International Journal of Research Studies in Zoology
Volume 4, Issue 1, 2018, PP 22-28
ISSN No. 2454-941X
DOI: http://dx.doi.org/10.20431/2454-941X.0401004
www.arcjournals.org

Reproduction Performance, Serum Biochemical and Growth Indices of Grower Rabbits (*Oryctolagus cuniculus*) fed Sheabutter (*Vitellaria paradoxa* C.F. Gaertn.) Nut Meal

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Abstract: *There are reports of possible world food shortage especially animal products which are veritable sources of essential nutrients required by human beings. This threat could be averted if rabbit production is increased due to its unique prolificacy, short generation interval and quick return on investment. Unfortunately, there are inadequate qualitative and quantitative feedstuffs hence, the quest for unconventional feedstuff to reduce competition with human beings for conventional food/feedstuff. The aim of this study was to investigate the influence of graded levels of sheabutter nut meal on reproduction performance, serum biochemical indices and growth indices of grower rabbits. Sixty grower rabbits (1 buck: 1 doe ratio) weighing about 1kg at 7 weeks of age were randomly allocated to treatments D1 (0.0% SNM), D2 (2.0% SNM), D3 (4.0% SNM), D4 (6.0% SNM) and D5 (8.0% SNM) such that each treatment had twelve rabbits. Sheabutter nut meal was collected from sheabutter nut milling centres in Lafia metropolis and used in formulating feed for the experimental animals. Sample of sheabutter nut meal was used in proximate analysis. Data were collected on body weight, morphometric traits, conception percentage and at the end of the experiment, blood samples were collected and processed for serum biochemical indices. Results showed that the animals gained weight ranging from 0.1 to 0.26g with the highest in control treatment. The body length varied from 0.22cm in D4 to 0.33cm in D3 and the girth circumference ranged from 0.26 to 0.36cm. While the albumin was highest (29.2g/l) in control, the creatinine was lowest (70.0µmol/l) in D4, the urea varied from 3.13 to 8.7µmol/l, cholesterol (2.9 to 3.85mmol/l), triglyceride (0.83 to 0.98mmol/l) and blood glucose was superior (1.36mmol/l) in D2. Since sheabutter nut meal did not seemingly influence the physiological wellbeing of the treated rabbits it could be utilized up to 8%.*

Keywords: *Rabbits nutrition; sheabutter; serum biochemistry; unconventional feedstuffs.*

1. INTRODUCTION

The feeding pattern and digestive system of rabbits made it possible to survive on low quality feedstuffs and are often reared in hutches at commercial level or allowed to roam in some homes as pets thriving on food crumbs and kitchen wastes. In any case, rabbits are produced for meat classified as "white meat" which was described [1] as lower in fat and higher in polyunsaturated fatty acids content than other meats. Also, rabbits provide by-products like fur, pelts, hides or skins required by the industries as well as source of income for sustenance of humanity. There is no doubt that this will immensely contribute to the gross domestic products of the nation. Unfortunately, constraints such as lack of good foundation stock, start-pack-capital, quantitative and qualitative feed ingredients are believed to pose threat to rabbit production. According to the report of [2], feeding accounted for about 70% in livestock production because conventional feedstuffs for humans are also used as feedstuffs in livestock production. This scenario has resulted in high cost of producing rabbits thereby, forcing many rearers to use stale and fungi-infected feedstuffs that would have rather been discarded. Even with glaring potentially mycotoxin contamination in foods and feeds, they are still

being used in formulating livestock feed, without minding possible residual effects on humans general wellbeing [3]. This phenomenon has resulted in the use of unconventional feedstuffs such as cassava peel [4, 5], cereal offals [2, 6] and citrus pulp [7, 8] in rabbit nutrition. Also, crude olive cake [9, 10], brewer's grains [11], sugarcane bagasse [12] and sun-dried Sulla [13] amongst host of other potential feedstuffs could be utilized in rabbits ration. Yet, little is known about the utilization of sheabutter (*Vitellaria paradoxa* C.F. Gaertn.) nut meal in rabbits.

