Milk composition of three breeds of cattle under extensive management as influenced by parity

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Abstract

This study sought to evaluate the influence of parity on milk composition of Sokoto Gudali, White Fulani and Red Bororo breeds of cattle. A total of 270 cows, 90 per breed, replicated into three parities of 30 cows each, were used for milk proximate and mineral composition evaluation. Proximate components evaluated were crude protein, fat, ash and moisture contents while minerals included calcium, phosphorus, potassium, iron and sodium. Data obtained were subjected to analysis of variance and discriminant function analysis and where significant differences occurred, means were separated using Duncan's Multiple Range Test. Results revealed that breed significantly influenced milk components in the first parity, White Fulani being significantly higher in protein (4.52 %) and moisture (84.56 %) while Red Bororo was significantly higher in phosphorus (375.62 mg/L) and sodium (71.22 mg/L). Sokoto Gudali milk was however highest in fat content (3.18 %). In the second parity, Sokoto Gudali milk was significantly higher in moisture, calcium (614.94 mg/L) and sodium (68.76 mg/L) contents than the other breeds. In the third parity, Sokoto Gudali milk was not significantly different from Red Bororo milk in fat and protein content, but they were significantly higher than the white Fulani milk in these components. The pooled effect of parity on milk composition in the three breeds of cows exhibited significant differences among the parities. Crude Protein values ranged from 3.64% (parity 3) to 4.11% (parity 1) being highest in the first parity and thereafter declined in the second and third parity. Breed and parity of the cows significantly influenced proximate and mineral components of milk samples. Proximate components such as crude protein, fat and ash, as well as calcium and mineral contents of the milk samples increased with the number of parities, third parity cow milk samples having highest values, followed by second and lastly first parity. Red Bororo and White Fulani cow milk samples harvested at the third parity could be processed for supplemental human infant feeding because of the high calcium content. The differences in milk composition based on parity provide scientific evidence for proper milk collection on the basis of milk properties.

Keywords: Nutrition, milk, cattle, composition, parity

Introduction

Milk is an important source of lipids, proteins, vitamins, and minerals in many human diets. The mammary gland is the specialized secretory organ that provides essential nourishment to mammalian young in the form of milk. Milk is composed of water, fat, protein, lactose and minerals (Ash). The variation in milks and milk yield within species depends on many factors (Ozrenk and Selcuk, 2008; Matei *et al.*, 2010). Some of these factors are genotype, stage of lactation, daily variations, parity, diet, age, udder health and season (Haenlein, 2003; Ebegbulem and Nwanjoku, 2021). Genetic factors can influence milk composition, and its genetic variation has been reported in previous studies (Soyeurt *et al.*, 2006; Schennink *et al.*, 2007). Furthermore, research has shown that nutrition affects mammary lipogenic gene expression (Bernard *et al.*, 2008; Mach *et al.*, 2011).

Among milk components, proteins are the most important constituents of the human diet contributing significant nutritional, biological, and functional properties (Rafiq *et al.*, 2016). Milk products could serve as alternative sources of essential and non-essential amino acid as a way of improving protein nutrition (Haug *et al.*, 2007; Barłowska *et al.*, 2011).

Cow milk is the standard and commercially acceptable milk. Milk production from indigenous breeds of cattle in Nigeria represents an important component of the agribusiness sector of the smallholder economy with great economic, nutritional, and social implications (Haug *et al.*, 2007; Oladapo and Ogunekun, 2015). Local breeds of cattle are the primary sources of milk, providing more than 90% of the total animal domestic milk output (Oladapo and Ogunekun, 2015) with the white Fulani or 'Bunaji' breed recognized as the principal producer (Alphonsus *et al.*, 2012; Adesina, 2012).

