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Manganese, Zinc and Chloride Content of Milk of West African Dwarf Goats as Influenced by Stage of Lactation

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Author's contribution

The sole author designed, analyzed, interpreted and prepared the manuscript.

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ABSTRACT

The manganese, Zinc and chloride content in milk of West African dwarf (WAD) goats as influenced by stage of lactation was assessed using three WAD does aged 18 months of age, weighing from 19 to 20 Kg. They were kept for lactation studies lasting for two 10-weeks periods. Individual milk samples were taken from each animal daily for the first seven days (colostrums), from day one after parturition and once per week for 10 weeks. The samples collected were thereafter assayed chemically for Mn, Zn and Cl. Colostrum was much higher in its content of Mn (0.24±0.02 mg/L), Zn (14.40±0.19 mg/L) and Cl (237.14±14.0 mg / 100 mL) compared with the mature milk which contained Mn (0.12±0.01 mg/L), Zn (4.40±0.15 mg/L) and Cl (192.70±2.2 mg/100 mL). The three elements decreased highly significantly ($P<0.01$) with stage of lactation. The decreasing trends were neither linear nor quadratic ($P>0.05$). In conclusion, the content of these minerals in milk of goat was highly dependent on the stage of lactation.

Keywords: Milching does; colostrums' content; mature milk; milk micro minerals; milk trace elements.

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1. INTRODUCTION

Milk is the creamy whitish liquid produced in the mammary gland of mammals [1]. It can also be defined chemically as an emulsion of fat globules, each surrounded by a membrane; in an aqueous phase which itself is a colloidal solution of casein micelles (aggregates of casein molecules and inorganic compounds) in a solution of proteins [2]. Milk is the main food of the young of all mammals including human being. It can be produced from cows, horses, goats, ewes, sheep, donkeys, dogs, etc. The composition of each type of milk is adapted to species producing it [1]. Usually, milk is a complete dietary condiment for mammalian infants and is believed to contain all vital nutrients needed for the growth of the young.

However, the potentialities of milk production from WAD goats have not been exploited because these animals are mainly kept for meat production. This is perhaps due to the fact that studies on milk yield and composition of WAD goats are few compared with cows. However, the milk composition and characteristics of goats have long ago been reviewed [3]. Milk composition studies hitherto undertaken in tropical environments are very few [4,5,6,7,8] and have not been given much attention till now. Report [6] on the composition of milk of exotic breeds of goat in a tropical environment revealed that milk composition values of the British Alpine and Anglo-Nubian goats were considerably lower than for the same breeds of goats under temperate conditions and the differences were attributed to inadequate nutrition of imported goats. Studies have also been undertaken on the milk composition of WAD (Fouta Djallon) Red Sokoto (Maradi) and Saanen goats at the different stages of lactation [9].

Nutritional essence of minerals such as Ca, P, Na, K and Cl in human and animal nutrition has been fully documented [10,11]. The critical roles of Zn, nay Mn in gestation, growth, neuropsychological performance, infants' morbidity as well as mortality and overall wellbeing of humans have been properly enunciated [12,13]. Zinc was reported to be present in virtually every plant and animal tissues. Contrarily, Mn was noted to be relatively deficient in the milk of humans compared to those from other animals [14].

There has been report on major elements in milk of WAD goats as affected by stage of lactation [8]. Recent documentations for minerals content [15] and the Na, K and Mg in milk of WAD goats as influenced by lactation stages [16] were limited to reports on few essential minerals. The present study therefore was undertaken to investigate the content of Mn, Zn and chloride in the milk of WAD goat with the advancing stage of lactation.

2. MATERIALS AND METHODS

Three West African dwarf (Fouta djallon) does, 18 months of age weighing 19 to 20 kg were kept for two lactation studies, each lasted for 10-week. They were housed in individual pens with concrete floors at the Goat Unit, Teaching and Research Farms, University of Ibadan, Ibadan. They were brought to heat (estrous) by synchronization and served by a herd buck. These does were mainly pen fed except that they were allowed to move out of the pen for two hours between 10:00 am-12:00 noon daily for exercise. They had free access to water and salt lick daily. They were offered 0.5 Kg concentrate supplements made of (g/100 g) Maize 58.5, *Dusa* 40.0, Common salt 0.5, vitamin-mineral premix 0.5 and oyster shell 0.5 in addition to a basal Giant star grass (*Cynodon nlemfuensis*) *ad libitum.*

Individual milk samples were taken from each animal daily for seven days (colostrums) from day one after parturition and once for ten weeks. The milk samples were stored in a freezing cabinet (at 2ºC) till required for analyses (within a week of collection).

