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Impact of Baobab (Adansonia digitata L.) Fruit Meal on the Reproductive Performance of Red Sokoto Does Crossed with South Africa Boer Bucks

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Abstract*— Red Sokoto goat (RSG) does was crossed with South African Boer (SAB) bucks with the aim of improving the reproductive performance of RSG. Oestrus was synchronized in thirty-two (32) primiparous RSG does using 45mg fluorogestone acetate vagina sponges for fourteen (14) days. Pregnant mare serum gonadotrophin hormone was administered immediately after sponge removal and SAB bucks were introduced for matting. Twenty four (24) gravid RSG weighing 18.80kg – 19.55kg were selected and fed graded levels of baobab (Adansonia digitata. L) pulp-seed meal (BPSM) 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 10% BPSM level had the highest mean weight value of 27.00kg while the does on 0% BPSM recorded the least value of 25.00kg. At pregnancy, animals on 10% BPSM had the highest weight gain value of 7.80kg, followed by 30% BPSM with a weight gain of 7.20kg. 20% BPSM had 6.25kg weight gain and the least value of 6.00kg was recorded for animals on 0% BPSM. Weight of RSG does at weaning ranged from 22.00kg to 24.00kg. The Birth weight of kids were significantly different (P<0.05) with highest value of 2.85kg (10% BPSM), as control diet (0% BPSM) recorded birth weight of 2.00kg. The sex ratio of male: female recorded in the study were significantly different (P<0.05) across treatments. The kid weight at weaning and daily weight gain of the kids was significantly different (P<0.05) at all levels of BPSM inclusion. There was no kid mortality at birth. However, kid mortality at weaning recorded infinitesimal value of 1% for 10% and 40% supplementation level.

***Keywords*— Red Sokoto goat, South African Boer, Baobab pulp-seed meal, Parturition, Birth weight**

I. Introduction

The increasing demand for meat and milk in Nigeria has led to increased interest in raising indigenous breeds of ruminants by crossbreeding between and among proven exotic breeds to improve their performance to meet the nutritional needs of Nigerians and the continent at large. This practice however, need to be complemented with high levels of management and nutrition, such as Baobab based diets and improve on them genetically by crossbreeding milk producing indigenous breed (RSG) with an established breed with high fertility rate and high milking trait such as South Africa Boer. Although, Cattle provides more than 90% of the total annual domestic milk output in Nigeria (Walshe *et al.*, 1991) with the White Fulani breed recognized as the principal producer

(Adeneye, 1989). Unfortunately, the domestic output of about 407,000 metric tonnes of milk (Olaloku, 1999) from an estimated 14 million cattle can hardly satisfy the dairy demands of an ever increasing population of Nigerians. Hence the need to augment the deficit with milk produced by small ruminants.
South Africa Boer goat (SABG) is native to South Africa. The breed has high fertility potential which is probably the most single economically important factor in livestock farming. The breed when combined with good management input can easily deliver 180% kidding percentages.
Baobab 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) is available and gotten from 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 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 research therefore investigated the impact of Baobab (*Adansonia digitata L.*) Fruit Meal on the Reproductive Performance of Red Sokoto Goats Crossed with South Africa Boer

II. Materials and Methods

Site
The study was conducted at the Small Ruminant Unit of the Teaching and Research Farm and Animal Nutrition and Biotechnology Laboratory of Ladoke Akintola University of Technology, Ogbomoso, Oyo State, a derived savannah zone of Nigeria, located on latitude 18°15'N of the equator and longitude 4°5'E of the Greenwich meridian (Ojedapo *et al*. 2009).

Collection of Test Ingredient (Baobab fruit –Adansonia digitata)
The baobab fruits was gathered from rural communities in Ogbomoso on longitude $4^{o}5'$ east of the Greenwich Meridian and latitude $8^{o}7'$ 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 was carefully scraped to avoid contamination with soil during processing. The scraped fruits were cracked and the pulp together with seeds was removed and sun dried for a week and thereafter milled for research diets formulation and laboratory analysis.

Laboratory Examinations of the Test Ingredient and Research Diets
Laboratory examinations of the research diets which include Determination of the chemical compositions of the Test Ingredient, Research diets, mineral composition and anti nutritional factors was out using the method of AOAC (2005).

Procurement of Research animals
Primiparous Red Sokoto goats - RSG *(Does)* and South Africa Boer bucks were sourced from reputable sources. A total of Thirty Two (32) Red Sokoto goats and Four (4) South Africa Boer bucks were used for cross breeding program out of which Twenty Four (24) gravid RSG *does* were selected for the study.

