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Comparative Proximate Analysis and Calcium Composition between Admiral Yoghurt and Local (Fulani) Yoghurt Sold at Mayo-Belwa Town, Adamawa State, Nigeria

Muhammad Mubarak Dahiru[1, 2 *], Mohammed Bobbo Hamid[2] and Neksumi Musa[2, 3]

[1]*Department of Biochemistry, Modibbo Adama University, Adamawa State, Nigeria.*

[2]*Department of Science Laboratory Technology, Adamawa State Polytechnic Yola. Nigeria*

[3]*Department of Environmental Sciences, Sharda University, Greater Noida, India*

Corresponding author: *mubaraq93@gmail.com*

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ABSTRACT

The varying in cow breeds for milk sources in yoghurt production could provide a difference in yoghurt quality, an important factor to be evaluated. The study aimed to compare the proximate and calcium composition of Admiral yoghurt and Local (Fulani) yoghurts which, the milk source, is from imported and indigenous breeds, respectively. The proximate and calcium compositions of Admiral yoghurt and Fulani yoghurts from three districts (Mbilla, Binkola, Mayo farang) sold in Mayo-belwa local government Area of Adamawa State, Nigeria, were determined. The result of the proximate composition indicated a significant difference ($p < 0.05$) between all the proximate Admiral yoghurt and the Fulani yoghurts except moisture. Admiral yoghurt had more crude fat (6.97%) than the Fulani yoghurts (4.98-4.66 %). However, the Fulani yoghurts had more ash (0.73-0.68 %), crude protein (4.88-3.81 %), crude fibre (0.04-0.03 %) and carbohydrate (3.69-3.48 %). The result also showed that all the Fulani yoghurts contain more calcium (3.88-3.46 mg/ml) than Admiral yoghurt (2.65 mg/ml). The overall result revealed that the Fulani yoghurts had a comparable proximate and calcium composition with Admiral yoghurt based on their proximate and calcium composition.

Keywords: *Mayo-belwa, Admiral, Fulani, Yogurt, Proximate*

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INTRODUCTION

Yoghurt is a viscous fermented milk product with a smooth texture and mildly sour flavour produced by converting lactose to lactic acid during the fermentation process. Yoghurt is made via the fermentation process by lactic acid bacteria. The word "Yoghurt" comes from the Turkish word "Yogurmak", meaning to thicken, coagulate or curdle [1]. *Streptococcus thermophilus*, *Lactobacillus delbrueckii ssp*. *bulgaricus* are mainly applied as starter cultures in yoghurt production [2, 3]. However, in the traditional production of yoghurt, cultures such as *Lactobacillus helveticus*, *Lactobacillus delbrueckii spp*. *lactis* are still employed in some parts of the world [1]. Yoghurt is produced through different processes or steps in the final product. Fresh milk is first heated, usually to a temperature of about 85 ^{0}C (185 ^{0}F), to denature the milk proteins, eliminate pathogens and other unwanted or undesirable microorganisms, and allowed to cool, followed by the addition of bacterial culture for fermentation [4].

Yoghurt and dairy product consumption is noticeably increasing worldwide, especially in developing countries. Nigeria and Africa depend on fermented foods for nutritional and organoleptic satisfaction [5]. Yoghurt is consumed as a dessert drink or snack due to its characteristic pleasant aromatic flavour, thick creamy consistency, and reputation as a food product associated with health benefits [6]. Cow milk contributes significantly to the nutritional intake requirements, including calcium, magnesium, selenium, riboflavin, vitamin B12 and pantothenic acid with little or no fibre [7, 8]. The variation in the relative rate of synthesis and secretion of milk components from mammary glands affects milk composition. However, weather conditions, including the weather or season, breed, diet, and stage of lactation, also determine the composition of milk [9].

Admiral yoghurt is a commercially available yoghurt produced by Sebore farms, Mayo Belwa, Nigeria, from the milk of imported breeds of cows, which are mainly Simmental and Brahman breeds. The cows are kept under normal temperature and fed with formulated feed and free water access. The feed comprises corn, cotton seeds, molasses, soybeans, calcium carbonate ($CaCO_3$), dicalcium phosphate, powdered milk, salt, and premix, mixed in the required amount [10]. While Fulani yoghurt, which is locally known as Fulani nono is a yoghurt produced from the fermentation of milk of indigenous breeds of cattle such as White Fulani and Adamawa Gudali breeds. The animal rearers practice nomadic animal husbandry, not ranching and are fed on grasses and not formulated feeds.

