FUDMA Journal of Agriculture and Agricultural Technology
ISSN: 2504-9496
Vol. 9 No. 3, September 2023: Pp. 99-104

https://doi.org/10.33003/jaat.2023.0903.15

COMPARATIVE ANALYSES OF THE PHYSICOCHEMICAL PARAMETERS OF MILK OF LACTATING COWS FROM UNGUWAR FULANI SOKOTO, NIGERIA

***[1]Abubakar, Y., [2]Jibril, A.H., [3]Usman, M.D., and [4]Bashir, M.D**
[1]Department of Veterinary Public Health and Preventive Medicine,
Federal University of Agriculture Zuru, Kebbi Nigeria
Orcid no.: 0009-0009-7187-2248/Email: yusuf.abubakar.sadiya@gmail.com
[2]Department of Veterinary Public Health and Preventive Medicine,
Usmanu Danfodiyo University, Sokoto Nigeria
Orcid no.: 0000-0003-4721-5642/Email: jibril.h assan@udusok.edu.ng
[3]Department of Veterinary Medicine, Bayero University, Kano Nigeria
[4]Veterinary teaching hospital, Bayero University, Kano
Orcid no.: 0000-0002-9200-2155/Email: mdusman.vmed@buk.edu.ng
*Correspondence: yusuf.abubakar.sadiya@gmail.com; +2348139278892

ABSTRACT

This study aimed to compare the milk composition of white Fulani (WF) and Sokoto Gudali (SG) indigenous breeds of cows raised in Unguwar Fulani of Sokoto, Nigeria. Twenty Primiparous and Multiparous lactating cows were raised under two different managements and feeding systems. Ten cows were raised under the indoor traditional system (ITM), while ten lactating cows were raised by Fulani nomadic system (FNS) with access to feed and water *ad libitum.* Fresh early morning milk was collected by hand milking from each group daily from November to December, 2016. There was no statistically significant difference between WF and SG in the macro-elements (Na, K, Ca, Fe, Mg, Mn, Zn and Cu) as measured by Atomic absorption spectrophotometer. Milk from cows raised under ITM showed statistically significant differences ($p < 0.05$) in milk moisture content (MMC), milk total solid content (MTC), milk protein content (MPC) and milk lipid content (MLC). Even though there was an obvious variation in the chemical parameters between the parity of the cow and the gender of the calves, this difference is not statistically significant. The analysis of the physicochemical components of the indigenous breeds (WF and SG) of lactating cows showed the importance and influence of the feeding system on milk quality.

Key words: Milk, Physicochemical parameters, Sokoto gudali, White fulani

INTRODUCTION

Products from food animals provide over 33 per cent of protein consumed in human diets globally and about 16 per cent of food energy supply (FAO, 2001). Undoubtedly, the quality of animal products consumed by humans determine the quality of their nutrition, this in turn is considerably affected by the nature of the raw materials consume by the animal (Avery, 1998). Globally, outdoor grazing is the most commonly used method feeding for dairy cows. This is usually supplemented with a small quantity of concentrate at the extremes of pasture-growing season (Gulati *et al*., 2017). Other feeding methods less popularly practised by farmers across the globe include the traditional in-door system where cows are fed with wheat bran, bean husk and mixed grass (Charlton *et al.*, 2011). The major advantage of this feeding system is the protection it offers to the cows against extreme environmental conditions such as heat, cold, and wetness (Legrand *et al*., 2009). It, however predisposes cows to a lot of animal welfare issues such as increased lameness, reduced comfort and mastitis, all of which can dramatically affect animal production (Haskell *et al*., 2006; Fregonesi *et al.*, 2007).

In Nigeria, Livestock contributes about 12.7% of the agricultural GDP (CBN 1999), with cattle (cow) providing more than 90% of the total animal milk output (Walshe *et al*., 1991). According to the livestock resource survey carried out by the Federal Department of Livestock and Pest Control Services in 1990, the cattle population of Nigeria was 13.9 million (RIM, 1990). Of these, 13.5 million (96%) are in the hands of the pastoral Fulani, which produce the bulk of the milk consumed in the rural and urban areas. In sub-Saharan Africa including northern Nigeria, white Fulani and Sokoto Gudali are the two major breeds of cattle managed for milk production. Whereas the Fulani breeds are predominantly raised and managed by a nomadic pastoral system, Sokoto Gudali are more commonly managed by a traditional in door system (Jimoh *et al*., 2017).

