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RESPONSE OF RABBITS FED TOASTED KIDNEY BEAN SEED (*Phaseolus vulgaris*) MEAL (TKBSM) AS A REPLACEMENT FOR SOYBEAN MEAL

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ABSTRACT

An 84 day experiment was conducted to evaluate the response of rabbits fed toasted kidney bean seed (*Phaseolus vulgaris*) meal (TKBSM) as a replacement for soybean meal. Five iso-nitrogenous and iso-caloric diets tagged T1, T2, T3, T4 and T5, were compounded to contain 18 and 15% crude protein and 2700 and 2500 kcal/kg of metabolizable energy for weaner and grower phases, respectively. The TKBSM was included at 0, 5, 10, 15 and 20% levels of inclusion in treatments such that T_1 served as the control diet. A total number of 25 rabbits were randomly divided into 5 treatment groups which were replicated 5 times in a Completely Randomized Design (CRD). Twenty five cross-bred rabbits of 3-4 weeks old were obtained from local farmers within Keffi Local Government Area of Nasarawa State. At the commencement of the feeding trial, the animals were administered anti-stress drugs and multi-vitamin as well as deworming drugs to treat against possible presence of endo-parasites. Feeds were offered into feeding troughs, clean and fresh water was made available to the animals *ad-libitum*. Data collected include growth parameters, nutrient digestibility, carcass characteristics, haematological indices and serum biochemical variables. The results showed that KB seed was rich in energy (3337.78 kcl/kg, ME) and carbohydrate (66.23%). The crude protein (18.38%) content indicates that it is not a good source of protein as compared to soybean. However, the fat content (3.78%) suggests it to be a good energy source. There was no significant ($P>0.05$) variation in all the parameters evaluated except for PER and FCR in the weaner and grower phases, respectively which were significantly improved ($P<0.05$). Rabbits fed diets T2 (73.83%) and T5 (78.60%) had the best ($P<0.05$) dry matter digestibility followed by those fed diets T3 (70.19%) and T4 (64.87%). Consistently, rabbits fed diet T2 and T5 produced the best ($P<0.05$) digestibility of crude fibre (58.38 and 65.50%), ash (2.34 and 2.57%) and NFE (69.98 and 75.98%), respectively. However, those fed diets T3 and T4 performed similarly compared to those fed the control for dry matter crude fibre, ash and NFE. There was significant ($P<0.05$) improvement in the weight of the neck (90.00g/rabbit) and weight of stomach (17.70g/rabbit) of rabbits fed the T5 and T4, respectively as compared to the other treatment groups. There was significant increase ($P<0.05$) in the values recorded for total protein, triglyceride, cholesterol and glucose. Rabbits fed diets T2 and T3 had the highest total protein of 70.50 and 71.00 g/l, respectively; on the other hand, those fed the T5 diet had the best triglyceride (1.15mmol/L) as compared to other treatment groups. Cholesterol was significantly increased ($P<0.05$) in those rabbits fed diet T2 (3.55 mmol/L), T3 (3.40 mmol/L) and T4 (3.35 mmol/L) followed by those fed the control (3.35 mmol/L) and T5 (3.10 mmol/L. There was no variation ($P<0.05$) in the values of albumin and globulin. From the results of this experiment, nutrient digestibility, absorption and rate of conversion of feed to flesh were not impaired by the inclusion of Kidney bean seeds even at 100% replacement. Rabbit farmers can therefore, use Kidney bean seeds as

dietary source of protein and energy without affecting the meat quality and health status of the rabbits.

Keywords: Rabbits, weaners, growers, toasting, Kidney bean seed (*Phaseolus vulgaris*), replacement value.

INTRODUCTION

The over dependence on the few identified conventional protein and energy sources in most developing countries of the world, particularly Nigeria, for feeding of livestock is reaching a worrisome state. The scenario point out above is further worsen by the increasing cost and limited quantities available of conventional protein and energy sources of ingredients, as the teaming drop-out-of-school and graduates of schools result to micro livestock production as a source of livelihood.

The dire need for alternative feeding stuff for animal nutrition cannot be over-emphasized. Kidney bean also called common beans (*Phaseolus vulgaris L*) comes to focus as they are most widely cultivated and consumed in Latin America, India and Africa as a whole seed (Salunkhe and Kadam, 1989). In Ethiopia, the beans are used as the least expensive protein source for poor people who cannot afford to buy expensive meat. Furthermore, the beans are produced primarily by small-scale farmers and function as a cash-generating crop in the central rift valley of Ethiopia (Dawit and Demelash, 2003). In Nigeria and particularly, the Eggon people of Nasarawa State use the common beans as a traditional food during their wedding rites.

The beans contain several undesirable chemical substances that limit its consumption and utilization by humans or animals. The endogenous phytochemicals present in common beans are produced by the plant to protect itself against environmental stress. In general, phytochemicals are compounds that impair health by destroying nutrients/vitamins or by reducing the uptake of such essential elements by different mechanisms.

