

EFFECT OF DIFFERENT COAGULANTS ON NUTRITIONAL AND SENSORY EVALUATION OF CHEESE PRODUCED FROM WHITE FULANI COW MILK

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Abstract

This study aimed to evaluate the nutritional and organoleptic characteristics of "Wara," a local cheese produced using selected plant-derived coagulants. Three cheese varieties were produced utilizing three natural coagulants: *Carica papaya* (PC), *Moringa oleifera* (MC), and lime juice (LC). A sample of commercially retailed cheese (CRC) was obtained from a Fulani agricultural settlement. A completely randomized design was employed. Raw milk was obtained from breastfeeding White Fulani cows from the Geke Fulani village in Igboora and divided into three equal portions. The milk was heated to 100°C and subsequently combined with additional milk, then heated until coagulation occurred. Protein content MC had the highest value of 17.65% while CRC the least value of 7.58%. Ash, fat and total solid (3.11%, 6.21% and 52.65% respectively) were higher in MC than others while the moisture content and lactose (67.99% and 5.86% respectively) were also higher in CRC. MC had the lowest values of 2.40% and 3.30% for texture and general appearance respectively. CRC had the highest value of 6.20% and 6.70% for favor/taste and color while PC had the lowest values of 2.20% and 1.50% for flavor/taste and color respectively.

Key words: Fresh cow milk, Plant sourced coagulants, Cheese samples

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Introduction

Milk is a yellowish-white opaque liquid produced by the mammary glands of all mammals. It comprises a balanced composition of all essential and digestible components for the construction and sustenance of the human and animal organism (Pandey and Voskuil, 2011). Cheese, a nutritious food, is one of the various products derived from the processing of milk from cows, goats, sheep, buffalo, camels, and yaks. It is generated through the coagulation of the milk protein termed casein (Scott, 1986).

Coagulant is a crucial component in cheese production, with rennet, an animal-derived coagulant, being the most prevalent type utilised (Roseiro et al., 2003). The quantity and quality of cheese are largely influenced by the quality of milk and the type of coagulant employed. Recent developments indicate that plant-based milk coagulants have supplanted the need of animal rennet. Animal rennet may be restricted due to dietary preferences (vegetarianism), religious beliefs (Judaism and Islam), or concerns over genetically engineered food; for instance, Germany and

the Netherlands prohibit the use of recombinant calf rennet (Roseiro et al., 2003). In Nigeria and several regions of West Africa, traditional cheese producers, predominantly Fulanis, utilise *Calotropis procera* (Sodom apple, referred to as ewe bomubomu in Yoruba and tumfafia in Hausa) extract as a coagulant in cheese production. This leaf contains an organic acid known as calotropin, which can coagulate milk (Aworth and Muller, 1987). The Sodom apple is also significant for its blooms and other plant components, which are utilised to treat colds, coughs, catarrh, asthma, stomach problems, and headaches (Abbas et al., 1992). Despite the therapeutic benefits and use in the cheese-making sector of *Calotropis procera*, it is not farmed commercially (Adetunji and Salawu, 2008). If *Calotropis procera* faces extinction, experiences a decline in population due to adverse weather, encounters increased demand due to its extensive utility, or if additional potentials are uncovered, cheese makers will be compelled to seek alternative coagulants. It is thus essential to identify alternative (perhaps superior) plants in tropical climates that can serve as viable substitutes for *Calotropis procera*. This study aimed to evaluate the impact of various coagulants on the nutritional and sensory characteristics of cheese made from white Fulani cow milk.

Materials and methods

Experimental site

The experiment was conducted in the garden of the Department of Animal Health and Production Technology at Oyo State College of Agriculture and Technology, Igboora, Nigeria.

Experimental materials and ingredients

Pot, gas stove, bowl, muslin cloth, plastic spoon, measuring cup, cheese basket, knife, matches, adhesive tape, marker, translucent plastic plate. Fresh bovine milk and various plant-derived coagulants

Samples collection

Fresh cow milk was sourced from a nomadic community situated within the GEKE agricultural settlement in the Ibarapa Central Local Government Area of Oyo State, Nigeria. A clean bowl was utilised to aseptically collect six litres of fresh milk from a healthy crossbred cow, which was then packaged in a sterile white container and stored in a chiller with ice crystals. This mitigated post-harvest contamination and temperature elevation during prolonged transportation. Fifty grammes of *Moringa Oleifera* seeds and fresh *Carica papaya* leaves were procured from trees on the college grounds, while twelve lime fruits were sourced from a reputable supplier in Igbo-ora.

