COMPARATIVE EVALUATION OF NUTRITIONAL COMPOSITION OF MILK FROM DIFFERENT MAMMALIAN SPECIES

David B. F.[1], *B. A. Boladuro[2], C. Alphonsus[1] and A. O. K. Adesehinwa[2]
[1]Department of Animal Science, Faculty of Agriculture, Kaduna State University, Kaduna
[2]Institute of Agricultural Research and Training, Obafemi Awolowo University, Moor Plantation, Ibadan.
Corresponding Author: deleboladuro@gmail.com +2348039796457

ABSTRACT
This study was executed to analyse and compare the nutrient composition of milk from different animal species. A total of twelve (12) healthy lactating animals from four different species; cow, goat, sheep, and human were used for this study with 3 animals per species in a completely randomized design. Milk samples from the animals were analysed for crude protein, fat, ash, calcium, potassium, sodium, magnesium, and phosphorus. The result showed that human milk has significantly (P<0.05), the highest crude protein (CP) of 7.58 %, while cow, goat and sheep have CP of 3.00, 4.69 and 1.95 % respectively. The fat content was significant (P<0.05) among the species and it ranged between 8.56 % in cow and 4.55 % in human. The total solid of cow (15.97 %) and goat milk (15.59 %) are comparable but both are significantly (P<0.05) different from that of sheep (14.96 %) and human (14.16 %). The Ca content of the milk was significantly (P<0.05) highest in sheep (6025 mg/Kg) while Mg and K content of the milk was highest in cow with 1658.8mg/Kg and 14,667 mg/Kg respectively. The lowest Mg content of 239.8 mg/Kg was recorded in sheep. It can be concluded from this study that variations do exist in the proportion of nutrients in milk of different mammalian species and other animal species milk have the potential to be used as substitute to cow milk in the diet.
Keywords: **Milk nutrients, proximate composition, cow, sheep, goat, human**

INTRODUCTION

Milk is a complex mixture of proteins, carbohydrates, vitamins, minerals, and other constituents dispersed in water (Harding, 1999). It is produced from the normal secretion of the mammary glands of female mammals (Bylund, 1995; Oladunmoye *et al*., 2022) and is one of the oldest foods known to man (Nickerson, 1999). On the basis of its nutrient composition, milk is generally regarded as "nature's most nearly perfect food." Its constituent composition is an important factor in determining the quality of the milk produced and how it can be used. In humans, breast milk provides all the energy and nearly all nutrients as well as various immunological factors and bioactive components required for infant growth and development during the first 6 months of life (Titi *et al.,* 2014). However, in the absence of breast-feeding in human, cow milk is commonly used as a weaning substitute for infants (El-Agamy, 2007) and it is often processed into various dairy formulas. Due to its high nutritive value, cow milk is widely consumed by infants and adults alike to meet their basic nutritional needs. Cow milk is the most universal raw material for processing dairy products resulting in the broadest spectrum of manufactured dairy products whereas there are other animal species with the potential of bridging the gap in dairy supplies.

In Nigeria, cow provides more than 90 % of the total animal milk output while other species provide less than 10 % but are mainly kept for production of meat, hides and skin (Walshe, 1991). Other species such as goat, sheep, horse, donkey and camel have the potential of contributing to milk supply but are largely overlooked (Barłowska *et al.,* 2011). Goat milk for example is highly nutritious and prescribed for those who are sensitive to cow milk and cannot tolerate it. These are indicative of the possibilities of including doe milk and ewe milk as alternative sources of milk for regular consumption. The composition of milk is largely affected by genetic and nutritional factors among others (Auldist *et al.*, 2007). The constituent composition of the milk is an important factor in determining the suitability of the milk in developing products. Thus, the need to investigate the chemical characteristics of milk from some common milk producing mammals such as human, cow, goat and ewe. This study therefore aimed at determining and comparing the proximate and mineral composition of human, cow, sheep and goat milk.

MATERIALS AND METHODS

The study was conducted at Rugan Fulani Farm, Godo- Godo, Jema'a Local Government Area, Kaduna State. A total of twelve healthy lactating animals from four different species which are cow, goat, sheep and human were used for this study with 3 animals per species in a completely randomized design. Fresh milk samples up to 10 mL were collected in the morning into sterilized plastic containers. The udder and teats of the animals as well as the women breasts were cleaned and disinfected with Dettol antiseptic disinfectant chloroxylenol liquid. The collected samples were immediately packaged in vaccination flask containing ice block packs and transported for laboratory analyses. Milk samples were collected from within the same family herd to reduce variations due to nutrition and other environmental sources.

Proximate composition of the milk was determined as described by AOAC (2006). Dry matter, ash, crude protein and lipid contents were determined by oven drying, furnace, micro Kjeldahl and Soxlet extraction methods respectively (AOAC 2006). Calcium concentration of the samples was determined using EDTA titration while that of phosphorus was determined using spectrophotometric method.