There are two factors that influence milk composition. External factors such as season, feeding system, and milking frequency and internal factors such as gene, parity, and stage of lactation (Cao *et al.*, 2010). For external factors, higher percentages of milk fat and protein are found in the evening milking (Quist *et al.*, 2008), but the seasonal variation has more significant effect on the milk composition than the milking time. Among internal factors, genes have a major effect on milk composition, but it is difficult to change milk production through gene manipulation. Some studies have focused on the effect of season variation and stage of lactation on milk composition (Auldist *et al.*, 1998). As an internal factor, parity also has correlated with milk composition (Cao *et al.*, 2010). The aim of this study was to investigate the Influence of Parity on milk composition in Sokoto Gudali, White Fulani and Red Bororo breeds of Cattle under Extensive Management.

Materials and Methods

The experiment was conducted in Maiduguri and its environs. Maiduguri is the capital of Bornu State, North Eastern Nigeria.

Management of experimental animals

The animals were raised under extensive management system, with little or no provision for shelter in the day and night. The animals were allowed to graze on natural pasture containing forages such as Northern gamba grass *(Andropogon gayanus)*, Stylo (*Stylosanthes gracilis*) and Leucaena (*Leucaena leucocephala*) during the day time. Occasionally, supplements such as groundnut haulm, beans shell, cereal offal and crop residues were sometimes provided after grazing of natural pastures especially during feed scarcity (April to May) and mineral blocks.

Experimental animals and study samples

A total of 270 cows, 90 each of Sokoto Gudali, White Fulani and Red Bororo were used for the study. The 90 animals of each breed were further replicated based on parities (first, second and third) and used for milk proximate and mineral composition assay. First parity cows were those that it was their first time of birthing and nursing calves, second parity were those on their second consecutive parturition and lactation while third parity were cows on their third consecutive parturition and lactation season.

Milk collection

Milk samples of the experimental animals was collected three times (third week of each month) in the season in 50mL falcon tubes from the experimental animals and taken to the Nutrition Biochemistry Laboratory of the Department of Animal Production, Adamawa State University, Mubi, Nigeria for proximate composition and mineral content analysis. The milk was analyzed for crude protein, fat and mineral contents while protein and fat yields were determined by multiplying the respective contents with the milk yield as described by Bradely *et al.* (1992). For minerals analysis, the milk solid content was taken and digested using two volumes of concentrated nitric acid. After adding one volume of perchloric acid, the content was heated gently on a hot plate followed by a vigorous heating till dryness (proximately 1-2ml)). This digestion technique makes no attempt to dissolve any silicate-base materials that may be present in the sample. After cooling, the digested samples were quantitatively transferred to a flask and diluted to 100ml with de -ionized double distilled water and then filtered. Minerals (Ca, P, K and Fe,) were estimated using an Atomic Absorption Spectrophotometer.

Statistical model

The statistical model for the experiment is as given below;

$Y_{ijk} = \mu + B_i + P_j + e_{ijk}$

Where:

Y_{ijk} = observed ijth component value of the Milk

μ= the overall mean

B_i = the fixed effect of the $_i{}^{th}$ breeds (i= Sokoto Gudali, White Fulani and Red Bororo)

Pj = the fixed effect of the $_i{}^{th}$ parity (j=1, 2 and 3)

e_{ijk} =the random residual error.

Statistical analysis

The data obtained on milk yield and composition were subjected to analysis of variance (ANOVA) using General Linear Model of (SAS) (2002) while means with significant differences were separated using Duncan's Multiple Range Test (Duncan, 1955). The degrees of relationship between all pairs of variables were computed for all the animals within each breed groups and as a pool using CORR procedure of the SAS (2002) statistical package.

