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Evaluation of Cheese Quality from Three Coagulants

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ABSTRACT

Soft cheese, often referred to as "Wagashi" in Ghana and parts of West Africa, was produced from cow milk using sodom apple, lime juice and rennet as coagulants. The effects of these coagulants on the yield, physicochemical properties and sensory properties were evaluated. With 3000 ml of milk, the percentage of cheese yield was 23.58%, 21.8% and 19.8% for sodom apple, lime and rennet, respectively. The volume of whey obtained using sodom apple extract was 2100 millilitres, while lime juice and rennet produced 2000 ml and 2200 ml of whey, respectively. The average pH of sodom apple cheese was 5.02, while that of lime juice and rennet was 5.10 and 5.35, respectively. Total titratable acidity values recorded were low, ranging from 0.0072% to 0.00965%, with no significant difference between all the treatments. The moisture content was high in rennet cheese (62.18%), while that of lime and sodom apple were 59.45% and 52.33%, respectively. For free fatty acids, rennet cheese was highest at 12.95%, and lime samples recorded the lowest at 4.65%. Sensory acceptance of samples revealed an acceptance for lime as a coagulant, with the least mean rank of 43.9 over rennet (63.3). The implication of lime acceptance is the readily commercial use and production of soft cheese.

Introduction

Cheese is a generic name for a group of fermented milk-based food products produced worldwide in a great diversity of flavour, texture and shape (Fox, 1993). Cheese's origin is unknown (O'Connor, 1993), as it has lost its roots in an unrecorded historical record. Cheese is one of the commonest milk products in the world and is highly nutritious and serves as a form of milk preservation since fresh milk is highly perishable (Farkye, 2004). The shelf life of unprocessed milk is approximately 2-3 hours to 24 hours when stored at high ambient temperatures (O'Connor, 1993).

Law and Tamime (2010) define cheese as a concentrated protein gel which absorbs fat and moisture. More than 1000 varieties are produced worldwide, such as Blue cheese, Feta cheese, Cottage cheese and Cream cheese. In milk coagulation for cheese processing, the addition of rennet or coagulating substances has been used extensively. Rennet is a general term that describes enzymes from animals (from the rumen of calves) used for milk coagulation during the preparation of cheese (Crawford, 1985). Fruit juice extracts and other plant parts have been used as coagulating agents in cheese preparation. The Sodom apple (*Calotropis procera*) plant has been given much attention as it has the potential to completely substitute for animal and microbial rennet (Chikpah, Teye, Teye and Mawuli, 2014) during the production of a local soft cheese known as "Wagashi". Extracts from the sodom apple plant leaves have been used to coagulate cow and soy milk.

"Wagashi" is a nutritious food with a rich source of protein, fat, vitamins and minerals such as calcium, iron and phosphorus. It is sometimes used as a substitute for meat and fish in various recipes and can solve problems related to protein deficiencies in African diets (Elkhider, El-Zubeir, Basheir and Fadlelmoula, 2011). The process of making "Wagashi", as indicated by Arthur (2016), was developed by the nomadic Fulani as a means of preserving surplus milk and is based on the milk-coagulating properties of the juice from the leaves and stems of the sodom apple (*Calotropis procera*) plant.

Milk is an essential source of quality protein, and key micronutrients, including calcium and vitamins A and B, are essential for pregnancy and lactation, as well as child growth and development (Brantsæter et al., 2012). Although underdeveloped, Ghana's local milk industry is a source of livelihood for many Ghanaians (Kunadu *et al*., 2019). Milk coagulant is vital to the cheese-making process and is responsible for the precipitation of milk into curds and whey. The curds are pressed and further processed into different forms of cheese. Rennet, acetic acid, citric acid, lactic acid, vinegar and lemon juice have been used to manufacture cheese. Plant extracts are suitable mainly for soft and fresh cheese consumed within a few days of production (Roseiro, Barbosa, Ames and Wilbey, 2003). In Ghana, the stem and leaf extracts of the sodom apple plant leaves are primarily used locally to coagulate milk for soft cheese production in the food industry, whereas rennet and lime juice are rarely used. Several studies have been conducted on the effect of different types of coagulants on milk for the processing of soft cheese.However, there have not been any known comparative studies on the evaluation of soft cheese quality using three coagulants namely, sodom apple, lime and rennet, in Ghana.The objectives of the study were to process soft cheese using lime juice, sodom apple extract and rennet as coagulants,estimate the cheese yield percoagulant,

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determine some physiochemical properties (pH, moisture, free fatty acid, total titratable acid) of cheese and whey and evaluate the sensory properties of cheese.