The main phytochemicals found in Phaseolus vulgaris are enzyme inhibitors, tannins, lectins (phytohaemagglutinins), phytic acid (phytate), and flatulence-causing α-galactosides and saponins (Liener, 1989). Flatulence-causing α- galactosides are oligosaccharides of the raffinose-series family which include raffinose, stachyose and verbascose α-galactosides contribute to flatulence production in humans and mono-gastric animals due to a lack of the necessary α-galactosidase enzyme which helps to break down raffinose-series oligosaccharides during the consumption of dry beans.

The WHO (2007) Technical Report on protein and amino acid requirements in human nutrition states that the best estimate for a population average requirement is 105 mg nitrogen/kg body weight per day, or 0·66 g protein/kg body weight per day. In many developing countries protein intake falls significantly short of these values. Schönfeldt and Gibson (2012) noted that apart from protein quantity, protein quality including bioavailability and digestibility, from different food sources, are currently on the global agenda. The 1st International Symposium on Dietary Protein for Human Health held in Auckland, in March 2011, and the consecutive Food and Agricultural Organization of the United Nations (FAO) Expert Consultation on Dietary Protein Quality, both highlighted the importance of assessing the quality of protein from different food sources through determination of amino acid content. Throughout the developed world, animal products and cereals are the two most important sources of protein; in developing countries this order is reversed. In low income countries only 3% of total dietary energy, as an indicator of diet composition, is derived from meat and offal, 11% from roots and tubers and 6 % from

pulses, nuts and oilseeds. The remainder of the dietary energy is mainly derived from cereal-based staple food.

Although the production of livestock has increased in developing countries, the consumption of protein in these countries with people consuming the most limited amounts of protein are continually decreasing. Under nutrition, including insufficient consumption of protein remains a persistent problem in the developing world, and although many diets within these developing countries are deficient in the quantity of protein compared to recommendations, the quality of the protein also strongly comes into focus (Schönfeldt and Gibson, 2012).

Rabbit has since been identified as an economy livestock that could bridge the wide gap in dietary protein intake in Nigeria (Kalio *et al.,* 2008). It is a micro-livestock producing about 47 kg of meat per doe per year, which is enough to solely meet the animal protein requirements of a medium-sized family under small-scale rural farming systems (Abdulmalik, 1994; Hassan and Owolabi, 1996). Available literature shows that the white meat of rabbit is very nutritious, easily digestible and extremely low in cholesterol and sodium levels (Omole *et al.,* 2005). The objective of this study is therefore, to evaluate the effect of graded levels of toasted Kidney bean seed meal on the performance of rabbits.

MATERIALS AND METHODS

The study was carried out at the research and teaching farm of Faculty of Agriculture Nasarawa State University Keffi, Shabu-Lafia Campus. It is located in the Guinea Savanna Zone of North Central. It is found in latitude 08 35N and longitude 08 33E. The mean monthly maximum and minimum temperatures were 35.06°C and 20.16°C respectively at the time of the experiment while the mean monthly relative humidity and rainfall were 74.67% and 168-190mm, respectively (NIMET, 2008).

Source of test ingredient

Kidney beans which is the test ingredient was purchased at the Lafia market, toasted and mixed with other feed ingredients to compound the experimental diets. Other feed ingredients used included rice offal, maize, soybean, salt, methionine, lysine, vitamin premix, groundnut cake and bone meal.

Chemical analysis

Proximate analysis of Kidney beans was done at Animal Science Laboratory of Faculty of Agriculture, Nasarawa State University, Keffi, Shabu-Lafia Campus, using the standard procedure of AOAC (2000). Nitrogen Free Extract (NFE) was calculated using the formula:

NFE (%) = 100 – CP + CF + EE + Moisture + Ash.

Management of the experimental animals

Twenty five cross-bred rabbits of 3-4 weeks old were obtained from local farmers within Keffi local government area of Nasarawa state. The rabbits were fed *ad-libitum* and had access to drinking water at all times. Lighting source was provided using electricity bulbs during the night for at least 10 hrs. and were administered anti-stress vitamin/mineral premix orally at the recommended dosage after the randomization before the commencement of the experiment. Other management practices were adopted as described by Aduku (2004).

Experimental diets for weaner and grower rabbits

Five isonitrogenous diets were compounded to contain 18 and 15% crude protein and 2700 and 2500 kcal/kg of metabolizable energy for the weaner and grower phases, respectively. The TKBSM was included at 0, 5, 10, 15 and 20% levels of inclusion in treatment T1, T2, T3, T4 and T5, respectively such that T_1 served as the

control diet. Other nutrients were included to meet the requirements of the animals for the respective classes. The gross compositions of the experimental diets for weaner and grower phases are presented in Table 1.

Experiment design

A total number of 25 rabbits were randomly divided into 5 treatment groups which were replicated 5 times in a Completely Randomized Design, designated as T1, T2, T3, T4 and T5, respectively, representing 0, 5, 10, 15 and 20% levels of TKBM bean inclusion.