Production of cheese

Production of Cheese using Moringa Oleifera as Coagulant

Fifty grammes of dried *Moringa oleifera* leaves and ten grammes of *Moringa oleifera* seeds were powdered and immersed in 0.4 litres of water. The resultant solution was permitted to rest for one hour. Two litres of fresh cow's milk were cooked in an aluminium pot at 100°C for 30 minutes. Fifty millilitres of *Moringa oleifera* seed solution was subsequently incorporated into the hot milk. The mixture was heated on low for 15 minutes until it coagulated. The cheese made was designated as sample MC.

Production of Cheese using carica papaya as Coagulant

Twenty-five grammes of fresh unripe pawpaw leaves were weighed and pulverised using a mortar and pestle. The pulverised leaves were immersed in distilled water at a 1:1 (w/v) ratio. After 10 minutes, the mixture was strained through a cotton cloth to obtain the extract. Two litres of fresh cow's milk were cooked in an aluminium pot at 100°C for 30 minutes. Fifty millilitres of unripe pawpaw leaf extract was combined with fifty millilitres of distilled water and thereafter added to the warm milk.

The mixture was heated on low for 15 minutes until it coagulated. The resultant cheese was subsequently designated as sample PC.

Production of cheese using lime fruit juice as coagulant

Twelve fresh limes were halved with a knife, and the segments were subsequently squeezed by hand into a small basin, then filtered through muslin fabric to collect the juice. The extracted juice was subsequently placed into a small bowl. Two litres of fresh cow's milk were cooked in an aluminium saucepan at 100°C for 30 minutes. Subsequently, 100ml of freshly squeezed lime juice was incorporated into the hot milk. The mixture was heated on low for 15 minutes until it coagulated. The cheese made was subsequently labelled LFC.

Sourcing for the commercially retailed cheese

The fourth sample of cheese labelled CRC was acquired from IYA Fulani Farm Settlement in Igboora. It was derived from *Calotropis procera* (Sodom apple leaf), commonly referred to as 'ewe bomubomu' among the Yoruba, serving as a coagulant source.

Organoleptic evaluation

A sensory evaluation form was developed to examine the organoleptic qualities of the cheese samples. The seven-point hedonic scale

was employed. Ten individuals were selected at random from the college to act as panellists. The responses gathered from the panellists after evaluating each sample were analysed to determine their average preference for the samples.

Nutritional evaluation of cheese

The nutrient contents (crude protein, ash, fat, moisture content, total solids, and lactose) of cheese produced from various coagulants were assessed using the standard AOAC technique (1995).

Sensory analysis

The organoleptic characteristics of each cheese produced with different coagulants were assessed. The items were evaluated for texture, flavour, colour, and overall acceptability using a seven-point hedonic scale (7, excellent; 6, very good; 5, good; 4, average; 3, fair; 2, poor; 1, extremely poor), and the mean scores for each feature were determined.

Statistical analysis

The collected data underwent one-way ANOVA, and the mean values exhibiting significant differences ($P < 0.05$) were distinguished using the Duncan multiple range test (Duncan 1955).

Table 1: Nutritional properties of the four cheese samples.

^{abcd}Means value in the same column with different superscript. ($p < 0.05$) are significantly different

Samples	Protein (%)	Ash (%)	Fat (%)	Moisture Content (%)	Total Solid (%)	Lactose (%)
CRC	7.58±0.17 ^c	2.05±0.29 ^c	3.27±0.12 ^c	67.99±0.12 ^a	32.01±0.12 ^d	5.86±0.12 ^a
LC	13.45±0.17 ^b	2.36±0.12 ^b	4.77±0.12 ^b	57.04±0.15 ^c	42.99±0.12 ^b	4.50±0.12 ^c
MC	17.65±0.17 ^a	3.11±0.58 ^a	6.21±0.12 ^a	47.42±0.23 ^d	52.65±0.12 ^a	3.80±0.12 ^d
PC	13.45±0.17 ^b	2.12±0.58 ^c	4.61±0.17 ^b	57.64±0.17 ^b	42.36±0.17 ^c	4.90±0.12 ^b
Sample	Texture	Flavour & Taste	Color	General Appearance		
CRC	6.80±0.13 ^a	6.20±0.33 ^a	6.70±0.15 ^a	6.80±0.13 ^a		
LC	5.30±0.58 ^b	2.40±0.34 ^c	1.90±0.41 ^{bc}	3.70±0.68 ^b		
MC	2.40±0.22 ^c	3.80±0.51 ^b	2.50±0.22 ^b	3.30±0.45 ^b		
PC	5.30±0.58 ^b	2.20±0.36 ^c	1.50±0.22 ^c	3.70±0.68 ^b		

Table 2; Results of questionnaire on the organoleptic assessments

^{abc}Means value in the same column with different superscript. ($p < 0.05$) are significantly different

