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Evaluation of Some Quality Parameter of Cheese Produced from Nigeria Dwarf Goat Milk, Cow Milk and Their Combination using *Brevibacterium linens* as Coagulant.

* Lawal, R. Ajoke., [1] Musa, Hamisu.[1], [2]Adebusoye, M. Sunday and [1]Haruna, U. Said
[1]Department of Food Science and Technology, Federal polytechnic, Bauchi, Nigeria.

[2] Department of Nutrition and Dietetics, Federal Polytechnic, Bauchi, Nigeria.

*Corresponding author: motherofbelievers54@gmail.com

Abstract: *Brevibacterium linens* come from the milk or from ripening cultures that are widely used in the cheese industry. This study investigated the evaluation of some quality parameter of cheese produced from Nigeria dwarf goat milk, cow milk and their combination using *B.linens* as coagulant. *Brevibacterium linens* was isolated from samples of milk. Milks were filtered and pasteurized at 90 ± 1 ºC for 10 min followed by direct acidification with *Brevibacterium linens* . The vats were incubated at 36 ^{o}C and gel was pressed, drained, cut, salted and package. The samples were analyzed for proximate, physicochemical properties and microbial assessment, using standard laboratory procedures. All the cheeses produced from *B. linens* as coagulant was significantly (P > 0.05) different when compared with control. The mean value for moisture content, fat, protein, ash and energy, pH, titratable acidity, total soluble solid and percentage yield were ranged: 43.22-52.01%, 12.33-14.01%, 17.84-19.04%, 1.18-2.35%, 56.04-62.01%,6.25-6.85%, 0.68-0.74%, 1.14-1.18% and 24.35-28.20% respectively. There was increase mineral content of all the cheese samples and decline in magnesium content (4.02mg/100g) for control sample. Similarly, the average total bacteria count, fungal and fecal coliform counts were ranged: 1.72 -2.24 10^4 cfu/ml, < 1.0 $x10^4$ cfu/ml -0.01$x10^2$ cfu/ml and fungal coliform were not detected in cheese produced from Nigeria dwarf goat milk. The organoleptic property (appearance, aroma, taste, texture and overall acceptably) of cheese produced from *Brevibacterium linens* as coagulant was adjudged acceptable compared with that of control sample. *Brevibacterium linens* can be used the production cheese and other dairy product.

Key words: Cheese, Coagulant, Nigeria dwarf goat milk, . *Brevibacterium linens,* cow milk.

1.0 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, Fawole, & Akinyosoye, 1999). Milk intended for use in cheese production must be stored at 40^{o}C and transported to factory where it is stored in insulated silos until it is used (FAO, 2008).

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). Cheese can also be made by coagulation of whole milk, skimmed milk, or full cream milk (Bodyfelt, Tobias, & Trout, 1998). 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, 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.

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).

The shelf life of cheese varies from 4-7 days depends largely on variety. 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).

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 large extent, the yield and quality of cheese is determined by the quality of milk and the type of coagulants used, and several plant coagulant such as *Cynara cardunculus*, sun flower, Moringa extract, pineapple,papaya, *Calotropis procera* (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 over-ridden the use animal rennin. The reason being that animal rennin may be limited for diet (vegetarianism), religious reasons (Judaism),or being genetically engineer food, of which the Germans and Dutch for example, forbid the use of recombinant calf rennin (Roseiro *et al*., 2003).

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, Munster, Brick, Tilsiter and Appenzeller (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. *Brevibacterium linens* is the type strain and has a growth temperature range of 8–37 °C and an optimum of 21–23 °C (Motta and Brandelli, 2008). *Brevibacterium* have also been isolated from wheat samples (Rattray and Fox 1999).*B.linens* produces red or orange or purple-coloured pigment of aromatic carotenoide type which are not common in other bacteria. This alcalophilic bacterium is able to produce methanethiol fromL-methionine and tolerate a high NaCl concentration up to 15%, *B.linens* produces antimicrobial substances which inhibits the growth many gram positive food poisoning bacteria as well as several yeasts and moulds. *B.linens* synthesizes highly active and multiple proteolytic enzymes during its growth. In acceleration of cheese ripening process, it is possible to improve flavor and eliminate bitterness with the use of enzymes (peptide) from *B.linens* alone or in combination with commercially available enzymes (Motta and Brandelli, 2008). The contribution of *Brevibacterium* towards cheese production has been under investigation for some time, showing that it can break down lipids and proteins (i.e. casein) with the use of extracellular proteases and lipases, (Rattray and Fox, (1999), Ozturkoglu-Budak *et al*., 2016) . Many *Brevibacterium* isolates also have the ability to modify sulfur-containing amino acids to produce volatile sulfur compounds which are important for flavor development, (Amarita *et al*., 2004, Yvon *et al*., 2000, Bonnarme, Psoni and Spinnler, (2000)). *Brevibacterium* strains are thus often used as surface-ripening cultures in many different cheese types, (Bockelmann *et al*., 2005). Understanding the functional potential of cheese bacteria is essential in the combined effort with cheese producers to shorten ripening times, reduce spoilage, better control cheese aroma, and increase food safety. Therefore, this study aimed to investigate the evaluation of some quality parameter of cheese produced from Nigeria dwarf goat, cow milk and their combination using *B.linens* as coagulant.