Several factors may dramatically affect the composition of milk in cattle. Of these factors, breeds of cattle certainly take the leading role. Hurley (1997) & Belewu (2006) have reported a great deal of variation in fat content among some foreign cattle breeds. Similarly, Adesina (2012) reported extensive variation in milk fat among indigenous Red Bororo and Muturu breeds of cattle raised in south-western, Nigeria. To date, however, there is a dearth of information on the milk composition of Sokoto Gudali and white Fulani breeds of cattle raised in Sudan savannah region of Nigeria. Therefore, in the present study, we investigated the effect of the management system, parity, breeds and sex of calves on the chemical parameters of lactating white Fulani and Sokoto Gudali breeds of cows.

MATERIALS AND METHODS

Animal breeds and experimental site

Two breeds of cattle, namely White Fulani and Sokoto Gudali, were used in this study. Both breeds were sourced from either nomadic Fulani herd that temporarily settled at the Unguwar Fulani area at Arkilla, Sokoto or a private farm located within the Sokoto metropolis in Sokoto state. Sokoto State is located between latitudes 12ºN and 13º58N and longitude 4º8 E and 6º 54 E in the north-western part of Nigeria. It is situated in the Sudan savannah vegetation belt and shares boundaries with Niger and Benin Republic. Agriculture, especially livestock, engaged most of the inhabitants of the state (Obi & Iwuoha, 2023). The state witnesses three major seasons from January to December, namely: the cold-dry (harmattan; CDS), hot-dry (HDS) and rainy (RAS) seasons (Igono & Aliu, 1982; Habibu *et al*., 2014)

Herd management systems

Out of the 20 cows used in this study, ten were raised under a nomadic system, while the remaining cows were traditionally managed in an indoor system. In the nomadic system, cows were allowed to move out of the shed for as long as a 5 km walk to graze on pasture early in the morning and return to the shed in the evening. They were kept in an open yard with cow sheds made up of sandy floors with wooden bars. They were fed on natural pasture comprising mainly guinea grass *(Panicum maximum)* and other forages *(Eleusine Spp, Pennisetum Spp, Asphilla africana* and *Tridax procumbens).* During the hot dry season (HDS) and cold dry season (CDS), the cows normally move to the south-western part of Nigeria for greener pasture. On the other hand, ten cows used in this study were raised on an indoor system and owned by a private farm. They were fed on hay and bean husk with concentrates. The length of their lactation period ranged between 9 to 10 months.

Sample collection

Milk samples were freshly collected early in the morning from ten each of (n = 20) Sokoto Gudali (SG) and White Fulani (WF), 21 days post-partum before morning grazing. The samples were collected between 06.00h -09:00h (GMT + 1) at Anguwar Fulani herdsmen Arkilla and Gwiwa area of Sokoto. Only the cows with no obvious signs of subclinical mastitis were sampled. The samples were collected in clean, well-labelled bottles and placed in ice boxes and transported to the Faculty of Agricultural Sciences, Usmanu Danfodiyo University, for analysis.

Determination of chemical parameters

The proximate composition of samples was analysed using the protocol recommended by Otache *et al.,* 2017.The moisture content was obtained from the difference between the known weight of the milk sample and the weight of the total solid obtained after evaporating the liquid component in the milk sample using hot plate. The ash content was obtained by incineration of the sample placed in the muffle furnace at 550 °C for 6 h. Nitrogen content (N) in the milk samples was estimated by Kjeldahl's method (Kjeldahl, 1983) and crude protein content was calculated as:

$$Crude\ protein\ content\ = N\ \times 6.25$$

Determination of macro-elements

Mineral concentrations were determined using a Kemtech Analytical Alpha-4 Model atomic absorption spectrophotometer for Ca, Fe, Mn, Mg, Zn and Cu, while flame emission spectrophotometer (Kemtech ® Analytical Alpha-4 model) was used to determine Na and K using appropriate instrumental conditions for each element. Phosphorus was determined using a UNICAMUV-1 ® Model UV visible spectrophotometer.