Milk samples were allowed to thaw and warm up to 20ºC to disperse the butterfat. Accurately 2 mL of each sample was pipetted and transferred to Kjeldahl's flask then digested with 25 mLs concentrated nitric acid and 5 mLs perchloric acid. The Zn and Mn in the digests were determined with atomic absorption spectrophotometer. The chloride content was determined according to the method of Davies [17]. The proximate and mineral compositions of Giant star grass were determined using AOAC [18].

Data were subjected to analysis of variance and where significant, weekly values were subjected to orthogonal test of Fischer and Yates [19] to check if observed trends were linear or quadratic.

3. RESULTS

The chemical composition of samples of Giant star grass and the concentrate fed to milking goats are shown in Table 1. The Mn (mg/L), Zn (mg/L) and Cl (mg/100 mL) content of milk samples for the two lactation periods did not differ significantly (P<0.05) hence the two set of values were pooled together. Each figure in Tables 2 and 3 which therefore corresponded to weeks 2-10, was a mean of 12 determinations each.

Results in Tables 2 and 3 revealed that colostrum was much higher in its content of Mn (0.24±0.02 mg/L)), Zn (14.40±0.19 mg/L) and Cl (237.14±14.0 mg/100 mL)) compared with mature milk which contained 0.12±0.01 mg/L, 4.40±0.15 mg/L and 192.70±2.2 mg/100 mL Mn, Zn and Cl, respectively. The concentration of these elements approached normal values on day 6 after parturition.

Table 1. Chemical composition of Giant star grass (*Cynodon nlemfuensis*) and supplements fed to milking goats

Components	Grass	Supplement
Ash	9.10	8.70
Crude protein	10.10	17.60
Crude fibre	27.50	18.20
Ether extracts	2.10	6.40
Nitrogen free extracts	51.20	48.00
Calcium	0.62	0.84
Phosphorous	0.16	0.62
Sodium	0.06	0.09
Potassium	2.50	3.80
Magnesium	0.23	0.44
Manganese (ppm)	127.10	127.0
Iron (ppm)	1570.00	1601.20
Zinc (ppm)	50.50	60.10
Copper (ppm)	14.10	16.80
Iodine (ppm)	5.10	7.20

The Mn and Cl content of colostrum of the three goats decreased in a non significant (P>0.05) trend as the content approached normal value. The decreasing trends were consistent for Mn and Cl. However, the Zn contents of the colostrum decreased highly significantly (P<0.01) with advancing days of lactation. There was no consistent trend in the content of Zn recorded for the individual goat milk.

The Mn, Zn and Cl of mature milk of experimental does are shown in Table 3. The Mn content decreased very highly (P<0.01) with advancing lactation. The decreasing trends could neither be described as linear nor quadratic. These inconsistent trends were similar for the three does. The concentration of Zn in goat milk decreased very significantly (P<0.01) with the advancing weeks of lactation with no clear trend (P>0.05) as to whether it was either linear or quadratic. The weekly concentration of Cl in goat milk increased from 179.90 mg/100 mL in the second week of lactation to 199.80 mg/100 mL in the week 9 and decreased slightly to 196.80 mg/100 mL in week 10. The increase was not quite consistent and the trend also neither linear nor quadratic (P>0.05).

4. DISCUSSION

The Mn, Zn and Cl content of the colostrum were much higher than the values in mature milk. A similar observation was documented for Na, K, Cl, Ca and P [7]. There was also, a similar report for cow's [20] and ewes [21] colostrum.

The Mn and Cl (except for Zn) concentrations approached a normal value on d6 after parturition. A similar observation has been reported for the major minerals in milk of WAD [7] and for the minerals (except Cl) in the Colostrum of Friesian cows [22].