Results and discussion

The effect of first parity on milk and mineral composition of White Fulani, Red Bororo and Sokoto Gudali cows are presented in Table 1. The results revealed significant ($p<0.05$) differences in protein, fat, moisture, phosphorus and sodium of the three breeds of cows in their first parity. White Fulani cow was superior in protein (4.52 %) and moisture (84.56 %). Red Bororo cow was superior in phosphorus (375.62 mg/L) and sodium (71.22 mg/L). Sokoto Gudali cow was superior in only fat (3.18 %). The protein values among the three breeds in first parity in this study ranged from 3.91 to 4.52 % which was within the ranged value of 3.72±0.05 % and 4.01±0.11% for local cows in Sudan and crossed between Sudan local cow and Holstein Friesian in their first parity (Shuiep *et al.*, 2016). The value obtained for protein in this study was higher than 3.51±0.01 % for Murrah Buffaloes in first parity (Yadav *et al.*, 2013) and also higher than 3.24±0.37% for Holstein Friesian in first parity (Bondad *et al.*, 2018). Values reported by Ebegbulem and Nwanjoku (2021) in their study using West African Dwarf goats in Cross River State, Nigeria fall within the range obtained in the present study. The variations in milk protein obtained in this study could also be attributed to genetic factors. Kucerova *et al.* (2006) reported high associations between genetic polymorphism in milk protein genes and milk quantitative and qualitative traits. The fat values obtained in this study ranged from 2.76 to 3.18 % which were lower than the values of 3.77±0.32 % and 5.16±0.32 % for Sudan and crossed between Sudan local cow and Holstein Friesian in their first parities (Shuiep *et al.*, 2016). The fat values obtained in this study were also lower than the value of 7.35±0.07 % for Murrah Buffaloes in first parity (Yadav *et al.*, 2013). The values obtained for fat in this study was also lower than the value of 3.47±0.67 % for Holstein Friesian in first parity (Bondad *et al.*, 2018). The variations in milk compositions of the breeds in the present study and previous authors' reports could be attributed to breed/ genetic differences, nutrition and management systems. The same quantity of fat that is dictated by breed genetic makeup potential when secreted in different amounts of milk, different concentrations was expected to occur (Pratap *et al.*, 2014). High milk fat is a typical characteristic of Zebu cattle as they produce more milk fat compared to temperate cows (Barbosa *et al.*, 2008). This phenomenon indicates that milk fat as quantitative trait is genetically influenced by set of genetic factors (Shuiep *et al.*, 2016). The variations in moisture, phosphorus and sodium could be attributed to differences in genetic makeup.

Table 2 shows the result of effect of second parity on proximate and mineral composition of milk of White Fulani, Red Bororo and Sokoto Gudali cows. The results showed significant ($P<0.05$) differences in moisture, calcium and sodium. White Fulani and Red Bororo cows were higher in moisture 83.75% and 83.43% respectively. Sokoto Gudali milk contained significantly higher calcium and sodium 614.94 mg/L and 68.76mg/L respectively. In previous research, Nantapo and Muchenje (2013) reported that genotypes had a significant effect on some milk mineral compositions, including magnesium, phosphorus, and calcium, with crossbreed (Jersey × Friesian) having higher composition of minerals, even though the animals grazed on the same pasture. The authors attributed the reason for the higher milk mineral compositions in the crossbreed compared to Jersey and Friesian cows were due to heterosis. This report disagreed with the report of Idamokoro *et al.* (2017) who studied mineral composition of goat, that there was no genotypic effect on the milk minerals. The mineral compositions in milk play a vital part in the structural organization of other components, such as the casein micelles, protein, as well as maintaining some physiological functions of livestock during lactation. These minerals include, among others, sodium (Na), magnesium (Mg), calcium (Ca), potassium (K), and iron (Fe) (Idamokoro *et al.*, 2017). The significant differences in mineral composition of milk in second parity could be a sign that growth and development have reached maximum therefore, the mineral used for growth and development was released in milk composition.