2.0 Materials and Methods

2.1 Source of Milk

Fresh Nigeria dwarf goat milk and cow milk were purchased from National Veterinary Research Institute (Vom) in division of Animal Health and Production Technology, (AHPT), Jos Plateau State, Nigeria. Milk samples were then kept in an ice box immediately after collection. The sample of cheese used as control was purchased from food chemical shop in Jos metropolis.

2.2Isolation of Brevibacterium linens from milk sample

Brevibactrium linens were isolated and characterized from milk samples. Prior to isolation of *Brevibacterium linens*, 5ml of each milk samples (goat and cow milks) were weighed and thawed in the dark at 4^oC. The smear were collected from milk samples, by scraping the surface of the milk and weighed. The culture was grown in 250ml Erlenmeyer flask containing 50ml of a medium composed of 20g/L D-glucose (Carloerba, London), 5g/L casamino acids (Difco), 1g/L yeast extracts (Biokar), 5g/L NaCl and 1g/L KH_2PO4. The pH was adjusted to 6.9 and the medium was sterilized at 121^oC for 15minutes and incubated at 25^oC for 48hours with stirring (150rpm) to oxygenate the medium (Galaup *et al*., 2005).

2.3Sample preparation

2.3.1Production of cheese

Three different cheese types were made from two samples of fresh milk: CCM (cheese made from cow's milk), CGM (cheese made from goat's milk) and CCGM (cheese made from cow's milk and goat's milk, 1:1 ratio, L:L). The cheeses were produced using the method described by Adetunji and Babatobi, (2011). 500ml of each sample of milks were filtered and pasteurized at 90 ± 1 ºC for 10 min followed by direct acidifying/inoculating with 10ml/l *Brevibacterium linens* .The vats were incubated at 36 ^oC until a firm curd was formed (approximately 40 min). The obtained gel was allowed to drain, press, gently cut into cubes, salted in brine (12 g/L NaCl), placed in perforated rectangular containers (approximate capacity of 250 g) and maintained at 10 ^oC under pressure for 4 h and vacuum packaged. The cheese obtained after storage at 10 ^oC for 24h was regarded as the final product.

