Nigerian J. Anim. Sci. 2013, vol. 15:134-144

Milk Yield and Composition of West African Dwarf (WAD) Does fed Bambara nut meal-based diets

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Target audience: Animal scientists, Nutritionists, Ruminant and dairy farmers.

Abstract

Twelve individually housed West African Dwarf (WAD) does in their mid-lactation were used to study the effect of Bambara nut meal on milk yield, composition and mineral content of goat milk. Four experimental diets designated A, B, C and D were formulated to contain 0, 10, 20 and 30% Bambara nut meal (BNM), respectively. The 12 WAD does were divided into four (4) groups of three animals each. Each group was assigned to one of the four experimental diets in a completely randomized design (CRD). Each animal in a group represented a replicate. The experiment lasted 28 days. Data on voluntary feed intake and milk yield were collected daily. Results showed that daily milk yield was similar (P>0.05) among the treatment groups. The values were 188.53, 174.86, 298.66 and 272.49 g for diets A, B, C and D, respectively. Similarly values for SNF, BF, CP, Lactose, TS, ASH and milk energy did not differ (P>0.05) among treatment groups. However, dietary inclusion of BNM significantly (P<0.05) affected Calcium, Phosphorus and Sodium contents of WAD goat milk but Magnesium and Potassium were not significantly influenced (P>0.05) by the diets. It was concluded that the dietary inclusion of Bambara nut meal at 20% level promoted higher milk content of Calcium, Phosphorus and Sodium.

Keywords: Bambara groundnut, goats, milk yield, composition and mineral content.

Description of problem

Milk is an important source of protein in Nigeria where it's consumption per caput is low (1). Cattle have been the primary source of milk supply that provides more than 90 percent of the total annual domestic milk output (2). This has been grossly inadequate prompting the continuous importation of large consignments of dairy products yearly, which is rarely affordable by the teeming population of rural dwellers (3, 4). If we must attain self-sufficiency in dairy production, then there is a need to explore other sources of milk from species like goats.

Goat keeping has assumed a key position in rural development programmes in the developing countries (5). There is a growing awareness on the importance of goats as a source of milk for man (6). Countries like Iraq and Libya obtain half their total milk requirement from goats (7). There is evidence that on live weight basis, the goat is a much more efficient milk producer than some other ruminant species (6). Globally, goat production yields about 60 percent of its value as milk, 35 percent as meat and 5 percent as skin (8). With the population of goats in Nigeria estimated at 53.8 million (9), the country is better placed to realize its significant contribution to the dairy industry.

In Nigeria, the West African Dwarf (WAD) goats is kept mainly for meat. Their dairy potential is presently unexploited (10). It has been reported that any targeted approach to the improvement of WAD goat for milk production must first address the issue of nutrition (4). Nutrition has been identified as one of the major factors responsible for the poor performance of WAD (11). They are exposed to severe nutritional stress, especially during the dry season when forage is scarce and of low quality (12). There is therefore need to supplement the diets of lactating WAD does with concentrates. This study was designed to evaluate the yield and composition of milk of West African Dwarf goats fed graded levels of dietary Bambara groundnut (*Vigna subterranea*) meal.

Materials and Methods

Experimental diets:

Four experimental diets designated 0 (control), 10, 20, and 30 % Bambara nut meal (BNM) respectively (Table 1). Guinea grass *(Panicum maximum*) was served as the basal diet.

Table 1: Composition of experimental diets

Ingredients	**Diets**			
	A	B	**C**	**D**
Maize offal	52.00	52.00	52.00	52.00
Brewers dried grain	18.00	14.00	11.00	7.00
Palm kernel cake	22.00	16.00	9.00	3.00
BNM seed meal	0.00	10.00	20.00	30.00
Molasses	5.00	5.00	5.00	5.00
Bone meal	2.00	2.00	2.00	2.00
NaCl	1.00	1.00	1.00	1.00
Total (%)	100	100	100	100

Experimental animals:

Twelve West African Dwarf (WAD) does in their mid-lactation with average live weight 17.32 ± 2.11kg were used for the experiment. The WAD does were divided into 4 groups of 3 animals each. Each group was assigned to one of the four experimental diets (Table 1) in a

Complete Randomized Design (CRD). Each animal in a group was a replicate. The animals were housed individually in pens. Each goat was offered 2.0 kg of forage (*Panicum maximum*) and 0.8 kg of the concentrate. Concentrate was fed to the goats at 0800 hours while the forage was fed later at 1100 hours. Clean drinking water was made freely available to the animals. The experiment lasted 28 days.

