice had the highest phosphorus content. Similarly, Cream Cheese made with lemon juice had the

highest calcium content. The sensory analysis indicated that the type of coagulant significantly affects the appearance, smell, taste, texture, and overall acceptability of both types of cheese. Mozzarella cheese made with lime juice and Cream Cheese made with unripe papaya pulp were generally preferred by the sensory panel.

In summary, the type of coagulant used in cheese production significantly influences the nutritional composition, mineral content, and sensory characteristics of Mozzarella and Cream Cheese. These findings can guide cheese producers in selecting appropriate coagulants to produce cheese with desired nutritional and sensory attributes.

6.2 Recommendation

Based on the results of the proximate composition, mineral and sensory analysis of various coagulants used, unripe papaya pulp should be considered a viable coagulant for producing cheese with higher protein and fat content. This can be particularly beneficial for consumers seeking nutrient-dense cheese products.

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APPENDIX

RESEARCH QUESTIONNAIRE

DEPARTMENT OF ANIMAL SCIENCE, FACULTY OF AGRICULTURE,
UNIVERSITY OF BENIN, BENIN CITY, EDO STATE, NIGERIA

SURVEY QUESTIONNAIRE FOR EVALUATION OF MOZZARELLA CHEESE AND CREAM CHEESE PRODUCED FROM GOAT'S MILK USING DIFFERENT COAGULANTS

NAME OF RESEARCHER: UWAYEMWEN OMORUYI (MISS)

Dear Sir/Madam,

I wish to solicit for your co-operation for information on the above subject matter.

The information provided will be used for research purpose only.

Thank you.

INSTRUCTION: Please tick (✓) in the boxes below and write where applicable 5 = excellent, 4 = above average, 3 = average, 2 = below average, 1 = very poor.

PROFILE OF PANELIST

Please, kindly Tick (✓) where appropriate

1. Age: 15- 20 [], 25-30 [], 30 and above []
2. Sex: Male [], Female []
3. Marital status: Single [], Married [], divorced []
4. Nationality: _____
5. Have you tried cheese before? Yes [] No []
6. Is cheese accessible to you: Yes [] No []

7. How often do you eat cheese? Frequently [] Occasionally [] Never []
8. How were you introduced to eating cheese: Friend [] family [] restaurant [] other _____
9. Which type of cheese have you tried before? Mozzarella [] cottage [] cream [] other _____