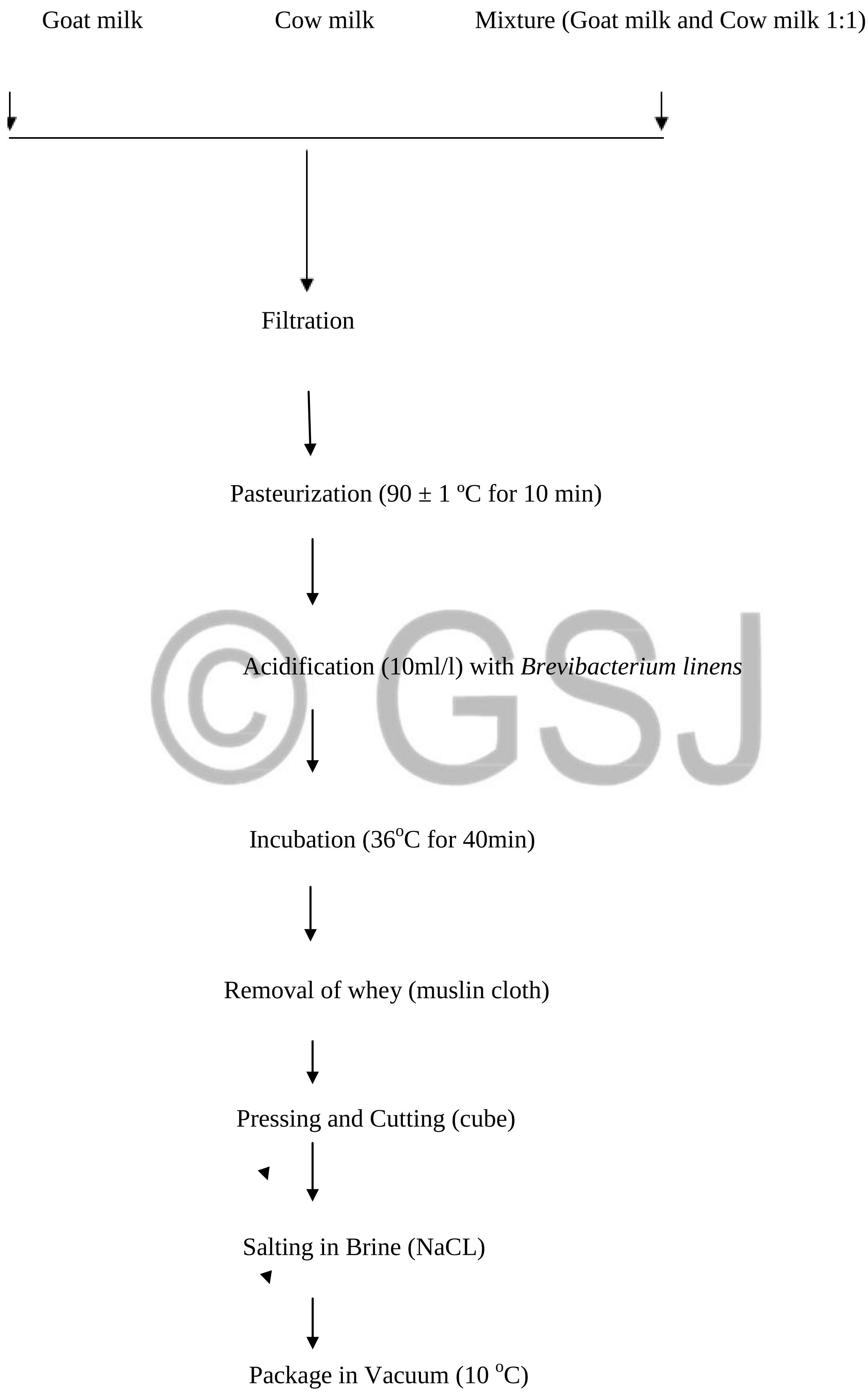
Goat milk
Cow milk
Mixture (Goat milk and Cow milk 1:1)
Filtration
Pasteurization (90 ± 1 ºC for 10 min)
Acidification (10ml/l) with *Brevibacterium linens*
Incubation (36ºC for 40min)
Removal of whey (muslin cloth)
Pressing and Cutting (cube)
Salting in Brine (NaCL)
Package in Vacuum (10 ºC)

Figure 1: flowchart for the production of goat milk, cow milk and their mixture cheese.

2.4 Determination of proximate composition of milk and cheese samples

The moisture, crude protein, crude fat and total ash contents of the milk and cheese samples were determined according to the standard methods of AOAC (2012). The carbohydrate content was determined as shown below:

% Carbohydrate = 100%−(% moisture + %protein + % fat + % ash), (Akume *et al*., 2019).

2.5 Determination of Physicochemical properties of cheese

2.51Total Titratable Acidity (TTA)

Total titratable acidity was determined using the AOAC (2005) method. About 10 g of the sample was dissolved in 30 ml of distilled water in a beaker and stirred. The mixture was filtered into 100 ml standard volumetric flask. The filtrate was made up to 100 ml. A 10 ml sample of the filtrate was pipetted into a beaker and 1 drop of phenolphthalein was added. The mixture was titrated against standard 0.01 N Sodium Hydroxide solutions until light pink color was attained. The reading of the burette was recorded.

$$TTA = \frac{N(NaOH) \times \text{titre value} \times \text{lactic acid value} \times \text{dilution factor} \times 100}{10}$$

Where N = Normality of NaOH (0.01)

Lactic acid value = 0.09

Dilution factor = 10

2.5.2 pH Determination

pH was determined using pH meter (Unicam 9450, Cambridge, UK). About 1.0g of the cheese was dissolved in beaker containing 10 ml of distilled water and stirred. The electrode of the pH meter was dipped into the beaker and readings were obtained from the photo-detector on the pH metre.

2.5.3 Total Soluble Solids

This was determined using the AOAC (2005) method. A clean glass dish was dried in an oven (103-105 ^{o}C) until constant weight was achieved, cooled in a desiccators and weighed. About 2.0 g was dissolved in 50 ml distilled water. About 20 ml of filtered water sample was evaporated on a water bath at temperature 90 ^{o}C followed by oven drying at temperature 103 ^{o}C- 105 ^{o}C for about an hour. The glass was cooled in desiccators, reweighed and the increased weigh recorded.