Data collection:

Data on voluntary feed intake and milk yield were collected daily for a period of 28 days. The does were hand-milked once daily in the morning before feeding. The daily milk yield of each doe was weighed and recorded before sub-samples of 20 ml were collected, bulked and refrigerated at -5^0C until they were analyzed for milk constituents. The daily milk yield was estimated for each doe on the assumption that actual daily milk production of WAD does could be realized if the animals were milked twice a day. Based on the concept of fixed milk yield responses to changing milking frequency (13), the constant 0.6596 was used as a weighing factor on the morning milk yield. Each day's milk yield (S) was estimated as:

$$S = M + 0.6596M.$$

Where M is the morning milk yield (Once-a-day milking).

Prior to each day's milking, the kids were separated from their dams at 1800 hours on the evening preceding the day of milking and were fed with milk replacers. The quantity of milk harvested from each WAD doe was measured using graduated glass cylinder and weighed back to the nearest gramme on a KENWOOD electronic scale (5 kg x 1 g). After milking, the dams were allowed to nurse their kids and they remained with the dams from 0800 - 1800 hours.

Milk sampling:

Milk samples were analyzed for lactose, total solids (TS), butterfat (BF), crude protein (CP), solids non-fat (SNF) and ash. They were also analyzed for some minerals like Calcium, Sodium, Potassium, Phosphorus and magnesium. Lactose content was determined daily from fresh milk samples as described by (14). Total solids were determined by drying about 5 g of milk sample to a constant weigh at 105^0C for 24 hours. Milk protein (N x 6.38) was determined by the semi-micro distillation method using Kjehldal and Markhamps apparatus.

Butterfat was determined by the Roese-Gottlieb method (15). Solid non fat (SNF) was determined as the difference between the total solids and butter fat. Milk energy Y (MJ/Kg) was computed using the multiple regression equation:

$$Y = 0.386F + 0.205SNF – 0.236 \quad (16)$$

Where, F and SNF represent percentages of fat and solids-non fat, respectively.

The mineral content of the milk samples was determined by the dry ash extraction method (17) following which specific mineral elements were determined. Phosphorus in each sample was determined by the Vanadomolybdate (yellow) spectrometry as described by

(18). Calcium and magnesium content of each test sample was determined by the Versanale EDTA complexiometric titration (19). Potassium and Sodium in the sample extract was determined by flame photometry (20).

Statistical analysis

The data from milk yield, composition and mineral contents were subjected to analysis of variance (ANOVA) while significant means were separated using Duncan's New Multiple Range Test (21).

Table 2: Proximate composition of experimental diets, Bambara nut meal (BNM) and *Panicum maximum* fed to Lactating WAD does.

	Diets					
Parameters	A	B	C	D	BNM	*P. maximum*
Dry matter (%)	94.2	94.3	94.44	94.78	95.28	35.00
Crude protein (%)	19.08	16.28	15.93	15.91	20.48	9.28
Ether extract (%)	5.01	6.00	5.03	4.10	3.02	3.01
Crude fibre (%)	4.33	4.14	3.33	2.00	4.33	22.31
N-free extract (%)	58.79	58.54	62.53	66.53	64.17	6.74
Ash (%)	7.00	9.34	7.65	6.34	3.30	2.67
Gross energy (Kcal/g)*	356.52	353.28	358.84	365.76	365.60	91.08

*Calculated; N = Nitrogen

Results and Discussion

The dry matter intake (DMI), milk yield and milk composition of WAD does fed *Panicum maximum* supplemented with Bambara nut meal-based concentrate diets are presented in Table 3. The values for daily dry matter intake did not differ significantly (P>0.05) among treatment groups. It was observed that WAD does fed the BNM diets had higher values for DMI than those fed the control diet. This observation is in agreement with the findings of (22, 23) that some leguminous seeds used in the diets of sheep and goats improved dry matter intake.

