COMPARATIVE STUDY OF MILK COMPOSITION FROM CATTLE, SHEEP AND GOAT

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ABSTRACT
This study was carried out to establish the differences or similarity in the milk composition of cattle, sheep and goat. Eighteen lactating animals (six cattle, goat, and sheep) were used for this experiment. The milk samples collected were refrigerated at 4℃ and analysed in a standard laboratory for protein, fat, ash and total solid while lactose and solid-non-fat were calculated using standard equation. Phenotypic correlation and regression of parameters were also determined. Protein, Ash and Lactose were regressed against total solid and solid-non-fat. Result obtained were statistically analysed and significance determined at $P<0.05$ and $P<0.01$. The result revealed that milk composition of sheep and goat do not vary ($P>0.05$), but vary ($P<0.05$) from that of cattle. Higher values were obtained from sheep and goat as compared to cattle. Protein and total solid, protein and solid-non-fat, lactose and solid-non-fat all showed a positive significant difference ($P<0.01$) for goat, sheep and cattle respectively. Regression of cattle and sheep milk for lactose ($Y= -0.20 - 0.37(TS) + 0.83(SNF)$ and protein ($Y= -1.81 + 0.22(TS) + 0.50(SNF)$ respectively against total solid and solid-non-fat were significant at $P<0.01$, while goat milk protein ($Y= -4.10 + 0.72(TS) + 0.05(SNF)$ was significant at $P<0.05$. It was concluded that sheep and goat milk had higher values than cattle. Also, total solid and solid-non-fat can be used to predict lactose content for cattle milk and protein content for sheep and goat.
Keywords: cattle milk, goat milk, sheep milk, solid-non-fat, lactose

INTRODUCTION
Ruminant animal is a member of a mammalian order Artiodactyla (sub-order ruminantia), that have a digestive system with a four compartment stomach which are rumen, reticulum, omasum and abomasum. Small ruminant animal are found in the agro-pastoral farmers utilizing extensive and semi intensive management system (Mbilu, 2007).

In the world of today, bovine milk serves as the main source of milk. Although milk are also gotten from sheep and goat. In Nigeria, cattle population is known to be about 15.3 million (Umar et al. 2008). In Nigeria. Local cattle breeds produce traditional diary despite their low potential for milk production (RIM 1992). White Fulani are the most common numerous and wide spread of all Nigerian Cattle breed (Meghen *et al,* 1999). Olaloku (1999) reported that 407,000 metric tonnes of milk are gotten from an estimate of 14 million cattle (RIM 1992). Major factors affecting milk production in our indigenous cattle breeds are poor nutrition (Adegbola, 2002) and low reproductive performance (Olaloku, 1999). Majorly sheep population in the country is owned by small-holder rural livestock farmers. A few are still in the urban area (Mbilu, 2007). Sheep constitute a good source of family income and livelihood assets and agricultural resources for small holder farmers (Iyayi and Tona, 2004: Shittu *et al* 2008). In Nigeria local breed, West African Dwarf (WAD) sheep are widely spread and also they supply deficit amount of milk in the country. Sheep milk is richer in nutrient except from the lacking lactose, than milk of humans, cattle and goats. It is also taken in Nigeria to have a better and natural taste than Bunaji milk. With the population of goat in Nigeria (about 53.8 million) it is better placed to realize its significant contribution to the dairy industry. Goat globally produce yield of about 60% and its value as 35% as meat and 5% of skin. Goats in Nigeria are kept mainly for meat and hide (Williamson and Brinkmann, 1997). There is growing awareness on the importance of goat as a source of milk for man in countries like Iraq and Libya. WAD breeds produce approximately about 0.4kg milk per day on a lactation period of 126 days (Lawal-Adebowale, 2012).

Rearing of sheep and goat for milk production in Nigeria is underutilized when compared to cattle. However, literatures have established that milk from sheep are also rich, components of certain nutrients. There is therefore paucity of information on the relationship in quality of milk composition of cattle, sheep and goat. The objective of the study is to establish the differences or similarity in the milk composition of cattle, sheep and goat.