2.54 Determination of Percentage Yield

Percentage yield of cheese was determined by method described by Igyor, Igbian, and Iorbo (2006). The yield of cheese from Nigeria dwarf goat milk; cow milk and goat milk and cow milk blends was determined by the calculation as follows:

$$\text{Yield of Cheese (\%)} = \frac{W_2 \times 100\%}{W_1}$$

W1 = Weight (g), goat milk, cow milk and cow-goat milk blend.

W2 = Weight (g), cheese produced.

2.5.5 Mineral Determination

The analysis of minerals was done according to the AOAC (2005) procedures. The quantitative determinations of minerals (P, K, Na, Mg and Ca) were done using beam atomic absorption spectrometer (Model S-929, Systonic, India). Working standards was used to establish calibration curve for each of the element to be determined. About 2.0 g of the sample was accurately weighed in a clean dry crucible. This was then transferred to hot plate in a fume cupboard and charred to burn off all the organic material until no more smoke was given off. It was then transferred using a pair of tongs into the muffle furnace at a temperature of 500 ^oC until it was fully ashed for 8 h. The sample (ash) was leached with 5 ml of 6 M HCI into a 100 ml volumetric flask and the volume was made up to 20 cm3 with distilled water. Also, the blank determination was carried out in a similar procedures described above, except for the omission of sample. The solution was then filtered through a What man No.1 filter paper and transferred into the AAS auto sampler vial for analysis of Calcium (Ca) Magnesium (Mg), Phosphorus (P), Sodium (Na) and Potassium (K).

2.6 Microbiological analysis of goat milk, cow milk and goat-cow milk mixture and control sample.

Method of Harrigan and McCane (1976) was employed. Exactly 1.0 g of the cheese was aseptically weighed and carefully introduced into 9 .0 ml of sterile distilled water. This was shaken manually in order to have a homogenous suspension. 1.0 ml of this was taken and introduced into the second tube followed with series of dilutions up to10-2 dilutions. 1ml was taken from 10-2 dilution and pour plated on: (a) Nutrient Agar and incubated at temperature 37 ^oC for 48 hours; (b) MacConkey Agar was used for the enumeration of total coliform organisms in the sample, the plates were incubated at temperature 35 ^oC for 48 hours; while (c) Sabouraud

Dextrose Agar was used for the enumeration of mould and yeast in the samples. The plates were incubated at temperature 30 oC for 24 hours for yeasts and 3 days for mould.

Microbial counts were calculated as follows. $\frac{DF \times N}{W}$

Where DF = dilution factor.

N = number of colonies.

W = weight of sample used.

2.7 Sensory evaluation

Sensory evaluation was conducted using a trained panel consisting of twenty members who are familiar with cheese. The Panelists were instructed to evaluate the coded samples for appearance, aroma, taste, texture, and overall acceptability. Each sensory attribute was rated on a 9- point hedonic scale (9 = like extremely and 1 = dislike extremely) (Ekanem and Ojimehkwe, 2017).Cheese samples were served in 3-digit coded white plastics. The order of presentation of samples to the panelists was randomized. Sensory evaluation was carried out under controlled conditions of lighting and ventilation.

2.8 Statistical analyses

The data obtained were subjected to Analysis of Variance (ANOVA), while Duncan Multiple range test was used to separate means where significant differences existed, data analyses was achieved using the Statistical Package for Social Statistics (SPSS) software version 20.0. All analyses were performed in triplicate determination**.**

3.0 RESULTS AND DISCUSSION

3.1Proximate composition of goat, cow and mixture of goat-cow milk samples

Table 1: Proximate composition of fresh milk samples from Goat, Cow and mixture of Goat- cow milks

Sample	% Moisture	%Fat	(%)Protein	% Ash	Energy
GTM	87.11± 0.02	4.45± 0.03	3.84 ±0.01	0.84 ± 0.01	65.45 ±0.02
CWM	87.09± 0.01	4.2 0 ±0.02	3.35 ± 0.04	0.72 ± 0.04	63.80 ± 0.01
MGC	88.71 ±0.02	3.91 ±0.02	3.62 ± 0.02	0.64 ± 0.02	68.52 ± 0.02

GTM: Nigeria dwarf Goat milk, CW: Cow milk, MGC: mixture of goat and cow milk. Values are means ± SD of triplicate determination