WAD does fed 10 % BNM (diet B) consumed more forage (P<0.05) compared those fed diets A and D, but was similar to the forage intake of does fed diet C. Daily concentrate dry matter intake (CDMI) was not significantly different (P>0.05) among the treatment groups. This also confirms that the inclusion of BNM in ruminant diets as reported for other leguminous seeds like mucuna, pigeon pea *etc.* improves DMI (22, 23, 24 and 25).

The values for DMI as percentage of body weight did not show any significant (P>0.05) difference among treatment groups. . The DMI as percentage of body weight in this study falls within the range of 4 - 6.8% recommended for lactating goats (26, 27). The values obtained are comparable to the values of 5.48% - 6.18% reported by (25) for lactating WAD goats fed mucuna seed-based concentrate diets. Dry matter intake per kilogram of milk yield (kg) did not differ

significantly (P>0.05) among treatment groups. Results also show that there was no weight loss by the does, instead the does gained weight. The result of this study corroborates the reports of (28) and (25) who reported that goats placed on high nutrition plane will loss less weight. In this study the inclusion of BNM in concentrate diets thus proved to support weight gain against weight loss in lactating does. This is indicative of high and adequate nutrition plane.

Total milk yield (kg) and daily milk yield (g) did not differ significantly (P>0.05) among treatment groups. The mean daily milk yield obtained in this study (233.64g) is high when compared to 92.5g reported by (29) while the values obtained for total milk yield (4.9 - 8.36 kg) is comparable to the values of 5.58 - 9.32Kg and 5.22 - 9.59 kg reported by (25) and (24) as milk yield for WAD does. However the mean total milk yield in this study is low when compared to 13.33±4.28 kg reported by (30) for the same breed. Litter size and parity have been identified as strong factors influencing variation in milk yield and composition in lactating animals (31, 32). Values for Total solids (TS) and Butterfat (BF) did not differ significantly (P>0.05) among treatment groups. The values obtained for TS and BF in this study are comparable to 11.63 $\pm$ 0.12% and 4.74 $\pm$ 0.03% reported for TS and BF respectively by (33) for WAD does. Earlier investigations by (34, 35 and 36) confirmed negative correlations between milk yield and TS and between milk yield and BF which is corroborated by the result of this study for TS but, is contradicted by the result obtained for BF in this study.

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Table 3: Dry matter intake (DMI), Milk yield and Composition of WAD does fed *Panicum maximum* supplemented with Bambara groundnut meal-based concentrate diets.

	DIETS				
Parameters	0	10	20	30	SEM
Daily FDMI (g)	393.13[b]	451.51[a]	438.29[ab]	405.00[b]	9.06
Daily CDMI (g)	568.20	566.92	648.67	601.83	46.93
Daily DMI (g)	961.33	1018.36	1086.96	1006.83	54.00
DMI as % BW	5.36	6.53	6.09	5.95	0.46
DMI/Kg Milk	5.14	5.84	3.92	4.22	0.59
Change in body weight (Kg)	0.80	0.70	1.90	1.80	0.41
Total milk yield (kg)	5.25	4.90	8.36	7.96	1.26
Daily milk yield (g)	188.53	174.86	298.66	272.49	44.90
Total solids (%)	12.35	11.77	11.73	12.03	0.53
Butter fat (%)	3.76	3.71	3.79	3.78	0.06
Crude protein (%)	3.75	3.82	3.77	3.83	0.03
Solids not fat (%)	8.59	8.05	7.76	8.26	0.51
Lactose (%)	4.19	4.14	4.22	4.15	0.02
Ash (%)	0.89	0.87	0.89	0.91	0.01
Milk energy (MJ/Kg DM)	2.98	2.85	2.82	2.92	0.12

a, b: Means in the same row with different superscripts differ significantly (P<0.05) SEM = Standard error of mean. FDMI = Forage dry matter intake; CDMI = Concentrate dry matter intake.