Effect of third parity on proximate and mineral composition of milk of White Fulani, Red Bororo and Sokoto Gudali cows is presented in Table 3. The results revealed significant ($p<0.05$) differences in protein, fat, calcium and sodium. White Fulani cow were significantly higher in protein (4.16%), calcium (611.48 mg/L) and sodium (75.33 mg/L) while Red Bororo had higher fat (3.75%) and also calcium (626.99 mg/L) content. Sokoto Gudali was also superior in fat (3.15%) and sodium (75.36 mg/L). The milk crude protein values from this study ranged from 3.01% to 4.16%. Shuiep *et al.* (2016) reported milk protein values of 3.84±0.12% and 3.16±0.04% for Sudan local cows and crossed between local and Holstein Friesian cows in third parity which falls within the ranged values of milk protein reported in this study. Yadav *et al.* (2013) reported a milk protein value of 3.48±0.01% for Murrah Buffaloes in third parity which also falls within the range of values (2.96 to 3.75 %) of milk protein obtained in this study. Shuiep *et al.* (2016) reported high milk fat value of 5.14±0.34% for local Sudan cow and 3.72±0.26% milk fat for cross between local and Holstein Friesian cows in third parity which falls within the range (2.96 – 3.75%) obtained in third parity in this study. Yadav *et al.* (2013) reported a milk fat of 7.60% for Murrah Buffaloes in third parity which is higher than the range obtained in this study. Differences in genetic makeup have significant role on milk production quality and quantity. Shuiep *et al.* (2016) remarked that although no single variable or a combination of variables could be used for prediction of milk composition, nevertheless, the influence of genes on milk constituents could not be neglected. The levels of variations in milk constituents within the three breeds of cows used in this study could serve as phenotypic indices to establish phenotype - genotype interactions for future technological interventions as genomic selection for sustainable cattle breeding.

Table 4 shows the pooled effect of parity on milk composition in three breeds of cows. Crude protein, fat, ash, calcium and sodium showed significant ($p<0.05$) differences among the parities. The crude protein values obtained from this research ranged from 3.64% (parity 3) to 4.11% (parity 1). Crude Protein was highest in the first parity and thereafter declined in the second and third parities. This finding agreed with the report of Shuiep *et al.* (2016) who reported that stage of lactation and parity have significant ($P<0.01$) influence on milk protein, with significant ($p<0.05$) higher milk protein content in early and mid-lactation and parity. The authors further stated that parity had significant ($p<0.01$) influence on milk protein among local and crossbred cows except after parity number four. The results from this study are in line with Auldist *et al.* (1998) who reported higher milk protein values in the late stage of lactation under natural pasture. The fat, calcium and sodium obtained in this study ranged from 2.97% (parity 1) to 3.29% (parity 3), 566.56mg/L (parity 1) to 599.58mg/L (parity 3) and 57.04mg/L (parity 1) to 71.77mg/L (parity 3) respectively. The milk fat values obtained from this research was lower than 4.29±0.11% (parity 2) to 4.59±32% (parity 4) for Holstein Friesian crosses in central highlands of Ethiopia (Shibru *et al.*, 2019). The authors further stated that an increase in milk yield and fat in cows could be due to increasing age which might partially be attributed to higher body weight, as well as increased development of the udder during recurring pregnancies which results in larger mass of digestive system and mammary glands for synthesis of milk. The increase of calcium from parity 1 to parity 3 could be as a result of increase in age and lactation which lead to high calcium demand for milk production as corroborated by Tesfaye (2019).

Breed and parity of the cows significantly ($p<0.05$) influenced proximate and mineral components of milk samples. Proximate components such as crude protein, fat and ash, as well as calcium and mineral contents of the milk samples increased with the number of parities, third parity cow milk samples having highest values, followed by second and lastly first parity. Red Bororo and White Fulani cow milk samples harvested at the third parity could be processed for supplemental human infant feeding because of the high calcium content.

The differences in milk composition based on parity provide scientific evidence for proper milk collection on the basis of milk properties.

References

Adesina, K. (2012). Effect of Breed on the Composition of Cow Milk under Traditional Management Practices in Ado-Ekiti, Nigeria. *Journal of Applied Science and Environmental Manag*ement, 16 (1): 55 – 59.

Alphonsus, C., Akpa, G. N., Barje, P. P., Finangwai, H. I. & Adamu, B. D. (2012). Comparative evaluation of linear udder and body conformation traits of Bunaji and Friesian x Bunaji cows. *World J. Life Sci. & Med. Research,* 2 (4): 134 - 140.