Materials and Methods

Sample Design and Preparation

Single factor design with three levels (treatments) was used as the experimental design, where the factor was coagulant and treatments, the three coagulants used. The three types of coagulants used were lime, sodom apple and rennet. All three coagulants (Plate 1) for the study were purchased and prepared as follows:

Lime: was washed and carefully squeezed to prevent contamination. The expelled lime juice was strained into a clean bottle and stored in a refrigerator until ready for use.

Microbial rennet: one Mad Millie vegetarian rennet tablet was dissolved in 50ml of deionised water, kept in a clean bottle and stored in a refrigerator until ready for use.

Plate 1. Lime fruits (*left*), Mad Mille vegetarian rennet tablets (*middle*) and sodom apple plant (*right*).

Sodom apple extract: Sixty grams of the succulent leaves and stems of the plant were ground using a laboratory mortar and pestle. The homogenized plant material was transferred into a 100 ml measuring cup. Fifty (50) millilitres of water was added, stirred and allowed to infuse for 10 minutes. The mixture was then strained into a clean bottle and stored in a refrigerator until ready for use.

Cheese Preparation

Purchased fresh and unpasteurised cow milk was used for soft cheese production and was prepared according to the process described by Akinloye and Adewumi, (2014). Three thousand (3000) millilitres of milk was used for each treatment. Each treatment was pasteurised at 85 ℃ and held for 5 minutes, and coagulants were added. The quantities of coagulants added were 150 ml, 50 ml and 50 ml for lime juice, sodom apple extracts and rennet, respectively. Two treatments (lime and rennet) were allowed to curd at room temperature. The remaining treatment (sodom apple extract) was allowed to curd at 50℃. When there was a visible separation of curds and whey (Plate 2), the curds were collected into a cheesecloth, and the whey drained. The pressed cheese and whey were weighed, packed, labelled and stored for laboratory analysis and sensory evaluation.

The quantity of cheese produced from each treatment was weighed with an electric weighing scale, recorded as yield and calculated as:

$$\% \text{ cheese yield} = \frac{Quantity\ of cheese produced(g)}{Qunatity\ of\ milk used\ (g)} \text{x } 100$$

Plate 2. Visible separation of curds and whey in lime (*left*), rennet (*middle*) and sodom apple (*right*).

Determination of Physiochemical Parameters

Moisture content, titratable acidity, pH and free fatty acid were determined for whey and cheese. All treatments were in triplicate.

Moisture Content Determination

The moisture content of treatments was determined according to the Association of Official Analytical Chemists (A.O.A.C), (2006). About 3g of cheese samples were weighed using an electronic scale and transferred into previously dried and cooled aluminium cans. The samples were oven dried at 105 ℃ for four hours and then cooled in a desiccator, after which the dried weight was measured. The percentage of moisture was calculated using the formula,

$$\% \text{ Moisture} = \frac{(weight\ of\ wet\ sample - weight\ of\ dried\ sample\ )}{weight\ of\ sample} \times 100\%$$

TotalTitratable Acidity of Whey

The whey samples were thoroughly mixed before testing. Ten (10) ml each of whey was dissolved in 10 ml of distilled water to obtain 20 ml. The sample was rapidly titrated against 0.1M NaOH using phenolphthalein as an indicator until the first definite colour changed into pink. Triplicate measurement was taken and calculated as lactic acid using the equation;

$$TTA\ (lactic\ Acid)\% = \frac{0.1M\ NaOH \times Volume\ of\ NaOH\ (titre\ end\ point) \times 90.08}{Volume\ \ of\ tested\ sample}$$

Where,

0.1M= Normality of titrant NaOH

90.08= Molecular weight of lactic acid

Total TitratableAcidity of Cheese Samples

For every 10g of treatment, 100 ml water was added. The mixture was then agitated and filtered into a conical flask. Twenty-five millilitres of the filtrate was measured into a conical flask and titrated against 0.1M NaOH using phenolphthalein as an indicator until a pink colour changed. The results were expressed as lactic acid.

