PRODUCTION OF CHEESE FROM GOAT'S MILK USING THREE COAGULANTS OF PLANT AND ANIMAL ORIGINS.

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ABSTRACT
Cheese is a nutritious food. Is one of the numerous products from processing of milk of cows, goat, buffalos, camels etc. It is processed from milk by acidification and coagulation by the application of a juice extract from Sodom apple, lime extract and enzyme rennin. However, more of us are becoming increasingly aware that cheese produce from cow's milk is mostly common and popular. Goat milk is known to have better qualities such as digestibility and longer shelf life when processed than cow milk. Despite these qualities, goats are kept mainly for meat in many countries. The promotion of the full use of goat milk at household level to achieve cheap balance diet and food security is yet to be exploited. The awareness in this project work showcases an eye opener to the process, procedure and development of cheese from goat milk. Goats' milk is nutritionally closest to cows' milk than other alternatives and yet it has certain physical properties that set it apart. Many people who perceive they have issues with cows' milk can drink goats' milk without any problems, and even say that their symptoms (such as eczema; asthma; bloatedness; constipation; digestive discomfort and catarrh) are reduced or go away altogether. Cheeses were produced from Goat milk using three different local coagulants both from plant and animal origin, namely: Sodom apple extract, lemon extract and enzyme rennin extract. 360ml of goat' milks were divided into three portions and subjected to different

temperatures (20℃, 30℃, 40℃). It contained appreciable amounts of minerals, protein fat etc.

The pH ranged (4.32 - 4.52 - 4.82), while the contents of protein ranged (21.67 - 20.19, 21.70) % and the fat content ranged (in between 16.63,17.08 throughout the study)% and the content ranged moisture (45.24– 46)%, carbohydrate content as (11.08- 13.73)% respectively. The study recommended the usage of goat's milk in dairy industry in Nigeria, because of its peculiar nutrition and medicinal qualities.

Keyword: *Goat's milk, Cheese, Sodom apple, Enzyme rennin, Lime extract.*

INTRODUCTION
Most of the goats in the tropical countries are kept for meat production, and are rarely milked despite their greatest potential as producers of good quality milk. Though the amount is a lot less than that of the cows, a good pooling together system can enable the milk to be processed in a small plant which can be started for a better storage of the milk. Also hygienic goat milk products could be available all the year round in most communities. Thus, improving household food security and nutrition.

Goat milk and milk products are important sources of protein for humans in many developing countries (Klinger & Rosenthal, 1997). However, its production and handling presents a major problem limiting its consumption. Most goat milk cheeses are manufactured from raw goat milk with or without thermal treatment (Klinger & Rosenthal, 1997). Cheeses made under these conditions may not have the minimum hygiene and sanitary guarantee necessary to obtain constant product quality. The naturally occurring antimicrobial system in milk, the lactoperoxidase (LP) system, can be used to improve the quality of goat milk cheeses.

Goat milk is known to have better qualities such as digestibility and longer shelf life when processed than cow milk. Despite these qualities, goats are kept mainly for meat in many countries. The promotion of the full use of goat milk at household level to achieve cheap balanced diet and food/nutrition security is yet to be exploited.

Cheese is the curd or hard substance formed by the coagulation of milk of certain mammals by rennet or similar enzymes in the presence of lactic acid produced by added or adventitious microorganisms from which part of the moisture has been removed by cutting, warming and/or pressing, which has been shaped in a mould and then ripened by holding for sometime at suitable temperatures and humidity. The conventional method for the production of cheese has been discussed extensively by Frazier and Westhoff (1988).

Cheese, a nutritious food is one of the numerous products from processing of milk of goats, cows, , sheep, buffalos, camels and yaks. It is produced by coagulation of the milk protein known as casein (Scott, 1986). Basically, cheese is product processed from milk by acidification, coagulation and (Fox et al., 2000). The shelf-life of cheese which varies from 4 days to 5 years depends largely on variety. Thus, cheese is a form of milk that is solidified to preserve its valuable nutrients (O'Connor, 1993). Cheese, an excellent source of protein, fat, vitamins and minerals such as calcium, iron and phosphorus is therefore an important food in the diet of human, both young and old (O'Connor, 1993).

One of the key ingredients in cheese making is coagulant, and rennin which serves as coagulants from animal origin is the commonest coagulant used (Roseiro et al., 2003). To a large extent, the yield and quality of cheese is determined by the quality of milk and the type of coagulant used, and several plant preparations such as *Cynara cardunculus* (Vieira and Barbosa, 1972), sun flower (Aworth and Muller, 1987), pineapple (O'Connor, C.B., 1993) and so on, have been used to clot milk (Domingos et al., 1997; Edwards and Kosikowski, 1983; Gupta and Eskin, 1997; Padmanabhan et al., 1993; Pozsar et al., 1969; Singh et al., 1973; Tamer, 1993).