Data collection

***Growth parameters Initial body weight*:** - This was recorded as the weight of the animal at the commencement of the research.

Final body weight: - This was recorded as the weight of the animal at the termination of the experiment.

***Body weight gain per rabbit*:** - This was measured by the difference between the final weight and the initial weight of the rabbits divided by the number of rabbits.

***Feed intake*:** - The rabbits were given weighed amount of feeds daily and their corresponding left over weighed and recorded. Daily feed intake was therefore calculated as the difference between the amount of feed fed and the leftover.

***Feed conversion ratio*:** - This was calculated as the rate of feed intake to live weight gain.

$$FCR = \frac{\text{Feed intake (g)}}{\text{Weight gain (g)}}$$

***Protein consumption*:** - This was calculated as the amount of protein in the diet multiplied by the quantity of feed consumed.

***Protein efficiency ratio* (PER):** - This was determined as the gain in body weight to the protein consumed:

$$PER = \frac{\text{Gain in body weight (g)}}{\text{Protein consumed (g)}}$$

***Mortality*:** Mortality record was kept throughout the experimental period and was calculated as:

$$\text{Mortality (\%)} = \frac{\text{Number of rabbits dead}}{\text{Total number of rabbits}} \times \frac{100}{1}$$

Digestibility trial

During the last 7days of the feeding trial, 8 rabbits from each of the 24 units were used for digestibility studies. Faecal samples were collected while fasting for 12hours was used to empty their gut to mark the beginning and end of collection. The droppings collected were oven-dried for a period of 18hours at a temperature of 105^0C and weighed daily. At the end of the collection period, the faecal samples collected from each replicate per day were bulked, ground and thoroughly mixed to obtain a homogenous mixture. Samples of the droppings were analyzed for proximate composition according to standard methods (AOAC, 2000) and the results obtained used to calculate the apparent digestibility using the formula below:

Apparent digestibility coefficient

$$= \frac{\text{Nutrient in feed} - \text{Nutrient in faeces}}{\text{Nutrient in feed}} \times \frac{100}{1}$$

Specific growth rate (SGR): The SGR was calculated using the formula below:

$$SGR = \frac{(\ln W_f - \ln W_i)}{T \text{ (days)}} \times 100$$

where W_f= final mean weight, W_i= initial mean weight and T = rearing period.

***Feed cost/kg*:** The cost/kg of each experimental diet was determined by using the prevailing market price in Lafia during the period of study (June – August 2017) and multiplied by the level of inclusion. The cost of feeding the rabbits on a particular diet for the period of study was computed by multiplying the cost/kg of the diet by the amount consumed.

Carcass evaluation

At the end of the feeding trial, 2 rabbits per replicate were randomly selected according to average group weight, starved for 18hours (to determine the actual live weight of the rabbits

and reduce gut content thus, reducing the risk of contamination of the carcass during dressing without affecting meat quality), slaughtered and their carcasses evaluated. Evaluation of the carcass was done according to the procedure outlined (Musa *et al.,* 2007). Linear and gravimetric measurements of the visceral organs e.g. gastrointestinal tract, heart, spleen, liver, thigh, legs, wings, neck, and heads were recorded.

Haematological indices

At the end of the feeding trial during the grower phase, blood samples were collected from 1 rabbit per replicate using 5mls sterile disposable needles. The blood were collected from the ear vein of the rabbits and emptied into sample mean corpuscular haemoglobin concentration (MCHC) were determined using the formulae of Schalm *et al.* (1975).

$$MCV = \frac{PCV \times 10}{RBC} \quad \text{fentolitre (fl)}$$

$$MCH = \frac{Hb \times 10}{RBC} \quad \text{picogram (pg)}$$

$$MCHC = \frac{Hb \times 100}{PCV} \quad \text{gram per deciliter (gm/dl)}$$

Serum biochemical variables

Blood samples were also collected in separate bottles without anti-coagulant to allow for clotting for serum biochemical analyses. Serum protein, globulin, urea and uric acid were analyzed using sigma kits. Glucose was analyzed according to Feteris (1965) and cholesterol according to Roschlan *et al.* (1974).

bottles containing ethylene diamine tetra acetic acid (EDTA) as anti-coagulant, to prevent clotting of the blood and used to evaluate the following haematological indices: red blood cells (RBC), white blood cells (WBC), haemoglobin (Hb), packed cell volume (PCV) and leucocytes differentials. The PCV was analyzed using Microhaematocrit method, total erythrocyte and total leucocytes count using haemocytometer method as described by Schalm *et al*. (1975). Haemoglobin concentration and differential leucocytes count was also determined by the methods outlined by Schalm *et al.* (1975). Mean corpuscular volume (MVC), mean corpuscular haemoglobin (MCH) and

Statistical analysis

Data collected were analyzed using One Way Analysis of Variance (ANOVA) and where significant differences ($P<0.05$) are observed, means were separated using Duncan Multiple Range Test (Duncan, 1955) as described by Steel and Torrie (1980).