MATERIALS AND METHODS
This experiment was carried out at the cattle section of Teaching and Research Farm in The Federal Polytechnic, Ilaro, Ogun State. Eighteen lactating ruminant animal at second parity were used for the

experiment, that is, six cattle (Bunaji), six goats (WAD) and six sheep (WAD). The animals were adequately fed with fresh grasses and concentrates and they have unlimited access to water. They were given 30% of concentrates and 70% of grasses to aid lactation. The milk samples were collected from each animal after parturition. The new born (offspring) were allowed to suck their dams approximately one week to ensure they got all the colostrum and there after the animal were isolated and the udder massaged for easy collection of the milk. The milk sample collected was refrigerated immediately after collection under the temperature of 4^{o} C and was taken to the laboratory immediately for analysis.

Percentage of milk Total Solid (TS) and Ash were determined following the procedure of AOAC (2010), Fat (Gerber's method) and protein (Kjeldahl's method). The lactose percentage was calculated as TS - (protein + fat +ash) while Solids-Non-Fat (SNF) was estimated as TS – fat.

The data collected were statistical analysed using one-way analysis of variance of SAS (2003). Means were separated using DMRT to establish the variation in specie's milk composition. Residual phenotypic correlation coefficients between milk constituents and multiple linear regressions of protein, fat, ash and lactose on TS and SNF in cattle, sheep and goats were also determined.

RESULTS AND DISCUSSION

The result for variation in milk composition of cattle, sheep and goat is presented in Table 1. It showed that sheep milk contained the highest milk constituent of protein (6.57), fat (5.32), Total solid (15.37), solid-non-fat (10.05), ash (0.79) and lactose (2.81). The milk composition of sheep and goat were very similar but not significantly different ($P>0.05$). However, that of sheep was significantly different ($P<0.05$) from cattle for Total-solid, Solid-non-fat and Lactose while goat milk constituents showed significant different ($P<0.05$) from cattle only at Total-solid and Lactose. All values obtained from milk constituent of the three animals were similar to the ranges reported from previous studies by Malau-Aduli and Anlade, 2002). The variation in total solid, lactose and solid non-fat in cattle milk component were against that of sheep and goat and is similar to the result of previous studies by (Baiomy and Hamad, (2010) and Ahmad *et al.* (2008) who observed a similar trends, when cattle milk was compared with that of buffalo. This suggests that small ruminant probably degrade their feed more efficiently than large ruminant. However, it could be attributed to differences in the bulkiness of their feed intake. Solid-non-fat of sheep was observed to be different from that of cattle and agrees with the report of (Malau-Aduli and Anlade, 2002) who observed that milk composition of sheep and goat were not different from each other and the milk composition were not affected by the breed of sheep and goat.

Table 1: Variation in milk composition of cattle, sheep and goat (%+_sd)

SPECIES	PROTEIN	FAT	TS	SNF	ASH	LACTOSE
CATTLE (BUNAJI)	5.94 ± 0.44^{a}	5.12 ± 0.57^{a}	13.80 ± 0.81^{b}	8.68 ± 1.02^{b}	0.67 ± 0.13^{a}	1.95 ± 0.64^{b}
SHEEP (WAD)	6.57 ± 0.58^{a}	5.32 ± 0.64^{a}	15.37 ± 0.44^{a}	10.05 ± 0.96^{a}	0.79 ± 0.11^{a}	2.81 ± 0.50^{a}
GOAT(WAD)	6.25 ± 0.56^{a}	5.28 ± 0.63^{a}	14.97 ± 0.76^{a}	9.70 ± 0.86^{ab}	0.65 ± 0.13^{a}	2.75 ± 0.59^{a}

a,b means with different superscript along column are significantly different ($p< 0.05$)

TS; Total Solid, SNF; Solid-Non-Fat, WAD; West African Dwarf.