Values for crude protein (CP) were also similar (P>0.05) among treatment groups. The values obtained in this study is comparable to 3.91% reported by (29) and higher than 3.27% reported by (33) but lower when compared to the values of 5.06% – 5.37% and 4.30% reported by (25) and (36) respectively for lactating WAD does. CP concentration in milk is generally influenced by diet quality. The values for Solids non fat (SNF) and lactose did not differ (P>0.05) among treatment groups. SNF followed a similar trend as observed in total solids. The values obtained for SNF in this study are lower but, comparable to the values (9.57 ± 0.42 and 9.73 ± 0.48) reported by (6) and (37) respectively. (38) observed that the higher the solids not fats (SNF) in the milk, the higher the buffer value of the milk and therefore the better its keeping quality. Values obtained for lactose in this study (4.14 – 4.22 %) is similar to 4.29 ± 0.004% reported by (33) and comparable to 4.43% reported by (29) but is much lower than 6.60 ± 0.19% reported by (30) for same breed of goats. Difference in dietary planes and composition has been reported to be responsible for variations in the milk yield and compositions observed within the same breed (39, 40).

Milk ash was similar (P> 0.05) among treatment groups. The mean value of 0.89 ± 0.01 obtained in this study is higher than 0.70 ± 0.21 and 0.68 ± 0.23 and 0.77% reported by (33), (25) and (6) respectively, but is lower when compared to the value 1.13 ± 0.04% reported by (37) for WAD does in an earlier study. There was no significant difference (P>0.05) among treatment groups for milk energy. Milk energy is a function of BF content and SNF (34, 24) which were also similar (P>0.05). Meanwhile the mean milk energy value (2.89 ± 2.17 MJ/Kg) obtained in this study is higher than (1.73 – 2.17 MJ/Kg) reported by (41 but, lower than (3.93 – 4.21 MJ/Kg) reported by (25) for WAD does.

Milk mineral content

Minerals in milk constitute less than 1% of the total composition. However, they are an important influence on the functional properties of milk (42). Presented in Table 4 is the mineral composition of milk from WAD does fed *Panicum maximum* supplemented with Bambara groundnut meal-based concentrate diets. Dietary inclusion of Bambara groundnut had no significant effect (P>0.05) on Magnessium (Mg) and Potassium (K) content of WAD goat milk. However, it significantly affected (P<0.05) the Calcium (Ca), Phosphorus (P) and Sodium (Na) content of the milk of WAD does. The mean values of 0.013% Magnesium obtained for the BNM - based diets is similar to 0.013% reported by (43) and comparable to 0.014% reported by (44) but lower than 0.018% reported by (45).

The values obtained for Potassium were lower than 0.21% reported by (46) and (47) for Alpine goats. However, the values were closer to 0.158% reported by (45) for WAD does. The potassium values in this study are not abnormal for goats in the tropics owing to their smallish body size. Mg and K concentrations in milk have been reported

as criteria for their requirements for lactation goats (48).

The milk concentration of Ca ranged from 0.140% for goats on diet A to 0.200% for goats on diet C. the values obtained in this study are in consonance with the values reported by (49) but, higher than values reported by (43). Lactating does fed 20 % Bambara nut meal concentrate had significantly ($P<0.05$) higher milk Ca than those fed 0, 10 and 30%.

Phosphorus (P) and Sodium (Na) concentration in milk also followed similar trend with Calcium. Phosphorus content was similar with does fed 0, 10 and 30% BNM diets and also among does fed 10, 20 and 30%. The Phosphorus in milk of animals fed diets A and B fall within the range of 0.065 – 0.088 % and 0.097 % reported by (43) and (50), respectively. However, the values of 0.130% and 0.100% obtained for diets C and D are slightly higher than the values of 0.084 – 0.090% reported by (45) for WAD does.

Table 4: Mineral composition of Milk from WAD does fed *Panicum maximum* supplemented with Bambara nut meal based concentrate diets.