In recent development, it has been observed that milk coagulants of plant origin have over-ridden the use of animal rennin. The reason being that animal rennin may be limited for diet (vegetarianism), religious reasons (Judaism and Islam), or being genetically engineer food, of which the Germans and the Dutch for example, forbid the use of recombinant calf rennet (Roseiro et al., 2003).

Standard cultures of *Lactobacillus bulgaricus* and *Streptococcus thermophilus* have been employed as starter cultures for cheese production (Frazier and Westhoff, 1988). For the production of high quality cheese rennet enzyme is added for effective curdling and in its absence it is possible to use extract from leaves of Sodom Apple (*Calotropis procera*) as alternative. The need arise to develop an appropriate formulation for the production of cheese due to inconsistency in the uniformity of cheese being produced locally.

The preparation of cheese probably dates back many centuries to the time when nomadic tribes of Eastern.

Mediterranean countries carried milk of domesticated mammals in sacks made from animal skins or gourds or in vessels such as stomachs or bladders (Helen and Elisabeth, 1990). When the milk is kept warm, it rapidly became sour and separated into curds and whey. In the absence of liquid milk, the curd is supplied as supplement as much of the milk value is retained.

LITERATURE REVIEW

Milk intended for use in cheese production must be stored at 40ºC and transported to factory where it is stored in insulated silos until it is used (FAO, 2008). Prentice and Neaves (1986) observed that raw milk on arrival at the creamery will have total counts of 103-107/ml depending on the levels of hygiene at the farms. They also observed that organisms present consist of psychrotrophs mostly *Pseudomonas*, *Aeromonas*, *Alcaligens*, small number of lactic acid bacteria, spore forming gram-positive rods, coryneform bacteria, *and Micrococcus* and coli forms. Of these, only the psychrotrophs will multiply during transport and storage, particularly if temperature in insulated tanks and milk silos is allowed to rise.

In recent development, it has been observed that milk coagulants of plant origin have over-ridden the use of animal rennet. The reason being that animal rennet may be limited for diet (vegetarianism), religious reasons (Judaism and Islam), or being genetically engineer food, of which the Germans and the Dutch for example, forbid the use of recombinant calf rennet (Roseiro et al., 2003).

In Nigeria and many parts of West Africa, the traditional cheese makers who are mostly *Fulanis* use *Calotropis procera* (Sodom apple, which is known as *ewe bomubomu* among Yorubas and *tumfafia* in Hausa language) extract as coagulant for cheese making. This leaf contains an organic acid called *calotropin* which has the ability to solidify/coagulate milk (Aworth and Muller, 1987). Other importance of Sodom apple include the use of the flowers and other parts of the plant to cure cold, coughs, catarrh, asthma, stomach pains, headaches and so on (Abbas et al., 1992). It is interesting to know however that despite the fact that *Calotropis procera* is very useful medicinally and in cheese making industry, it is not being cultivated commercially (Adetunji and Salawu, 2008). If *Calotropis procera* should therefore go into extinction or there is reduction in the population of the plant due to unfavourable weather, or there is higher demand because of its wide range of usefulness, or better still, if its other potentials and usefulness are discovered, there is definitely going to be a compulsion on cheese makers to source for alternative coagulants. It is therefore highly imperative to source for alternative (possibly better alternative) plants in West Africa that can be of suitable replacement for *Calotropis procera* should incase it becomes hard to get. A stitch in time saves nine.

Milk composition: Goat milk, like any other milk from other animal sources, is a complex mixture. Also, the composition of goats milk compares very well with that of the cow. All fresh normal milks are an emulsion of fat in a watery solution. However, the acidity of that of goat milk is slightly lower than that of the cow, i.e. pH 6.4 as compared to pH 6.7 (Gall, 1981). Furthermore, the four major components of goat milk are lactose, fat, nitrogen compounds and minerals

These components are also similar to that of cows milk. However, the goat milk contains more small fat globules, i.e. globules of less than 1.5 mm in size. If these small globules are compared to that of the cow the percentage is 28 and 10 respectively. Le Jaouen (1988) reported that the higher amount of these small fatglobules in the goat milk is responsible for the better

digestibility of goats milk. It is also known to possess peculiar (good) nutrition and medicinal qualities (Hasnain, 1985).

