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Milk Yield and Composition of Red Sokoto Goats Fed Varying Levels of Baobab (Adansonia digitata) Fruit Meal Supplement in the Diet

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Abstract
The milk yield and mineral composition of Red Sokoto goats fed varying levels of baobab *(Adansonia digitata)* fruit meal supplement was investigated over a period of 84 days. Twenty four (24) lactating Red Sokoto goats averaging 19.75 $\pm$ 1.26 kg body weight were randomly allotted to four dietary treatments with six animals per replicate in a completely randomized design to determine the quantity and quality of milk produced. Treatment 1 was control with no baobab pulp and seed supplement, Treatments 2, 3 and 4 had 10%, 20% and 30% baobab pulp and seed inclusion respectively. The milk yield and mineral composition were significantly affected ($P<0.05$). Milk yield progressively increased for all treatments to week four where the peak was recorded for the yield with 20% baobab fruit inclusion levels having a clear significant value of 5043.50g, followed by 30%, 10% above the control with varying values of 4905.25g, 4835.60g and 3922.31g respectively. The milk yield recorded a decreased values of 3325.00g, 3189.69g, 3183.25g and 2523.50g for 20%, 10%, 30% and 0% inclusion levels at the end of 12th week. There were significant difference ($P<0.05$) in the values of Total solids, Fat and lactose. For milk composition; 30% inclusion level recorded the highest values for Total solids, fat and lactose at figures of 17.38%, 5.78% and 6.64% respectively. The fat content of the milk in the study were at the increasing range of 3.0 %, 4.05%, 4.60% and 5.78% respectively for inclusion levels of 0% – 30% baobab fruit in the experimental diets. Milk produced by the experimental animals on 20% and 30% levels of inclusion recorded the overall best results in term of mineral composition. The results of the study had shown that inclusion of baobab fruit at 20 % in the diet of Red Sokoto goats gave the highest milk yield . Inclusion at 30% level also gave better results in term of mineral composition.
Keywords: baobab pulp and seed, red sokoto goat, milk yield and mineral composition.

INTRODUCTION

The rising demand for milk and its products in the tropics has made it imperative to find means for increasing local milk production. The traditional dairy subsector is dominated by indigenous cattle breeds whose potential for milk production is largely underexploited (Olorunnisomo *et. al.,*2013). Even though cattle produces best milk in terms of quantity to meet the nutritional need of ever increasing human population; milk production by goats also cannot be overlooked.

Goat production plays a very vital role in the livelihood of rural populations in Nigeria as it contributes significantly to improvement of family nutrition and health. Also, sales of animals and their products help to stabilize household income. Goat husbandry, therefore, is considered as a form of food security and source of independent income for rural households and subsistent farmers. . The demand for animal products including milk have informed the need to raise indigenous goats even outside their natural habitat/environment; this practice helps in performance evaluation of animals in locations outside their domain (Ahamefule et. al.,2012).

The nutritional role of milk and milk products in human diet especially in developed countries has been well documented (Ibeawuchi *et al*. 2000). Milk from ruminants is a good alternative to augment animal protein intake. The West African Dwarf and the Red Sokoto goats are indigenous goat breeds found in southern and northern Nigeria, respectively. Records of their dairy performance in their natural environment exist (Ahamefule and Ibeawuchi, 2005; Akpa *et al.* 2002). However, their potentials for milk and meat production outside their natural ecology are continuously under survey (Akpa, 1999; Akpa *et al*. 2003;Ahamefule and Ibeawuchi, 2005). It is possible that these small ruminant breeds can do well, or even better, outside their natural habitat if well managed. Good management practices include adequate feeding of materials of great potentials for better performance. Therefore, feeding regime using non-conventional feedstuff such as baobab (*Adansonia digitata*) fruit is a pointer to accomplish this due to its beneficial health properties as antioxidant, analgesic, anti-inflammatory (Ramadan *et al*.,1994), and good source of micronutrients and energy (Lockett *et al*., 2000). Folktales among fulani herdsmen has it that Baobab fruit pulp enhances milk yield and milk letdown among Zebu cows.

1.1 MATERIAL AND METHODS

The study was conducted at the Small Ruminant Unit of Ladoke Akintola University of Technology Teaching and Research Farm. Sixteen lactating Red Sokoto goats (Does) were used for the study. Milk collection lasted for 84 days (12 weeks). The animals were allotted to four treatment comprising of six (6) animal per treatment in a Completely Randomized Experimental Design.