Result and discussion

The result obtained were as presented in **Table 1 and 2**

Treatments Code	Description of the treatment
CRC (T1)	Commercially retailed cheese (control)
LC (T2)	Lime fruit juice extract coagulated cheese
MC(T3)	Moringa seed extract coagulatedcheese
PC(T4)	Unripe Pawpaw leaves extracts coagulated cheese

Proximate analysis revealed significant variations ($p < 0.05$) in protein, ash, fat, moisture content, total solids, and lactose among commercially retailed cheese, lime cheese, moringa cheese, and pawpaw cheese. Among the four samples generated, moringa cheese exhibited the highest fat level at 6.21%, which is lower than the 14.68% reported by Johnson et al. (2001). Moringa cheese possesses the highest fat content value at 6.21%, surpassing lime, commercially available cheese, and pawpaw cheese. The protein content of cheese generated from various coagulant sources, ranging from 7.58% to 17.65% in this study, was comparable to the findings of Orherba and Taiwo (2016) but lower than the 45% reported by Johnson et al. (2001). The discrepancies in the findings may arise from various factors, including the different species of coagulants employed, the maturity and nutrient composition of the plant-derived coagulants utilised, and the quantity of protein present in the milk post-extraction. The elevated fat content (6.21%) of cheese derived from Moringa seed coagulant may be ascribed to the coagulated protein in the milk potentially encapsulating some of the fat inside the heterogeneous solution of Moringa

oleifera seed. Nevertheless, the fat content of the cheese was elevated in comparison to the fat levels documented for steep water coagulated products and certain widely consumed plant meals (Oboh and Omotosho, 2005). The fat content of 3.27-6.21% observed in this study exceeded the 3.78-5.71% butter fat range reported by Ndubueze et al. (2006) in the milk of grazing White Fulani cows fed poultry waste-cassava peel-based diets and surpassed the 4.10% fat content reported by Olorunnisomo and Ibhaze (2010) in fresh milk from a White Fulani herd. The moisture percentage of commercially available cheese (67.99%) exceeded that of moringa, lime, and pawpaw cheese, maybe attributable to the superior coagulating strength of Calotropis procera. Increased moisture content may promote the growth and reproduction of microbes, as indicated by Adegoke et al. (1992), hence diminishing the shelf-life of cheese. The total solid content of Moringa cheese was 52.65%, the highest, whereas Calotropis procera (CRC) cheese in T1 exhibited the lowest value at 32.01%. Calotropis procera (CRC) coagulated cheese exhibits the greatest lactose level at 5.86%, followed by pawpaw coagulated cheese, lime juice coagulated cheese, and moringa coagulated cheese, which has the lowest content. The ash content values from the four cheese samples are closely aligned, with moringa coagulated cheese exhibiting the highest value at 3.11%. Nonetheless, respondents to the Questionnaire Assessment indicated a preference for coagulated cheeses made from Moringa and Calotropis procera, based on their nutritional attributes, including fat, protein, moisture content, ash, and lactose. The cheese coagulated with lime juice had a sour flavour. This is attributable to the citric acid found in lime juice, which serves as a natural preservative in food products.

Organoleptic properties

Table 1 illustrates the impact of each coagulant on the organoleptic properties of the cheese samples. It also indicates that variations in the volume of each coagulant result in corresponding changes in the organoleptic properties. The following are the organoleptic properties of the assessed local cheese samples:

Texture

There were notable discrepancies in the average responses recorded for the samples ($p < 0.05$). CRC, LC, MC, and PC exhibited substantial differences among themselves, indicating that, on average, they possess a comparable texture ranging from somewhat firm (3) to firm (4). However, they were markedly distinct from LC2, which has a texture classified between extremely soft (1) and soft (2), approaching soft (2).

General appearance

No significant variations were seen in the mean answer regarding general appearance among the samples ($p > 0.05$). This indicates that they possess a comparable appearance, ranging from somewhat unattractive to moderately appealing. Despite notable differences in observation, PC is perceived as fairly unattractive, while others are regarded as appealing, with the exception of CRC, which is viewed as moderately attractive.

Flavour and taste

There were notable disparities in the average responses among the samples ($p < 0.05$). The flavour profiles of MC and CRC ranged from mildly sweet (5) to distinctly sweet (7), with no significant difference seen between them. They were markedly dissimilar from PC. LC was not markedly different from PC (which had a slightly sour flavour) but was notably different from CRC and MC. CRC exhibited a marked distinction from PC in flavour and taste. MC possesses a subtly sweet flavour, whilst PC exhibits a fairly sour taste.