The nitrogen compounds form the major complex part of the milk and their difference with other milk sources stems from this constituent. The nitrogen compounds are divided into proteins and non-proteins. The proteins are the casein, i.e. casein a casein ß and casein K. Casein K is susceptible to the enzyme action of rennet.

The soluble non-coagulable proteins and proteosespeptons occurs in small amounts. The coagulable part (casein) of goat milk differs from that of the cows. This peculiarity is used to detect the presence of cow's milk in goats milk/products as a way of quality control Furthermore, goat milk does not contain carotene like that of cow's milk and the absence of carotene in goats milk is the reason why it does not have a yellow colour both as milk and milk products.

CLASSIFICATION OF CHEESE

The criteria for classifying cheese depends on the type of coagulation, type of cheese making (industrial or farmstead), cheese-making technique, method, shape, geographical origin, mixed milk content, exterior aspect (colour, moulds), consistency (soft or hard) and current legislation (Le Jaouen, 1987). Penfield and Campbell (1990) reported that the moisture content of hard cheeses and semi-soft cheeses to be in the ranges of 30-40% and 50-75% respectively. FAO/ WHO (1973) has classified cheese as indicated.

FAO/WHO Classification of Cheese by Fat Content

Classification	**Fat Content (%)**
High Fat	<60
Full Cream	45-60
Half Fat	25-45
Low Fat	10-25
Skimmed	<10

Source: FAO/ WHO (1973)

According to Potter and Hotchkiss (1995) the basic types of cheese evolved as products of different types of milk, regional environmental conditions, accidents, and gradual improvement by trial and error. There are over 800 names of cheeses, but many of the names describe similar products made in different localities or in different sizes and shapes. Of these, however, only about 18 are distinct types of natural cheeses, reflecting the different processes by which they are made.

Potter and Hotchkiss (1995) indicated a means of classifying the types and important varieties of cheeses. It is based largely on the textural properties of the cheeses and the primary kind of ripening. There are hard cheeses, semi-hard cheeses, and soft cheeses, depending on their moisture content, and they may be ripened by bacteria or moulds, or they may be unripened. The bacteria may produce gas, and so form eyes as in the case of Swiss cheese, or they may not produce gas as in the case of cheddar and so no eyes are formed.

NUTRITIONAL BENEFITS OF GOAT'S MILK

Goat's milk is less allergenic protein. It is essential for growth, development and repair of the body El-Agamy (2007) However, research indicates that peoples' intolerance of cows' milk is often due to the proteins El-Agamy (2007) in particular Aplha-S1-casein. Goats' milk has less of this protein than most cows' milk which is one of the reasons it may be better tolerated by some

people. It is bio-availability, that is, is closer to human mother's milk than cow's milk, it is easier to digest and assimilate in the body Tomotake H et al (2006) .Goat's milk is a great option for people who want to lose weight. It has less fat, but still maintains the high levels of proteins and essential amino acids than in cow's milk. Goat's milk has averages thirty five percent fatty acids, making it more nutritionally wholesome. In fact, up to 50% of people with lactose intolerance to cow's milk find that they can easily digest goat's milk, especially if it is raw Bean MB (1998). It rich mineral, most especially calcium. Many people worry that they need to drink cow's milk for calcium intake and the prevention of bone loss. Goat's milk also offers high amounts of calcium, the amino acid tryptophan, and much less side effects of drinking cow's milk. More so, goat' milk is an anti- mucousal, Barba et al (2005). While drinking cow's milk is a common reason for allergies and excess mucous, goat's milk is not. Cow's milk is high in fat, which may increase mucous build-up. Moreover, the fat globules in goat's milk are one ninth the size of those found in cow's milk, another possible reason why it does not produce irritation in the gut Poddar et al (2009). Goats' milk has more oligosaccharides than cows' milk, with an amount similar to human milk. These act as prebiotics in the gut and may help to maintain the health of the digestive tract by encouraging the growth of beneficial gut bacteria and preventing the growth of harmful bacteria FSA (2002).Goat's milk is also a good source of key vitamins. One (200ml) serving of goats' milk provides 13% of the NRV for vitamin B5 (pantothenic acid), which is needed for the release of energy from food and 12% of the NRV of biotin (a B-vitamin which is important for a healthy nervous system FSA (2002).

It also contain conjugated linoleic acid and sphingolipids which prevents cancer. It contains a lot of vitamin-B which develops in it during the fermentation process. It protects against diseases like Beriberi. Also enhances blood formation, strengthens the liver and facilitate the absorption of nutrients in the body Zemel MB et al (2005).

