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Original article

Influence of baobab fruit in the diet on intake, milk yield and milk composition in Red Sokoto goats

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ABSTRACT

Baobab fruit *(Adansonia digitata)* is a nutritious but grossly underutilized food resource with great potentials for improving the productivity of milking goats in Nigeria. Twenty four Red Sokoto goats fed diets containing 0, 10, 20 and 30% baobab pulp and seed meal (BPSM) were used to evaluate the influence of baobab fruit on yield and composition of goat milk. The experimental design adopted was the completely randomized design. Animals were exercised daily inside a fenced paddock where they had access to forage. Dry matter (DM) intake, milk yield, feed conversion ratio (FCR) and milk composition in the goats were measured over a period of 84 days. There were significant (P<0.05) differences in intake, milk yield and FCR of the goats. DM intake increased from 21.5 to 27.5 % of live weight (LW) and milk yield from 333.8 to 441.9 g/day with inclusion of BPSM in the diet. FCR was 1.40, 1.30, 1.28 and 1.29 for 0, 10, 20 and 30% BPSM diets respectively. Milk composition was also significantly (P<0.05) influenced by level of baobab meal in the diet. Total solids in milk increased from 12.23 to 14.10 %; protein from 3.50 to 4.08 %; and fat from 3.38 to 4.45 % with BPSM in the diet. Addition of BPSM to the diet enhanced feed intake and milk production in Red Sokoto goats raised in the derived savanna of Nigeria.

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1. Introduction

Increased awareness of the nutritional and health benefits of milk in tropical areas has led to increased demand for milk and its products (Ahamefule et al., 2003). Although the bulk of milk consumed in Nigeria is derived from cattle, the proportion derived from goats and sheep is on the increase. Milk production from small ruminants in the tropics is often limited by poor nutrition and inadequate energy, protein, mineral and vitamin intake by the animals (Ahamefule et al., 2012). In order to maximize opportunities presented for milk production by goats in Nigeria, there is need to improve the nutrition of the milking goat.

The Red Sokoto goat (also known as Maradi goat) is indigenous to the northern parts of the country. While they are traditionally raised for meat and skin, they are also a good source of milk for household consumption (Wilson, 1991; Akpa et al., 2003). The increasing demand for meat and milk in the southern parts of Nigeria has led to increased interest in raising these animals outside their natural habitat (Ahamefule et al., 2012). This practice however, needs to be complemented with high levels of management and nutrition.

The baobab tree (*Adansonia digitata*) is widespread in the drier savannas of northern Nigeria and to a lesser extent in the derived savanna of southern Nigeria. The fruit which is oval shaped consist of a woody shell encasing numerous seeds embedded in a whitish, dry and powdery pulp (Nnam and Obiakor, 2003). The pulp and seed is a good source of carbohydrates, fats, protein, vitamins and minerals (Kaboré et al., 2011). Baobab fruit also has high antioxidant and medicinal properties (Vertuani et al., 2002; Kaboré et al., 2011), making it a valuable health food. Tales by Fulani herdsmen in Nigeria claims that baobab fruit pulp enhances milk flow and yield in women and cows. These purported attributes of the fruit stimulated the interest in its use for improving milk production in lactating goats. This study was therefore conceived to evaluate the milk yield and milk composition in Red Sokoto goats fed different levels of baobab pulp and seed meal in the feed mixture.

Photo 1. Baobab fruit.

Photo 2. Red Sokoto goat.

2. Materials and methods

2.1. Location

This study was conducted at the Teaching and Research Farm of the Ladoke Akintola University of Technology, Ogbomoso, Oyo State which is located mainly within the derived savanna of Nigeria.

2.2. Preparation of diets

Baobab fruits were gathered from surrounding rural communities in Ogbomoso. The dry fruits were broken manually; the pulp and seeds were removed and sun-dried for two days. The dried pulp and seed was later milled and mixed with other ingredients at 0, 10, 20 and 30% to form the following experimental diets:

- Bb-0: diet without baobab meal
- Bb-10: diet with 10% baobab meal

- Bb-20: diet with 20% baobab meal
- Bb-30: diet with 30% baobab meal.

Proximate composition of baobab meal and experimental diets was determined in the laboratory using the general procedures of AOAC (2005) while detergent fibre fractions were determined using the procedures of Van Soest et al. (1991). The composition of the experimental diets is given in Tables 1 and 2.