Auldist, M. J., Walsh, B. J. & Thomson, N. A. (1998). Seasonal and lactation influences on bovine milk composition in New Zealand. *Journal of Dairy Resources,* 65:401–411.

Barbosa, S.P., Ramalho, R.P., Monardes, H.G., Dias, F.M., dos Santos, D.C. & Batista, A.V. (2008). Milk and fat production of crossbred Holstein-Gir cows (*Bos Taurus taurus-Bos taurus indicus*) in the Agreste region of the Brazilian State of Pernambuco. *Genetics and Molecular Biology,* 31(2): 468-474

Barłowska, J., Szwajkowska, M., Litwi´nczuk, Z. & Kr´ol, J. (2011). Nutritional Value and Technological Suitability of Milk from Various Animal Species Used for Dairy Production. *Comprehensive Review on Food Science and Food Safety,* 10: 291- 302

Bernard, L., Leroux, C. & Chilliard, Y. (2008). Expression and nutritional regulation of lipogenic genes in the ruminant lactating mammary gland. *Advanced Experiment of Medicinal Biology,* 606:67-108.

Bondad, C., Folchini, J. A., Noro, M., Quadros, D. L., Machado, K. M. & Gonzalez, F. H. D. (2018). Milk composition of Holstein cows: a retrospective study. *Ciencia Rural,* 48(12):88-100.

Bradely, R. L. Jr., Arnold, E. Jr., Barbano, D. M., Semerad, R. G., Smith, D. E. & Vines, B. K. (1992). Chemical and physical methods in: Standard methods for the examination of dairy products, Marshall, R.T. (Ed). 16 Edition, American publication health association, USA, 433-529.

Cao, Z., Huang, W., Wang, T., Wang, Y., Wen, W., Ma, M. & Li, S. (2010). Effects of parity, days in milk, milk production and milk compositions on milk urea nitrogen in Chinese Holstein. *Journal of Animal and Veterinary Advances,* 9:688–695.

Duncan, D. B. (1955). Multiple range and multiple F-test. *Biometrics,* 11: 1 – 14.

Ebegbulem, V. N. & Nwanjoku, J. E. (2021). Composition and physicochemical characteristics of milk of West African Dwarf goats in Cross River, Nigeria. *Annual Research and Review in Biology,* 36 (7): 92-96.

Haenlein, G. (2003). Nutritional value of dairy production of ewe and goat milk, Retrieved January 28-2019. http://ag.edu/extension/information/goatmgt/gn-10.htm.

Haug, A., Høstmark, A. T. & Harstad, O. M. (2007). Bovine milk in human nutrition – a review. *Lipid in Health and Disease,* 6(25): 1-16.

Idamokoro, E. M., Muchenje, V. & Masika, P. J. (2017). Yield and Milk Composition at Different Stages of Lactation from a Small Herd of Nguni, Boer, and Non-Descript Goats Raised in an Extensive Production System. *Sustainability,* 9(1000):2-13.

Kucerova, J., Matějíček, A., Jandurová, O. M., Sørensen, P., Němcová, E., Štípková, M., Kott, T., Bouška, J. & Frelich, J. (2006). Milk protein genes CSN1S1, CSN2, CSN3, LGB and their relation to genetic values of milk production parameters in Czech Fleckvieh. *Czech Journal of Animal Science,* 51(6): 241- 247.

Mach, N., Jacobs, A. A. A. Kruijt, L., Van Baal, J. & Smits, M. A. (2011). Alteration of gene expression in mammary gland tissue of dairy cows in response to dietary unsaturated fatty acids. *Animal,* 5(8):1217–1230.

Matei, S. T., Groza, I. Andrei, S. Bogdan, L. Ciupe, S. & Petrean, A. (2010). Serum metabolic parameters in Healthy and Sub chemical mastitis cows. Bulletin UASVM, *Veterinary Medicine,* 67(1):110-114.