Determination of pH

Ten(10)g of each cheese sample was weighed into a beaker, and 10 ml of distilled water was added. The content was homogenised and allowed to stand for 10 minutes. The pH reading was determined by dipping the probe of a calibrated Mettle Toledo pH meter into the sample. The probe of the pH meter was dipped into 20 ml of test samples to determine the pH of the whey samples.

Determination of Free Fatty Acid

Cheese samples were thoroughly homogenised before testing. For every 10g of samples, 25 ml of hexane was added. The conical flasks were agitated on a shaker for an hour, centrifuged for 5 minutes at 3500 revolutions per minute, and hexane was evaporated by placing the conical flask in a hot water bath for 30 minutes. The weight of the conical flasks was taken after removal from the water bath and allowed to cool. A drop of 1% phenolphthalein indicator was added to the content of the conical flask and titrated against 0.1M

KOH in ethanol until a faint pink colour change, which persisted for 30 seconds. The free fatty acid value was determined by dividing the acid value by 2. The acid value was calculated as;

$$AcidValue = \frac{Titrevalue \times NormalityofKOH \times 5.61}{Weightoffatsample}$$

Where,

Titre value = 0.1N of KOH solution used for sample – 0.1N KOH solution used for blank

$$FreeFattyAcidValue = \frac{AcidValue}{2} \times 100\%$$

Sensory Evaluation of Cheese

The consumer acceptance test was conducted using 30 untrained final-year students as panellists. The sensory attributes evaluated were colour, aroma, taste, texture, mouthfeel and overall acceptability. A five-point hedonic scale (1= dislike extremely, 2= dislike, 3= neither like nor dislike, 4 = like, 5= like extremely) was used to assess the quality attributes of the cheese. The stored products were removed from the refrigerator and thawed. Thawed treatments were diced, and each dice weighed in the range of 10-15 g, and deep fried. The fried products were presented to panellists on three digits coded disposable plates with water and bread to serve as a palate cleanser (neutralizer) in between products.

Statistical Analysis

The difference among means data generated for moisture, free fatty acid and total titratable acidity were analysed by subjecting to the analysis of variance (ANOVA) using GenStat Statistical Software (18th edition). A non-parametric test (Kruskal- Wallis test) was used to analyse data collected on sensory evaluation. Means were separated using Tukey multiple means of the comparison test.

Results and Discussion

Produced Cheese Yield and Whey Volume

The results of the cheese yield and whey quantity of produced cheese (Plate 3) are indicated in Table 1. The curdling time was rennet (360 minutes), sodom apple (25 minutes) and lime (10 minutes) which recorded the least clotting time.

Plate 3. Produced cheese lime (*left*), sodom apple (*middle*) and rennet (*right*).

Table 1. Curding time, cheese yield and whey quantity of treatments

Treatments	Curding time (min)	Cheese weight (g)	Cheese yield (%)	Volume of whey (ml)
Lime	10	654	21.8	2100
Sodom apple	25	708	23.58	2000
Rennet	360	594	19.8	2200

Physiochemical Parameters of produced Cheese

The pH of produced cheese and whey, free fatty acid of produced cheese, total titratable acidity of cheese and whey and moisture content were measured.

pH of Produced Cheese and Whey

The pH of cheese from lime was high, with a value of 5.02, followed by sodom apple 5.1 and then rennet 5.35. The low pH of cheese produced from lime could be due to the citric acid in the lime, which made the cheese acidic, while the proteolytic enzyme in rennet made the cheese slightly alkaline. The pH of cheese produced from sodom apple was slightly acidic (5.1); this may be due to the use of raw extracts, which had a pH of 5.11.

pH is the measure of the acidity or basicity of a substance. The results of whey and cheese pH are indicated in Table 2. Whey pH recorded for lime coagulated cheese (5.17) indicated slight acidity, whereas the whey pH values for sodom apple (6.74) and rennet (6.65) were similar and near neutral while lime was acidic (5.17). The coagulant pH of sodom apple and rennet suggests that milk coagulation was mainly by enzymatic activities while lime was by acidic reactions.