Residual phenotypic correlation between the milk constituents of cattle, sheep and goat result were shown in Table 2. It indicated that residual phenotypic correlation between protein and fat, fat and lactose, fat and solid-non-fat of sheep milk sample were negatively correlated. This implies that as the percentage of fat increases in sheep, there is corresponding decrease in protein solid-non-fat and lactose. A similar trend was observed in goat milk when fat was correlated with lactose. Our findings support an earlier observation by Antunac *et al*. (2001), Pavic *et al.* (2002). However, positive correlation was observed between protein and ash in goat milk sample and total-solid in goat, cattle and sheep milk and protein and solid-non-fat, total solid and solid-non-fat, lactose and solid-non-fat in sheep and cattle milk. Implication of this is that as protein in goat milk sample increases the ash also increases. Likewise, in goat and sheep milk between protein and total-solid in sheep and cattle milk protein total solid and lactose are the major component of solid-non-fat. These results are in line with the previous studies by (Antunac *et al*., 2001), Chandrakor *et al*., (2017), (Malau-Aduli and Anlade, 2002), Pavic *et al*., 2002).

Table 2: Residual phenotypic correlation between milk constituent in cattle, sheep and goat

VARIABLE	CATTLE (BUNAJI)	SHEEP (WAD)	GOAT (WAD)
Protein and fat	-0.32	-0.86*	0.28
Protein and ash	0.09	-0.13	0.36*
Protein and total solid	0.83*	0.85*	0.93**
Protein and lactose	0.63	0.73	0.02
Protein and solid-non-fat	0.84*	0.97**	0.61
Fat and ash	-0.14	0.31	0.79
Fat and total solid	-0.06	-0.56	0.24
Fat and lactose	-0.78	-0.86*	-0.85*
Fat and solid not fat	-0.61	-0.92	-0.52
Ash and total solid	-0.53	0.25	-0.24
Ash and lactose	-0.28	0.68	0.67
Ash and solid-non-fat	0.34	-0.32	0.36
Total solid and lactose	0.63	0.67	0.20
Total solid and solid-non-fat	0.83*	0.83*	0.70
Lactose and solid-non-fat	0.94**	0.88*	0.80

WAD; West African Dwarf, *P<0.05, **P<0.01

Multiple linear regression of protein, ash, fat and lactose on total solids and solid-non-fat were carried out and the results are shown in Table 3. There was significant difference in probability value of proteins in sheep (P<0.01) and goat (P<0.05). The lactose of cattle and goat milk are significantly different (P<0.01; P<0.05 respectively). It showed that protein and lactose in cattle, sheep and goats can be predicted from total solid and solid-non-fat whereas ash percentage couldn't be accurately predicted. This implies that we cannot have confidence in the predicted values of ash percentage because the R^2 values were low. This in turn infers that multiple linear regression equation would be inadequate for predicting ash from total solid and solid-non-fat Malau Aduli and Anlade (2002).

Table 3: Multiple linear regressions of protein, ash, fat and lactose on total solids and solid-non-fat in cattle, sheep and goat

Species	Dependent variable	Model	R^2	P-value
Cattle	PROTEIN	Y= 0.86 + 0.23(TS) + 0.21(SNF)	0.77	0.11
	ASH	Y= -0.66 + 0.13(TS) - 0.4(SNF)	0.31	0.57
	LACTOSE	Y= -0.20 - 0.37(TS) + 0.83(SNF)	0.95	0.01
Sheep	PROTEIN	Y= -1.81 + 0.22(TS) + 0.50(SNF)	0.94	0.01
	ASH	Y= 0.88 + 0.01(TS) -0.04(SNF)	0.10	0.85
	LACTOSE	Y= 0.94 + 0.23(TS) + 0.54(SNF)	0.79	0.10
Goat	PROTEIN	Y= -4.10 + 0.72(TS) + 0.05(SNF)	0.86	0.05
	ASH	Y= 1.64 + 0.16(TS) + 0.16(SNF)	0.62	0.24
	LACTOSE	Y= 2.46 + 0.56(TS) + 0.90(SNF)	0.90	0.30

CONCLUSION

Despite the volume of consumption of cattle milk, this research revealed that milk composition of goat and sheep is of better quality than that of cattle. Protein is the major component of total solid in cattle, sheep and goat. Protein and lactose were also observed to be correlated with solid-non-fat in cattle and sheep. Total solid and solid-non-fat can be used to predict milk lactose in cattle as well as protein for sheep and goat.