2.3. Milk production study

Milk collection lasted for a period of 84 days using 24 primiparous Red Sokoto does weighing 21.5±1.3 kg. These animals were fed experimental diets containing different levels of baobab meal in a formulated diet. Animals were exercised daily inside a fenced pasture planted with Guinea grass (*Panicum maximum*) for 1 hour. The chemical composition of the basal Guinea grass is given in Table 2. Intake of animals inside the paddock was estimated with a 1 x 1m quadrate using the procedure described by Olorunnisomo et al. (2014). Prior to milk production, animals were synchronized for oestrus using 45mg fluorogestone acetate vagina sponges and pregnant mare serum gonadotrophin (PMSG) hormone. Proven bucks were introduced when signs of heat were detected. Response of the does to dietary treatments during gestation is discussed in a separate paper. Milking commenced 4 days post-partum to give kids access to sufficient colostrums. Thereafter, kids were separated from their dams and allowed to suckle for 20 mins at 9.00, 12.00 and 15.00 h daily. Milk intake by kids was estimated using the weigh-suckle-weigh method (Williams et al., 1979). Animals were hand milked once daily between 7.00 and 9.00 h. Milk off-take was measured daily using a measuring cylinder and, daily milk yield was estimated as a summation of milk off-take and intake by the kids over a 12-week period (84 days). Milk samples were taken from each treatment group at 4 weeks interval to determine milk composition using the procedures of AOAC (2005).

2.4. Statistical analysis

The experimental design adopted for this study was the completely randomized design. All data collected were subjected to analysis of variance and significant means were separated by Duncan's multiple range tests, following the procedures of SAS (1995).

3. Results

3.1. Composition of test diets

The ingredient composition of test diets is presented in Table 1 while the chemical composition of baobab meal and the test diets is shown in Table 2. Test diets were similar in composition except for the proportion of BPSM and wheat offal which was varied. The proportion of baobab in the different diets varied from 0 % in Bb-0 to 30 % in Bb-30 while wheat offal decreased from 63 % in Bb-0 to 33 % in Bb-30. Other ingredients were fixed in the diets.

Table 1
Ingredient composition of the experimental diets.

Ingredient (%)	Bb-0	Bb-10	Bb-20	Bb-30
BPSM	0.00	10.0	20.0	30.0
Wheat offal	63.0	53.0	43.0	33.0
Cassava peels	20.0	20.0	20.0	20.0
PKC	15.0	15.0	15.0	15.0
Vitamin Premix	0.50	0.50	0.50	0.50
DCP	0.50	0.50	0.50	0.50
Salt	1.00	1.00	1.00	1.00
Total	100	100	100	100

Bb-0: diet without baobab meal, Bb-10: diet with 10% baobab meal, Bb-20: diet with 20% baobab meal, Bb-30: diet with 30% baobab meal. BPSM: baobab pulp and seed meal, PKC: palm kernel cake, DCP: di-calcium phosphate.

Table 2
Chemical composition of Guinea grass (*Panicum maximum*), baobab fruit *(Adansonia digitata)* and experimental diets.

Constituent (%)	Guinea grass	Baobab pulp and seed meal	Bb-0	Bb-10	Bb-20	Bb-30
Dry matter	24.6	89.8	88.5	88.1	87.9	87.0
Crude protein	6.40	13.2	14.5	14.1	13.7	13.3
Crude fibre	33.4	12.0	10.7	11.1	11.5	11.8
Ether extract	1.25	9.00	6.50	7.00	7.40	7.83
Ash	10.6	7.56	5.00	5.29	5.97	6.65
NFE	48.4	58.2	63.3	62.5	61.4	60.4
NDF	35.8	50.6	41.5	43.6	45.5	46.9
ADF	64.5	26.0	18.2	19.8	20.8	22.1
ADL	13.8	10.0	8.75	10.0	10.7	10.8

NFE- nitrogen free extract, NDF- neutral detergent fibre, ADF- acid detergent fibre, ADL- acid detergent lignin. Bb-0: diet without baobab meal, Bb-10: diet with 10% baobab meal, Bb-20: diet with 20% baobab meal, Bb-30: diet with 30% baobab meal.

Table 2 shows that the crude protein content of the diets varied from 13.3 to 14.5 %; fat content (ether extract) from 6.50 to 7.83 %, carbohydrates (NFE) from 60.4 to 63.3 % and NDF from 41.5 to 46.9 %.

3.2. Milk production

The average daily milk yield of Red Sokoto goats fed different proportions of baobab fruit in the diet during the 12-week study is shown in Figure 1. Milk yield was highest when baobab was fed at 20 % inclusion in the diet and least when no baobab (control) was fed. Although milk yield of goats fed baobab at 10 or 30 % inclusion was not significantly different from each other, it was higher than that of control animals. Peak yield of milk occurred around 4th week of lactation for all treatments during the 12-week study.