MATERIALS AND METHOD

400 ml of Goat milk was collected from Tsakani Bauchi Local Government, Bauchi. It divided in to three portions and labeled. The sample A was divided into three portions and warmed at

temperature of 20^{o}c 30℃ and 40℃ respectively and Sodom apple (Calotropis procera) extract

was added to warm milk and leaved the mixture for 2-minutes to note the changes. The mixture was strained with muslin cloth in a sieve for 30-minute for whey to drain out and wrap in film.

The sample B was divided into three portions and warmed at temperature of 20℃ 30℃ 40℃

respectively. Lime extract was added and the same procedures were followed. Also, sample C

was warmed at the same temperature and enzyme rennin was added and the same procedures were followed. The fat, protein, carbohydrate, moisture, PH, Vitamin A, Vitamin C, Calcium and Zinc were determined according to the method described by SAS.

FLOW CHAT OF CHEESE PRODUCTION

Raw Milk (water in pot)

Heat the milk to temperature (20℃ or 30℃ or 40℃ respectively)

Add the coagulant (Sodom apple extract or lime extract or enzyme rennin)

Heat the mixture till curd formed

Strain the mixture with muslin in a sieve for whey to drain

Wrap in film

Cool.

Source: Adetunji VO'and Babalobi, 2011

THE PH AND TITRATABLE ACIDITY

The solution was filtered and 25 ml of filtered solution was used for titration. Three drops of phenolphthalein were added and titrated with 0.1N NaOH until the first permanent pink color (Ercan, 2009).

MOISTURE DETERMINATION OF GOAT CHEESE

The method described by Kirk and Sawyer (1991) was used. Moisture content was determined as the loss in weight due to evaporation from sample at a temperature of 105°C.

ASH DETERMINATION OF GOAT CHEESE

This was determined according to the method described by Kric and Sawyer (1991). The crucible with sample was gently heated on the Bunsen flame until smoke ceased, and then transferred into a muffle furnace where it was burnt at 600°C to white ashes. The crucible and its contents were then removed and placed in a desiccator to cool after which it was weighed to a constant weight and calculated the amount of ash content.

CRUDE FIBER

The crude fibre content was carried out using the method described by Kirk and Sawyer (1991). 2-4 g of sample was defatted. The defatted sample was boiled under reflux for 30 min with 200 ml (1.25%) H2SO4. It was further filtered and washed with boiling water until the washing was no longer acidic. The residue was boiled in a round bottom flask with 200 ml (1.25%) NaOH for another 30 min filtered and washed with boiling water until the washing was no longer alkaline. The residue was scraped into a previously weighed crucible and dried at 100°C. It was left in a desiccators to cool and weighed. It was thereafter incinerated in a muffle furnace at about 600°C, left in a desiccator to cool and then weighed and calculated the crude fibre.

PROTEIN

The method described by Kirk and Sawyer (1991) was used. The nitrogen content was multiplied by 6.38 (conversion factor) to obtain the percentage protein for Goad milk cheese. The procedure was carried out in three stages: digestion, distillation and titration.

FAT/LIPID

Determination of fat was carried out by Werner-Schmid process (Kirk and Sawyer, 1991). Proteins are digested with conc. hydrochloric acid. Liberated fat is extracted with alcohol, ethyl ether and petroleum ether. Ethers are evaporated and residue left behind is weighed to calculate the fat content.

CARBOHYDRATE

Carbohydrate content was calculated by subtraction of the sum of moisture, protein, fat, crude fibre and ash contents.

Total energy (calorific value) determination

The energy value was calculated using the Atwater factor method [(9 x fat) + (4 x carbohydrate) + (4 x protein)] as described by Eneche (1991); Chinma and Igyor (2007) and Nwabueze (2007). The proportion of protein, fat and carbohydrate were multiplied by their physiological fuel values of 4, 9 and 4 kcal, respectively and the sum of the product was taken.

DETERMINATION OF MINERAL ELEMENT COMPOSITION

The analytical method employed was that of Atomic Absorption Spectrophotometry (A.A.S). The technique is a very sensitive one, in which the absorption of radiant energy by the atoms of the metal in question is determined. Here, a solution of the element of interest is aspirated into the flame where the bulk of the atoms remain in the ground state while only 1% are excited to higher electronic state by absorbing some of the radiant energy from a characteristic wavelength hollow cathode lamp which is passed through the flame. Decrease in radiation is then measured using a monochromator and a detector system.

The extent of absorption depends on the number of atoms in the ground state and the decrease in intensity is related to the concentration of the element in solution.

MINERALS AND HEAVY METAL DETERMINATION

Minerals were determining according to Kirk and Sawyer (1991). Weight the sample and ash was prepared in muffle furnace. The stock solution was prepared by using hydrochloric acid and then minerals and heavy metals were determined by using the Atomic Absorption Spectrophotometer (AAS), model: Thermo scientific, ICE 3000 series.