	Dietary inclusion levels of BNM, %				
Minerals (%)	0	10	20	30	SEM
Magnesium	0.011	0.012	0.013	0.013	0.009
Calcium	0.140^{b}	0.160^{b}	0.200^{a}	0.140^{b}	0.010
Phosphorus	0.070^{b}	0.090^{ab}	0.130^{a}	0.100^{ab}	0.010
Potassium	0.070	0.080	0.070	0.080	0.008
Sodium	0.080^{c}	0.080^{bc}	0.120^{a}	0.100^{b}	0.006

^{a,b,c} means in the same row with different superscripts differ significantly ($P<0.05$) SEM= Standard error of mean

Lactating does fed 20 % Bambara nut meal concentrate had significantly ($P<0.05$) higher milk Sodium than those fed 0, 10 and 30 %. While Na content in milk was similar ($P>0.05$) for does fed 0 and 10 % BNM but differed ($P<0.05$) between does fed 0 and 30 %. Values obtained in this study for Sodium are high when compared to 0.060% and 0.050% reported by (43) and (50) for some European breeds. In general, results obtained in this study indicate that the inclusion of BNM affected and enhanced the mineral content of milk of WAD does with 20 % inclusion level as optimum for Ca, P and Sodium concentration in milk of WAD does. Minerals in milk originate from blood contents (51) and diets are the primary source of serum minerals (45). Olomu (52) reported that Bambara groundnuts are rich in phosphorus. De-Kock(53) also reported that they are a good source of calcium, potassium and iron.

Conclusion and applications

It was concluded that Bambara groundnut meal can be included up to 20% level in the diet for lactating West African Dwarf does to enhance higher Calcium, Phosphorus and Sodium content in WAD goat milk.

References

1. Egbowon, B.F., Osinowo O.A., Biobaku, W.O. and Dipeolu M.A. (2005). Factors affecting colostrum and milk of West African Dwarf goats. *Arch. Zootec.* 54:643-646.
2. Walshe, M.J., Grindle, A., Nell, C. and Benchman, M. (1991). Dairy development in sub-saharan Africa. World Bank Tech. Paper. No. 135. Africa Technology Department Service.
3. Ibeawuchi, J.A. Ahamefule, F.O. and Ringim, I.A. (2003). The influence of lactation stage on the milk constituent of Sahelian goats. *Nig J. Anim. Prod.* 30(2): 259-264.
4. Ahamefule, F.O., Ohaeri, O. and Ibeawuchi, J.A. (2007). Early lactation milk yield and composition of Muturu, N'dama and White Fulani cows managed semi-intensively in a hot-humid environment. *J. Anim. and Vet. Adv.* 6 (12): 1458-1463.
5. Odoemelam, V.U. (2012). Evaluation of Bambara nut (*Vigna subterranean*) seed meal-based diets for goat production in south eastern Nigeria. Ph.D dissertation. Michael Okpara University of Agriculture Umudike.
6. Malau-Aduli, E.O. and Anlade, Y.R. (2002). Comparative study of milk compositions ofcattle, sheep and goat in Nigeria. *Anim. Sci., J.* 73: 541-544.
7. Webster, C.C. (1989). *Agricultural production in the tropics*. Longman Inc. New York, Pp. 357-370.
8. Devendra, C. and Mcleroy, G.B. (1988). *Sheep and goat production in the tropics.* ELBSLongman Ltd. Singapore, Pp. 271.
9. Wikipedia (2010). The free encyclopedia.
10. Ahamefule, F.O., Ibeawuchi, J.A. and Nwachinemere G.C. (2007). Comparative evaluation of milk yield and composition of West Africa dwarf goats raised in the village and university envitronment. *J. Anim. and Vet. Adv.* 6 (6): 802-806.
11. Adamu, H.Y., Abbator, F., Abdul, S.B., Jokhtan, G.E. and Yashim, S.M. (2010). Chemical composition of some common supplementary feeds for ruminants in semi arid zone of Nigeria. Proc. 35th Conf. Nig. Soc. for Anim. Prod. 14th -17th March, University of Ibadan Pp. 537.
12. Lamidi, A.A., Aina A.B.J. and Sowande S.O. (2010). Nutrient digestibility and nitrogrn balance in West African Dwarf goats fed blended diets for dry season

production. Proc. 35th Conf. Nig. Soc. for Anim. Prod. 14th -17th March, University of Ibadan Pp. 476.