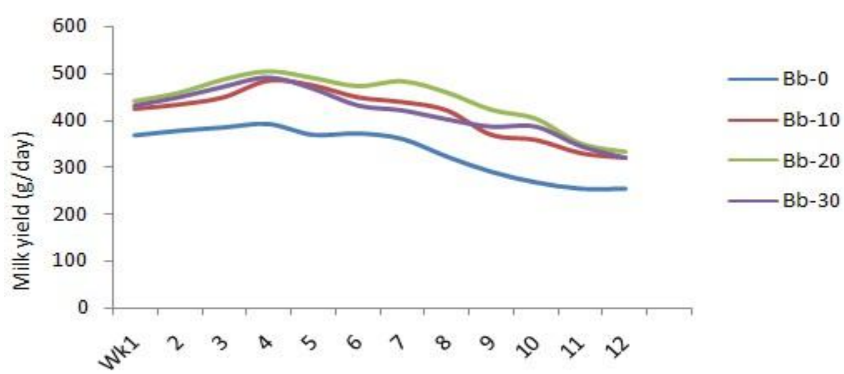

Fig. 1. Daily milk yield (g) of Red Sokoto goats fed graded levels of baobab fruit meal in the diet.

The intake, milk yield and feed conversion ratio of goats fed baobab fruit in the diet is presented in Table 3. Forage intake from pasture was estimated and constant for all treatment groups while intake of test diets varied significantly ($P < 0.05$) across the treatments. Total intake varied from 469.3 to 566.2 g/day and 21.5 to 27.5 g/kg of live weight.

Milk yield in Red Sokoto goats varied significantly ($P < 0.05$) across dietary treatments from 333.8 to 441.9 g/day. The lowest milk yield was recorded for diet without baobab (control) and the highest value recorded for diet with 20 % level of baobab. Inclusion of baobab fruit meal in the diet significantly ($P < 0.05$) reduced the feed conversion ratio. The FCR reduced from 1.40 in control (Bb-0) to 1.28 in treatment with 20 % of baobab fruit (Bb-20). There were no significant ($P > 0.05$) differences in FCR among animals fed 10, 20 or 30 % of baobab in the diet.

3.3. Milk composition

The composition of milk in Red Sokoto goats fed baobab fruit in the diet is presented in Table 4. Total solids of milk varied from 12.23 to 14.10 % while protein varied from 3.50 to 4.08 %. Fat content of the milk also varied from 3.38 to 4.45 %. There were no significant differences in ash or lactose content of the milk in goats fed different levels of baobab in the diet. Protein and fat in the milk increased with inclusion of baobab fruit in the diet.

Table 3

Intake, milk yield and feed conversion ratio (FCR) of Red Sokoto goats fed baobab fruit meal in a mixed diet.

Parameter	Bb-0	Bb-10	Bb-20	Bb30	SEM
DM intake (g)					
Pasture (g/day)	115.0	115.0	115.0	115.0	-
Test diets (g/day)	354.3^{c}	420.5^{b}	451.2^{a}	419.5^{b}	8.23
Total (g/day)	469.3^{c}	535.5^{b}	566.2^{a}	534.5^{b}	10.2
Total (g/kg LW)	21.5^{c}	25.0^{b}	27.5^{a}	25.0^{b}	0.60
Protein intake (g/day)	68.05^{c}	75.51^{a}	77.57^{a}	71.09^{b}	1.35
Milk yield (g/day)	333.8^{c}	411.6^{b}	441.9^{a}	415.8^{b}	8.19
FCR	1.40^{a}	1.30^{b}	1.28^{b}	1.29^{b}	0.03

abc: means with different superscripts within the row are significantly different (P < 0.05). Bb-0: diet without baobab meal, Bb-10: diet with 10% baobab meal, Bb-20: diet with 20% baobab meal, Bb-30: diet with 30% baobab meal. DM: dry matter, LW: live weight, FCR: feed conversion ratio.

Table 4

Milk composition of Red Sokoto goats fed varying levels of baobab fruit meal in the diet.

Constituents (%)	Bb-0	Bb-10	Bb-20	Bb-30	SEM
Total solids	12.23^{c}	13.09^{b}	14.10^{a}	13.97^{a}	1.10
Protein	3.50^{b}	3.68^{b}	4.08^{a}	4.00^{a}	0.18
Fat	3.38^{c}	3.95^{b}	4.45^{a}	4.38^{a}	0.12
Ash	0.80	0.86	0.90	0.88	0.07
Lactose	4.55	4.60	4.67	4.64	0.18

abc: means with different superscripts within the row are significantly different (P < 0.05). *Lactose was calculated as total solids – (protein + fat + ash).