Acclimatization, vaccination and distribution of the research animals to research diets
Upon arrival, animals were given prophylactic treatment which consist of oxytetracycline long acting antibiotic (1ml/10kg body weight of the animal) and vitamin B complex. They were also drenched with albendazole to control endoparasites. Mange and other ectoparasites was treated/prevented using Ivomec$^{(R)}$. The animals were vaccinated against *Pestes des petits ruminante* (PPR) using a tissue culture Rinderpest Vaccine. During the acclamatization/adaptation of four weeks, the animals were offered diets they were eaten from where they were purchased. The purchased RSG were synchronized for oestrus two weeks before the end of adaptation period.

Oestrous Synchronization
Individual Female animal (Red Sokoto *does*) was weighed before synchronization. Oestrus was artificially synchronized in all the thirty two Red Sokoto *does* using 45mg fluorogestone acetate vagina sponges. One 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, the does were weighed again and thereafter grouped into four (4) with eight (8) RSG *does* in each group. Four (4) South Africa Boer bucks were introduced to the RSG *does* in each group comprising of Eight (8) animals for mating.
A month later, the thirty two does were examined for pregnancy and twenty seven (27) of them which represents 84.36% of the synchronized RSG *does* were pregnant. Of the twenty seven (27) gravid *does*, twenty four were selected and balanced up for uniformity. The animals were later grouped randomly into four (4) with six (6) in each group with tags for reproductive index examinations. The selected does were weighed fortnightly until parturition. The animals were fed baobab fruit supplement individually at 4% of body weight throughout the duration of the trial. The animals were allowed to graze daily on a well partitioned and irrigated guinea grass *(Panicum maximum)* paddock for three (3) hours daily between 10.00am to 1.00pm. Where nature prevented paddock grazing in the course of the research; zero grazing was adopted.

Heamatological and Serum Biochemical indices examinations
For the purpose of accuracy of this research and basically because the research is mainly about crossbreeding, blood samples was collected from individual animals in three (3) stages: On arrival, at the mid-duration and at he end of the study, to distinct clearly the responses of the animals to the experimental diets. Blood samples was collected using standard procedures and analyzed accordingly.

Preparation of Research Diets
Experimental diets tagged Baobab Fruit Meal (BFM) comprising of Baobab fruit at varying levels of inclusion and other feed components which include cassava peels, palm kernel cake, rice husk/wheat offal, ruminant premix, Di-calcium phosphate and salt was prepared and stored for use in the course of the experiments.
Guinea grass *(Panicum maximum)* established and partitioned for rotational grazing by the animals was patronized throughout the period of the research. Fresh water was equally made available *ad libitum* for the research animals.

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 with seed (PS)	Seed only (SO)	SEM
Dry matter	90.39^{a}	90.39^{a}	89.88^{a}	89.92^{a}	3.01
Crude protein	7.53^{c}	3.50^{d}	13.38^{b}	17.33^{a}	0.95
Crude fiber	23.00^{a}	8.00^{d}	13.00^{c}	16.00^{b}	1.01
Ether extract	15.00^{c}	11.00^{d}	18.00^{b}	22.00^{a}	1.00
Ash	6.00^{b}	6.00^{b}	7.00^{a}	7.80^{a}	0.05
Nitrogen free extract	48.47^{b}	71.50^{a}	48.62^{b}	36.87^{c}	1.75
Neutral detergent fiber	71.00^{a}	48.00^{c}	60.60^{ab}	65.75^{b}	2.10
Acid detergent fiber	41.00^{a}	30.50^{b}	26.00^{c}	16.50^{d}	1.11
Acid detergent lignin	26.59^{a}	10.50^{b}	10.00^{b}	8.50^{c}	0.90
Hemicellulose	30.00^{c}	31.50^{b}	34.60^{a}	35.25^{a}	1.00
Cellulose	14.41^{a}	6.00^{c}	11.00^{ab}	12.00^{b}	0.80

^{abc} *Means within each row with different superscript are different (P<0.05)*
Source: Okunlola et. al., 2015

Experimental Design
Completely Randomized Experimental Design..
Statistical analysis
Data collected was subjected to analysis of variance (ANOVA) using the procedure of SAS (2003) package to determine the effect of dietary treatments on the various parameters studied. Significant means was separated using Duncan multiple range test of the same software.