Data analysis

Data was expressed as mean ± standard deviation (SD) using Microsoft Excel 2010®. The data was later exported to Graph pad Instat® version 2 for further statistical analysis. Independent student t-test was used to compare the means between two categories (Nomadic and indoor traditional system, between sex of calves and between WF and SG) while one way analysis of variance (ANOVA) with Duncan post hoc test was used to compare means between parities. Values of $p< 0.05$ were considered significant.

RESULTS

Variation in mineral composition of milk in WF and SG breeds of lactating cows

Figure 1 shows a graphical representation of the mineral composition of milk from SG and WF indigenous breeds of lactating cows. The graph indicated that milk from both breeds was high in potassium and calcium ions with low in zinc and manganese. There is, however, no significant ($P=0.004$) variation between breeds in their mineral composition.

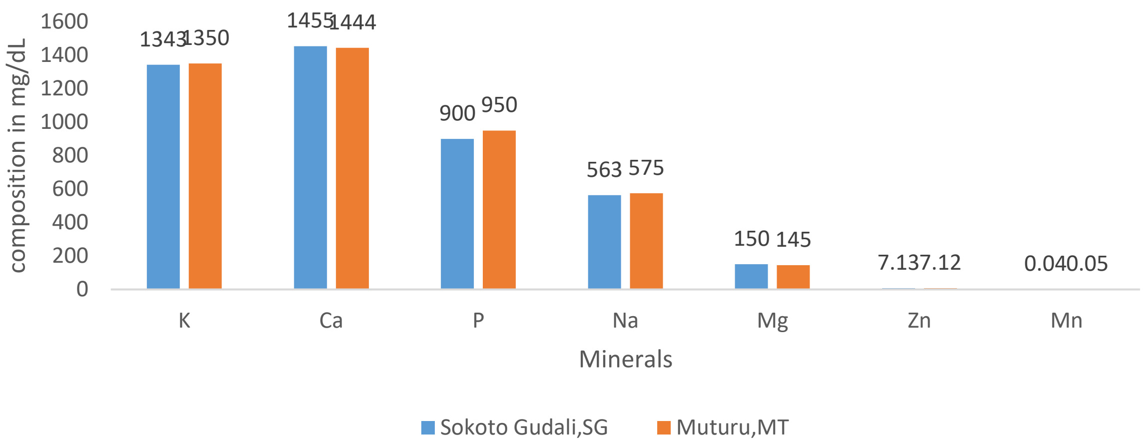

Figure 1: Mean value of mineral composition mineral parameters of milk samples collected from Sokoto gudali and White Fulani in Sudan savannah, Nigeria

Effects of Breeds and management system on the chemical composition of milk

Tables 1 and 2 show the chemical composition of milk from lactating cows based on breeds and management systems. SG shows a significantly (*p*=0.0002) higher moisture content Compared with WF. On the other hand, WF breeds were observed to have significantly higher amounts of total solids, lipids and protein content (*p*=0.001) in comparison with the SG breeds. Furthermore, cows raised under an indoor traditional system of management were shown to have higher total solids and protein contents (Table 2) compared to those managed under a nomadic system (p=0.049).

Table 1: Comparative analysis of chemical parameters of milk samples collected from Sokoto gudali and White Fulani in Sudan savannah, Nigeria**.**

	Breeds		
	WF (n= 10)	SG (n = 10)	*p* value
Parameter (g/100g)	Mean ± SD		
Moisture	86.3±1.3	88.6.7±0.9	0.0002
Ash	0.72±0.1	0.66±0.01	0.196*NS
Total solids	14.5±6.1	12.5±4.3	0.001
Lipid	7.1±0.2	5.76±0.1	0.004
Protein	4.68±0.2	3.63±0.01	0.0002

*NS = Not significant
SD = Standard Deviation
n = number of cows per group

Table 2 Mean variation in chemical properties of milk samples based on management system collected from milking cows in Sudan savannah, Nigeria.

