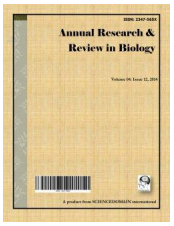

Annual Research & Review in Biology

28(1): 1-6, 2018; Article no.ARRB.36965
ISSN: 2347-565X, NLM ID: 101632869

Nutritional Effects of Baobab (*Adansonia digitata L.*) Pulp-seed Meal on the Reproductive Index of Red Sokoto Goats

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Authors' contributions

This work was carried out in collaboration between all authors. Author DOO designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors AJA and MDS managed the analyses of the study. Author MDS managed the literature searches and prepared the manuscript. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/ARRB/2018/36965
Editor(s):
(1) Jamal M. Abo Omar, Professor, Department of Animal Production, An-Najah National University, Palestine.
(2) George Perry, Dean and Professor of Biology, University of Texas at San Antonio, USA.
Reviewers:
(1) Mysa'a Ata, Jerash University, Jordan.
(2) Arnolfo M. Monleon, Marinduque State College Torrijos, Philippines.
Complete Peer review History: http://www.sciencedomain.org/review-history/25883

Original Research Article

Received 25th September 2017
Accepted 17th January 2018
Published 14th August 2018

ABSTRACT

Oestrus was artificially synchronized in thirty-six (36) primiparous Red Sokoto goats (RSG) done using 45 mg fluorogestone acetate vagina sponges for fourteen (14) days. Pregnant mare serum gonadotrophin (PMSG) hormone was administered immediately after sponge removal and the does were mated thereafter. Twenty four (24) gravid weighing 15.8 kg – 23.7 kg were selected and fed graded levels of baobab *(Adansonia digitata.* L*)* pulp-seed meal supplement in a completely randomized experimental design of six (6) replicates per treatment. There were significant differences (P<0.05) in the results obtained. At parturition, animals on 20% baobab fruit inclusion

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level had the highest mean weight value of 28.8 kg and the does on 0% inclusion level recorded the least value of 20.5 kg. At pregnancy, animals on 30% baobab inclusion level had the highest weight gain value of 5.9 kg, followed by 10% inclusion level with a weight gain of 5.5 kg. 20% inclusion level had 5.1 kg weight gain and the least value of 4.7 kg was recorded for animals on 0% baobab fruit inclusion. Similarly, the weight of dam at weaning ranged from 17.1kg to 24.8 kg. The Birth weight of kids were 1.7, 2.2, 2.1 and 2.0 kg for 0, 10, 20 and 30% levels of baobab fruits inclusion respectively. The sex ratio of male: female recorded in the study were significantly different ($P<0.05$). 0, 10, 20 and 30% baobab fruit inclusion recorded 33:67 (2 males, 4 females), 50:50 (3 Males, 3 Females), 83:17 (5 Males, 1 Female) and 67:33 (4 Males, 2 Females) respectively. The kid weight at weaning and daily weight gain of the kids was significantly different ($P<0.05$) at all levels of baobab fruit inclusion. The percentages of kid mortality at birth and at weaning were zero in this study.

Keywords: Red Sokoto goats; Baobab pulp-seed meal; weight at parturition; goat birth weight.

1. INTRODUCTION

Proteins of animal origin holds a pride place in human nutrition and existence. However, feed is the single largest cost associated with raising small ruminants. Therefore, nutrition exerts a very large influence on flock reproduction, milk production and kid growth [1]. Several methods have been used to stimulate and manipulate reproduction in farm animals. These include genetic engineering and cloning using somatic cell nuclear transfer (SCNT). These methods however are incomparable with natural reproduction by mating because they are detrimental to genetic makeup of animals. Cloning in particular hampers genetic diversity.

Enhancing reproduction following the natural course in ruminant production requires placing the highest attention to the nutritional demands of the animals. Nutritional levels especially protein largely determines the growth rate in lambs and kids [1]. Small ruminants require energy, protein, vitamins, minerals, fiber and water. Energy is usually the most limiting nutrient, while protein is the most expensive. Fiber is necessary to maintain a healthy rumen environment thereby preventing digestive upsets. However, deficiencies or excesses and imbalances of vitamins and minerals can limit animal performance and lead to various health problems [1]. Hence the need to feed animals on a feed materials containing high plane of nutritional status.