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III. RESULTS AND DISCUSSION

Tables 1, 2 and 3 presents chemical composition of Baobab fruit *(Adansonia digitata L.)* in the derived savannah zone of Nigeria, gross composition of the experimental diets and chemical composition of guinea grass and the experimental diets (Baobab pulp and seed meal diets) and were culled from the research conducted by Okunlola *et al.*, 2018 where Reproductive performance of Red Sokoto goats within breed was investigated.

The major aim of research in animal production is to maximize available opportunities to improve the performance of domestic animals in a target area of interest. However, every targets of all improvement(s) revolves round the genetic composition of the target animal species and its environment. Environment in this context is broad and encompassing but not limited to research unit, animal environment, feeding, health care management, prenatal, perinatal and postnatal stages of female animals as well as adequate care of males. Genetic components are innate but could be masked by the environment and consequently affect expression of traits and good performance by the animal. Therefore, for the performance of livestock to be fully expressed, both genetic and environmental factors must be explored.

Table 4 shows the results of the reproductive performance of RSG does crossed with SAB bucks. Findings from this study showed basically both the effects of nutrition and genetic expressions by both breeds as the results were significantly affected ($p<0.05$) across the treatments. The birth weight of the kids ranged from 2.00kg (Control diet) to 2.85kg (T2) which contained 10% Baobab fruit meal. This was higher than 2.05kg recorded by Yahya and Midau, (2023) on reproductive performance Red Sokoto goats and birth weight range of 1.5 – 2.0kg recorded by Osubhor *et al*., (2002) in a growth study on Sahelian and Red Sokoto goats. The variation could be linked to the experimental diets and breeds of the animals, especially, boer bucks used for the crossing. The average birth weight recorded in this study however falls within the range of birth weight of 2.0kg - 2.8kg recorded of Sahelian goats kid by Akinwole *et al.*, 1999.

Usually, male kid of small ruminant at birth outweighs female kid(s) (Nwakalor and Obochi(2000), Makun *et al*., (2005) and Okunlola *et al.*, (2018). Findings from this study justifies the assertion as the 10% inclusion of BBSM (T2) recorded average birth weight of 2.85kg with corresponding male to female (M:F) ratio of 65:35%. This was followed by T3 and T4 with record birth weight of 2.75kg and 2.55kg, with a sex ratio of 60:40% and 55:45%, respectively. The weight of kids at weaning (kg) and daily weight gain of the kids were significantly different ($P<0.05$) at all levels of baobab fruit inclusion. 10% inclusion level (T2) recorded the highest weaning weight of 12.50kg. This was followed by 30% inclusion (T4) with a weaning weight record of 12.00kg, ahead of T3(20%) inclusion which had 10.90kg weaning weight. The control diet, T1 (0%) recorded the least value of 7.50kg. The average daily weight gain were also significant ($p<0.05$) across the treatment. The record pattern followed birth and weaning weight. The birth weight, average daily weight gain and weight at weaning recorded in this study is a testament to the superiority of genetic factors as a major determinant for improvement in animal husbandry. The effects of crossing South African Boer buck with Red Sokoto goats (*Does*) was purely dominant on the crossbred kids as the growth potentials of South African Boer was expressed by the kids. The birth weight, daily weight gain and weight at weaning recorded in this study were higher than the values recorded by Okunlola *et al.*, (2018) where same treatment diets were offered to Red Sokoto goats in a similar study. The variation gaps could be linked to the genetic interactions and dominance of South African Boer bucks crossed with Red Sokoto goats.

Worthy of note was the litter size of the red sokoto goats used for the study. The percentage of twin birth in this study justified the fertility fecundity of both breeds used for the experiment. When single birth is common in yearling doe, the potentials for multiple births in Red Sokoto goats crossed with South African boer on Baobab meal diets was expressed in this study. Twin births in this study was significant ($p<0.05$) across treatment. The litter ratio (%) with reference to twin birth records was 25% (T1), 40% (T2), 50% (T3) and 20% (T4), respectively. This could be traced to the quality and utilization of the experimental diets, effect of synchronization and genetic potentials of the breeds of experimental animals. South African boer is popularly known for high fertility rate. Cases of triplet and quadruplets has been reported of the breed (*Makun et al.*, 2005).
Baobab fruits on the other hand contains phytochemicals and phytoadditives which may influence hormone synthesis which protects sperms from oxidative damage; thereby improving motility and viability. The

antioxidant activity of Baobab alongside phytochemicals may have improved spermatogenesis, sperm quality and reproductive hormone regulation in the experimental animals to bring about the obtained results in this study

There was no kid mortality at birth in all animal replicates at all levels. The gestation period varied across treatment with the highest being average of 154 days (T2). However, kid mortality was recorded within 90 days of weaning, but at infinitesimal percentage of 1%, 2%, 1% and 1% for TI, T2, T3 and T4, respectively. This minimal loss could be attributed to the good management procedures and mothering ability of Red Sokoto *does* used for the study.