Table 2. Mean product pH per treatment

Treatments	Milk	Coagulant	Cheese	Whey
Lime	6.57	2.15	5.02	5.17
Sodom apple	6.57	5.11	5.10	6.74
Rennet	6.57	6.78	5.35	6.65

Moisture Content and Free Fatty Acid (FFA) Values of Cheese

Table 3 summarises the results for moisture and free fatty acid value. Moisture percentage was high in rennet followed by lime and sodom apple treatments. From the results, it was observed the mean percentage moisture content in the cheeses was high. This assertion agrees with the description of Ashaye *et al*. (2006), who reported that soft cheese had a moisture content of about 50%-60%. There were significant differences between the three treatments.

Table 3. Mean percentage values of moisture content and free fatty acid (FFA)

Treatments	Moisture	FFA
Lime	52.33^{a}	4.65^{a}
Sodom apple	59.45^{b}	9.55^{ab}
Rennet	62.18^{c}	12.95^{b}
P value	0.010	0.007

*Means with the same superscript columns are not significantly different at $p<0.05$.

Rennet treatment had the highest FFA value of 12.95%, followed by sodom Apple with FFA value of 9.55% and then lime having the most negligible FFA value of 4.65%. FFA gives the amount of oleic acid in the cheese. With the low values of FFA, which represents low levels of oleic acid, the cheese, maybe be less prone to oxidation. Significant differences at $p<0.05$ were observed for mean FFA values of the three soft cheese from 4.65% to 12.95%. The high moisture content in the rennet treatment is undesirable as it can provide favourable conditions for spoilage.

Total Titratable Acidity (TTA) of Cheese and Whey

The summary of the results for titratable acidity is shown in Table 4. Results showed low values of TTA in cheese and whey, but the TTA of whey was high compared to the TTA of cheese. The total titratable acidity value recorded for cheese ranged from 0.0072% to 0.0096%. Total titratable acidity represented the amount of lactic acid in the soft cheese.

Table 4. Mean percentages of total titratable acidity of cheese and whey

	Cheese	Whey
Lime	0.0084[a]	0.0543[a]
Sodom apple	0.0096[a]	0.0603[a]
Rennet	0.0072[a]	0.0633[a]
P value	0.702	0.206

*Means with the same superscript in columns are not significantly different at p<0.05.

The low TTA values may be presumably due to the absence or low amount of lactic acid bacteria in the samples. Results obtained showed that there was no significant difference between the mean values of cheese titratable acidity. At a significance level of 5%, there were no significant differences between the mean Total titratable acidity values of whey.

Cooking Loss

Cooking loss was used to measure the amount of weight lost during frying. The cooking loss ranged from 142 g to 172 g (table 5). These losses, although high, meant cheese still contained high amounts of moisture after draining and needed to be lost. This loss enhanced the samples' shelf life and general acceptability of the samples.

Table 5. Weight (g) differences before and after cooking of cheese from the three treatments

Treatments	Initial	Final	Loss
Lime	624	452	172
Sodom apple	627	483	144
Rennet	447	305	142

Sensory Evaluation of Soft Cheese

The sensory parameters recorded were colour, aroma, taste, mouthfeel, texture and overall acceptability. The mean ranked scores are shown in table 6.

Table 6. Sensory evaluation of cheese from the treatments

Attributes	Treatments			P value
	Lime	Sodom apple	Rennet	
Colour	47.0[a]	45.2[a]	44.3[a]	0.924
Aroma	37.1[a]	38.0[a]	61.5[b]	< 0.001
Taste	38.5[a]	31.9[a]	66.1[b]	< 0.001
Mouthfeel	37.1[a]	34.2[a]	65.3[b]	<0.001
Texture	52.5[a]	35.1[ab]	49.0[b]	0.024
Overall acceptability	43.9[a]	29.3[a]	63.3[b]	< 0.001

*Scores with the same superscripts in columns are not significantly different at p < 0.05.