Although, it was suggested that sheabutter nut meal could be utilized in diets of rabbits, the safe inclusion level was not stated [14] and in a study where 25% was fed, mortality and effects on performance were recorded [15]. According to [16], sheabutter nut meal is a major by-product of the sheabutter oil industry. It was reported that though it is rich in carbohydrates and proteins, it contains antinutritional factors that limits its use in livestock nutrition. However, it was reported [17] that sheabutter nut meal was used in ruminant nutrition and observed that they could tolerate up to 30% inclusion level. While a maximum of 2.5% inclusion level was recommended in poultry [18], 20% was given in pigs [19].

Since there are little or no information on the possible use of sheabutter nut meal in rabbit production and it was speculated to be a potential toxicity, low in protein content and to be used as non-nutritive bulk in livestock diets [20]. This study was aimed at investigating the effects of feeding graded levels of sheabutter nut meal on rabbit reproduction, growth and serum biochemical indices.

2. MATERIALS AND METHODS

Climatic conditions of the study location

The study was carried out at the Teaching and Research Demonstration Farm, Faculty of Agriculture, Nasarawa State University, Keffi, Shabu-Lafia Campus, Lafia located within the north central zone of Nigeria. Lafia is situated on latitude 08^{o} 35^{l} N, longitude 08^{o} 34^{l} E with an altitude of 181 m above sea level, temperature ranging from 32 to 35^{o}C, relative humidity between 58 and 63%, average day light of 9 to 12hours and approximately 1,400 mm rainfall per annum [21]. The vegetation consists of different species of trees, shrubs, leguminous browse plants and grasses with fairly undulated terrain.

Experimental design

Sixty grower rabbits (1 buck: 1 doe ratio) of New Zealand and Flemish Giant crosses, average weight of 1kg at about 7 weeks of age, were obtained from National Veterinary Research Institute, Plateau State, Nigeria. All the rabbits were randomly allocated based on initial live weight to treatments D1 (0.0% SNM), D2 (2.0% SNM), D3 (4.0% SNM), D4 (6.0% SNM) and D5 (8.0% SNM) in a completely randomized design. Each treatment had a total of twelve rabbits with six bucks and six does that were paired based on sex in hutches measuring 64cm length x 62cm width x 48cm height. During acclimatisation period that lasted for two weeks, anti-stress, antibiotics and anthelmintic were administered. The hutches, pens, waterers, feeders as well as the surroundings were regularly cleaned to maintain good hygiene. Lighting system was provided in the pens in order to give warmth and enhance feeding at night throughout the nine weeks experimental period.

Proximate determination of sheabutter nut meal

Sheabutter nut meal was collected from local milling centres in Kwandere, Nasarawa State, where the oil was extracted. Aliquot from each centre was collected, pooled, mixed properly and samples were taken from the mixed aliquots for proximate determination following the procedures of [22] and the composition is shown in Table 1.

Table 1. *Nutrient composition of sheabutter nut meal*

Nutrients	Compositions
Crude protein (%)	1.2
Crude fibre (%)	5.2
Ether extract (%)	45.0
Ash (%)	15.0
Moisture (%)	25.0
Nitrogen free extract (%)	8.5
Gross energy (kcal/kg)	3,995.3

Experimental diets formulation and animal welfare

All the feedstuffs were procured from market outlets in Kwandere, Shabu, Lafia, Nasarawa State except, the premix and soya bean meal that were obtained from Jos, Plateau State. These were used in compounding the experimental diets according to [23] recommendations for rabbits as presented in Table 2. The nutritional values of the feedstuffs were used in determining the calculated nutrients using feedstuff table [24]. The compounded feed and clean drinking water were offered to the experimental animals *ad libitum*. The hutches, pens, water and feed troughs were regularly cleaned, washed, disinfected and the environment was cleared always to keep good hygiene. Lighting system was given in the pens to provide illumination, warmth and to enhance feeding especially. Anti-stress, antibiotics and anthelmintic were administered according to the manufacturers' instructions during the adaptation period that lasted 2 weeks.