	Management system		
	Traditional, indoor (n= 8)	Nomadic (n = 12)	
Parameter (g/100g)	Mean ± SD		*p* value
Moisture	85.3±1.9	85.7±1.1	*0.645NS
Ash	0.70±0.1	0.58±0.1	0.026
Total solids	15.3±9.2	11.9±5.6	0.049
Lipid	6.97±0.3	5.38±0.2	0.048
Protein	4.9±0.2	2.5±0.2	0.036

*NS=Not significant
SD = Standard deviation
n = number of animals per group

Effects of parity and sex of calves on the chemical composition of milk

Tables 3 and 4 show the effects of parity and sex of calves on the chemical parameters of milk collected from lactating cows. Results indicate that the parity and sex of calves do not significantly (Table 3 & 4) affect the chemical parameters of milk, even though cows that calved male off-springs demonstrated a higher total solids and lipid content as compared to those that calved female young ones.

Table 3 Median values (at 95%) of chemical properties of milk sample based on parity collected from milking cows in Sudan savannah, Nigeria

	Parity			
	P1 (n= 2)	P2 (n = 9)	>P2 (n = 9)	*p* value
Parameter (g/100g)	Mean ± SD			
Moisture	84.6(83.8-85.4)	85.6(83.4-88.0)	85.5(84.0-90.4)	0.716
Ash	0.70(0.6-0.8)	0.71(0.6-0.8)	0.67(0.6-0.8)	0.670
Total solids	15.0(13-16)	12.5(10-13)	12.8(11-13)	0.619
Lipid	6.9(5.8-7.0)	5.87(4.6-7.2)	5.87(4.6-7.2)	0.531
Protein	5.4(5.3-6.0)	5.2(5.0-5.4)	5.2(5.0-5.4)	0.695

P1 = Primipara,
P2 = Second parity
>P2 = Multipara
n = number of cows per group

Table 4 Mean of chemical parameters of milk sample based on calve gender from milk samples collected from milking cows in Sudan savannah, Nigeria**.**

	Sex of Calves		
	Male (n= 12)	Female (n = 8)	
Parameter (g/100g)	Mean ± SD		*p* value
Moisture	85.7±1.4	84.2±1.8	0.505
Ash	0.67 ±0.1	0.73±0.1	0.200
Total solids	12.8±7.0	14.1±9.2	0.536
Lipid	5.8 ±0.2	7.5±0.3	0.300
Protein	5.5±0.2	4.8±0.2	0.238

*Not significant
SD = Standard Deviation
n = number of males and females calves

DISCUSSION

Effect of breed difference on macro elements and Chemical Composition

The present study shows that there is no obvious variation in the macro element composition of milk from different breeds of lactating cows regardless of the system under which they were managed. This observation is in line with the report of Hurley, (1997) that mineral composition is one of the least variables influenced by breed differences in cows. Furthermore, Adesina, (2012) reported that breeds of cattle have non-significant effects on the mineral composition of lactating cows. Since these minerals are involved in several metabolic processes which are essential to the well-being of all cattle breeds, it is not uncommon to observe little or no effect of breed predisposition on the concentration of these minerals in the milk.

In the case of moisture, total solids and lipid contents, there appeared to be a significant difference between WF and SG breeds considered in this study. The variation in concentrations of lipids, ash and total solids was greater in WF as previously reported by Adesina, (2012) while the moisture content was higher in SG. This obvious variation in the chemical composition of cow milk could be attributed to the genetic background of the breeds studied, as previously speculated by Khatib *et al*., (2008). Similarly, Belewu, (2006) reported that variations in fat content among breeds of cow is an inherited character which perhaps explains why breeds with high-fat content produce less milk quantity than those with low-fat content.

Effect of management systems and parity on the chemical composition

Results from this study clearly indicate that the total solids, lipids and protein concentration were significantly higher in the traditional indoor system of housing as compared with the nomadic system. This could be because of difference in the feeding system; the indoor system involve feeding cows with wheat bran, bean husk, mix grass and in some instances, concentrates are incorporated in their feed, while in the nomadic system, cows solely rely on grazing pasture with little or no access to concentrate. As reported by Nocek, (1992), the method or sequence of feeding can affect the milk yield as well as composition. Indeed, lower milk fat content were observed from cows on a pasture system when compared with others receiving a totally mixed ration (White *et al.,* 2001; Bargo *et al.,* 2002). However, some other studies by Kolver & Muller (1998) reported only a numerical reduction of the milk fat content between cows consuming pasture alone and those receiving mixed ration. Similarly, Ferris *et al.* (2006) reported no effect by the feeding system on the milk yield, fat content or percentage protein of the milk. Also in a more recent report by (Ferland, 2017) the indoor systems resulted in greater production of fat, protein, and lactose.