Colour

The mean rank value for lime was higher than sodom apple and rennet. The high mean rank value for lime (47.0) showed that it was the least liked than the other two treatments sodom apple and rennet, which recorded mean values of 45.2 and 44.0, respectively. The low mean rank recorded for rennet indicated that consumers liked samples. Consumer preference based on colour was not significantly different. A slightly greenish colour was observed in cheese when sodom apple was used. The green colour of the sodom apple coagulated cheese resulted from the chlorophyll present in the leave and stem of the sodom apple. This agrees with the study of (Chikpah *et al*., 2015), where soy curds produced with sodom apple extracts had a green colour.

Aroma

The Aroma of cheese with rennet recorded a high mean value (61.5), indicating the most dis-liked of the three cheese types. Lime coagulated cheese (37.1) was fairly liked compared to sodom coagulated cheese (38.0) which was much liked. The low preference for rennet coagulation may be attributed to fermentation that had begun to set in during storage. The aroma was associated with the undesirable smell of fermented cassava dough by a consumer panellist. The aroma score indicated a statistical difference between the three types of cheese lime coagulated cheese, sodom apple cheese and rennet coagulated cheese.Statistically, there was no significant difference in aroma between lime and sodom apple.

Taste

From the results, sodom apple coagulated cheese recorded a low mean rank (31.9); this indicated that highly preferred by the consumer panellists. This can be associated with the elastic and fried egg perception of the panellists. The higher mean rank of rennet (66.1), indicating dislike, can be attributed to the perceived sour taste panellists did not accept. The mean rank values of sensory attributes of soft cheese shown in the table at a 5% significance level regarding taste indicate a significant difference between the three treatments. Taste mean rank values showed no statistical difference between lime and sodom apple.

Mouthfeel

Rennet coagulated cheese had the highest mean rank of 65.3, indicating the least preferred. Sodom apple coagulated cheese with the least mean rank value (34.2) was much preferred.Lime-coagulated cheese had an intermediate preference with a mean rank value of 37.1. There was a significant difference between treatments on the mouthfeel. Statistically, there was no difference in the mean rank values of lime (37.1) and sodom apple (34.2).

Texture

Mean rank values ranged from 49.0 to 52.5, with lime-coagulated cheese recording the highest mean rank (52.5), indicating the least liked. This rank can be attributed to the smooth nature of produced cheese. The low mean rank value of 35.1 recorded for sodom apple indicates much preference by the panellist. The texture was assessed by pressing samples between the fingers. There were significant differences between all treatments.

Overall acceptability

Sodom apple had the least mean rank value (29.3), indicating much preference, followed by lime (43.9). Rennet coagulated cheese recorded the highest mean rank (63.3). The least acceptability means rank value for sodom apple could be attributed to the palatability of cheese. The intermediate preference for lime-coagulated cheese could be attributed to the flavonoids in the lime, which gave the cheese a sweet aroma. A low preference for rennet can also be related to fermented cheese's sour and bitter taste. There was a significant difference in the overall acceptability between treatments. However, there was no significant difference between the mean rank values of lime and sodom apple.

Conclusion

The three coagulants, sodom apple extract, lime juice and rennet, were successfully used to process soft cheese with different milk coagulating times and cheese yield. Sodom apple extracts recorded an intermediate clotting time of 25 minutes, produced soft cheese with higher cheese yield than lime, with a shorter coagulating time of 10 minutes and rennet with a longer coagulating time of 360 minutes (6 hours). This coagulating difference suggests that sodom apple extract is a better milk coagulant than lime and rennet. Lime, however, performed well when compared with sodom apple

extracts with closer cheese yield and can therefore be considered an alternative coagulant to sodom apple in the processing of soft cheese. Coagulation was quicker when lime juice was used compared with the remaining coagulants. The moisture content of cheese from rennet was high compared to the other coagulants. The high moisture content in rennet cheese could have influencedfermentation resulting in the developed sour taste. The pH of cheese showed slight acidity in all the cheese types which is a good attribute for cheese. Except for cheese produced from the rennet, which had significantly lower acceptability, cheese precipitated with lime or sodom apple extracts had similar consumer acceptance in this study.