Table 2. *Gross composition of the experimental diets*

	Treatments				
Feedstuffs (%)	**D1**	**D2**	**D3**	**D4**	**D5**
Maize offal	35.0	34.5	34.0	33.5	33.0
Rice offal	27.0	26.5	26.0	25.5	25.0
Wheat offal	25.0	24.5	24.0	23.5	23.0
Soybean meal	10.0	9.5	9.0	8.5	8.0
Sheabutter nut meal	0.0	2.0	4.0	6.0	8.0
Fish meal	1.2	1.2	1.2	1.2	1.2
Premix	1.0	1.0	1.0	1.0	1.0
Salt	0.25	0.25	0.25	0.25	0.25
Bone meal	0.25	0.25	0.25	0.25	0.25
Lysine	0.15	0.15	0.15	0.15	0.15
Methionine	0.15	0.15	0.15	0.15	0.15
Total	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**
Calculated nutrients					
Crude protein	16.5	16.1	15.8	15.4	15.0
Crude fibre	11.4	11.4	11.2	11.7	11.0
Metabolizable energy	2, 869.3	2,854.9	2,938.7	2,908.9	2.992.4

Premix composition/100kg diet: Vitamin A = 15,000 IU, Vitamin D3 = 300,000 IU, Vitamin K = 2.5mg, Vitamin B1 = 200mg, Vitamin B2 = 600mg, Niacin = 40mg, Vitamin B12 = 2mg, Pantothenic acid = 10.0mg, Folic acid = 100mg, biotin = 8mg, Antioxidant = 12.5g, Cl = 50g, Mn = 96g, Zn = 6g, Fe = 24g, Cu = 0.6g, I = 0.14g, Se = 24mg, Co = 2.4mg.

Data collection and statistical analysis

The animals were weighed weekly using table scale (Five Goats ®) and the difference between the final and initial weight values was considered as the weekly body weight gain. The body, hind limb, ear, tail, hair and head length values were obtained weekly using measuring tape (Butterfly Brand®). Similarly, the girth, chest, neck and head circumference values were collected on weekly bases using measuring tape (Butterfly Brand®). At the seventh week, six does and six males per treatment were randomly selected and mated to obtain conception percentage, litter size and mortality value. At the end of the ninth week, blood samples were collected from six rabbits (1buck: 1doe) per treatment by a Veterinarian, centrifuged and processed for serum biochemical indices as described by [25] to obtain albumin, creatinine, urea, cholesterol, triglyceride and glucose values. Unfortunately, one of the mated does died shortly after blood sample was mistakenly collected from it (See Plate 1).

All the sets of data gathered were analysed according to analysis of variance of [26] statistical package and the mean values were separated using least significant difference of the same software package. Whereas, data on the reproductive potential, were analysed using simple descriptive statistics prescribed by [27].

3. RESULTS

Table 1 shows the chemical composition of sheabutter nut meal. It was shown to be very poor in crude protein (1.2%) but the crude fibre value was 5.2%, ether extract (45%), ash (15%), nitrogen free extract (8.5) and was very rich in energy value (3, 995.3kcal/kg). Thus, it could be utilized as energy feed resource with a potency to provide the required fibre in rabbit nutrition.

Gross compositions of the experimental diets are provided in Table 2. The determined crude protein values varied from 15 to 16.5%, crude fibre (11.0 to 11.7%) and the energy values ranged from 2, 854.9 to 2, 992.4kcal/kg.

Presented in Table 3 are the growth indices of grower rabbits fed sheabutter nut meal. There were no significant differences (P>0.05) in the mean values of all the parameters measured. Meanwhile, weight gain was highest (0.26g) in D1 followed by D5 (0.18g) and the least (0.1g) was recorded in D3. On the other hand, body length mean value was highest (0.33cm) in D3 and girth circumference mean value was best (0.34cm) in D2. While the hind limb length value ranged between 0.30cm in D2 and 0.35cm in D1, the head length value varied from 0.15 to 0.3cm and the head circumference value was highest (0.38cm) in D5.