Table 1: Gross composition of experimental diets for weaner and grower rabbits

	Weaner diets					Grower diets				
Grower Ingredients	**T_1 (0%)**	**T_2 (25%)**	**T_3 (50%)**	**T_4 (75%)**	**T_5 (100%)**	**T1 (0%)**	**T2 (25%)**	**T3 (50%)**	**T4 (75%)**	**T5 (100%)**
Kidney bean (Full fat)	0.00	5.75	11.50	17.25	23.00	0.00	4.25	8.50	12.75	17.00
Soybean (Full fat)	23.00	17.25	11.50	5.75	0.00	17.00	12.75	8.50	4.25	0.00
Groundnut cake	11.00	14.00	21.00	30.00	34.00	11.00	14.00	19.00	22.00	22.00
Rice offal	24.00	15.00	2.00	0.50	0.00	0.00	32.00	22.75	14.00	12.00
Maize	38.00	46.00	51.00	39.50	33.00	30.00	39.75	38.00	36.00	32.00
*Premix	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Salt	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Bone meal	1.00	1.00	1.00	1.00	0.00	3.00	1.00	1.00	1.00	0.00
Palm oil	1.50	0.00	1.00	1.00	9.00	0.00	0.50	2.00	4.00	5.00
Methionine	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Lysine	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Total	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**
Calculated energy and nutrient compositions										
**Energy (kcal/kg, ME)	2708.73	2733.57	2721.05	2726.23	2729.32	2597.26	2566.10	2536.35	2543.74	2458.84
Crude protein (%)	18.75	18.04	18.67	18.17	18.24	15.75	15.14	15.79	15.83	15.26
Crude fibre (%)	10.59	3.16	2.84	2.41	2.19	6.21	5.60	4.60	3.61	3.27
Ether extract (%)	8.07	7.11	6.18	9.57	13.34	8.57	8.40	8.83	9.70	10.23
Calcium (%)	0.13	2.18	4.23	0.38	0.61	0.70	0.09	0.19	0.31	0.36
Phosphorus (%)	0.43	1.36	2.29	0.32	0.30	0.90	0.80	0.63	0.51	0.46

*The vitamin – mineral premix supplied the following per 100kg of diet: Vitamin A, 15,000 I.U; Vitamin D_3, 300,000 I.U; Vitamin E 3,000 I.U; Vitamin K, 2.50mg; Thiamin (B_1), 200mg; Riboflavin (B_2), 600mg; Pyridoxine (B_6), 600mg; Niacin, 40.0mg; Vitamin B_{12}, 2mg; Pantothenic acid, 10.0mg; Folic acid, 100mg; Biotin, 8mg; Choline chloride, 50g; Anti-oxidant, 12.5g; Manganese, 96g; Zinc, 6g; Iron, 24g; Copper, 0.6g; Iodine, 0.14g; Selenium, 24mg; Cobalt, 214mg.

**Pauzenga (1985): ME kcal/ kg = 37 X %CP + 81.1 X %EE + 35.5 X %NFE.

RESULTS

The proximate composition of Phaseolus vulgaris

The biochemical analysis of the KBSM (Table 2) shows that the seed is rich in energy (3337.78 kcl/kg, ME) and carbohydrate (66.23%). The crude protein (18.38%) content indicates that it is not a good source of protein as compared to soybean. However, the fat content (3.78%) suggests it to be a good energy sources.

Table 2: Proximate and energy composition of KBSM

Nutrient	*Energy (kcal/kg, ME)	CP (%)	CF (%)	EE (%)	Ash (%)	Moisture (%)	NFE (%)	CHO (%)
(%)	3337.78	18.38	1.89	3.78	2.85	6.89	66.23	68.12

*Pauzenga (1985): ME kcal/ kg = 37 X %CP + 81.1 X %EE + 35.5 X NFE, CHO= Carbohydrate.

Effect of replacing full fat soybean meal with KBSM on growth indices of weaner rabbits

Table 3 summarizes the effect of replacing full fat soybean meal with KB meal on growth parameter of weaner rabbits. There was no significant (P>0.05) variation on all the parameters evaluated except for PER which was significantly improved (P<0.05). Rabbit fed diets T1 (1.41), T3 (1.13), T4 (1.04) and T5 (1.90) had the best PER as compared to those fed T2 (3.07). Feed cost/kg was highest (₦283/kg) in diet T1 and reduces as the level of KBSM increase in the diet. Mortality (25%) was recorded in those animals fed diet T3 only.