Nantapo, C. T. W. & Muchenje, V. (2013). Winter and spring variation in daily milk yield and mineral composition of Jersey, Friesian cows and their crosses under a pasture-based dairy system. *South African Journal of Animal Science,* 43 (5): 17–21.

Oladapo, A. F. & Ogunekun, T. O. (2015). Quality Assessment of Fresh Milk from Traditionally Managed Nigerian Bunaji and Bokolooji Breeds of Cattle. *The Pacific Journal of Science NNLRS & Technology,* 16(1): 280 -285.

Ozrenk, E. & Selcuk, I. S. (2008). Effect of seasonal variation on the composition of cow milk in Van Province. *Pakistan. Journal of Nutrition,* 7: 161-164.

Pratap, A., Verma, D. K., Kumar, P. & Singh, A. (2014). Effect of pregnancy, lactation stage, parity and age on yield and components of raw milk in Holstein Friesian cows in organized dairy farm in Allahabad. *IOSR Journal of Agriculture and Veterinary Science,* 7(2): 112- 115.

Quist, M. A., LeBlanc, S. J., Hand, K. J., Lazenby, D., Miglior, F. & Kelton, D. F. (2008). Milking-to-milking variability for milk yield, fat and protein percentage, and somatic cell count. *Journal of Dairy Science,* 91:3412–3423.

Rafiq, S., Huma, N. & Pasha, I. (2016). Chemical Composition, Nitrogen Fractions and Amino Acids Profile of Milk from Different Animal Species. *Asian-Australian Journal of Animal Science,* 29(7):1022–1028.

SAS, (2002). Statistical Analysis System User Guide. SAS/STAT version 9.0 for windows. SAS institute Inc., Inc Cary, North Carolina, USA.

Schennink, A., Stoop, W. M., Visker, M. H. P. W., Heck, J. M. L., Bovenhuis, H., Van Der Poel, J-J., Van Valenberg, H. J. F. & Van Arendonk, J. A. M. (2007). DGAT1 underlies large genetic variation in milk-fat composition of dairy cows. *Animal Genetics,* 38:467–473.

Shibru, D., Tamir, B., kasa, F. & Goshu, G. (2019). Effect of season, parity, exotic gene level and lactation stage on milk yield and composition of Holstein Friesian crosses in central highlands of Ethiopia. *European Journal of Experimental Biology,* 9:4-15.

Shuiep, E. S., Eltaher, H. A. & El Zubeir, I. E. M. (2016). Effect of Stage of Lactation and order of Parity on Milk Composition and Daily Milk Yield among Local and Crossbred Cows in South Darfur State, Sudan. *SUST Journal of Agricultural and Veterinary Sciences,* 17(2):1 -14.

Table 1: Effect of first Parity on chemical composition of the milk of White Fulani, Red Bororo and Sokoto Gudali cows

Parameters	White Fulani	Red Bororo	Sokoto Gudali	SEM	p-Value
Crude protein (%)	4.52^{a}	3.97^{b}	3.91^{b}	0.12	0.07
Fat (%)	2.76^{b}	2.89^{b}	3.18^{a}	0.05	0.00
Ash (%)	0.35	0.35	0.36	0.05	0.00
Moisture (%)	84.56^{a}	81.13^{b}	81.72^{b}	0.16	0.11
Calcium (mg/L)	571.06	585.05	549.33	0.47	0.42
Iron (mg/L)	1.03	1.01	1.02	0.05	0.00
Phosphorus(mg/L)	282.52^{c}	375.62^{a}	326.86^{b}	0.58	0.53
Sodium(mg/L)	49.62^{c}	71.22^{a}	51.91^{b}	0.12	0.07

^{abc}Means within the same row with different superscripts are significantly different ($p < 0.05$), mg/L=milligram per litre, % = percent, SEM = standard error of mean

Table 2: Effect of second parity on chemical composition of the milk of White Fulani, Red Bororo and Sokoto Gudali cows