Table1, show the result of the proximate composition of the milk samples from Nigeria dwarf goat milk, cow milk and its mixture. The quality of the raw milk is the single most important criterion that determines the quality of the end product. The quality of the raw fresh milk in turn is dependent on the sanitary procedures followed during the milk production and handling (Igwegbe *et al*., 2015) The moisture content of the milk samples ranged from 88.7% - 86.1%, with goat milk having the highest value. There was no significant ($P < 0.05$) variation between the moisture content of milk from goat milk and cow milk samples. The moisture content for all milk samples were within the range (87.09% - 88.71%) which correlates with results reported by (Ladokun and Oni, 2014). High moisture content indicates high water activity which supports microbial growth and subsequent reduction the shelf life of the milk (Ajai *et al.,* 2012). Low moisture content on the other hand, implies low water activity which results in reduction of microbial growth and increased shelf life of milk (Ajai *et al.,* 2012). The percentage of protein in goat milk was highest followed by mixture of goat-cow milk and cow milk respectively. Research finding of (Raynal-Ljutovac *et al*., 2007). Showed that goat milk contains a relatively large amount of free amino acids particularly of non -protein amino acid taurine (obtained biosynthetically from cysteine) at 9mg/100g. This is 20-fold more than in cow milk and this similar to the level in human milk. The goat milk had the highest fat content followed by mixture cow milk sample. However, goat milk is rich in short and medium- chain fat 6-10 carbon atoms, containing up to twice as much as cow milk (Sanz Sampelayo *et al*., 2007). These fats have a different metabolism to that of long- chain fat and a source of rapidly available energy, particularly relevant for people suffering from malnutrition or fat absorption syndrome and in the diets of pre-term babies (feeding formulas for premature infants often contain medium-chain triacylglycerol) and elderly people (Raynal-Ljutovac *et al*., 2008). High fat content in food is an indication of more total energies available (Udeozor, 2012). The ash content of the milk samples showed significant ($P>0.05$) difference with goat and cow milk showing highest and lowest values mixture of goat-cow milk respectively. Ash content in food is an indication of its total mineral element content (Akume *et al*., 2019). There was significant difference ($P>0.01$) in the carbohydrate content of the goat milk samples compare with cow milk, goat-cow (mixture) milk having the highest value. Aside lactose which occurs as a major carbohydrate in cow milk, there is also small amounts of glucose, gelatos and others. Carbohydrate contributes to the bulk of energy found in be the milk. The calories are provided by the protein, fat and carbohydrate which can help to meet the energy requirement. However, goat milk exhibits beneficial virtues for individuals with certain dietetic problems, thus it is recommended traditional by physicians for infant and others allergic to other milks. Similarly it has been used in treatment of ulcers (Kumar *et al*., 2012).

3.2Proximate composition of cheese produced from Nigeria dwarf goat milk, cow milk and their mixture using *Brevibacterium linens* as coagulant

Table 2: Proximate composition of cheese produced Nigeria dwarf goat, cow cheese and their mixture

Sample	Moisture (%)	Protein (%)	Fat (%)	Ash (%)	CHO (%)
GC	45.21 ± 0.06	14.01 ±0.04	19.04 ± 0.01	1.18 ± 0.01	56.04 ± 0.02
CC	48.13 ± 1.00	12.50 ± 0.01	18.10 ± 0.04	2.04 ± 0.04	58.10 ± 0.02
MC	52.01 ±0.02	13.19 ± 0.05	18.50 ± 0.06	2.35 ± 0.01	62.01 ± 0.01
CS	43.22 ± 00.5	12.33 ±0.01	17.88 ± 0.04	2.08 ± 0.01	60.02 ±0.01

Values are means ± SD of triplicate determination. GC: Nigeria dwarf cheese, CC: cow cheese, MC: mixture of goat-cow cheese, CS: control sample.