Table 3: Effect of replacing full fat soybean meal with KBSM on growth indices of weaner rabbits

Parameters	T1 (0%)	T2 (25%)	T3 (50%)	T4 (75%)	T5 (100%)	SEM	LOS
Initial weight (g/rabbit)	662.50	687.20	662.50	662.50	675.00	81.13	NS
Final weight (g/rabbit)	1275.00	136.50	1350.00	1337.5	11.75	12.52	NS
Weight gain (g/rabbit)	14.58	16.07	15.73	14.87	11.90	3.23	NS
Feed intake (g/rabbit)	63.57	54.86	65.55	59.73	43.65	6.42	NS
Feed conversion ratio	4.53	3.75	4.19	4.27	4.29	0.74	NS
Protein efficiency ratio	1.41^{a}	3.07^{b}	1.13^{a}	1.04^{a}	1.90^{a}	0.42	*
SGR (g/rabbit/d)	1.04	0.72	0.76	0.72	0.5	0.14	NS
Feed cost (₦/Kg)	283.00	280.00	261.00	269.00	236.00	-	-
Mortality	0	0	25	0	0	-	-

SEM – Standard Error of Mean, NS- Not Significantly different (P>0.05), *- Significantly different (P<0.05), ab- Means on the same row carrying different superscripts differ significantly (P<0.05), SGR-Specific growth rate

Effect of replacing full fat soybean meal with KBSM **on growth indices of grower rabbits**

The effect of replacing full fat soya bean meal on growth indices of grower rabbit is presented in Table 4. Similar to the observations recorded in the weaner phase, there was no variation (P<0.05) in all the growth indices evaluated except for FER for animals in T2, T3, T4 and T5 which were significantly (P<0.05) better than that of treatment T1 (4.52).

Table 4: Effect of replacing full fat soybean meal with KBSM on growth indices of grower rabbits

Parameters	T1 (0%)	T2 (25%)	T3 (50%)	T4 (75%)	T5 (100%)	SEM	LOS
Initial weight(g)	662.50	687.20	662.50	662.50	675.00	81.13	NS
Final weight(g)	1412.5	1437.8	1437.5	1612.5	1287.5	24.7	NS
Weight gain(g)	157.96	187.17	171.42	181.24	155.35	93.29	NS
Feed intake(g)	3336.7	3402.3	3390.0	2821.0	2660.27	40.89	NS
Feed conversion ratio	4.52^{b}	3.18^{a}	3.93^{a}	3.56^{a}	3.44^{a}	1.13	*
Protein efficiency ratio	0.26	0.33	0.24	0.34	0.39	0.12	NS
Specific growth rate	0.08	0.15	0.22	0.09	0.06	0.08	NS
Feed cost/ kg (₦/kg)	230.00	240.00	288.00	135.00	180.00	-	-
Mortality	0	0	25	0	0	-	-

SEM – Standard Error of Mean, NS- Not Significantly different (P>0.05), *- Significantly different (P<0.05), ab- Means on the same row carrying different superscripts differ significantly (P<0.05)

Effect of replacing full fat soybean meal with KBSM **on nutrient digestibility by grower rabbits**

Table 5 gives the result of the effect of replacement of KBM on nutrient digestibility by grower rabbits. Dry matter digestibility was significantly improved (P<0.05), rabbits fed diets T2 (73.83%) and T5 (78.60%) had the best dry matter digestibility followed by those fed diets T3 (70.19%) and T4 (64.87%). Consistently, rabbits fed diet T2 and T5 produced the best digestibility of crude fibre (58.38and 65.50%), ash (2.34 and 2.57% and NFE (69.98 and 75.98%), respectively. However, those fed diets T3 and T4 performed similarly compared to those fed the control for dry matter, crude fibre, ash and NFE.

Table 5: Effect of replacing full fat soybean meal with kidney bean meal on nutrient digestibility by grower rabbits

Parameters (%)	T1 (0%)	T2 (25%)	T3 (50%)	T4 (75%)	T5 (100%)	SEM	LOS
Dry matter	57.86^{b}	73.83^{a}	70.19^{ab}	67.87^{ab}	78.60^{a}	2.56	*
Crude protein	77.41	77.09	89.36	83.91	79.49	2.76	NS
Ether extract	83.09	90.21	88.50	87.17	91.20	1.08	NS
Crude fibre	32.82^{b}	58.38^{a}	54.03^{ab}	47.61^{ab}	65.50^{a}	4.21	*
Ash	1.45^{b}	2.34^{a}	2.06^{ab}	1.85^{ab}	2.57^{a}	0.14	*
Nitrogen-free extract	53.24^{b}	69.98^{a}	66.53^{ab}	63.71^{ab}	75.98^{a}	2.80	*

SEM – Standard Error of Mean, NS- Not Significantly different (P>0.05), *- Significantly different (P<0.05), ab-Means on the same row carrying different superscripts differ significantly (P<0.05)

Effect of replacing full fat soybean meal with KBSM **on carcass characteristics and linear measurements of grower rabbits**

The replacement of full fat soybean meal with KBM in the diets of grower rabbits (Table 6) significantly (P<0.05) improved the weight of the neck of the rabbits as those fed the 100% KBM (T5) produced the heaviest (90.00g/rabbit) as compared to the other gravimetric measurements which were not affected (P>0.05) by the various treatments. Similarly, the linear cuts (Table 7), intestine, large intestine and carcass length were not affected by the treatments.