Fresh forages and grasses with potentials to supply nutritional requirements of animals in the tropics unarguably scarce in the dry season. Hence relevance efforts put in place by researchers to combat this nutritional problems became necessary. These efforts include hay making and ensiling which is difficult in tropical regions at the time when forage is of acceptable quality for conservation. Also, artificial drying is expensive and facilities are not widely available. Other practices include mixing legumes with cereal crops, wilting, using silage additive as well as use of small-scale silos. However, this procedure seems stressful to local livestock farmers, hence the need for adoption of a faster and reliable means of overcoming the nutritional challenge(s) such as feeding concentrates with available component materials capable of supplying the nutritional needs of livestock especially during the dry season when forage of good quality is scarcely found and easy to prepare by livestock owners. Baobab fruit *(Adansonia digitata L)* falls into the category of these highly nutritious but underutilized feed materials which are available in the dry season. Hence, this study was carried out to investigate the reproductive performance of Red Sokoto goats fed graded levels of baobab fruit meal supplement in the diet.

2. MATERIALS AND METHODS

2.1 Experimental Site

The study was conducted at the Small Ruminant Unit of Ladoke Akintola University of Technology Teaching and Research Farm.

2.1.1 Preparation of experimental diets

The baobab fruits were gathered from rural communities in Ogbomoso on longitude $4^{o}5^{1}$ east of the Greenwich meridian and latitude $8^{o}7^{1}$ North of the equator in the derived savannah zone of Nigeria. The fruits were picked from the ground because matured fruits would fall naturally from the parent tree. The outer covering

of the fruits were carefully scraped with hard brush. This is done to avoid contamination due to mixing during processing. The fruit pulp and seeds were removed and sun-dried for a week to reduce the anti-nutrients and moisture content. Dried baobab pulp and seeds was later milled and included at varying levels of 0, 10, 20 and 30% respectively with other feed component to prepare a concentrate tagged baobab fruit meal (BFM). Other components of the experimental feed include wheat offals (63.00%, 53.00%, 43.00% and 33.00% for diets 1-4) respectively. Cassava peels, palm kernel cake, ruminant premix, di-calcium phosphate and salt were all at a fixed proportion in all experimental diets. The Experimental diets were tagged baobab pulp and seed meal (BPSM) diets, designated as Bb-0, Bb-10, Bb-20 and Bb-30, respectively for diet 1 to 4 respectively.

2.1.2 Chemical evaluation

Dry matter, crude protein, crude fibre, ash, ether extract and nitrogen free extract were determined according to [2]. All samples were analysed. Neutral detergent fibre, acid detergent fibre and acid detergent lignin were determined according to [3]. Hemicellulose was calculated as the difference between NDF and ADF and cellulose as the difference between ADL and ADF [4].

2.2 Experimental Animals

Thirty six (36) primiparous Red Sokoto goats does were synchronized, out of which twenty four (24) gravid ones were used for the study. The animals were allotted to four treatment comprising of six (6) animal per treatment. Treatments 1, 2, 3 and 4 contained 0%, 10%, 20% and 30% baobab fruit inclusion respectively. Experimental design was completely randomized and the experiment lasted 6 months.

2.2.1 Oestrous synchronization

Oestrus was artificially synchronized in 36 does using 45mg fluorogestone acetate vagina sponges and this fluorogestone acetate sponge was placed deep in the vagina of each doe, and left to remain there for 14 days. Pregnant mare serum gonadotrophin (PMSG) hormone was administered immediately after sponge removal. Twenty four hours after sponge removal, Red sokoto goats (bucks) were introduced to the does in each group. Each group represents a treatment. Twenty eight does of experimental animals did not show signs of oestrus within one month after mating and were considered gravid out of which twenty four (24) were selected for the reproductive study.

3. RESULTS AND DISCUSSION

Table 3 presents the chemical composition of guinea grass and the experimental diets (Baobab pulp and seed meal diets). The dry matter value was in decreasing order with increased level of baobab pulp and seed meal. Bb-0 recorded the highest value of 88.5%, this was followed by Bb-10 (88.1%), Bb-20 (87.9%) while Bb-30 recorded the least dry matter of 87.0%. The same trend was recorded for the crude protein (CP) values. The values ranged from 13.3 to 14.5 % in decreasing order of 0% < 10% < 20% < 30%, but ether extract (EE) increased with the level of inclusion of baobab pulp and seed meal. The ether extract values ranged from 6.5 to 7.8 % with Bb-0 having the least value of 6.5%. Also ash and crude fibre values increased with the level of baobab pulp and seed meal inclusion, 0 < 10 < 20 < 30% inclusion. Acid detergent fibre (ADF) values were Bb-0 (18.2), Bb-10 (19.8), Bb-20 (20.8) and Bb-30 (22.1). Also, the acid detergent lignin (ADL) values increased with the level of baobab pulp and seed meal inclusion. The values ranged from 8.8 (Bb-0) to 10.8 % (Bb-30). However, guinea grass chemical composition values were CP (6.4), crude fibre (33.4), EE (1.3), Ash (10.6), ADF (35.8) and ADL (13.8), respectively.