Reference

1. Akinloye, A. M. and Adewumi, O. O. Effects of Local Coagulants on the Yield of Cheese Using Cow and Sheep Milk. International Journal of Development and Sustainability, 2014;3(1):150–161.

2. Arthur, A. B. Optimising the "Wagashie" (A Traditional Cottage Cheese) Process and Sensory Quality (Doctoral dissertation, Department of Nuclear Agriculture and Radiation Processing, School of Nuclear and Allied Sciences, University of Ghana) (2016).Available at: http://197.255.68.203/handle/123456789/21881. Accessed (29/4/2020).

3. Ashaye, O. A., Taiwo, O. O. and Adegoke, G. O. Effect of Local Preservative (*Aframomum danielli*) on the Chemical and Sensory Properties of Stored Warakanshi. African Journal of Agricultural Research, 2006; 1(1):10–16.

4. Brantsæter, A. L., Olafsdottir, A., Forsum, E., Olsen, S. and Thorsdottir, I. Does Milk and Dairy Consumption During Pregnancy Influence Fetal Growth and Infant Birthweight: A Systematic Literature Review? Food and Nutrition Research, 2012;56(1):20–50.

5. Chikpah, S., Teye, G. A., Teye, M. and Mawuli, F. F. Effects of Different Concentrations of Fresh and Dried *Calotropis Procera* (Sodom Apple) Extract on Cow Milk Coagulating Time, Cheese Yield and Organoleptic Properties of West African Soft Cheese ("Wagashie"). European Scientific Journal,2014; 10(27):317–326.

6. Chikpah, S., Teye, M., Annor, J. A. F., and Teye, G. A. Potentials of Sodom Apple (*Calotropis procera*) Extract as a Coagulant to Substitute Alum in Soy Cheese Production in Ghana. Elixir International Journal Food Science, 2015;79(1):30166–30170.

7.Crawford, R. J. M. Future Development in Rennet and its Use in the Cheese Factory. International Diary Federation Bulletin, 1985;194:14–23.

8. Elkhider, I. A. E., El Zubeir, I. E. M., Basheir, A. A. and Fadlelmoula, A. A. Composition and Hygienic Quality of Sudanese White Cheese Produced by Small Scale in Rural Area of Eastern Sudan. Annual Food Science Technology, 2011;12(2):186–192.

9. Farkye, N. Y. Cheese Technology. International Journal of Dairy Technology, 2004;57(2–3):91–98. Available at: https://doi.org/10.1111/j.1471-0307.2004.00146.x. Accessed (3/12/2019).

10. Kunadu, A. P. H., Aboagye, E. F., Colecraft, E. K., Otoo, G.E, Adjei, M. Y, Acquaah, E., et al. Low Consumption of Indigenous Fresh Dairy Products in Ghana Attributed to Poor Hygienic Quality. Journal of food protection, 2019; 82(2), 276–286. Available at: https://doi.org/10.4315/0362-028X.JFP-18-146. Accessed (28/8/2020).

11. O'Connor, C. B. Traditional Cheese Making Manual. ILCA (International Livestock Centre for Africa), Addis Ababa, Ethiopia. 1993; Pp.1–50. Available at:http://dairyasia.org/Presentations/Traditional%20Cheesemaking%20Manual.pdf. Accessed (27/8/2020).

12.Roseiro, L. B., Barbosa, M., Ames, J. M. and Wilbey, R. A. Cheese making with Vegetable Coagulants: The Use of Cynara Cardunculus L. for the Production of Ovine Milk Cheeses. International Journal of Dairy Technology, 2003; 56(2):76–85. Available at: https://doi.org/10.1046/j.1471-0307.2003.00080.x. Accessed (15/06/2020).