Table 6: Effect of replacing full fat soybean meal with KBSM on carcass characteristics of grower rabbits

Parameters	T1 (0%)	T2 (25%)	T3 (50%)	T4 (75%)	T5 (100%)	SEM	LOS
Live weight (g/rabbit)	1550.00	1575.00	1325.00	1550.00	1425.00	165.15	NS
Empty carcass (g/rabbit)	902.50	825.00	825.00	850.00	825.00	109.44	NS
Scalded weight (g/rabbit)	1.50	1.48	1.45	1.58	1.40	0.12	NS
Dressing percentage (%)	58.69	52.13	63.63	54.59	50.00	7.17	NS
Neck (g/rabbit)	49.40^{bc}	59.15^{b}	37.95^{c}	35.10^{c}	90.00^{a}	4.85	*
Chest (g/rabbit)	160.25	129.45	159.95	133.95	115.85	27.17	NS
Belly (g/rabbit)	49.80	59.15	37.95	35.10	32.45	26.58	NS
Shoulder (g/rabbit)	125.55	90.50	113.60	119.50	108.85	32.52	NS
Head (g/rabbit)	140.70	121.75	131.45	144.85	131.30	13.52	NS
Fore limb leg (g/rabbit)	21.05	20.05	22.05	23.65	19.10	2.84	NS
Thigh (g/rabbit)	247.00	226.60	214.95	243.65	244.45	29.79	NS
Sharks (g/rabbit)	26.95	23.85	25.15	25.70	23.75	3.75	NS

a,b,c Means with different superscript on the same row differ significantly (P< 0.05), LOS- levels of significant, NS-Not significant.

Table 7: Effect of replacing full fat soybean meal with KBSM on linear measurements of grower rabbits

Parameter (cm)	T1 (0%)	T2 (25%)	T3 (50%)	T4 (75%)	T5 (100%)	SEM	LOS
Small intestine	312.50	265.50	348.50	269.00	265.50	46.24	NS
Large intestine	108.50	107.50	98.50	107.00	99.50	12.17	NS
Carcass length	34.00	34.25	33.00	32.00	32.50	1.10	NS

LOS-level of significant, NS-Not significant.

Effect of replacing full fat soybean meal with KBSM on visceral organs of grower rabbits

The result of the effect of replacing full fat soya-bean with KBM on visceral organs of grower rabbits is presented in Table 8. All the parameters evaluated were not affected (P<0.05) by the treatment except for weight of stomach which significantly (P<0.05) increased in rabbits fed diet T4 (17.70g/rabbit) as compared to other treatment groups.

Table 8: Effect of replacing full fat soybean meal with KBSM on visceral organs of grower rabbits

parameter	T1 (0%)	T2 (25%)	T3 (50%)	T4 (75%)	T5 (100%)	SEM	LOS
Heart (g/rabbit)	2.90	4.10	3.40	3.15	3.25	0.51	NS
Kidney (g/rabbit)	39.15	10.20	9.20	9.15	9.65	0.66	NS
Liver (g/rabbit)	39.15	40.50	34.85	35.25	37.35	2.30	NS
Lungs (g/rabbit)	8.55	6.35	8.30	9.80	7.65	0.89	NS
Stomach (g/rabbit)	14.30^{c}	14.60^{bc}	11.10^{c}	17.70^{a}	14.40^{c}	0.94	*
Small intestine (g/rabbit)	39.20	35.25	41.10	31.00	29.70	7.13	NS
Large intestine (g/rabbit)	31.35	28.20	27.30	30.40	31.20	5.59	NS

a,b,c Means with different superscript on the same row differ significantly (P< 0.05), LOS-level of significant, NS-Not significant.

Effect of replacing full fat soybean with KBSM **on haematological parameters of grower rabbits**

Table 9 shows the effect of replacing full fat soybean meal with KBM on the haematological parameters of grower rabbits. There was no significant variation (P>0.05) across the treatment for all parameters evaluated.

Table 9: Effect of replacing full fat soybean with KBSM on haematological parameters of grower rabbits

parameters	T1 (0%)	T2 (25%)	T3 (50%)	T4 (75%)	T5 (100%)	SEM	LOS
PCV (%)	35.00	34.00	36.50	35.00	37.00	1.97	NS
Hb (g/dl)	11.75	11.40	12.15	11.65	12.30	0.64	NS
WBC ($x10^{12}$ /L)	3.80	3.35	3.90	4.65	3.70	0.66	NS
RBC ($x10^{12}$ /L)	3.41	3.28	3.47	3.38	3.52	9.23	NS
MCHC (%)	33.70	33.20	33.25	33.25	34.90	1.58	NS
MCH (Pg)	35.30	35.10	35.15	34.90	35.10	3.78	NS
MCV (FL)	104.50	104.65	105.75	104.80	105.65	7.95	NS
Neutrophil (%)	43.00	41.00	48.00	42.50	38.00	5.40	NS
Leucocytes (%)	57.00	58.50	46.00	55.50	58.50	5.34	NS

SEM = Standard error mean, LOS = level of significant, NS = No significant, PCV = packed cell volume, Hb = Haemoglobin concentration

Effect of replacing full fat soybean with KBSM **serum biochemistry of grower rabbits**
There was significant increase (P<0.05) in the values recorded for total protein, triglyceride, cholesterol and glucose (Table 10). Rabbits fed diets T2 and T3 had the highest total protein of 70.50 and 71.00 g/l, respectively. However, those rabbits fed the T5 diet had the best value of triglyceride (1.15 mmol/L) as compound to other treatment groups. Cholesterol was significantly increased (P<0.05) in those rabbits fed diet T2 (3.55 mmol/L), T3 (3.40 mmol/L) and T4 (3.35 mmol/L) followed by those fed the control (3.35 mmol/L) and T5 (3.10 mmol/L. There was no variation (P<0.05) in the values of albumin and globulin).