The largest differences in total solid and protein were observed in first-parity cows, with smaller differences in second- and third-parity cows. This is similar to the report of Yang *et al.,* 2013, which described seasonal and parity variation in daily milk yield, milk solids percentage, milk fat percentage, milk protein percentage and other parameters in Chinese Holstein cows in northern China.

Effect of the gender of calve on the chemical composition

From this study, there was an obvious variation in the chemical composition of milk parameters between cows based on the gender of the calves. However, they are not statistically significant. This agrees with the report of (Chegini *et al.,* 2015), cows with female calves had higher milk and fat yield than those that gave birth to males. Also, in a dairy cow model to investigate sex-biased milk synthesis by (Hind *et al.,* 2014), reported that there was no variation in milk yield and parameters in milk from cows that calved opposite sexes. However, recently (Gillespie *et al.,* 2017) reported that heifer calves were associated with a reduction in saturated fatty acid content of milk in the first lactation, but there was no significant difference between the genders in the second lactation.

CONCLUSION AND RECOMMENDATION

Variations in the chemical properties have been observed between white Fulani and Sokoto Gudali indigenous breeds of lactating cows raised under different management systems. White Fulani showed higher proteins and lipids in milk and thus have more nutritional value. Also, cows raised under indoor housing systems produced milk with increased concentrations of fat and protein. It is therefore recommended that, cows should be reared indoors (intensively) to increase milk yield and quality.

Competing interest

The authors declared no financial or any other competing interest that could influence the publication of this manuscript.

Acknowledgement

The authors will like to appreciate the input of all the laboratory staff in the Faculty of Agricultural Sciences, Usmanu Danfodiyo University, for their contribution.

REFERENCES

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

Avery, D.T. (1998). It is time for the world to get realistic about meat. *Outlook on Agriculture*, 27.

Bargo, F., Muller, L.D., Delahoy, J.E. & Cassidy, T.W. (2002). Performance of high-producing dairy cows with three different feeding systems combining pasture and total mixed rations. *Journal Dairy Science*. 85: 2948–2963.

Belewu, M.A. (2006). A Functional Approach to Dairy Science and Technology. Adlek Printing Enterprises, Ilorin. 117 - 136.

CBN (Central Bank of Nigeria) (1999). *Annual report. CBN, Lagos, Nigeria*.

Charlton, G.L., Rutter, S.M., East, M. & Sinclair, L. A. (2011). Preference of dairy cows: Indoor cubicle housing with access to a total mixed ration verces access to pasture. *Applied Animal Behaviour Science Volume* 30: 1–9.

Chegini, A., Hossein-Zadeh, N.G. & Hosseini-Moghadam, H. (2015). Effect of calf sex on some productive, reproductive and health traits in Holstein cows, *Spanish Journal of Agriculture Research Volume* 13(2), *1-605*

FAO (Food and Agricultural Organization) (2001). https://www.fao.org/3/y5019e/y5019e03.htm.

Ferland, M.C., Guesthier, M.A., Cue, R.I., Lacroix, R., Burgos, S.A., Lefebvre, D. & Wade K.M. (2017). Effect of feeding system and grain source on lactation characteristics and milk components in dairy cattle, *Journal Dairy Science* 101:1–14 https://doi.org/10.3168/jds.2017-13787

Ferris, C.P., Frost, J.P., Binnie, R.C. & Patterson, D.C. (2006). Dairy cow performance and labour inputs associated with two silage-feeding systems. *Grass Forage* Science. 61:304–314.

Fregonesi, J.A., Veira, D., Keyserlingk, M. & Weary, D. (2007). Effects of bedding quality on lying behavior of dairy cows. *Journal Dairy Science* 90:5468–5472.

Gillespie, A.V., Ehrlich, J.L. & Grove-White, D.H. (2017). Effect of Calf Gender on Milk Yield and Fatty Acid Content in Holstein Dairy Cows. *PLoS ONE 12 (1): 0169503*.