REFERENCES

Adegbola, A. A (2002).Nutrient intake, digestibility and rumen metabolites in bulls fed rice straw with or without supplement. *Nigerian Journal of Animal production*. 29:40-46.

Ahmad .S, Gaucher .L, Rousseau .F, Beaucher .F, Piot .M, Grongnert .J.F and Gaucheron .F (2008). Effects of acidification on physico-chemical characteristics of buffalo milk: A comparison with cow's milk. *Food chemical*. 106; January, P. 11-17.

Antunac .N, Havranek .L, Samarzua .D (2001). Effect of breed on chemical composition of goat milk. (zech). *Animal. Sci* 46, (6): 268-274.

AOAC (2010). Official methed of Analysis of the AOAC. Washighton, D.C

Baiomy A.A and Hamad, M.N.E (2010). Physical properties and chemical composition of cow's and buffalo's milk in Qena Governorate. *Journal of food and dairy sciences* 1 (7): 397-405.

Chandrakor .C, Kumar .P, Shakya S, Jaiswal .S, Monika and Wasist (2017) U. Raw milk composition of cross bred cow, and correlation between milk constituent in selected districts of chhattisgarh, India. *International journal of Bio-resources and stress management*. 8 (6) 811-814.

Iyayi E. A. and Tona G.O (2004). Management practices among small holders of sheep, goats and pigs is derived savannah zone in Oyo state, Nigeria. *Nigeria journal of animal production*, 31 ;1 86-93.

Lawal-Adebowale O.A (2012). Dyanamics of ruminant livestock management in the context of the Nigerian agricultural system. DOI:10.5772/52923

Malau A.E.O and Anlade Y.R. (2002). Comparative study of milk composition of cattle, sheep and goat in Nigeria. *Animal science journal* vol.73, Pg 541-544.

Mbilu,T.J.N.K (2007).Status of mastitis in lactating goats at sokoine university of agriculture and neigbouring small holder farms in morogoro municipality. *Tanzania livestock research for rural development* 19(3).

Meghen, C., D. E. MacHugh, B. Sauveroche, G. Kana & D. G. Bradley (1999). Characterisation ofthe Kuri Cattle of Lake Chad using Molecular Genetic Techniques. In The origin anddevelopment of African livestock. R.M.Blench & K.C. MacDonald. (eds.) London: UniversityCollege Press.

Olaloku E. A(1999).Problems and possibilities for milk production.In Animal production in the tropics, Ibadan press ,Pg:43-64

Pavić V., N. Antunac, B. Mioč, A. Ivanković , J. L. Havranek (2002). Influence of stage of lactation on the chemical composition and physical properties of sheep milk. *Czech J. Anim. Sci*., 47, (2): 80–84

RIM (1992) resources inventory management limited. Nigerian livestock survey. Vol.2. National synthesis .Federal department of livestock and pest control service, Abuja Nigeria .Pg289.

SAS (2003). SAS STAT User's Guide. Version 8 for windows. SAS Institute Inc., SAS Campus Drive, Cary, North Caroline, USA.

Shittu, A, Chafe U.M, Buhari S, Junaidu A.U, Magaji A.A Salihu M.D and Jubril A, (2008), An overview of mastitis is sokoto red goat. *Nigeria sokoto journal of veterinary Animal production* ,7(1).65-70.

Umar, A. S., Alamu, J. F., & Adeniyi, O. B. (2008). Economic Analysis of Small-scale Cow Fattening Enterprise in Bama Local Government of Borno State, Nigeria.

Williamson, P.N and Brinkmann W.E (1997).The effect of plane of nutrition live weight gain and the external measurement of kids. *K. Agric. Sci*. 50(2) Pg 198-200.