Table 10: Effect of replacing full fat soybean with KBSM on serum biochemistry of grower rabbits

parameters	**T1 (0%)**	**T2 (25%)**	**T3 (50%)**	**T4 (75%)**	**T5 (100%)**	**SEM**	**LOS**
Total protein (g/L)	64.00^{b}	70.50^{a}	71.00^{a}	61.50^{b}	66.00^{ab}	3.50	*
Albumin (g/L)	27.00	29.50	28.50	24.00	27.50	2.45	NS
Triglyceride (mmol/L)	1.00^{ab}	0.90^{b}	0.85^{b}	1.05^{ab}	1.15^{a}	2.34	*
Globulin (g/L)	23.00	22.50	24.00	19.00	22.00	1.63	NS
Cholesterol (mmol /L)	3.25^{ab}	3.55^{a}	3.40^{a}	3.35^{a}	3.10^{ab}	0.1	*
Glucose (mmol /L)	10.33^{a}	10.55^{a}	9.25^{a}	6.3^{b}	7.3^{b}	0.47	*

SEM = Standard error mean, LOS = level of significant, NS = No significant, * = Significant at 5% (P<0.05), PCV = packed cell volume, Hb = Haemoglobin concentration

Effect of replacing full fat soybean with KBSM on serum electrolytes of grower rabbits
Table 11 summarizes the effect of replacing full fat soybean meal with KBM on serum electrolytes of grower rabbits. The result shows that there was no significant variation (P>0.05) across the treatment groups for calcium, sodium and phosphorus.

Table 11: Effect of replacing full fat soybean with KBSM on serum electrolytes of grower rabbits

Parameters (mmol/L)	**T1 (0%)**	**T2 (25%)**	**T3 (50%)**	**T4 (75%)**	**T5 (100%)**	**SEM**	**LOS**
Calcium	2.60	2.45	2.50	2.65	2.55	0.17	NS
Sodium	148.50	154.50	149.50	144.50	149.00	4.21	NS
Phosphorus	5.50	4.40	4.40	5.25	5.30	1.39	NS

SEM = Standard error mean, LOS = level of significant, NS = No significant

Effect of replacing full fat soybean with KBSM **on serum enzymes of grower rabbits**

Serum glutamate oxaloacetate transaminase was significantly (P<0.05) increased (Table 12) as rabbit fed diet T3 (26.50 iu/L), T4 (23.00 iu/ L) and T5 (26.00 iu/ L) were higher than those fed the other diets. Alkaline phosphatase was also significantly higher in rabbits fed diet T5 (253.50 iu/L) as compared to those fed the other diets.

Table 12: Effect of replacing full fat soybean with KBSM on serum enzymes of grower rabbits

Parameters	T1 (0%)	T2 (25%)	T3 (50%)	T4 (75%)	T5 (100%)	SEM	LOS
GPT (iu/L)	18.80	13.00	20.40	19.90	19.85	1.67	NS
GOT (iu /L)	23.50[a]	18.50[b]	26.50[a]	23.00[a]	26.00[a]	1.30	*
Alkaline phosphatase (iu /L)	213.50[b]	188.50[c]	172.50[c]	239.00[b]	253.50[a]	21.70	*

SEM = Standard error mean, LOS = level of significance, * = Significant at 5% (P<0.05), NS = No significant at 5% (P>0.05), GPT = Glutamate Pyruvate transaminase, GOT = Glutamate oxaloacetate transaminase

DISCUSSION

The proximate composition of KBSM

The test ingredient is less fibrous (1.89%) and may not require any form of processing against non-starch polysaccharides. Yellavila *et al.* (2015) earlier reported a higher crude protein content of 20.69–23.08 %, crude fat, 0.59–1.14 %, crude fibre, 4.06–6.86 %, ash, 4.39–5.61%, moisture 9.19-11.83 %, carbohydrate 54.31-59.64 % and energy, 313.28-328.10 kcal/100 g. This indicates that the bean has a functional property that can conveniently replace other protein and energy conventional feedingstuff.

Growth parameter of weaner and grower rabbits

The non-significant (P>0.05) variation observed in most of the parameters evaluated showed that heat treatment satisfactorily destroyed the anti-nutritional factors to bring about an efficient utilization of the dietary kidney beans by the rabbits. This is probably due to the fact that the processing method adopted in this trial involved the application of heat. The values recorded in the present study agree with earlier findings of Damang *et al.* (2017) and Hussein *et al.* (2015).