1.1.1 Preparation of experimental diets

The baobab fruits were gathered from a rural community in Ogbomoso area of Oyo State , Nigeria. The fruit pulp and seeds were removed and sun-dried for a week to reduce the anti nutrients. Dried baobab pulp and seeds was later milled and included at varying levels of 10%, 20% and 30% respectively with other feed component to prepare a concentrate tagged baobab pulp and seed meal (BPSM).

1.1.2 Chemical evaluation

Proximate analysis

Proximate composition of the whole baobab fruit, pulp, seeds, pulp and seed mixture as well as experimental diets were carried out according to the procedure of AOAC (1990). The crude protein was determined by the Kjeldahl method as described by AOAC (1990). Crude fiber determination was carried out using trichloroacetic acid (TCA) method. The ash and crude fat content were obtained by charring in furnace and extraction with ether

1.1.3

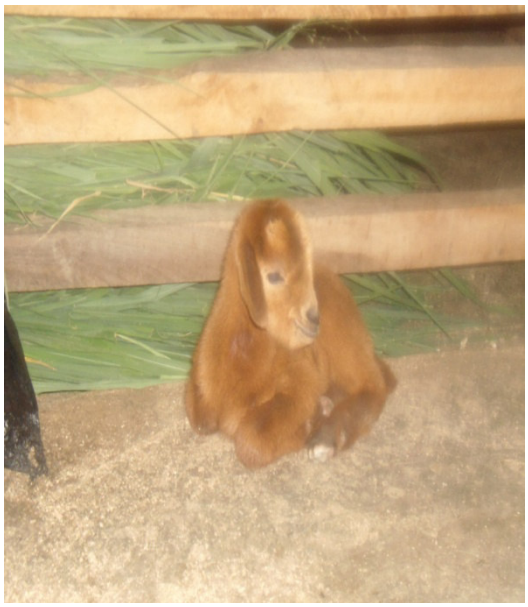
Experimental Animals – Twenty four (24) lactating Red Sokoto goats fed varying levels of baobab *(Adansonia digitata)* fruit inclusion levels of 0%, 10%, 20% and 30% meal were used for the study in a 84 days milk collection.

Experimental Design – Completely Randomized Design

In a completely randomized design with six replicates of lactating doe per treatment, animals were randomly distributed to 4 treatments.

1.1.4 Milk Collection

Collection of milk from each lactating doe commenced 7 days after parturition to allow for colostrums intake by the kids. Milking procedure of Olorunnisomo et.al., 2012 in a study on Sokoto gudali cows was adopted in milk collection in the study. Milking was done by hand twice daily at 7am and 4pm in the presence of the kids for 84 days. Milk let-down was stimulated by the suckling the kid for 5 minutes after which the doe was milked. Weight of the kids was taken before and immediately after suckling to estimate milk intake. Kids were separated from does after milking and part of the milk collected was fed back to the kids using a nipple-bottle. Milk yield was calculated as the summation of milk off-take and intake by the kid



Kid – A week after parturition

A doe after milking

1.1.5. MILK SAMPLING

Milk sampling was initiated a week after parturition and terminated on the 56th day (8 weeks) post partum for each lactating doe. Sample from daily milk yield for each doe was recorded and stored in a refrigerator (-5^{o}C). At the end of 8th week of samples collection; Total solids, Crude protein, Fat and Ash samples from each treatment were analyzed for as described by AOAC (1995).

Mineral Analysis was carried out by wet digestion of samples using Atomic Absorption Spectro-photometer (AAS)

1.1.6 STATISTICAL ANALYSIS

Data collected was subjected to analysis of variance (ANOVA) procedure of SAS (1999) and differences between treatment means was separated using Duncan Multiple Range Test