Table 2: Gross composition of the experimental diets

Ingredient (%)	**T1**	**T2**	**T3**	**T4**
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	100	100	100

T1: diet without baobab meal, T2: diet with 5% baobab meal, T3: diet with 10% baobab meal, T4: diet with 15% baobab meal, PKC: palm kernel cake, DCP: di-calcium phosphate.

Table 3: Chemical composition of Guinea grass and experimental diets

Parameters (%)	**Guinea grass**	**T1**	**T2**	**T3**	**T4**
Dry matter	24.60	82.57	83.07	83.98	81.92
Crude protein	6.40	14.50	14.10	13.70	13.30
Crude fiber	33.40	11.68	12.08	12.48	12.83
Ether extract	1.30	15.50	16.00	16.40	16.83
Ash	10.60	9.56	8.65	7.97	7.29
Nitrogen free extract	48.40	48.76	49.17	49.45	49.74
Neutral detergent fiber	64.50	40.50	46.02	52.50	56.85
Acid detergent fiber	35.80	32.00	35.75	40.80	45.05
Acid detergent lignin	13.80	10.75	12.00	12.65	12.80
Hemicellulose	28.70	8.50	10.27	11.70	11.80
Cellulose	22.00	21.25	23.75	28.15	32.25
M.E (kcal/kg)	-	2013.70	2172.20	2220.70	2320.20

T1: diet without baobab meal, T2: diet with 10% baobab meal, T3: diet with 20% baobab meal, T4: diet with 30% baobab meal. *Source: Okunlola et. al., 2018*

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Fig 1: Representative Replicates of the South African Boer Buck and Red Sokoto Doe

Table 4: Reproductive Performance of Red Sokoto Does Crossed with South Africa Boer Bucks

	Treatments				
Parameters	**T1**	**T2**	**T3**	**T4**	**SEM**
Wt. at mating (kg)	19.00^{b}	19.20^{a}	19.55^{a}	18.80^{ab}	1.75
Wt. of does at parturition (kg)	26.70^{d}	29.00^{a}	27.60^{b}	28.00^{c}	1.00
Wt. after parturition (kg)	22.05^{c}	23.75^{a}	22.30^{c}	22.90^{b}	1.05
Wt. of does at weaning (kg)	24.00^{a}	22.00^{c}	23.50^{a}	23.00^{b}	0.50
Mean gestation length (days)	151.00^{b}	153.00^{a}	152.50^{a}	150.00^{ab}	1.50
Wt. gain in pregnancy (kg)	7.70^{c}	9.80^{a}	8.05^{c}	9.20^{b}	1.00
Birth weight of the kids (kg)	2.00^{c}	2.85^{a}	2.75^{a}	2.55^{b}	0.50
Sex ratio of the kids – M:F (%)	30:70	65:35	60:40	55:45	-
Kid weight at weaning (kg)	7.50^{c}	12.50^{a}	10.90^{b}	12.00^{a}	0.50
Litter ratio (Single:Twin birth) (%)	75:25	60:40	50:50	80:20	-
Average daily wt. gain of the kids **(g)**	83.33^{d}	138.88^{a}	121.11^{c}	133.33^{b}	2.80
Kid mortality at birth (%)	0	0	0	0	-
Kid mortality at weaning (%)	1	2	1	1	-

^{abcd} *Means within each row without superscript in common are different at P<0.05*
T1: diet without baobab meal, T2: diet with 10% baobab meal, T3: diet with 20% baobab meal, T4: diet with 30% baobab meal.

IV. CONCLUSION

The findings from this study showed improvement in genetic potentials of Red Sokoto goats; The oestrous response of Red Sokoto does to synchronisation with fluorogestone acetate vagina sponge and administration of pregnant mare serum gonadotrophin (PMSG) was successful and satisfactory. Crossing Red Sokoto goats with South African Boer had improved birth weight, litter size as well as weaning weights of RSG. Responses of Red

Sokoto goats to baobab fruit meal supplement confirmed Baoaba as a reliable feed resource with nutritional potentials to supply the nutritional requirements of ruminant animals, especially in the dry season when forages are usually scarce, with poor nutritional values where available.

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