The reduction in the feed cost/kg as the level of KBSM increased in the diets was attributed to the low cost of the test ingredient as compared to the conventional soybean. This observation is in consonance with the earlier report of Chinedum and Evans (2001) who reported that the use of non-conventional feeds increases profitability and reduces production cost.

The mortality recorded (25%) in those animals fed diet T3 was not as a result of the treatment as it occurred in a particular replicate of that treatment only. However, it was suspected to be due to pathogenic infection arising from the hutches. The variation recorded in the FCR in the grower phase may be attributed to the wastage of feed by the mature rabbits which are the usual characteristic burrowing nature of *Leporidae* family. However, the slight bitter taste of tannin noticed even after toasting may reduce the rate of conversion of feed to tissue.

Nutrient digestibility by grower rabbits

The improved (P<0.05) dry matter, crude fibre and NFE digestibility obtained could be attributed to the heat treatment (heat effect) which is generally known to have positive influence on digestibility of seeds. As the level

(quantity) of the test ingredient increases, the diets also reduce in the fibrous nature, hence giving way to more and readily digestible materials. However, the non-significant variation observed on ether extract may be probably due to the effects of some anti-nutritional factors from the test ingredients such as tannins on activities of lipase, α-amylase and digestion of lipids (Longstaff and McNab, 1991). The trend recorded in the present study is in agreement with the earlier findings of Shaahu *et al.* (2014) and Osakwe and Nwose (2008). Osakwe and Nwose (2008) observed significant improvement ($P<0.05$) in nutrient digestibility when they evaluated feed intake and nutrient digestibility of weaner rabbits fed cassava peel as replacement for maize.

Carcass characteristics

The non-significant variation most of the carcass parameters evaluated may be an indication of the nutritional adequacy of the diets which produced uniform sizes of the animal. This is corroborated by the non-variation ($P>0.05$) in the final weight of the animals, empty carcass weight as well as those of the visceral organs. However, significant ($P<0.05$) improvement in the weight of the neck of the rabbits in treatment (T5) (90.00g/rabbit) may be attributed to the breed difference since the rabbits used for the experiment were mixed and cross bred. This observation may be probably because the inclusion levels of the test ingredients did not reach the threshold level that could have affected the weight of the various cut parts and the visceral organs. However, the values recorded in the present study were close to those earlier reported (Aduku and Olukosi, 1990; Alu *et al.*, 2009; Alu, 2010).

Haematological parameters of grower rabbits

The state of the haematological parameters of animals defines, to a large extent, the health and well-being of the animal. The non-significant difference recorded in the present study suggests that all the diets, irrespective of the level of inclusion, were adequate and nutritionally balanced for growth and development of the rabbits, this suggests that the processing method adopted in the present study was efficient in alleviating the presence of toxic substances that may be injurious to the health of the animals. However, mean values of each parameter were within the normal range as reported by David *et al.* (2002).

Serum biochemistry of grower rabbits

Absorption and utilization of nutrients by animals is a major function of the diet, adult rabbits absorb most nutrients in the small intestine (up to 90%), but this depends on the source. For instance, the protein in soybean meal is very digestible, but a high portion of the protein in alfalfa (which is largely bound to the plant cell wall) is indigestible to rabbits. Rabbits digest cellulose poorly (Fraga 1990). This seems a paradox for an animal that lives naturally on vegetation. However, the low digestibility of fiber and rapid elimination of large, hard-to-digest particles enable the rabbit to maintain a higher level of feed intake than it would otherwise be able to (Sakaguchi 1992). Thus, the significant increase ($P<0.05$) in the values recorded for total protein, triglyceride, cholesterol and glucose supports the earlier assertion of Fraga (1990) indicating that the diets were not highly lignified. The values recorded for most of the constituents evaluated were within the normal range for mature rabbits (David *et al.*, 2002).

The significant ($P<0.05$) increase in the serum glutamate oxaloacetate transaminase and alkaline phosphatase may suggest a likelihood of necrosis. This assertion is based on the fact that enzymes like alanine aminotransferase is elevated in serum under conditions of significant cellular necrosis and is used as a measure of liver function. Levels of ALT may be elevated in cases of congestive heart failure, liver or biliary duct damage, or myopathy. Diet, restraint, and drug administration may also affect plasma ALT in rodents (Osa *et al.*, 2015).

CONCLUSION AND RECOMMENDATION

From the results of this experiment, nutrient absorption and rate of conversion of feed to flesh were not impaired by the inclusion of Kidney bean seeds even at 100% replacement. This implies that rabbit farmers can effectively utilize the available Kidney beans in feeding their rabbits as a source of dietary energy and protein.

For efficient digestibility and nutrient utilization by the rabbits, Kidney beans should be properly toasted to reduce the deleterious effect of anti-nutritional factors that may impair absorption of nutrients by the rabbits.

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