Table 4 shows the results of the reproductive performance. The result shows positive response by the experimental animals to Baobab fruit meal supplement. The highest mean weight of 2.1 kg recorded at Bb-20 inclusion level was due to the sex ratio of the kids. [5] reported that birth weight of males in small ruminants is heavier than birth weight of the females this was accountable for the mean values of birth in the study.

The sex ratio of Male : Female recorded in the study were 33:67% (2 males, 4 females), 50:50% (3 Males, 3 Females), 83:17% (5 Males, 1 Female) and 67:33% (4 Males, 2 Females) for treatments Bb-0, Bb-10, Bb-20 and Bb-30, respectively. Although, investigation is still underway to validate the ethno-veterinary claim by local Fulani of the efficacy of baobab fruit seeds in spermatogenesis with reference to volume, quality and sex determination. However, the male - female ratio increased with the inclusion levels of baobab fruit. Bb-20 level had highest male – female ratio of 83:17 %. A decline

value was recorded in animals on Bb-30 inclusion where the sex ratio was put at 67:33% male-female ratio. Further study into potentials of baobab fruit in sex determination in ruminant would further justify the ethno-veterinary claim.

Table 1. Chemical composition of Baobab fruit *(Adansonia digitata L.)* in the derived savannah zone of Nigeria

Parameters (%)	Whole fruit (WF)	Pulp only (PO)	Pulp and seed (PS)	Seed only (SO)	SEM
Dry matter	90.4[a]	90.4[a]	89.8[b]	89.9[b]	3.0
Crude protein	7.5[c]	3.5[d]	13.2[b]	17.3[a]	1.0
Crude fibre	23.0[a]	8.0[d]	12.0[c]	16.0[b]	1.0
Ether extract	15.0[b]	11.0[c]	9.0[d]	22.0[a]	1.0
Ash	6.0[b]	6.0[b]	7.6[a]	7.8[a]	0.1
Nitrogen free extract	48.5[c]	71.5[a]	58.2[b]	36.9[d]	1.8
Neutral detergent fibre	71.0[a]	48.0[c]	50.6[ab]	65.8[b]	2.1
Acid detergent fibre	41.0[a]	30.5[b]	26.0[c]	16.5[d]	1.1
Acid detergent lignin	26.6[a]	10.5[b]	10.0[b]	8.5[c]	0.9
Hemicellulose	30.0[c]	31.5[b]	24.6[d]	35.3[a]	1.0
Cellulose	14.4[a]	6.0[c]	16.0[a]	12.0[b]	0.8

[abcd] Means within each row with different superscript are different (P<0.05)
Source: Okunlola et al., 2015

Table 2. Gross composition of the experimental diets

Ingredient (%)	Bb – 0	Bb – 10	Bb – 20	Bb – 30
Baobab pulp and seed	0.0	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
Premix	0.5	0.5	0.5	0.5
DCP	0.5	0.5	0.5	0.5
Salt	1.0	1.0	1.0	1.0
Total	100.0	100.0	100.0	100.0

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, PKC–Palm kernel cake, DCP – Di-calcium phosphate

Table 3. Chemical composition of Guinea grass and Baobab pulp and seed meal diets

Constituent (%)	Guinea grass	Bb – 0	Bb – 10	Bb – 20	Bb – 30
Dry matter	24.6	88.5	88.1	87.9	87.0
Crude protein	6.4	14.5	14.1	13.7	13.3
Crude fibre	33.4	10.7	11.1	11.5	11.8
Ether extract	1.3	6.5	7.0	7.4	7.8
Ash	10.6	5.0	5.3	6.0	6.7
Nitrogen free extract	48.4	63.3	62.5	61.4	60.4
Neutral detergent fibre	64.5	41.5	43.6	45.5	46.9
Acid detergent fibre	35.8	18.2	19.8	20.8	22.1
Acid detergent lignin	13.8	8.8	10.0	10.7	10.8
Hemicellulose	28.7	23.3	23.8	24.7	24.8
Cellulose	22.0	9.5	9.8	10.1	11.3
M.E (kcal/kg)	-	2013.7	2172.2	2220.7	2320.2

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 4. Reproductive performance of Red Sokoto goats fed Baobab *(Adansonia digitata L.)* fruit meal