Table 2, shows the result of proximate composition of the cheese samples made from Nigeria dwarf goat milk, cow milk, mixture of goat-cow milk and control sample (produced from cow milk which coagulated from Sodom apple). Moisture content of the cheese produced from all the cheese samples ranged; 43.22-52.01s%. Moisture content of control sample in which Sodom apple was used as coagulant was significantly ($P < 0.05$) lower than all other samples from *Brevibacteruim linens* as coagulant. The disparities observed in the moisture content of the mixture goat-cow cheese, variation may be attributed to the mixture of their milk. However, moisture content noted from cheese produced from cow milk, was significantly ($P > 0.05$) higher than cheese produced from Nigeria dwarf goat milk. Higher moisture content could favour growth and proliferation of microorganisms; thus reducing the shelf-life of cheese (Orhevba and Taiwo, 2016). There were significant ($P < 0.05$) differences in the protein profile of the studied cheese samples. Besides the cheese from Nigeria dwarf goat milk was recorded highest followed by their mixture while cow milk and control sample recorded low protein profile .The disparity seen in the protein content of cheese in this study could probably be due to the denaturization of whey protein during pasteurization and the resulting β-lactoglobulin–κ casein entraps denatured whey proteins, which may lead to some minor differences in amino acid profiles between lactic cheese and soft cheese (Henry *et al*., 2002 cited in Raynal-Ljutovac et al., 2008). This work was in agreement with the contribution of Rattray & Fox, (1999) *Brevibacterium linens* towards cheese production, showing that it can break down lipids and proteins (i.e. casein) with the use of extracellular proteases and lipases,(Ozturkoglu-Budak, et al., 2016).This study also, in line with report of Henning *et al*., (2006) casein remains in the curd, but caseins are low in sulphur-containing amino acids and the nutritional value of cheese protein is slightly lower than that of total milk protein. Also, progressive breakdown of casein during ripening is reported to increase its digestibility (Henning et al., 2006). Moreover, proteolysis induced by fermentation and ripening increases amounts of bioactive peptides and free amino acids present in the cheese .Fat content of Nigeria dwarf goat cheese was significantly ($P > 0.05$) than all other sample cheeses. The curd contains almost 95 percent of the fat, and during cheese-making the fat is concentrated between 6- and 12-fold, depending on cheese variety (Fox and McSweeney, 2004). Although the content of nutritionally interesting FAs such as CLA can be increased by lipid supplementation of the goat diet, this may be accompanied by a change in cheese flavour (Chilliard and Ferlay, 2004, Chilliard *et al.*, 2005 and Chilliard *et al*., 2006a, cited in Raynal-Ljutovac *et al.*, 2008).. The ash content in foodstuff is a measure of mineral elements in food (Balogun *et al* 2016). Cheese samples made from Nigeriadwarf goat milk was significantly ($P < 0.05$) different in ash content than those produced from other milk samples and the control. Carbohydrate value ranged from 56.04 % to 62.01% among the samples, with the highest content recorded for cheese made from mixture of goat- cow milk followed by that from control sample. Decrease in carbohydrate content in cheese produced from Nigeria dwarf goat milk due to the lost lactose in cheese production. Whey contains up to 94 percent of the lactose, much of which is lost in cheese making.The remaining lactose is partially transformed into L-lactate or D-lactate (Trujilllo *et al.*, 1999, cited in Raynal-Ljutovac *et al.*, 2008),or into glucose and galactose on cheese-making. These residual carbohydrates found in fresh cheeses disappear with increasing ripening time (Raynal-Ljutovac *et al.*, 2008).

3.3 physicochemical properties of cheese samples

Table 3: Physicochemical properties of cheese samples

Sample	pH (%)	TTA (%)	TSS (%)	Yield (%)
GC	6.82 ± 0.06	0.68 ± 0.01	1.18 ± 0.04	24.35 ± 0.02
CC	6.85 ± 0.02	0.70 ± 0.01	1.14 ± 0.02	26.15 ± 0.02
MC	6.50 ± 0.02	0.74 ± 0.02	1.16 ± 0.02	28.20 ± 0.06
CS	6.25 ± 0.01	0.72 ± 0.04	1.17 ± 0.04	26.02 ± 0.04

Values are means $\pm$ SD of triplicate determination. GC: Nigeria dwarf goat cheese, CC: cow cheese, MC: mixture of goat-cow cheese, CS: control sample. TTA: Titratable acidity, TSS: Total soluble solid.

The physicochemical properties of milk samples from Nigeria dwarf goat cheese, cow cheese, and their mixture and control sample are presented in Table 3. The pH of the samples was ranged from: 6.25%, 6.50%, 6.82% and 6.85%. There was no significant ($p< 0.05$) difference in the pH of all the samples of the cheese. The higher the pH, the lower the TTA and vice versa (Korshina *et al*., 2019). Fresh cow milk typically has a pH between 6.5 and 6.7. As milk goes sour, it becomes more acidic and the pH gets lower. Casein is the most important protein in milk, while the proportion of whey proteins is relatively low (Barlowsk *et al*., 2011). The report of the TTA of the cheese produced from mixture of Nigeria dwarf goat milk and cow milk were significantly ($P>0.05$) different from other sample. This may be as a result of microbial proliferation during transportation from where the samples were purchased. The percentage of acid present in milk is a rough indicator of its age (Gemechu *et al*., 2015). Normal fresh milk has an apparent acidity of 0.14 to 0.16% as lactic acid (Siriwardhana and Gunasena, 2018). The Total Soluble Solids (TSS) content in Nigeria dwarf goat milk was significantly ($P>0.05$) higher than those of cow, mixture and control sample respectively. The values reported in this study followed similar trend with those reported by (Hamad *et al*., 2016) who revealed that considerable content of TSS and fat was detected in coconut milk than in cow milk. There was increase in percentage yield of cheese produced from mixture of Nigeria dwarf goat milk-cow milk followed by cow cheese and control sample increased in the percentage yield may depends on the level of protein available for curdling by enzymes or acid, and a subsequent decrease in percentage yield 24.35% of Nigeria dwarf goat milk. This result agreed with the work of Weimer, *et al*., (2000), who highlight the positive contribution of this *Brevibacterium linens* to cheese production by accelerating the ripening process, final appearance and quickening maturation of cheese production. However, the decrease in percentage yield of cheese with goat milk and increasing cow milk agreed with the findings of Igyor et al. (2006) who reported a decline in the percentage of cheese yield as the percentage of soy milk inclusion increased in cheese.