1.1.7 RESULT AND DISCUSSION

Table 4 presents the average milk yield (g) over 90 days lactation in Red Sokoto goats fed baobab fruit meal supplement. The result is significantly (P<0.05) different among the treatments for the twelve weeks of collection. Milk yield progressively increased for all treatments from week one to week four where the peak was recorded for the yield with 20% baobab fruit inclusion levels having a clear significant value of 5043.50g, followed by 30%, 10% above the control with varying values of 4905.25g, 4835.60 and 3922.31g respectively. This is in agreement with the findings of Ahamefule et. al., 2012 , Ahamefule and Ibeawuchi (2005) and Akpa *et al*. (2003) where peak production was recorded in West African Dwarf and Red Sokoto goats at the 4th week of lactation. The differences in milk yield may be attributed to feed intake and varying inclusion levels of baobab fruit in the experimental diets. Meanwhile, even though a decrease in yield was observed generally across the treatment at the fifth week of the study; animals on 20% inclusion level recorded the highest values in milk yield. The milk yield recorded a decreased values of 3325.00g, 3189.69g, 3183.25g and 2523.50g for 20%, 10%, 30% and 0% inclusion levels at the end of 12th week. This could be attributed to gradual reduction in milk synthesis by the animals with reference to gradual offset of lactation.

The milk composition of Red Sokoto goats fed varying levels of Baobab *(Adansonia digitata)* fruit meal supplement was presented in table 5. There were significant difference (P<0.05) in the values of Total solids, Fat and lactose. For milk composition; 30% inclusion level recorded the highest values for Total solids, fat and lactose at figures of 17.38%, 5.78% and 6.64% respectively. It has been documented that the concentration of lactose in milk cannot be easily altered by nutrition. Ahamefule *et al.,* 2012. Ahamefule *et al.* (2003) recorded lactose concentrations of 4.46, 4.62 and 4.60% in early, mid and late lactation stages in West African Dwarf goat which affirm the relative consistency of lactose in milk. Lactose is a disaccharide synthesized in the udder. It is composed of a molecule of galactose joined to a molecule of glucose. Ash values were not influenced ((P>0.05) by graded level of baobab pulp and seed in the experimental diets. The values recorded were 0.80%, 0.84% 0.90% and 0.90% respectively for treatment 1 to 4. These values were within the range of 0.90 and 0.86% recorded by Ahamefule *et al.* (2004) and Ibeawuchi *et al.* (2003) for West African Dwarf and Red Sokoto goats, respectively.

The fat content of the milk in the study were at the increasing range of 3.0 %, 4.05%, 4.60% and 5.78% respectively for inclusion levels of 0 – 30% baobab fruit in the experimental diets.. These values were in agreement with 5.04 % and 4.94% recorded by Zarhraddeen et al., 2007. Alawa and Oji, 2008 also put fat content of Red sokoto goats in an experiment at 5.7%, Mba *et al*., 1975, put it at 5.32% . Sankey, 1991 recorded 4.30 while Akinsoyinu *et al*., 1981 and Ehoche and Buvanendran, 1983 reported 4.60% and 4.75% milk fat content respectively for the Red sokoto goats.

Table 6 presents the mineral composition of milk produced by Red Sokoto goats fed varying levels of baobab fruit inclusion levels meal supplement.. The result were significantly different (P<0.05) among the minerals examined except for 30% inclusion level of the test ingredient. Generally, the mineral composition of goat milk is between 0.7-0.8%. Among macro-minerals, potassium accounts for the greatest percentage in milk, followed by calcium, phosphorus, sodium and magnesium Ahamefule , 2012. Milk produced by animals on 20% and 30% levels of inclusion recorded the overall best results in term of mineral composition. 30% inclusion of baobab pulp and seed recorded 0.25% for calcium, 0.33% for potassium. However, there was no significant difference (P>0.05) in the value of magnesium as they both recorded 0.13. For sodium content however, 10 and 20% inclusion levels are not significantly different as the both values were put at 0.14 %. Even though there was variation in phosphorus levels as recorded in the study; its variation in value had no significant difference (P>0.05) . Alawa and Oji (2008) reported 0.14 and 0.13%, potassium to phosphorus level respectively, for Red Sokoto goat which compares favorably with the results obtained in this study even though potassium level in this study was higher. Ahamefule, 2012 reported 0.15%, 0.09%, 0.11% ,0.11% and 0.13% for Calcium, Potassium, Magnesium, Sodium and Phosphorus respectively in a study on Milk yield and composition of Red Sokoto goats. The significant variation of mineral composition recorded in this study was attributed to high mineral composition of baobab fruit. Baobab fruit especially the seed has been reported to contain high level of minerals. Nkafamiya et. al, (2007) reported phosphorus, calcium and potassium as the major mineral elements present in the seed.