4. Discussion

The diet offered to goats in this study was based on partial grazing (1 hour/day) of *Panicum maximum* pasture and *ad libitum* feeding of four experimental diets in which wheat offal was replaced by different levels of BPSM. Addition of baobab fruit to the diet slightly reduced the crude protein and NFE content of the diets while fibre components, ether extract and ash slightly increased. Since protein and carbohydrate components of experimental diets reduced with addition of baobab fruit, it may be inferred that the effect of baobab on performance of the goats was mediated through increased DM intake, improved health in the animals and better utilization of nutrients due to the vitamins, antioxidant and medicinal entities in the fruit. Baobab fruit has been reported to be a rich source of vitamin C, antioxidants, minerals and medicinal substances (Nour et al., 1980; Vertuani et al., 2002; Kaboré et al., 2011). The belief among Fulani herdsmen in the southwest of Nigeria, that baobab fruit pulp enhances milk yield and milk flow in humans and cattle may be related to its medicinal and antioxidant properties.

The lactation curve was similar for all treatments (Figure 1) and followed a similar trend as reported by Akpa et al. (2001) for Red Sokoto goats in the northern Nigeria. Milk production increased during early lactation and reached its peak at the 4th week of lactation and subsequently decreased until the 84th day of lactation. This was within the 2 to 5 weeks peak yield reported for Red Sokoto goats (Akpa et al., 2001) and comparable to 30 days reported for Saanen goats by Souza et al., (2014). While peak yield of milk generally occurs during early lactation, it is more desirable to shift it toward mid lactation in order to sustain a fairly high milk production throughout lactation. This appears to be a genetic trait and may not be easily influenced by nutrition as noted in Marete et al. (2014) where peak yield tended towards early lactation for local goats and mid lactation for Alpine dairy goats in Kenya. Although lactation pattern was similar for all treatments in this study, goats fed baobab in the diet had higher milk yields than goats without baobab in the diet. This supports the claim by Fulani herdsmen that baobab fruit possess intrinsic factors that enhances milk production the cow.

Dry matter intake, protein intake and milk yield of goats increased with inclusion of baobab in the diet. The milk yield of goats in this study was a direct response to DM and protein intake by the animals (Table 3). Although CP content of the diets reduced with higher levels of baobab in the feed mixture, the DM and protein intake by the animals increased significantly. The higher protein intake with baobab in the diet was a reflection of higher DM intake induced by baobab fruit in the diet. The pleasant taste of baobab fruit and its vitamin content may be responsible for the observed increase in DM intake of the animals. Milk yield of goats in this study increased with addition of baobab to the diet and was directly proportional to protein intake by the animals. This agrees with the findings of Olorunnisomo (2013) where milk yield of zebu cows increased in proportion to their protein intake.

Composition of the milk was largely influenced by the DM intake of the goats which increased as level of baobab in the diet increased. The protein content of the milk increased with higher levels of baobab in the diet. This was influenced by the higher protein intake of goats as the level of baobab fruit increased in the diet. The fat content of the milk also increased with addition of baobab to the diet in response to higher DM intake by the goats. The fat content of goat milk in this study ranged from 3.38 to 4.45%. This is lower than values of 4.38 to 5.70 % reported by other workers (Akinsoyinu et al., 1981; Zarhraddeen et al., 2007; Alawa and Oji, 2008) for Red Sokoto goats. The ash and lactose content of the milk however, was not influenced by the level of baobab in the diet or protein intake by the animals. It has been noted that lactose concentration in milk is not easily altered by nutrition (Ahamefule et al., 2003; 2012).

5. Conclusion

Addition of baobab fruit meal to the diet of Red Sokoto goats increased DM and protein intake of the animals. Milk yield of the lactating goats also increased with addition of baobab fruit to the diet while feed conversion ratio decreased. Protein and fat content of goat milk increased while ash and lactose content was not altered with addition of baobab to the diet. Baobab fruit enhanced feed conversion efficiency and enhanced milk production in Red Sokoto goats.

References

Ahamefule, F.O., Ibeawuchi, J.A., Ejiofor, C.A., 2003. A comparative study of the constituents of cattle, sheep and goat milk in a hot humid environment. Disc. Innov., 15, 64-68.

Ahamefule, F.O., Odilinye, O., Nwachukwu, E.N., 2012. Milk yield and composition of Red Sokoto and Wea dwarf does raised intensively in a hot humid environment. Iran. J. Appl. Anim. Sci., 2(2), 143-149.