3.4 Mineral composition of cheese produced from Nigeria dwarf goat milk, cow milk and their mixture.

Table 4: Mineral composition of cheese produced from Nigeria dwarf goat milk, cow milk and their mixture

Sample	Ca (mg/100g)	P (mg/100g)	Na (mg/100g)	K (mg/100g)	Mg (mg/100g)
GC	78.60 ± 0.12	60.29 ± 0.01	42.60 ± 0.01	76.02 ± 0.02	4.26 ± 0.01
CC	84.02 ± 0.01	56.50 ± 0.01	46.18 ± 0.04	74.33 ± 0.01	4.88 ± 0.01
MC	82.88 ± 0.04	62.10 ± 0.05	50.15 ± 0.01	76.82 ±0.01	5.01 ± 0.06

CS	80.04 ±0.04	58.01 ± 0.02	44.11 ± 0.04	72.45 ± 0.02	4.02 ± *0.01*

Values are means ± SD of triplicate determination. GC: Nigeria dwarf goat cheese, CC: cow cheese, MC: mixture of goat-cow cheese, CS: control sample. Calcium (Ca), Potassium (K), Phosphorus (p), Sodium (Na), Magnesium (Mg).

The results of the mineral compositions of cheese produced from Nigeria dwarf goat milk, cow milk, mixture of Nigeria dwarf goat - cow milk and control sample are presented in Table 4. The result showed that there was significant difference ($p<0.05$) in mineral elements evaluated. Mineral contents vary with cheese type. The strong decrease in pH occurring early in the production process of some types of cheeses (during coagulation) make calcium, phosphorus and zinc (mainly bound to caseins) soluble and these are therefore lost with the whey during draining (Raynal-Ljutovac *et al.,* 2008). The highest calcium value was recorded in cheese produced from cow milk followed mixture of Nigeria dwarf goat-cow milk and control sample. Potassium and magnesium, which are essentially soluble, also decreased as dry matter increased through pressing or aging (Raynal-Ljutovac *et al.,* 2008). An acid-coagulated fresh cheese like cottage cheese contains 83 mg of calcium/100 g, compared with 720 mg/100 g in a hard cheese like cheddar (USDA, 2009). The calcium in cottage cheese is mainly from the whey that remains with the curd after processing. All lactic goat cheeses were found to have similar calcium contents, showing an overall similar demineralization (Raynal-Ljutovac *et al.,* 2008). Magnesium concentrations in fresh lactic goat cheeses were reported to be similar to that in goat milk, while Camembert-type cheeses were reported to contain higher quantities of magnesium (Raynal-Ljutovac *et al*., 2008). However, studies on the bioavailability of minerals from cheese have reported few differences between milk and cheese. Furthermore, few differences in the absorption coefficient of calcium (in humans) between milk and other dairy products such as hard cheese (Cheddar) or fresh cheeses have been reported (Gueguen and Pointillart, 2000, cited in Raynal-Ljutovac *et al*., 2008).

3.5 Microbial properties of cheese produced from Nigeria dwarf goat milk, cow milk, their mixture and control sample

Table 5: Microbial properties of cheese produced from Nigeria dwarf goat milk, cow milk, and their mixture and control sample

Parameters	TBC (cfu/ml)	FCC (cfu/ml)	TFC (cfu/ml)
GC	1.41×10^6	NIL	NIL
CC	1.82×10^4	$<1.0 \times 10^4$	$< 0.01 \times 10^2$
MC	1.17×10^4	NIL	NIL

CS	2.24 x10^4	1.1 x 10^2	< 1.0 x10^1

Values are means $\pm$ SD of triplicate determination. GC: Nigeria dwarf goat cheese, CC: cow cheese, MC: mixture of goat-cow cheese, CS: control sample. TBC: Total Bacterial Count, FCC: Faecal Coliform Count, TFC: Total Fungi Count, NIL: Not detected.