Gulati, A., Galvin, N., Eva-Lewis, E., Hennessy, D., O-Donovan, M., McManus, J.J., Fenelon, M.A. & Guinee, T.P. (2017). Outdoor grazing of dairy cows on pasture versus indoor feeding on total mixed ration: Effects on gross composition and mineral content of milk during lactation, *Journal Dairy Science* 101:2710–2723 https://doi.org/10.3168/jds.2017-13338

Habibu, B., Kawu, M.U., Makun, H.J., Aluwong, T., Yaqub, L.S., Ahmad, M.S., Tauheed, M. & Buhari, H.U. (2014). Influence of sex, reproductive status and foetal number on erythrocyte osmotic fragility, haematological and Physiologic parameters in goats during the hot-dry season, *Veterinary Medicine-Czech*. 59:479-490.

Haskell, M.J., Rennie, L., Bowell, V., Bell, M. & Lawrence, A. (2006). Housing system, milk production, and zero-grazing effects on lameness and leg injury in dairy cows. *Journal Dairy Science* 89:4259–4266

Hinde, K., Carpenter, A.J., Clay, J.S. & Bradford, B.J. (2014). Holsteins Favour Heifers, Not Bulls: Biased Milk Production Programmed during Pregnancy as a Function of Foetal Sex. *PLoS ONE* 9(2): 86169.

Hurley, W.L. (1997). *Factors affecting milk yield and composition*. http://classes.aces.u. 1 - 5.

Igono, M.O. & Aliu, Y.O. (1982). Environmental profile and milk production of Friesian-Zebu crosses in Nigerian Guinea Savannah. *International Journal Biometeorology* 26: 115-120-

Jimoh, S.O., Adeleye, O.O., Dele, P.A., Amisua, A.A., Olalekana, Q.O., Jolaosho, O.A. & Olanite, J.A. (2017). Behaviour of White Fulani calves grazing panicum/stylo pasture in Southwest Nigeria, *Applied Animal Behaviour Science* 193:1–6

Khatib, H., Monson, R.L., Schutzkus, V., Kohl, D.M., Rosa, G.J. & Rutledge, J.J. (2008). Mutations in the STAT5A gene are associated with embryonic survival and milk composition in cattle. *J. Dairy* Science 91:784–793.https://doi: 10.3168/jds.2007-0669.

Kolver, E.S., & Muller, L.D. (1998). Performance and nutrient intake of high-producing Holstein cows consuming pasture or a total mixed ration. *Journal Dairy Science* 81:1403–1411.

Legrand, A.L., Von-Keyserlingk, M. & Weary, D. (2009). Preference and usage of pasture versus free-stall housing by lactating dairy cattle. *Journal Dairy Science* 92:3651–3658.

Nocek, J.E. (1992). Feeding sequence and strategy effects on the ruminal environment and production performance in first lactation cows. *Journal Dairy Science* 75:3100–3108.

Obi, K.C. & Iwuoha, V.C. (2023). Untold story of the expanding armed banditry in Nigeria's northwest: linking the communal-level collaborators. Third World Quarterly, pp.1-19.

Otache, M.A., Ubwa, S.T. & Godwin, A.K. (2017). Proximate analysis and mineral composition of peels of three sweet cassava cultivars. *Asian J. Phys. Chem. Sci, 3(4),1-10.*

RIM (Resource Inventory and Management) (1990). *Livestock resource survey*.

Walshe, M.J., Grinddle, A., Neji, C. & Benchman, M. (1991). Dairy Development in Sub-Sahara Africa. World Bank Technology Paper 135, African Technology Department 1 - 20.

White, S.L., Bertrand, J.A., Wade, M.R., Washburn, S.P., Green, J.T. & Jenkins, T.C. (2001). Comparison of fatty acid content of milk from Jersey and Holstein cows consuming pasture or a total mixed ration. *Journal Dairy Science* 84:2295–2301.

Yang, L., Yang, Q., Yi, M., Pang, Z.H. & Xiong, B.H. (2013). Effects of seasonal change and parity on raw milk composition and related indices in Chinese Holstein cows in northern China. *Journal Dairy Science* 96: 6863–6869.