The varying nature of yoghurt quality due to differences in breeds of cows is an essential factor to consider. There is a need to understand, compare, estimate, and evaluate the extent of the variation in the nutrient contents of these fermentation products. Though Admiral yoghurt and the Fulani yoghurts are produced through similar fermentation processes, the proximate and calcium content quality has differed [11]. Thus, this study aimed to compare the nutritional composition of both yoghurts and determine if the locally produced Fulani yoghurt can compete nutritionally with the industrially produced Admiral yoghurt.

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EXPERIMENTAL

Area of Sampling

Sebore farms is an export processing zone located at km 12 along Mayo-Belwa-Ngurore road, Mayo-Belwa local Government. Mayo-belwa is in Adamawa State, North-East Geo-Political zone of Nigeria, with a latitude of 9°3'10.38''N and a longitude of 12°3'27.17''E [12].

Collection of Samples

A total of nine samples of Admiral yoghurt were collected immediately after packaging from Sebore farms, Mayo-belwa, Nigeria. A total of 27 samples of Fulani yoghurts were collected in sterile containers from vendors in Mbilla (n=9), Mayo-farang (n=9) and Binkola (n=9) districts of Mayo-belwa local government area of Adamawa State, Nigeria and transported immediately to the laboratory for analysis.

Determination of Moisture Content

The moisture content was determined by the oven method as described by the Association of Official Analytical Chemists (AOAC) [13]. Two grams of the sample were evaporated in a water bath to remove excess water and then dried in a hot air oven at 105 ^{0}C for three hours. The loss in weight was determined and recorded as the moisture content following the Equation 1:

$$\%\ \text{Moisture} = \frac{\text{weight of water in sample}}{\text{weight of sample}} \times 100 \qquad \text{Equation 1}$$

Determination of Total Ash

The ash content was determined by the direct heating method as described by AOAC [13]. Two grams of the sample were measured and evaporated in a water bath to remove excess water and then burnt to ash in a muffle furnace for three hours at 550 ^{0}C. It was then cooled in a desiccator, and the ash's weight was determined using Equation 2:

$$\%\ \text{Ash} = \frac{\text{weight of ash}}{\text{weight of sample}} \times 100 \qquad \text{Equation 2}$$

Determination of Crude Fat

The crude fat content was determined by the centrifugation method as described by AOAC [13]. Three grams of the sample were weighed and transferred to centrifuge tubes where chloroform and methanol were added in a ratio of 2:1. The mixture was shaken for 30 minutes and centrifuged for 20 minutes. The liquid layer was collected using a pipette and then evaporated and dried in an oven for 30 minutes to remove both

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chloroform and methanol, leaving the crude fat residue. Then it was reweighted, and the crude fat was determined using Equation 3 as follows:

$$\%\ \text{Crude fat} = \frac{\text{weight of the fat}}{\text{weight of sample}} \times 100 \qquad \text{Equation 3}$$

Determination of Crude Protein

The crude protein was determined by the titration method as described by AOAC [13]. Ten millilitres of the sample were transferred to a volumetric flask, three drops of phenolphthalein indicator were added and then 1 mL potassium oxalate. The sample was allowed to stand for 2 minutes, then neutralised with 0.1 mol/L NaOH solution to pink colour. Five millilitres of neutral formaldehyde were added and allowed to stand for 2 minutes. Then three drops of phenolphthalein indicator were added and then titrated against 0.1 mol/L NaOH to pink colour. Percentage crude protein was determined using the following Equation 4:

$$\%\ \text{Crude protein} = 1.7\ (\text{a} - \text{b}) \qquad \text{Equation 4}$$

$$\text{a} = \text{Average volume of NaOH used}, \text{b} = \text{blank}$$

Determination of Crude Fibre

The crude fibre was determined according to the method described by AOAC [13]. Three grams of the defatted sample were transferred to a 1 L conical flask where 200 mL of 0.2 N sulphuric acid was added, boiled for 30 minutes, and filtered under suction. The insoluble matter was washed with boiling water till acid-free, then 200 mL of 0.3 N NaOH was added, boiled again for 30 minutes, filtered, washed with boiling water followed by 95% ethanol, dried at 100 ^{0}C, then ashed in a muffle furnace at 550^{0}C for 3 hours, cooled and weighed. The ash weight was subtracted from the weight of the insoluble matter, and the difference was expressed as a crude fibre percentage of the original weight content, as shown in Equation 5:

$$\%\ \text{Crude fibre} = \frac{\text{weight of ashed sample}}{\text{weight of sample}} \times 100 \qquad \text{Equation 5}$$