Parameters	White Fulani	Red Bororo	Sokoto Gudali	SEM	p-Value
Crude protein (%)	3.93	3.64	3.55	0.05	0.00
Fat (%)	3.07	3.23	3.09	0.05	0.00
Ash (%)	0.37	0.35	0.37	0.08	0.03
Moisture (%)	83.75[a]	83.43[a]	81.21[b]	0.06	0.01
Calcium(mg/L)	560.50[b]	555.42[b]	614.94[a]	0.40	0.35
Iron(mg/L)	1.08	0.99	1.15	0.17	0.12
Phosphorus(mg/L)	361.54	310.01	314.25	0.10	0.05
Sodium(mg/L)	61.25[c]	62.68[b]	68.76[a]	0.15	0.10

[abc]Means within the same row with different superscripts are significantly different ($p < 0.05$), mg/L=milligram per litre,
% = percent, SEM = standard error of mean

Soyeurt, H., Dardenne, P., Dehareng, F., Lognay, G., Veselko, D., Marlier, M., Bertozzi, C., Mayeres, P. & Gengler, N. (2006). Estimating fatty acid content in cow milk using mid-infrared spectrometry. *Journal of Dairy Science,* 89:3690–3695.

Tesfaye, A. (2019). Calcium requirement in relation to milk fever for high yielding cows: E review. Journal homepage. *Journal of Faculty of Food Engineering,* 18(1): 27- 35.

Yadav, S. P., Sikka, P., Kumar, D., Sarkar, S., Pandey, A. K., Yadav, P. S. & Sethi, R. K. (2013). Variation in milk constituents during different parity and seasons in Murrah buffaloes. *Indian Journal of Animal Sciences,* 83 (7): 747–751.

Table 3: Effect of third parity on chemical composition of the milk of White Fulani, Red Bororo and Sokoto Gudali cows

Parameters	White Fulani	Red Bororo	Sokoto Gudali	SEM	p-Value
Crude protein (%)	4.16[a]	3.01[b]	3.78[b]	0.06	0.01
Fat (%)	2.96[b]	3.75[a]	3.15[a]	0.00	0.00
Ash (%)	0.46	0.40	0.43	0.08	0.03
Moisture (%)	85.25	84.00	82.08	0.28	0.23
Calcium(mg/L)	611.48[a]	626.99[a]	560.26[b]	0.42	0.37
Iron(mg/L)	1.23	0.84	1.23	0.00	0.00
Phosphorus(mg/L)	325.76	350.92	323.21	0.08	0.03
Sodium(mg/L)	75.33[a]	64.62[b]	75.36[a]	0.12	0.07

[abc]Means within the same row with different superscripts are significantly different ($p < 0.05$), mg/L=milligram per litre,
% = percent, SEM = standard error of mean

Table 4: Pooled effect of parity on milk composition of Sokoto Gudali, Red Bororo and White Fulani cows

Parameter	First Parity	Second Parity	Third Parity	SEM	p-value
Crude protein (%)	4.11 [a]	3.73 [b]	3.64 [b]	0.07	0.02
Fat (%)	2.97 [b]	3.14 [ab]	3.29 [a]	0.08	0.03
Ash (%)	0.35 [b]	0.36 [b]	0.43 [a]	0.01	0.00
Moisture (%)	82.40	82.99	83.78	0.28	0.11
Ca (mg/L)	566.56 [b]	572.20 [ab]	599.58 [a]	6.00	0.04
Fe (mg/L)	1.02	1.05	1.10	0.02	0.40
P (mg/L)	328.18	330.40	339.07	5.82	0.73
Na (mg/L)	57.04 [b]	63.66 [b]	71.77 [a]	10.03	0.02

[abc] Means in the same row with different superscripts are significantly different ($P<0.05$),
SEM=standard error of mean. Ca=calcium, Fe=Iron, P=Phosphorus, Na=sodium, mg/L=milligram per litre