	Treatments				
Parameters	**Bb – 0**	**Bb – 10**	**Bb – 20**	**Bb - 30**	**SEM**
Wt. at mating (kg)	15.8[c]	20.4[b]	23.7[a]	21.2[b]	1.23
Wt. of does at parturition (kg)	20.5[c]	25.9[b]	28.8[a]	27.0[a]	1.1
Wt. after parturition(kg)	17.7[c]	22.3[b]	25.6[a]	25.0[a]	1.2
Wt. of does at weaning (kg)	17.1[c]	22.0[b]	24.8[a]	24.0[a]	0.1
Mean gestation length (days)	148.5[b]	150.2[a]	152.2[a]	147.8[b]	0.5
Wt. gain in pregnancy (kg)	4.7	5.5	5.1	5.9	1.8
Wt. change in lactation and nursing (kg)	0.6[c]	0.9[b]	1.2[a]	0.9[b]	0.0
Birth wt. of kids (kg)	1.7[b]	2.2[a]	2.1[a]	2.0[a]	0.1
Sex ratio of kids M:F (%)	33:67	50:50	83:17	67:33	-
Kid wt. at weaning (kg)	6.0[c]	6.9[c]	8.2[a]	7.5[b]	0.3
Daily wt. gain of kids (g)	57.5[c]	66.0[c]	80.5[a]	70.0[b]	3.5
Kid mortality at birth (%)	0	0	0	0	-
Kid mortality at weaning (%)	0	0	0	0	-

[abc] *Means within each row without superscript in common are different at 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

The kid weight at weaning (kg) and daily weight gain of the kids were significantly different (P<0.05) at all levels of baobab fruit inclusion. As observed in the birth weight of the kids; The kid weight at weaning (kg) and daily weight gain (kg) were significantly different (P<0.05). Bb-20 recorded the highest values of 8.2kg and 80.5g for kid weight at weaning and daily weight gain. This was followed by Bb-30 with a record value of 7.5 kg kid weight at weaning and 70.0g daily weight gain. Bb-10 recorded 6.9 kg kid weight at weaning and 66.0g daily weight gain while the least value was recorded for Bb-0 with a record of 6.0kg kid weight at weaning and 57.5g daily weight gain respectively.

The significant difference (P<0.05) in kid weight at weaning and daily weight gain was also attributed to the sex ratio of kids at birth and quality of experimental diets. Baobab fruit was reported to contain high nutritional values required for good health [6] and [7].

Sex of the kids was another factor accountable for the significant difference (P<0.05) in kid weight at weaning and daily weight gain. The heavier weight (P<.0.05) of the males weaning compared to the females could be associated with the hormonal differences between sexes with reference to the anabolic effect of the male hormone (Androgen). Unlike the depressing effect of estrogen of female animals. [8] and [5] had similarly reported heavier birth weight for male lambs. The heavier weight for male implies that sex effects are pronounced even at birth.

The zero mortality rate when BPSM was fed to RSG was attributed to the analgesic potential of baobab pulp. [9] study reported analgesic effect of baobab pulp. The results shows that 800 mg/kg baobab pulp aqueous extract gives comparable and long lasting effects with classical drugs - equivalent to 50 mg/kg acetylsalicylic acid analgesic effect. This activity may be attributed to the presence of sterols, saponins and triterpenes in the aqueous extract, in the fruit pulp [9].

Furthermore, baobab fruit pulp has traditionally been used as an immunostimulant [10]; its efficacy in the treatment of diarrhoea and dysentery has also been reported [9]. Healthy appearance and stability of the Red sokoto goats fed BPSM in this study was attributed to the analgesic potential of the experimental diets (BPSM). The fruit pulp has been evaluated as a substitute for improved milk biosynthesis in zebu cows. In addition to this, good health management procedures which include proper cleaning and sanitation of the experimental unit and its surrounding, provision of good water and feeding of good quality feed also contributed to zero mortality in this study.

4. CONCLUSION

The results of the study show that inclusion levels of baobab pulp-seed meal in the diet of Red Sokoto goats improved the reproductive index of the red Sokoto goat. There was no mortality throughout the period of the experiment.

This further confirmed health potentials of baobab fruit. Weight at weaning of the kids in the study was an indication of availability of the nutrients in baobab to the experimental animals and the sex ratio which increased with increasing levels of baobab pulp-seed in the diet further supports the ethnoveterinary claim of its potentials in sex determination especially the seed. The availability of baobab fruit during the dry season when fresh and nutritive forages are scarcely found is a pointer to its potential as reliable feed resource and supplement towards improving ruminant production and management.

ETHICAL APPROVAL

All authors hereby declare that "Principles of laboratory animal care" (NIH publication No. 85-23, revised 1985) were followed, as well as specific national laws where applicable. All experiments have been examined and approved by the appropriate ethics committee.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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Peer-review history:
The peer review history for this paper can be accessed here:
http://www.sciencedomain.org/review-history/25883