Determination of Carbohydrate

The difference determined the total carbohydrate content. The sum of the percentage moisture, ash, crude protein and crude fibre was subtracted from 100 as described by Ihokoronye and Ngoddy [14], summarised in Equation 6:

$$\text{fibre Carbohydraterate} = 10\ \text{crude} - \%(\text{ash} + \text{fat} + \text{protein} + \text{crude fiber} + \text{moisture}) \qquad \text{Equation 6}$$

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Determination of the Calcium Content

Calcium content was determined by the complexometric titration method described by AOAC [13]. Five millilitres of the sample were pipetted into a conical flask. 40 mL of distilled water and 4 mL of 8 mol/L NaOH were added and allowed to stand for about 5 minutes with occasional swirling, with 0.1g of Patton-Reeder indicator. The sample was titrated with 0.025 mol/L EDTA solution to change from pink to blue. The average volume of EDTA solution used was calculated from the titre values, as EDTA moles were required to complex the Ca^{2+} ions in the sample. Using the method ratio Ca^{2+}: EDTA is equal to 1:1, the concentration in mol/L of Ca^{2+} in the sample solution was calculated.

Statistical Analysis

Data were expressed as mean ± standard error of triplicate determinations' mean (± SEM). Differences among the group means were assessed by one-way analysis of variance (ANOVA) followed by the Tukey multiple comparison test. Group means were considered to be significantly different at $P < 0.05$. Data were statistically evaluated using Statistical Package for the Social Sciences (SPSS) version 22 Software.

RESULTS AND DISCUSSION

Proximate Composition

The proximate composition of Admiral and Fulani yoghurts is shown in Table 1, revealing a significant difference ($P < 0.05$) between the proximate (except moisture) and calcium composition of Admiral and Fulani yoghurts. As shown in Table 1, moisture content revealed no significant difference ($p > 0.05$) between the yoghurt's moisture content. However, the moisture content of Admiral yoghurt (84.62 %) was slightly lesser than that of the Fulani yoghurts (FY1: 86.25%, FY2: 85.98 %, FY3: 87.12 %). The Fulani yoghurt from the Mayo-farang district (FY3) contains more moisture (87.12 %) compared to the other two Fulani yoghurts Mbilla (FY1) and Binkola (FY2) districts, with 86.25 % and 85.98 % respectively.

The moisture content of the Fulani yoghurts was above the value reported by Ezeonu *et al*. [15] (83.80 %), Adelekan and Saleh [16] (80.21 %) and Ihemeje *et al.*, [17] (84.67 %), but within the range reported by Mbaeyi-Nwaoha *et al.*, [18] (85.28–87.14 %) and Jimoh, [19] (82.87-87.02 %) for local yoghurt. The moisture content of Admiral yoghurt was below the values reported by Mohammed and Aliyu [20] (89.12-90.01 %), Igbabul *et al.*, [9] (78.62-82.41 %) for commercial yoghurts. The high moisture content of the Fulani yoghurt might be due to the reconstitution of the milk before fermentation.

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Table 1: Proximate and Calcium composition of Admiral yoghurt and Fulani yoghurts

Parameters	Admiral yoghurt	Fulani yoghurt		
	AY	FY1	FY2	FY3
Moisture (%)	84.62 ± 2.52	86.25 ± 2.43	85.98 ± 2.21	87.12 ± 2.22
Ash (%)	0.46 ± 0.02^{a}	0.68 ± 0.04^{b}	0.73 ± 0.042^{b}	0.71 ± 0.041^{b}
Crude fat (%)	6.97 ± 0.32^{a}	4.68 ± 0.26^{b}	4.98 ± 0.31^{b}	4.66 ± 0.32^{b}
Crude protein (%)	2.91 ± 0.33^{a}	4.88 ± 0.31^{b}	4.62 ± 0.26^{b}	3.81 ± 0.21^{c}
Crude fibre (%)	0.02 ± 0.002^{a}	0.03 ± 0.004^{b}	0.04 ± 0.003^{b}	0.03 ± 0.002^{c}
Carbohydrate (%)	2.49 ± 0.24^{a}	3.48 ± 0.16^{b}	3.69 ± 0.34^{b}	3.67 ± 0.31^{b}
Calcium (mg/mL)	2.65 ± 0.25^{a}	3.46 ± 0.20^{b}	3.56 ± 0.23^{b}	3.88 ± 0.23^{b}