Table 3. *Effects of feeding sheabutter nut meal on growth indices of grower rabbits*

	Experimental diets					Statistics		
Parameters	**D1**	**D2**	**D3**	**D4**	**D5**	**Mean**	**MSE**	**P-value**
No. of animals	12	12	12	12	12	-	-	-
Weight gain (g)	0.26	0.12	0.10	0.13	0.18	0.16	0.030	0.528
Body length (cm)	0.29	0.28	0.33	0.22	0.26	0.28	0.014	0.584
Hind limb length (cm)	0.35	0.30	0.31	0.32	0.33	0.32	0.025	0.985
Girth circumference (cm)	0.27	0.34	0.28	0.26	0.36	0.30	0.038	0.855
Ear length (cm)	0.29	0.42	0.25	0.23	0.28	0.29	0.036	0.461
Tail length (cm)	0.17	0.25	0.16	0.16	0.29	0.21	0.012	0.162
Hair length (cm)	0.11	0.10	0.13	0.10	0.13	0.12	0.005	0.807
Chest circumference (cm)	0.29	0.30	0.23	0.22	0.39	0.29	0.019	0225
Neck circumference (cm)	0.20	0.22	0.34	0.35	0.26	0.27	0.027	0.410
Head length (cm)	0.16	0.30	0.29	0.15	0.26	0.23	0.015	0.108
Head circumference (cm)	0.25	0.16	0.25	0.23	0.38	0.25	0.019	0.107

Serum biochemical indices of grower rabbits fed sheabutter nut meal are given in Table 4. There were no significant differences (P>0.05) in the mean values of all the parameters monitored across the treatments except, urea that was significantly highest (P<0.05) in D3 and blood glucose which was significantly lowest (P<0.05) in D4.

Table 4. *Serum biochemical indices of grower rabbits fed sheabutter nut meal*

	Experimental diets					Statistics		
Parameters	**D1**	**D2**	**D3**	**D4**	**D5**	**Mean**	**MSE**	**P-value**
No. of animals	6	6	6	6	6	-	-	-
Albumin (g/l)	29.2	26.5	24.3	25.8	26.0	26.4	8.66	0.104
Creatinine (µmol/l)	77.5	75.0	75.3	70.0	74.2	74.4	144.3	0.866
Urea (µmol/l)	5.70^{b}	5.30^{b}	8.70^{a}	3.13^{d}	4.03^{c}	5.37	2.05	0.000
Cholesterol (mmol/l)	3.38	3.85	3.65	2.90	3.35	3.43	0.43	0.164
Triglyceride (mmol/l)	0.83	0.85	0.98	0.93	0.98	0.91	0.026	0.336
Glucose (mmol/l)	1.18^{a}	1.36^{a}	0.98^{bc}	0.82^{c}	1.08^{b}	1.16	0.035	0.030

a,b,c,d: Means with different superscripts differ significantly (P<0.05).

Albumin value ranged from 24.33g/l in D3 to as high as 29.17g/l in D1, creatinine (70 to 77.5µmol/l), cholesterol (2.9 to 3.85mmol/l) and triglyceride varied from 0.83mmol/l (D1) to 0.98mmol/l in D5.

Table 5 shows the reproductive potential of rabbits fed sheabutter nut meal.

Table 5. *Reproductive potential of grower rabbits fed sheabutter nut meal*

	Treatments				
Parameters	**D1**	**D2**	**D3**	**D4**	**D5**
Number of does	6	6	6	6	6
Conception percentage (%)	0	0	0	0	1 (3.33)
Number of embryos	0	0	0	0	4
Mortality (%)	0	0	0	0	1 (3.33)

There was no conception in all the does mated except in D5, where only a doe was pregnant (representing 3.33% conception) out of the 30 does mated. Unfortunately, the pregnant doe died (representing 3.33% mortality) shortly after the Veterinarian mistakenly collected blood from it.