The Cl level of the colostrum (192.7±2.2 mg/ 100 mL) was higher than the corresponding values in early, mid and late lactation recorded for WAD, Saanen and Red Sokoto [9,23,24]. These values were however, lower than the amount reported elsewhere [7] and sufficiently higher than documented 0.076% for ewes [21] and the reported value of 0.087% for goats milk [25]. The level of Mn in the colostrum 0.24±0.02 mg/L) and weekly sample (0.12±0.01 mg/L) was lower than the corresponding values recorded for WAD goat and Red Sokoto [9,26]. Zinc in the colostrum (14.4+0.19 mg/L) in this study was higher than the reported values for WAD and Red Sokoto [9] but comparable to those obtained for Saanen goats.

Treatment (replication) had a highly significant effect on the colostra content of Zn. This conforms to the earlier assertion that the levels of trace elements in goat milk are subject to a very wide variations [3,9]. The values of 68 µg/100 g for Fe and 57 µg/100 g Cu [27,28] for a herd of goats are in wide contrast to documented 25 µg/100 g for Fe [25] and 4 µg/100 g for Cu in Russian goats' milk [29].

Table 2. Manganese, zinc and chloride in colostrum of experimental West African dwarf goats

Days	Mn (Mg/L	Zn (Mg/L)	Cl (Mg/100 mL)
1	0.30±0.007	15.30±0.2	280.20±0.1
2	0.28±0.01	14.10±0.1	270.60±0.6
3	0.26±0.006	13.80±0.09	260.10±0.06
4	0.24±0.01	14.10±0.005	251.20±0.50
5	0.21±0.007	14.40±0.06	220.80±0.3
6	0.20±0.004	14.50±0.03	191.60±0.09
7	0.19±0.004	14.70±0.1	185.60±0.3
Mean±SD	0.24±0.02	14.40±0.19	237.14±14.0

Table 3. Manganese, zinc and chloride in mature milk of West African dwarf does as affected by weeks of lactation

Weeks	Mn (Mg/L	Zn (Mg/L)	Cl (Mg/100 mL)
2	0.18±0.004	5.21±0.05	179.90±0.15
3	0.15±0.007	4.87±0.03	186.80±0.4
4	0.12±0.01	4.85±0.03	190.60±0.3
5	0.10±0.01	4.08±0.02	191.80±0.12
6	0.13±0.006	4.10±0.02	192.00±0.06
7	0.11±0.004	4.18±0.07	197.80±0.22
8	0.10±0.004	4.23±0.03	198.90±0.24
9	0.10±0.009	4.13±0.09	199.80±0.3
10	0.11±0.12	3.97±0.03	196.80±3.1
Mean±SD	0.12±0.01	4.40±0.15	192.70±2.2

Similar high variations in the content of trace minerals particularly Zn, Fe and Mn have been recorded [9]. Zinc concentration in milk of individual goat varied even within the same breed. The level of Zn in the colostrum (14.7±0.1 mg/L) fell remarkably to 5.21±0.05 mg/L in the second week of lactation. Similar observation in laboratory animals implies that colostrum was four to five times higher in Zn than later milk and that Zn concentration of mammalian milk is high compared with other trace elements [30].

West African dwarf goats used in the present study were different in age (i.e. 18 months old) from 2 years nannies used by earlier authors [8] and older ones used by Mba et al. [9]. The difference in age and number of lactation might account for the variation in values obtained in this study and that earlier documented. Much early reported observation for British goats [31] revealed that the composition and yield of milk of goats increased from first lactation and becomes fairly stable when goat has attained the age of 4-5 years and then starts to depress. It may therefore be imperative to examine the trace mineral milk yield of the WAD and other tropical goats with emphasis on parity and age at lactation.

The present findings in line with the earlier records [8,9,26] indicated that Cl, Mn and Zn were higher in goat milk than in cow milk, a factor of considerable importance in the nutrition of infants and young growing animals. Particularly, goat milk could be the choice dietary supplement in established human deficiency of Mn, Zn and Cl compared with cow or even human milk.

5. CONCLUSION

The Mn, Zn and Cl content were considerably higher in the colostrum than in mature milk of goat. The composition of the three minerals was lowered by the advancing stage of lactation.

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COMPETING INTERESTS

Author has declared that no competing interests exist.

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