Values are mean ± SEM in triplicate determinations. AY= Admiral Yogurt, FY1= Fulani Yogurt 1 (Mbilla), FY2= Fulani Yogurt 2 (Binkola), FY3 = Fulani Yogurt 3 (Mayo-farang). Values in the same row with different superscripts are significantly different ($P < 0.05$).

The findings revealed a significant difference ($P < 0.05$) between the ash content of Admiral yoghurt (0.46%) and the Fulani yoghurts (0.73-0.68 %). However, no significant difference ($P > 0.05$) was recorded between the ash content of all the Fulani yoghurts. But FY2 (Binkola) contains slightly more ash (0.73%) compared to FY3 (Mayo-farang) (0.71%) and FY1 (Mbilla) (0.68%). The ash content of Admiral Yogurt (0.46%) was above the values reported by Mohammed and Aliyu [20] (0.42-0.39 %), Mbaeyi-Nwaoha *et al.*, [18] (0.30 %), Igbabul *et al.*, [9] (1.02-0.41 %), Usman and Bolade [21] (0.45%), Ityotagher and Julius, [22] (0.19 %), but within the range reported by Matela *et al.*, [23] (0.28-0.95 %) for commercial yoghurt. Meanwhile, the value of the Fulani yoghurt (FY2) corresponded with the value reported by Ezeonu *et al.* [15] (0.73 %) but was above the value reported by Jimoh [19] (0.18 %) for local yoghurt. The higher ash content of the Fulani yoghurt might result from higher mineral content. Thus, our findings indicate that the Fulani yoghurt was a better source of minerals than Admiral yoghurt.

The result showed a significant difference ($P < 0.05$) between the crude fat content of Admiral yoghurt and the Fulani yoghurts. The crude fat of Admiral yoghurt (6.97 %) was higher than that of FY1 (4.68 %), FY2 (4.98 %) and FY3 (4.66 %). Although there was no significant difference ($P > 0.05$) between the crude fat contents of the Fulani yoghurts, FY2 contains slightly more crude fat (4.98 %) than FY1 (4.68 %) and FY3 (4.66 %). Our reported crude fat content for Admiral yoghurt was higher than previous reported values by Olorunnisomo *et al.*, [24] (2.21 %), Igbabul *et al.*, [9] (1.32- 3.25 %), Matela *et al.*, [23] (1.49-3.50 %) Ityotagher and Julius, [22] (1.02 %), Mohammed and Aliyu [20] (2.29-3.11 %), Mbaeyi-Nwaoha *et al.*, [18] (0.70 %) for commercial yoghurt. The crude fat content of Fulani yoghurts reported in our study was higher than the values reported by Ihemeje *et al.* [17] (1.8 %) for local yoghurt. Njarui *et al.* [25] reported that pastoral herds suffer inadequate feed supply and handling to support good quality milk production indicators of fat, protein, and solid contents. The lower fat content of Fulani yoghurts reported

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here might be due to the open grazing practices applied by the Fulani herders. Fat plays an important role in improving yoghurt's consistency, texture, appearance, flavour, and taste [7].