Color

Table 2 indicates significant differences in the mean replies of the participants regarding the perceived colour of the samples ($p < 0.05$). The colours of samples LC and MC, which exhibited moderate whiteness, did not differ significantly from one another. The stark whiteness of CRC was not markedly distinct from the moderate whiteness of LC or the modest greenness of MC, indicating that they were not considerably different from one another. The stark whiteness of CRC sharply contrasted with the hue of PC. The data presented in Table 1 and Figures 1 to 4 indicate that each coagulant introduced to the cheese samples exerts distinct effects on their nutritional and organoleptic features.

The comparative analysis of the nutritional and organoleptic characteristics of cheese varieties produced with fruit juice and seed extracts from four plants indicates that *Moringa oleifera* (MC) and *Calotropis procera* (CRC) are promising and generally favourable local coagulants in cheese production. This study revealed that the nutritional and organoleptic qualities of the cheese, based on the additional coagulant, exhibit modest variations. The study's findings suggest that cheese made with *Moringa oleifera* coagulant in T3 exhibited the highest protein content (17.65%) and ash content (3.11%), alongside the lowest moisture content (47.42%). This indicates that it could serve as an alternative plant-based coagulant for local Fulani communities in the derived savanna zone of Nigeria for cheese production.

The plant-derived coagulant from *Moringa oleifera* can be utilised efficiently in the manufacture of high-quality cheese, without adversely affecting its nutrient and chemical makeup.

Cheese made with *Moringa oleifera* coagulant possesses enhanced nutrients, superior quality, and increased yield, making it economically advantageous and effective in addressing protein and nutrient deficiencies in developing nations.

Conflict of Interest

No conflict of interest in this study.

References

- Abbas, B., El-Tayeb, A.E. and Sulleiman, Y.R. (1992), "Calotropis procera: feed potential for arid zones", *Veterinary-Record*, Vol. 131 No. 6, pp. 132.
- Adegoke, G.O., Nse, E.N. and Akanni, O.O. (1992), "Effects of heat, processing time and pH on the micro- flora, aflatoxin content and storability of 'wara', a soft white cheese", *Die Nahrung*, Vol. 36, pp. 259 – 264.
- Adetunji, V.O. and Salawu, O.T. (2008), "West African soft cheese 'wara' processed with Calotropis procera and Carica papaya: A comparative assessment of nutritional values, *International Journal of Dairy Science*, Vol. 6 No. 1, pp. 58 – 65.
- A.O.A.C. (1995). Official Methods of Analysis. 15th Edition. Association of Official Analytical Chemists Washinton, DC. Pp: 68-69.
- Aworth, O.C. and Muller, H.G. (1987), "Cheese making properties of vegetable rennet from Sodom apple (*Calotropis procera*)", *Food Chemistry Journal*, Vol. 26 pp. 71-79.
- Duncan, B.D. (1955). Multiple Range Test Biometrics 1:1-42
- Johnson, M.E., Chen, C.M and Jaeggi, J.J. (2001). "Effect of Rennet Coagulation Time on Composition, Yield and Quality of Reduced-Fat Cheddar Cheese". *Journal of Dairy Sci.* 84: 1027-1033.
- Ndubueze A I, Ukachukwu S N, Ahamefule F O and Ibeawuchi J A. (2006). Milk yield and composition of grazing White Fulani cows fed poultry waste cassava peel based diets. *Pakistan Journal of Nutrition*, 5 (5): 436- 440.
- Obboh, G., and Omotosho, O.E. (2005). Effect of types of coagulant on the nutritive value and *In- vitro* multi-enzyme protein digestibility of tofu. *Journal of Food Technology*, 3: 182-187.
- Olorunnisomo O A and Ibhaze G A. (2010). Physico-Chemical properties of 'Wara' Cheese Precipitated with Sodom Apple and Pawpaw Leaf juice. Proceedings of 35th Annual Conference of the Nigerian Society for Animal Production, University of Ibadan, Nigeria. pp 834-836.
- Orherba, B.A. and Taiwo, A.D. (2016). Comparative assessment of Wara (Local Cheese) produced using three natural additives as coagulants. *Journal of Food and Dairy Technology* 4(3): pp. 1-7.
- Pandey, G.S. and Voskuil, G.C.S. (2011). Manual on milk safety quality and hygiene. Golden Valley Agricultural Research Trust, Zambia, 52.
- Roseiro, L.B., Barbosa, M., Ames, J.M. and Wilbey, R.A. (2003), "Cheese making with vegetable coagulants - the use of Cynara L. for the production of ovine milk cheeses", *International Journal of Dairy Technology*, Vol. 56 No. 2, pp. 76 - 85.
- Scott, R. (1986), "Cheese making practice", 2nd Edition, Elsevier Applied Science Publisher, London, pp529.