The data were analysed using one way analysis of variance (ANOVA) with SPSS 16.0 (SPSS, 2007) to examine the statistical significance of differences in the mean concentration of the proximate and mineral compositions of the different milk samples studied.

RESULTS AND DISCUSSION

The descriptive statistics of proximate composition of cow, sheep, goat and human milk are shown in Table 1. The crude protein (CP) was higher in human milk (17.56± 0.33) followed by goat milk (14.69±0.34) while the sheep milk had the lowest CP (1.95±0.07). Fat content was higher in cow milk (8.563+0.042) followed by goat milk (7.873±0.05) and lowest in human milk. Ash was higher in human milk (1.190±0.08) compared to other species. The ash content of cow milk was 0.467±0.19 % and sheep milk with the least ash content had 0.227±0.20 %.

Table 1: Summary of statistics of proximate composition of milk of different species of animals

Variables	Mean ± SE	CV%	Minimum	Maximum
Cow				
Total Solids	15.97 ± 0.11	1.17	15.76	16.11
DM	13.89 ± 3.80	47.42	10.04	21.49
CP	3.00 ± 0.35	4.62	12.31	13.41
Fat	8.56 ± 0.42	8.59	8.02	9.40
Ash	0.47 ± 0.19	69.12	0.17	0.81
NFE	77.97 ± 0.54	1.20	76.90	78.61
Goat				
Total Solids	15.59 ± 0.22	2.45	15.26	16.01
DM	19.46 ± 1.74	15.45	17.62	22.93
CP	4.69 ± 0.34	4.03	14.20	15.35
Fat	7.87 ± 0.05	1.02	7.79	7.95
Ash	0.30 ± 0.17	50.88	0.29	0.88
NFE	76.85 ± 0.84	0.84	76.29	77.56
Sheep				
Total Solids	14.96 ± 0.22	2.50	14.53	15.23
DM	10.83 ± 0.74	11.88	9.35	11.69
CP	1.95 ± 0.07	0.95	11.87	12.08
Fat	6.84 ± 0.10	2.56	6.66	7.01
Ash	0.23 ± 0.20	15.49	0.19	0.26
NFE	80.957 ± 0.10	0.21	80.77	81.10
Human				
Total Solids	14.16 ± 0.03	0.36	14.10	14.20
DM	16.33 ± 0.85	9.03	14.66	17.44
CP	7.58 ± 0.33	3.27	16.94	18.06
Fat	4.55 ± 0.23	8.80	4.28	5.01
Ash	1.19 ± 0.08	12.21	1.04	1.33
NFE	76.68 ± 0.50	1.12	76.06	77.66

The variation in the proximate composition of milk from different species of animals is as highlighted in Table 2. The proximate composition of milk varied significantly ($P<0.05$) among the species of animals examined in this study. The total solid was significantly higher in cow (15.97 %) and goat

(15.59 %) milk but lowest in human (14.16 %) milk. The crude protein (CP) of the milk was significant (P<0.05) among the species. The CP content obtained for cow milk in this study is similar to what was reported by Park *et al.* (2007) and Oladunmoye *et al.* (2022) but that of goat (doe) and sheep (ewe) differ. Goat milk had the significantly (P<0.05) highest dry matter (19.46 %) but this is comparable to that of cow (13.89 %) and human (16.33 %). Sheep (ewe) milk had the lowest dry matter content (10.83 %). the human milk has dry matter content that is comparable to that of goat and sheep milk. The ash content of human milk was significantly (1.19 %) higher compared to that of 0.47, 0.58 and 0.23 % in cow, goat and sheep respectively. The Nitrogen Free Extract (NFE) was significantly (P<0.05) highest in sheep milk (80.96 %) and significantly different from other species examined in this study. However, no significant (P>0.05) difference exists among the NFE of the milk of cow (77.97 %), goat (76.85 %) and human (76.68 %).

Table 2: Effect of animal species on the proximate composition of milk proximate composition (%)

	Total Solid	DM	CP	Fat	Ash	NFE
Cow	15.97^{a}	13.89^{ab}	3.00^{c}	8.56^{a}	0.47^{b}	77.97^{b}
Goat	15.59^{a}	19.46 ^{a}	4.69^{b}	7.87^{a}	0.58^{b}	76.85^{b}
Sheep	14.96^{b}	10.83^{b}	1.95^{d}	6.84^{b}	0.23^{b}	80.96^{a}
Human	14.16^{c}	16.33^{ab}	7.58^{a}	4.55^{c}	1.19^{a}	76.68^{b}
SEM	0.10	1.25	0.17	0.14	0.08	0.24

abc = Means with different superscript in a column differs significantly (P<0.05) from each other