13. Erdman, R.A. and Verner, M. (1995). Fixed yield responses to increasing milk frequency. *J. Dairy Sci.,* 78:1199 – 1203.
14. Marrier, J. and Boulet, M. (1959). Direct analysis of lactose in milk and serum. *J. Dairy Sci.,* 42: 1390 -1391.
15. A.O.A.C. (1980). Association of Official Analytical Chemists. Official methods of analysis. 13th edition. Washington DC., USA.
16. MAFF (1975). Energy allowance and seeds system for ruminants. Tech. Bull. 33. Min. of Agric. Fisheries and Food. London.
17. Onwuka, G.I. (2005). Food analysis and instrumentation. Naphtali Prints, Nig. Ltd., Lagos, Nigeria. Pp. 140 – 143.
18. James, C.S. (1996). *Analytical chemistry of foods.* Blacke Academic and Professionals, Glasgow
19. Pearson, D. (1976). *The chemical analysis of foods.* Churchhil, Livingstone, Edingburgh.
20. A.O.A.C. (1984). Official Methods of Analysis. Association of Official Analytical Chemists. Washington DC. USA.
21. Duncan, D.B. (1955). Multiple Range and Multiple F-Tests. *Biometrica.* 11: 1 – 42.
22. Mendoza-castillo, H., Castillo-caamal, J.B. and Ayala-Burgos, A. (2003). Impact of *Mucuna* bean (*Mucuna spp*) supplementation on the milk production of goats. *Tropical and subtropical agroecosystems,* 1:93-96.
23. Castillo-caamal, A.M., Castillo-caamal, J.B. and Ayala-Burgos, A.J. (2003). *Mucuna* bean (*Mucuna spp*) supplementation of growing sheep fed with a basal diet of napier grass (*Pennisetum purpureum*) of Mexico. *Tropical and subtropical agroecosystems.* 1:107-111.
24. Ahamefule, F.O. (2005). Evaluation of pigeon pea-cassava peel based diets for goat production in south eastern Nigeria. Ph.D dissertation. Michael Okpara University of Agriculture Umudike, Nigeria.
25. Ukpabi, U.H. (2007). Evaluation of *Mucuna* seed meal based diets for goat production in south eastern Nigeria. Ph.D dissertation. Michael Okpara University of Agriculture Umudike, Nigeria.
26. Morand-Fehr, P. and Sauvant, D. (1978). Nutrition and optimum performance of dairy goats. *Liv. Prod. Sci.,* 5:203-213.
27. Louca, A., Antoniou, T. and Hatzipanayiotou, M. (1982). Comparative digestibility of feedstuffs by various ruminants, specifically goats. Proc. 3rd Intl. Conf. on goat production and disease. January 10th -15th 1982. Tucson, Arizona USA Pp. 122-141.

28. Matenga, V.R., Ngongoni, N.T., Titterton, M. and Maasdorp, B.V. (2003). *Mucuna* seeds as a feel ingredients for small ruminants and effect of ensiling on its nutritive value. *Tropical and sub-tropical agroecosystem,* 1: 97-105.
29. Ahamefule, F.O., Odilinye O. and Nwachukwu, E.N. (2011). Comparative evaluation of milk yield and composition of Red Sokoto and West African does in a hot humid environment. Proc. 36th conf. Nig Soc. for Anim. Prod. 13th -16th March, 2011, Univ. of Abuja. Pp. 513-514.
30. Akinsoyinu, A.O. (1974). Studies on protein and energy utilization by the WAD goats. Ph.D thesis University 0f Ibadan, Nigeria.
31. Akpa, G.N., Asiribot, O.O. and Alawa, J.P. (2001). The influence of non-genetic factors on the shape of lactatioin curves in Red Sokoto goats. *J. Anim. Sci.,* 72: 233-239.
32. Butswat, I.S.R., Zahraddeen, D., Manch, Y.B. and Dachollom, C.C. (2002). Effects of breed and parity on milk yield of Red Sokoto and Sahel goats. Proc. Ann. Conf. Anim. Sci. Ass. Nig. 7: 17-19.
33. Zahradden, D., Butswat, I.S. and Mbap S.T. (2008). Evaluation of Some factors affecting milk composition of indigenous goats in Nigeria. www.gpav.org/irrd/irrdig/11/zah. Retrieved 22nd September 2008 1800 hrs.
34. Jenness, R. (1980). Composition and characteristics of goat milk: reviews (1968-1979). *J. Dairy Sci.,* 63:1605-1630.
35. Ahamefule, F.O Ibeawuchi, J.A and Ejiofor, C.A. (2003). A comparative study of the constituents of cattle, sheep and goat milks in a hot humid environment. *Discovery and Innov.,* 15:64-68.
36. Ahamefule, F.O. Ibeawuchi, J.A. and Okonkwo, C.I. (2004). Comparative evaluation of the constituents of colostrum and milk of the West African Dwarf sheep and goat reared in a humid tropical environment. *Niger. Agric. J.* 35: 118-126.
37. Ahamefule, F.O., Ibeawuchi, J.A. and Ejiofor, C.A. (2000). A comparative study of the constituents of cattle, sheep and goat milks in a hot humid environment. *J. Sustain. Agric. Envt.* 2 (2): 168-173.
38. French, M.H. (1970). Observations on the Goat. FAO Animal production and health services No.14. Pp. 204.
39. Ibeawuchi, J.A. (1985). A study on variation of some milk constituents of freisian cows at Vom. *Nig. J.Anim. Prod. Res.* 5 (11):113-124.
40. Morand-Fehr, P. and Sauvant, D. (1980). Composition and yield of goat milk as affected by