The microbial (bacterial, faecal coliform and fungi) load of the different milk cheeses are shown in Table 5. The result of total bacterial growth in all the samples of cheese was ranged: 1.17 x 10^4 – 2.24 10^4 cfu/ml. There was no significant ($p< 0.05$) different in all the samples of cheese for total bacterial count, expect control sample. This may be attributed to the use of coagulant in the cheese production. The sample of cheese produced from Nigeria dwarf goat milk and their mixture revealed no faecal coliform and fungal were detected is thought to be as result of the antimicrobial effects of the *Brevibacterium linens*, causing the pH of the growth environment to decrease to levels quite unfavorable for the growth of those organisms (Pazakova *et al*., 1997; Lee and Chen, 2004). It has antimicrobial properties which can reduce the effect of pathogenic *Listeriamono cytogenes* by1-2 log units .This property makes it safer for human consumption (Motta and Brandelli, 2008).

The study thus, reveals all samples were microbiologically safe for human consumption, since the microbial loads did not exceed the acceptable limits of >10^5 recommended by the International Commission of Microbiology Specifications of Foods (Korshina*et al*., 2019). This is an indication that all cheese samples were well processed under good hygienic conditions.

3.6 Sensory attribute of cheese produced from Nigeria dwarf goat milk cow milk and their mixture

Table 6: Sensory attribute of cheese produced from Nigeria dwarf goat milk cow milk and their mixture

Sample	Appearance (colour)	Aroma	Taste	Texture	Overall acceptability
GC	8.87 $\pm$ 0.12	7.22 $\pm$ 0.04	7.84 $\pm$ 0.01	8.44 $\pm$0.07	7.98 $\pm$0.02
CC	8.24 $\pm$ 0.07	8.09 $\pm$0.14	8.62 $\pm$ 0.02	8.27 $\pm$ 0.04	8.67 $\pm$0.02
MC	7.32$\pm$ 0.02	7.45$\pm$0.02	7.76$\pm$0.01	8.50 $\pm$0.03	8.18 $\pm$0.04
CS	8.00$\pm$ 0.08	8.01$\pm$ 0.01	8.04 $\pm$ 0.02	8.04 $\pm$ 0.06	8.05 $\pm$0.04

Values are means $\pm$ SD of triplicate determination. GC: Nigeria dwarf goat cheese, CC: cow cheese, MC: mixture of goat-cow cheese, CS: control sample.

Sensory assessment as judged by 20 taste panelists is presented in Table 3 as means of the scores. The sensory attribute of cheese is a combination of the flavour, colour (appearance), taste and texture (the mouth feel). The cheese made from Nigeria dwarf goat milk was found to be significantly different (P > 0.05) in colour (appearance) but lower in aroma, taste and overall acceptability (P < 0.05) to those made from cow milk, mixture of goat-cow milk and control sample (Table 6), with average scores of 8.87 $\pm$ 0.12 – 7.42 $\pm$ 0.02 for colour; 8.09 $\pm$ 0.14 - 7.22 $\pm$ 0.04 for aroma; .8.62 $\pm$ 0.02 – 7.76 ± 0.01 for taste, 8.50 $\pm$ 0.03-8.04 $\pm$ 0.06 for texture and 8.67$\pm$0.02- 7.98 $\pm$ 0.02 for overall acceptability respectively. The disparity seen in the result of aroma, taste and overall acceptability in cheese produced from Nigeria dwarf goat milk, may be attributed its’’ goaty flavor”.

4.0 Conclusion

This study has proven the potential of *Brevibacterium linens*, as a coagulant, which contributes to the final appearance, flavour, colour and aroma of cheese. Many recent studies have purified and identified *Brevibacterium linens*, for application in food technology, which aims to extend food preservation time, treat pathogen disease and cancer therapy, and maintain human health. Therefore, *B linens* may become a potential drug candidate for replacing antibiotics in order to treat multiple drugs resistance pathogens in the future. Microbial communities from rinds of surface-ripened cheeses are composed of various bacteria, yeasts and molds, which contribute to the flavor, texture and appearance of the final products.

However, fresh Nigeria dwarf goat milk and cow milk produced under good hygienic condition in the manufacture of acceptable cheese of excellent nutritional, microbial and sensory qualities. 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. Goat milk is non allergic as compared to cow milk and it can be used in the treatment of certain diseases. Efforts should therefore be intensified toward commercial production of cheese and other dairy products using *Brevibacterium linens*, as a coagulant.

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