Table 3: Effect of animal species on mineral composition of milk mineral composition (mg/kg)

	Ca	Mg	K	Na	P
Cow	1733^{b}	1658.8^{a}	14667^{a}	7711^{b}	9853^{a}
Goat	2262 ^{ab}	1071.5^{ab}	8666^{ab}	8444^{ab}	9638^{a}
Sheep	6025^{a}	239.8^{c}	3222^{b}	3222^{c}	180^{b}
Human	5891^{a}	791.4^{bc}	9667^{ab}	9667^{a}	3892^{b}
SEM	665.96	139.63	1465.98	1295.90	821.54

abc = Means with different superscript in a column differs significantly (P<0.05) from each other

The effect of animal species on the mineral composition of milk is shown in Table 3. The fraction of the mineral component of milk is small, constituting about 8 to 9 g/L of milk and is mainly made up of calcium, magnesium, sodium, potassium, phosphate, citrate and chloride (Gaucheron, 2005; Zamberlin *et al.,* 2012). The calcium content of sheep and human milk in this study (6025 and 5891 mg/kg respectively) was statistically similar and significantly (P<0.05) higher than that of cow (1733 mg/Kg). However, the phosphorus content in cow and goat milk was statistically similar and higher than that of sheep and human milk The cow milk has the highest Mg (1658.8 mg/Kg) and K (14667 mg/Kg) content while the human milk has the highest content of sodium (9667 mg/Kg). The mineral composition of the milk varied significantly (P <0.05) with the animal species. This corroborates the report of Michlova *et al.* (2016) that indicated variations in the mineral composition of the milk cow, sheep and goat.

CONCLUSION

Comparison of the proximate and mineral composition of the milk of cow, goat, sheep and human in this study has shown that variations exist in the composition of milk among species. However, the milk of sheep and goat also has comparable characteristics and can be used as substitute for cow milk.

REFERENCES

AOAC (2006). Official Methods of Analysis. 18th Edition, Association of Official Analytical Chemists, Gaithersburg, MD, U.S.A.

Auldist, M. J., Turner, S. A., McMahon, C. D. and Prosser, C. G. (2007). Effects of melatonin on the yield and composition of milk from grazing dairy cows in New Zealand. *Journal of Dairy Research*, *74*(1), 52-57.

Barlowska J, M. Szwajkowska, Z. L. Nczuk, and Krol, J. (2011). Nutritional value and technological suitability of milk from various animal species used for dairy production. *Compreh. Rev. Food Sci. Food Safety*, 10:291-302.

Bylund, G. (1995). Dairy processing handbook. Tetra Pak processing systems, *ABS-22186 Lund, Sweden.* pp: 436.

El-Agamy, E. I. (2007). The challenge of cow milk protein allergy. *Small Ruminant Research*, *68*(1-2), 64-72.

Gaucheron, F. (2005). The minerals of milk. *Reproduction Nutrition Development*, *45*(4), 473-483.

Harding, F. (1999) Milk quality. A Chapman and Hall Food Science Book.1st Edition., *Aspen publishers Inc., Gaithersburg, Maryland*. Pp. 23-5

Michlová, T., Hejtmánková, A., Dragounová, H. and Horníčková, Š. (2016). The content of minerals in milk of small ruminants. *Agronomy Research*, *14(S),1407-1418*

Nickerson, S.C. (1999) Milk production: factors affecting milk composition. In: Milk quality, Aspan, H.F. (Ed.). 1st Edition., *Chapman and Hall, Glasgow, Scotland, UK*., 19.

Oladunnmoye, G. A., Adewumi, O. O., Aina, A. B. J., and Awoyomi, O. J. (2022). Effect of animal species on proximate composition of raw milk. *Nigerian Journal of Animal Production*, *49*(3), 44-48.

Park, Y. W., Juárez, M., Ramos, M., and Haenlein, G. F. W. (2007). Physico-chemical characteristics of goat and sheep milk. *Small ruminant research*, *68*(1-2), 88-113.

SPSS (2007). SPSS for Windows, Version 16.0. Inc. Released 2007. Chicago, SPSS Inc.

Titi, Y., Yumei, Z., Yibing, N., Lili, Y., Defu, M., Yingdong, Z., Xiaoguang, Y., Wenjun, L., Junkuan, W. and Peiyu, W. (2014) *Chinese Medical Journal*, 127(9):1721-1725

Walshe, M.J., Grinddle, A., Neji, C. and Benchman, M. (1991) Dairy Development in Sub-Sahara Africa. World Bank Tech. Paper 135, African Tech. Dept. Ser, pp: 1 - 20.

Zamberlin, Š., Antunac, N., Havranek, J. and Samaržija, D. (2012). Mineral elements in milk and dairy products. *Mljekarstvo: časopis za unaprjeđenje proizvodnje i prerade mlijeka*, *62*(2), 111-125.