nutritional manipulation. *J. dairy Sci.,* 63:1671-1680.

41. Ahamefule, F.O. and Ibeawuchi, J.A. (2005). Milk yield and composition of West African Dwarf (WAD) does fed pigeon peal based diets. *J. Anim. and Vet. Adv.* 4 (2): 991-999.
42. ANON (2011). Anonymous: Goat milk ingredients. http://www.everything-goat-milk.com/milk-ingredient.html. Retreved 1st October, 2011 at 1330 hrs.
43. Sawaya, W.N., Khahl, J.K., Al-shalhat A.F. (1984). Mineral and Vitamin content of goat's milk. *J. Anim. Diet. Assoc.* 84: 433-435.
44. Brendehaug, J. and Abrahamsen, E. (1987). Trace element in bulk collected milk. *Milchwirsenschaft,* 42: 289-290.
45. Bawala, T.O., Isah, O.A. and Akinsoyinu, A.O. (2006). Studies on milk Mineral composition of lactating WAD goats. *J. Anim. and Vet Adv.,* 5(10): 805-809
46. Kessler, J. (1981). Major and Trace elements in goat. Basic data and recommended allowance. In: Studies on milk mineral composition of lactating WAD goats. *J. Anim. and Vet. Adv.,* 5(10): 808-809.
47. Guegue, L. and Barlet, J.P. (1978). Besionsd nutritionnels en mineraux at Vitamins de la brebis et de la chevre (Mineral and Vitamins requirements of ewes and goats). 4e journee de la recherché ovine et caprin ITOVIC-SPEOC, Paris (France) Pp. 19-37.
48. Kessler, J. (1991). Vitamin nutrition of goats. In: Goat nutrition. Morand-Fehr, P. (ed). EAAP Publication N0. 46 Pudoc Wageningen. The Netherland. Pp.120-123.
49. Simos, E.L.,Vontsinas, P. and Pppas, C.P. (1991). Composition of milk of native Greek goats in the region of Metsovo. *Small Rum. Res.* 4: 47-60.
50. Kondyli, E., Katsiari, M.C. and Voustsinas, L.P. (2011). Variations of vitamin and mineral content in raw goat milk of the indigenous Greek breed during Lactation. http://www.sciencedirect.com/science/artiele/Pii/50308814605008344.
51. Smith, V. (1959). Physiology of lactation. 5th Ed. IOWA State University press Ames.
52. Olomu, J.N. (1995). *Non ruminant animal nutrition.* Nadem Nigeria Pp.108.
53. De-kock, C. (2011). Bambara nut. Speciality foods of Africa PVT Ltd. Harare,Zimbabwe.(http://www.underutilizedspecies.Org/documents/publications/bambara_groundnut_paper.pdf). Retrieved 11th febuary 0010 hrs.
54.