CONCLUSION

The results of the study had shown that inclusion of baobab at 20 % in the diet of Red Sokoto goats gave the highest milk yield . Inclusion at 30% level also gave better results in term of mineral composition especially the macro minerals such as Calcium, Potassium. Magnesium, Sodium and Phosphorus which are essential nutrient needed by man and animal for a good health condition. Calcium for example is vital for the formation of strong

bones and teeth and is also important in the maintenance of regular heartbeat and the transmission of nerve impulses. It is needed for muscle growth and contraction and for the prevention of muscle cramps. Also, Potassium is important for a healthy nervous system and a regular heart rhythm. It aids in proper muscle contraction, and works with sodium to control the body's water balance. The roles of Magnesium in human and animal diet cannot be over-emphasized. Magnesium is vital to enzyme activity. It assists in potassium uptake. A deficiency interferes with the transmission of nerve and muscle impulses, causing irritability and nervousness. It plays a role in the formation of bone and in carbohydrate and mineral metabolism. So also is Sodium which is necessary for maintenance of proper water balance and blood pH. It is also needed for stomach, nerve, and muscle function. Importance of Phosphorus cannot be left out as its presence in human and animal diet play a major functions in the existence of these species. Phosphorus is needed for bone and tooth formation, cell growth and contraction of the heart muscle. It also assists in the utilization of vitamins and the conversion of food to energy. Baobab pulp and seed meal has been established in this study to contain all these essential nutrients and as such recommended for inclusion in ruminant diet.

In addition, baobab fruit plays a significant role in the diet of man meeting their daily vitamin C, Iron, and protein requirement. Its antioxidant capacity among other numerous health benefits has been documented. Therefore, considering the potentials of baobab fruit to supply these vital nutrient both to human and animals, its inclusion in ruminant diet no doubt will bring about the production of healthy animals and their products for human consumption.

The availability of baobab fruit in the dry season during which fresh forages are scarcely found; even where even where available; the nutritive value used to be low. Feeding this naturally reach in nutrient material; baobab fruit would thereby improve the performance of Red Sokoto goats and as such promote good health quality and their products for human consumption.

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Table 1
Chemical composition of Baobab fruit *(Adansonia digitata)*

Parameters (%)	Whole fruit	Pulp only	Pulp and seed	Seed
Dry matter	90.39	90.39	89.88	89.92
Crude protein	7.53	3.50	13.38	17.33
Crude fiber	23.00	8.00	13.00	16.00
Ether extract	15.00	11.00	18.00	22.00
Ash	6.00	6.00	7.00	7.80
NFE	48.47	71.50	48.62	36.87
NDF	71.00	48.00	60.60	65.75
ADF	41.00	16.50	26.00	30.50
ADL	26.59	10.50	15.00	18.50

NDF- Neutral Detergent Fiber, ADF- Acid Detergent Fiber, ADL- Acid Detergent Lignin

Table 2 : Gross composition of the experimental diets

Ingredient (%)	Bb - 0	Bb – 10	Bb – 20	Bb – 30
Baobab pulp and seed	0.00	10.00	20.00	30.00
Wheat offal	63.00	53.00	43.00	33.00
Cassava peels	20.00	20.00	20.00	20.00
PKC	15.00	15.00	15.00	15.00
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	100.00	100.00	100.00	100.00

Bb- 0% - Baobab pulp and seed, Bb- 20% - Baobab pulp and seed, Bb- 30% - Baobab pulp and seed, Bb- 10% - Baobab pulp and seed, PKC–Palm kernel cake, DCP – Di-calcium phosphate.

Table 3 : Chemical composition of experimental diets

Parameters (%)	Bb – 0	Bb – 10	Bb – 20	Bb – 30
Dry matter	82.57	83.07	83.98	81.92
Crude protein	14.50	14.10	13.70	13.30
Crude fiber	11.68	12.08	12.48	12.83
Ether extract	15.50	16.00	16.40	16.83
Ash	9.56	8.65	7.97	7.29
NFE	48.76	49.17	49.45	49.74
NDF	40.50	46.02	52.50	56.85
ADF	32.00	35.75	40.80	45.05
ADL	10.75	12.00	12.65	12.80
M.E (kcal/kg)	2013.70	2172.20	2220.70	2320.20

NFE- Nitrogen free extract, NDF- Neutral Detergent Fiber, ADF- Acid Detergent Fiber, ADL- Acid Detergent Lignin, Bb- 0% - Baobab pulp and seed, Bb- 20% - Baobab pulp and seed
Bb- 30% - Baobab pulp and seed, Bb- 10% - Baobab pulp and seed

Table 4

Weekly milk yield (g) over 84 days lactation period in Red Sokoto Goats fed varying levels of baobab (*Adansona digitata L.)* fruit meal supplement.