The Crude protein content of both Admiral and the Fulani yoghurts are shown in Table 1. There was a significant difference ($P < 0.05$) between the crude protein content of Admiral and the Fulani yoghurts. Admiral yoghurt had lower crude protein (2.91 %) than the Fulani yoghurts (3.81- 4.88 %). However, there was a significant difference ($P < 0.05$) between the crude protein content of the Fulani yoghurts, FY3 (3.68 %) content was significantly lower (0.05) than FY1 (4.88 %) and FY3 (4.63 %) contents. The protein content of Admiral yoghurt was lower than values reported by Igbabul *et al*., [9] (4.02-6.14 %), Mohammed and Aliyu [20] (3.10-3.44 %), Ityotagher and Julius, [22] (2.98 %) but higher than the range reported by Matela *et al.*, [23] (1.95-2.70 %), and Igbabul *et al*., [9] (4.02-6.14 %) for commercial yoghurt. Meanwhile, the Fulani yoghurt's crude protein content was higher than values reported by Jimoh [19] (3.76 %), Usman and Bolade [21] (3.1 %) but lower than those reported by Ihemeje *et al.*, [17] (9.97 %), and Ezeonu *et al.*, [15] (7.41 %) for local yoghurt. O'Callaghan *et al*. [26] reported that feeding a perennial pasture resulted in higher concentrations of fat, protein, true protein, casein, and whey than milk from cows fed with formulated feed. The higher protein content of Fulani yoghurt might be due to the pastoral practice by the herders.

The crude fibre content of the Yoghurt samples differs, as shown in Table 1. Admiral yoghurt had less ($p < 0.05$) crude fibre (0.02%) as compared to the Fulani yoghurts (0.04-0.03%). There was a significant difference ($p < 0.05$) between the crude fibre contents of the Fulani yoghurts, which FY2 (0.04 %) being higher than FY1 (0.03 %) and FY3 (0.03 %). The crude fibre content of Fulani yoghurt was higher than the value reported by Jimoh [19] at (0.02 %) but lower than the values reported by Mbaeyi-Nwaoha *et al.* [18] (1.31 %) and Usman and Bolade [21] (0.36%) for local yoghurt. The fibre content of Admiral yoghurt was within the range reported by Matela *et al.*, [23] (0.01-0.07 %) and lower than the value reported by Igbabul *et al*., [9] (0.21-0.51 %) for commercial yoghurt. The low crude fibre contents reported in this study might be due to the lower carbohydrate contents of the yoghurts compared to the other studies.

The findings revealed a significant difference ($P < 0.05$) between the carbohydrate contents of Admiral and the Fulani yoghurts. However, there was no significant difference ($P > 0.05$) between the carbohydrate contents of the Fulani yoghurts, though FY2 (3.69 %) contains a slightly higher amount of carbohydrate than FY1 (3.48 %) and FY3 (3.67 %). The carbohydrate content of the Fulani Yogurt was lower than values reported by Jimoh [20] (5.90 %), Adelekan and Saleh [16] (10.42 %), Usman and Bolade [21] (4.79 %), but within the range reported by Ezeonu *et al.*, [15] (3.38 %) for local yoghurt. Meanwhile, the carbohydrate content of Admiral Yogurt (2.49 %) was lower than the value reported by Igbabul *et al*. [9] (9.38-12.85 %) for commercial yoghurt.

Calcium Content

Calcium content in mg/ml of the yoghurt samples has been shown in Table 1. Admiral yoghurt had significantly less ($P < 0.05$) calcium (2.65 mg/mL) than the Fulani yoghurt Local (3.46-3.88 mg/mL). Although there was no significant difference ($P < 0.05$) in the calcium content between the Fulani yoghurts, it has been noted that FY3 contains slightly more (3.88 mg/mL) calcium than FY2 (3.56 mg/mL) and FY1 (3.46 mg/mL). The Fulani yoghurts' calcium composition content reported here was lower than the value

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reported by Ezeonu *et al.* [15] but higher than the values reported by Mbaeyi-Nwaoha *et al.* [18] and Usman and Bolade [21] at 2.81 mg/mL, 2.95 mg/mL, respectively for local yoghurt. Admiral yoghurt is an industrially processed yoghurt. Thus, its lower calcium content might be due to a mineral loss during processing, as revealed in its ash content.

CONCLUSION

This research showed that both Admiral and the local Fulani yoghurts contain a significant proximate and calcium composition. Nutritionally, both yoghurt samples met the dietary requirements of pure yoghurt. However, Admiral Yogurt has a significantly higher crude fat percentage than the Fulani yoghurts. Meanwhile, the Fulani yoghurts were significantly higher in crude protein, crude fibre, carbohydrate and Ash content, which indicate higher mineral content.

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AUTHOR’S CONTRIBUTION

Muhammad Mubarak Dahiru and Neksumi Musa carried out the research and wrote the article. Mohammed Bobbo Hamid had conceptualised the central research idea and provided the theoretical framework.

CONFLICT OF INTEREST STATEMENT

The authors declare no conflict of interest.

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