Akinsoyinu, A.O., Tewe, O.O., Ngere, L.O., Mba, A.U., 1981. Milk composition and yield of Red Sokoto (Maradi) goats. Trop. Anim. Prod., 6(2), 186-187. http://www.fao.org/livestock/agap/frg/tap62/62_186.pdf

Akpa, G.N., Asiribo, E.O., Oni, O.O., Alawa, J.P., 2001. The influence of non-genetic factors on the shape of lactation curves in Red Sokoto goats. Anim. Sci., 72, 233-239.

Akpa, G.N., Osuhor, C.U., Olugbemi, T.S., Nwani, P.I., 2003. Milk flow rate and milking frequency in Red Sokoto goats. Pak. J. Nutr., 2(3), 192-195.

Alawa, J.P., Oji, U.I., 2008. Effect of pendulous udder enlargement on yield of Red Sokoto goats. J. Anim. Vet. Adv. 7, 870-872. http://docsdrive.com/pdfs/medwelljournals/javaa/2008/870-872.pdf

AOAC., 2005. Official Methods of Analysis, 18th edn. Association of Official Analytical Chemists, Washington DC.

Kaboré, D., Sawadogo-Lingani, H., Diawara, B., Compaoré, C.S., Dicko, M.H., Jakobsen, M., 2011. A review of baobab (*Adansonia digitata*) products: Effect of processing techniques, medicinal properties and uses. Afr. J. Food. Sci., 5(16), 833-844.

Marete, A.G., Mosi, R.O., Amimo, J.O., Jung'a, J.O., 2014. Characteristics of lactation curves of the Kenya Alpine dairy goats in smallholder farms. Open. J. Anim. Sci., 4, 92-102. http://dx.doi.org/10.4236/ojas.2014.42013

Nnam, N.M., Obiakor, P.N., 2003. Effect of fermentation on the nutrient and antinutrient composition of baobab (Adansonia digitata) seeds and rice (Oryza sativa) grains. Ecol. Food. Nutr., 42, 265-277.

Nour, A.A., Nagboul, B.I., Kheiri, N.H., 1980. Chemical composition of baobab fruit (*Adansonia digitata* L.). Trop. Sci., 22, 383-388.

Olorunnisomo, O.A., 2013. Milk production in Sokoto Gudali cows fed legume or elephant grass ensiled with cassava peel. Livest. Res. Rural. Dev., 25, Article #105. Retrieved, from http://www.lrrd.org/lrrd25/6/olor25105.htm

Olorunnisomo, O.A., Akinpelu, W.A., Oni, A.A., 2014. Performance of zebu heifers under heat mitigation measures in a humid-tropical environment. Agr. Trop. Subtrop., 47(4), 119 – 123.

SAS Institute, 1995. SAS/STAT User's Guide. Version 6, 4th Edition. Volume 1 and 2. SAS Institute Inc., Cary, NC.

Souza, R., Alcalde, C.R., Oliveira, C.A.L., Labio Molina, B.S., Maceo, F.A.F., Gomes, L.C., Hygino, B., Possama, A.P.S., 2014. Lactation curves and economic results of Saanen goats fed increasing dietary energy levels obtained by the addition of calcium salts of fatty acids. Rev. Brasil. Zoot., 43(2), 73-79.

Van Soest, P.J., Robertson, J.B., Lewis, B., 1991. Methods for dietary fibre, neutral detergent fibre and non-starch polysaccharides in relation to animal nutrition. J. Dairy. Sci., 74, 3583-3597.

Vertuani, S., Braccioli, E., Buzzoni, V., Manfredini, S., 2002. Antioxidant capacity of *Adansonia digitata* fruit pulp and leaves. Acta Phytotherapeutica, 2, 2-7.

Williams, J. H., Anderson, D.C., Kress , D.D., 1979. Milk production in Hereford cattle. 1. Effects of separation interval on weigh-suckle-weigh milk production estimates. J. Anim. Sci., 49, 1438-1442.

Wilson, R.T., 1991. Small ruminant production and the small ruminant genetic resource in tropical Africa. FAO Animal Production and Health Paper 88. Food and Agriculture Organization of the United Nations, Rome http://www.fao.org/docrep/009/t0376e/T0376E07.htm

Zahraddeen, D., Butswat, I.S.R., Mbap, S.T., 2007. Evaluation of some factors affecting milk composition of indigenous goats in Nigeria. Livest. Res. Rural. Dev., *19, Article #166.* Retrieved from http://www.lrrd.org/lrrd19/11/zahr19166.htm

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