Table 8: Milk yield (g) on weekly basis over 84 days lactation period in Red Sokoto Goats fed graded levels of baobab *(Adansonia digitata.L)* fruit meal.

	T R E A T M E N T S				
Week	**Bb – 0**	**Bb - 10**	**Bb - 20**	**Bb - 30**	**SEM**
1	3678.50^{c}	4235.00^{b}	4410.00^{a}	4306.75^{ab}	161.35
2	3780.00^{c}	4326.00^{b}	4585.00^{a}	4483.50^{ab}	159.25
3	3850.00^{c}	4483.50^{b}	4870.95^{a}	4709.60^{ab}	221.41
4	3922.31^{c}	4835.60^{b}	5043.50^{a}	4905.25^{b}	245.56
5	3680.95^{c}	4730.25^{b}	4900.00^{a}	4665.50^{b}	245.00
6	3920.00^{c}	4480.00^{ab}	4728.50^{a}	4305.00^{b}	240.45
7	3500.00^{c}	4378.50^{ab}	4830.00^{a}	4200.00^{b}	198.17
8	3118.50^{d}	4200.00^{b}	4590.25^{a}	4007.50^{c}	238.42
9	2887.50^{d}	3678.50^{c}	4220.30^{a}	3850.00^{b}	237.65
10	2660.00^{c}	3570.00^{b}	4026.75^{a}	3850.00^{ab}	216.86
11	2523.50^{c}	3290.00^{b}	3500.00^{a}	3433.50^{a}	161.28
12	2523.50^{c}	3189.69^{b}	3325.00^{a}	3183.25^{ab}	145.25
TOTAL	40044.76^{c}	49397.04^{b}	53030.25^{a}	49899.85^{b}	2470.65

^{abcd} *Means within each row without superscript in common are different at P<0.05*

Bb- 0% - Baobab fruit, Bb- 10% - Baobab fruit, Bb- 20% - Baobab fruit, Bb- 30% - Baobab fruit

Table 5 : Milk composition of Red Sokoto Goats fed varying levels of Baobab *(Adansonia digitata L.)* fruit meal supplement.

Components (%)	**Bb – 0**	**Bb - 10**	**Bb – 20**	**Bb – 30**	**SEM**
Total solids	11.05^{d}	13.33^{c}	15.25^{b}	17.38^{a}	1.05
Protein	3.50^{b}	3.98^{b}	4.28^{a}	4.06^{a}	0.17
Fat	3.0^{d}	4.05^{c}	4.60^{b}	5.78^{a}	0.10
Ash	0.80	0.84	0.90	0.90	0.05
Lactose	3.75^{d}	4.46^{c}	5.47^{b}	6.64^{a}	0.15

^{abcd} *means within the same row with different superscripts are significantly different (P<0.05).*

**Lactose was calculated as total solids – (protein + fat + ash)*

Table 6: Mineral composition of Milk produced by Red Sokoto Goats fed varying levels of Baobab *(Adansonia digitata L.)* fruit meal supplement.

Minerals (%)	**Bb - 0**	**Bb - 10**	**Bb – 20**	**Bb – 30**	**SEM**
Calcium	0.15^{d}	0.18^{c}	0.20^{b}	0.25^{a}	0.001
Potassium	0.09^{c}	0.20^{b}	0.30^{a}	0.33^{a}	0.005
Magnesium	0.08^{b}	0.11^{a}	0.13^{a}	0.13^{a}	0.002
Sodium	0.10^{c}	0.14^{b}	0.14^{b}	0.16^{a}	0.02
Phosphorus	0.12^{b}	0.15^{a}	0.17^{a}	0.20^{a}	0.01

^{abcd} *means within the same row with different superscripts are significantly different (P<0.05).*

Bb- 0% - Baobab pulp and seed **Bb- 20% - Baobab pulp and seed**

Bb- 30% - Baobab pulp and seed **Bb- 10% - Baobab pulp and seed**

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