RESULTS AND DISCUSSION

These components are also similar to that of cows milk. However, the goat milk contains more small fat globules, i.e. globules of less than 1.5 mm in size. If these small globules are compared to that of the cow the percentage is 28 and 10 respectively. Le Jaouen (1988) reported that the higher amount of these small fat globules in the goat milk is responsible for the better digestibility of goats milk. It is also known to possess peculiar (good) nutrition and medicinal qualities (Hasnain, 1985)

The sample A (with Sodom apple extract) showed the highest protein contents 21.67 and moisture content 45.24 which are constant with different coagulant. Sample A and C have highest PH compare with sample A. Therefore, Sodom apple produced cheese is hereby recommended for both growing children and adult due to the high percentage of protein and high calcium content for the formation of bone and teeth.

Table 2: PHYSICOCHEMICAL* PROPERTIES OF *CHEESE PRODUCED FROM GOAT'S MILK

Parameters analyzed	**Goat's milk Cheese (%) Using Sodom Apple Extract**		
	Sample A (warm under 20°c)	***Sample B (warm under 30°c)***	***Sample C (warm under 40°c)***
Moisture Content	45.24	45.24	45.24
Ash Content	4.21	4.21	0.70
Fat/lipid	16.63	16.63	4.24
Protein	21.67	21.67	21.70
Carbohydrate	13.73	13.73	11.08
Energy (kcal)/100 gm	285.35	285.35	267.35
PH	4.82	4.82	4.52
Calcium	1284.30	1284.30	1284.30
Iron	2.09	2.23	2.39
Zinc	6.14	6.14	6.14
Vitamin A	32.8953	32.8953	32.8953
Vitamin C	298.023	298.023	299.0234

Parameters analyzed	**Goat's Milk Cheese (%) Using Lemon Lime Extract**		
	Sample A (warm under 20°c)	***Sample B (warm under 30°c)***	***Sample C (warm under 40°c)***
Moisture Content	45.24	45.24	45.24
Ash Content	4.21	4.21	4.21
Fat/lipid	16.63	16.63	16.63
Protein	21.19	21.19	21.19
Carbohydrate	13.73	13.73	13.73

Energy (kcal)/100 gm	285.35	285.35	285.35
PH	4.32	4.42	4.52
Calcium	1284.30	1284.30	1284.30
Iron	2.42	2.42	2.42
Zinc	6.14	6.14	6.14
Vitamin A	32.8953	32.8953	32.8953
Vitamin C	261.0233	261.0233	261.0233

Parameters analyzed	**Goat's Milk Cheese (%) Using Enzyme Rennin**		
	Sample A (warm under 20^{o}c)	***Sample B (warm under 30^{o}c)***	***Sample C (warm under 40^{o}c)***
Moisture Content	45.24	45.24	45.24
Ash Content	4.21	4.21	4.21
Fat/lipid	16.63	16.63	16.63
Protein	20.19	20.19	20.19
Carbohydrate	13.73	13.73	13.73
Energy (kcal)/100 gm	285.35	285.35	285.35
PH	4.82	4.82	4.82
Calcium	1284.30	1284.30	1284.30
Iron	2.42	2.42	2.42
Zinc	6.14	6.14	6.14
Vitamin A	32.8953	32.8953	32.8953
Vitamin C	261.0233	261.0233	261.0233

CONCLUSION

Nigeria was inoculated with pure cultures of *Lactobacillus bulgaricus* and *Streptococcus thermopilus* with extract from Sodom apple leaf (*Calotropis procera*) as coagulant in the absence of rennin. Fermentation was done for 0-40 minute for the development of necessary aroma and coagulation. Physiochemical analysis of the fermenting sample showed a gradual drop in pH from 5.8-3.20 and an increase in total titratable acidity from 0.049-0.137%. Proximate analysis of the cheese sample showed a moisture, ash, fat, protein and carbohydrate (by difference). This Sodom Apple produced cheese is hereby recommended for both growing children and adult due to the retention of a high percentage of protein after fermentation and its expected ability to correct protein deficiencies.

This report has shown that in the absence of rennet, extract from *Calotropis procera* (Sodom Apple) leaves can be used to coagulate milk product without necessarily destroying the nutritive value of milk but rather improve its quality. It also shows that such extracts are adequate replacement for rennet as the plant are available everywhere. It is hoped that the chemical characteristics of the Sodom Apple leaves will be analyzed in subsequent studies to ascertain its constituent.

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