Plate 1. *Uterus of the dead doe showing four embryos*

Plate 1 shows the embryos in the dead doe. It was revealed that there were four developing embryos in the uterus.

4. DISCUSSION

The crude protein value differed from 116 to 133g reported by [16] and 8.6% given by [17] in sheabutter nut meal. Also, the crude fibre value was lower than the reported range of 53.8 to 59.3g/kg [16] and 8.0% [17] respectively, but the ether extract value was similar to 50.2% reported. Meanwhile, the ash content and energy values were much more than 3.5% and 28.5MJ/kg DM reported by [17]. The observed disparities could be largely due to the analytical protocols adopted [28] (Givens *et al.* 2000), sheabutter nut processing technique and partly due to the agronomic practices as well as climatic variations in the study areas. In any case, the sheabutter nut chemical analysis, revealed that it was rich in gross energy and the composition values somewhat compared favourably well with other feed resources evaluated and recommended for livestock nutrition [2, 24]. Thus, sheabutter nut meal could be utilized as energy source in rabbit production.

The experimental diets quality was in consonant with the recommendation of [23] for rabbits of similar age, sex and physiological status. This was probably why the growth parameters recorded were similar to the values earlier reported elsewhere [6, 8, 29]. It was observed that the weight gain was lower than 7.7 – 10.2g/day reported by [30] when bread waste and *Moringa oleifera* leaf was fed to rabbits of similar age, sex and physiological status. Meanwhile, it was higher than 2g recorded in 13 days, when fresh ash (*Fraxinus angustifolia*) leaves was offered to growing rabbits [31]. This observation could be largely due to the breed and age of the animals used in the studies and partly due to the nutritional content of the diets fed and environmental differences.

More significantly, the serum biochemical indices were within the values reported in healthy rabbits of similar age, sex and physiological status [32, 33]. However, some disparities in values were observed probably due to the physiological status of the animals used, laboratory protocols adopted and the nature of the feeds fed. This probably suggested that the test diet did not exert undue effects on the kidneys, livers and other organs in the system of the experimental animals. Consequently, sheabutter nut meal may be a suitable feed resource in rabbit nutrition.

Meanwhile, the conception percentage was very poor, largely due to the age of the rabbits thus, buttressing the reports of [34], that rabbits attain sexual maturity at about 24 weeks of age and [35], who described puberty as the stage when the endocrine functions of the testicles become clearly evident. Also, it could be probably due to mating failure often associated with hand mating technique. Hence, the suggestion of artificial insemination technique, in rabbit production may be a better option [36, 37, 38]. Nonetheless, in as much as the conception recorded was in rabbits fed highest inclusion of sheabutter nut meal. It might be an indication that sheabutter nut meal, may perhaps not distort rabbit reproduction potential. Therefore, sheabutter nut meal may be included up to 8.0% in rabbit nutrition with little or no detrimental effects on performance.

5. CONCLUSION

Proximate analysis of the sheabutter nut meal revealed that it was rich in calories thus, could be utilized as energy feed resource in rabbit nutrition. The increase in the growth indices values probably

indicated that the animals were healthy and growing. The apparent similarity of the serum biochemical values with established standards possibly showed that the treated rabbits were not negatively affected. More importantly, pregnancy was recorded in a doe fed the highest inclusion level of sheabutter nut meal. As a result, sheabutter nut meal may be utilized in rabbit ration, probably up to 8.0% with mild or no harmful effects.

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Citation: *K. O. Idahor et al., "Reproduction Performance, Serum Biochemical and Growth Indices of Grower Rabbits (Oryctolagus cuniculus) fed Sheabutter (Vitellaria paradoxa C.F. Gaertn.) Nut Meal ", International Journal of Research Studies in Zoology, vol. 4, no. 1, p. 22-28, 2018. http://dx.doi.org/10.20431/2454-941X.0401004*