2023 International Conference on Science, Engineering and Business for Sustainable Development Goals (SEB-SDG) | 979-8-3503-2478-5/23/$31.00 ©2023 IEEE | DOI: 10.1109/SEB-SDG57117.2023.10124513

Growth performance and blood profile of weaned rabbits fed graded levels of Hevea brasiliensis seed meal as a protein source

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Abstract— A ten-week investigation was undertaken to assess the incorporation of *Hevea brasilliensis* seed meal (RSM) as an alternative to soyabean meal (SBM) in rabbits' feed. Sixty kit rabbits were distributed at random to four treatments diets and five rabbits / replicate in a completely randomized design (CRD). The diets consist of a control diet (0% RSM) as well as three experimental diets, containing 25%, 50% and 75% RSM. Results showed that RSM affected ($P < 0.05$) the rabbits' blood profile and performance. The weight gain was similar ($P > 0.05$) up to 50% SBM replacement, while feed conversion ratio (FCR) were similar ($P > 0.05$) across the replacement levels. The highest weight gain and best FCR were observed in diets containing 50% and 25% RSM respectively. The highest values of packed cell volume (PCV), haemoglobin (Hb), white blood cells (WBC), mean corpuscular volume (MCV), and mean corpuscular haemoglobin (MCH), were noted in Diet 4 (75% RSM). The total protein increased with an increased level of RSM in the diet, while as RSM in the diet increased, the liver enzymes dropped. . In conclusion, RSM could effectively replace 50% SBM as protein ingredient in growing rabbits' diets.

Keywords— Haematology, Performance, Proximate components, Rabbit, Rubber seed, Serology

I. INTRODUCTION

The periodic shortage of conventional feedstuffs for livestock feeding has made livestock feed prices to rise sharply, resulting in high production costs. This has resulted into searching for potentially useful, less expensive and readily available protein and energy sources in unusual feedstuffs.

Rabbit production and consumption may be strategically promoted, with better information sharing at the grassroots, to close the protein intake gap. The optimization of the benefits rabbit has to offer depends largely on nutrition.

Rubber production in Nigeria is about 159,264 tons in 2017 [1] and contributes about 10175 tonnes of seed annually making its seeds abound in Nigeria, particularly in the south, where the seeds are often abandoned and the *Hevea brasilliensis* is produced for both domestic and international markets. .

Potentially, rubber seeds (RS) might be given to animals as a source of vegetable protein [2]. In addition, the high level of essential amino acids (tryptophan, methionine and lysine) and phosphorus in rubber seed meal (RSM) as reported by [3] makes it a good alternative feedstuff in monogastric animal production Rubber is widely cultivated in Southern Nigeria for domestic use and for export. The tree begins to yield latex after six to nine years of cultivation but seed production occurs between four and six years. For rubber farmers who also use intercropping with arable crops for sustenance, soil improvement, and weed control techniques before natural rubber production begins, gathering rubber seed for the production of animal feed could be an additional source of income. [4]. The present Nigerian government's effort at increasing rubber cultivation as a means of diversifying its revenue base will directly lead to a proportional increase in the available rubber seeds for feed production.

RSM, which has been estimated to contain crude protein (CP) of 24.0 to 34.1% [5; 6], has attracted a lot of interest recently as a potential animal protein source. In a previous study it was reported that 30% RSM can be added to meat type chicken feed without any negative consequences on their

performance [3]. The RSM has been reported to be part of human menu in India, Indonesia [7] and Malaysia, while in the livestock sector, it has been successfully incorporated into fishmeal, small ruminants, swine [8] and poultry [3].

Therefore, the purpose of this study is to assess the utilization of graduated levels of RSM as a protein source in the diets of growing rabbits. .

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II. MATERIALS AND METHODS

A. Experimental site

This experiment was executed at the Rabbitry Unit of the Teaching and Research Farm, and the Animal Nutrition Laboratory of the Department of Animal Science, Landmark University, Omu Aran, Kwara State (latitude 8° 7' 16" north and longitude 5° 4' 50" east), Nigeria for a period of ten weeks.

B. Procurement of materials

The RS were obtained from the rubber plantation at Ovia South-West (6.4653° N, 5.3103° E) Local Government Area of Edo state, Nigeria. Other feed components were bought in Omu Aran market. Daily cuts of *Pueraria phaseoloides* fodder were made in the neighborhood of the research area. To prepare the RSM, the raw rubber seeds were exuviated, sun dried, then ground.

C. Experimental design and management of animals

Sixty crossbred rabbits (weaners) were used for this study. Each of the four treatment diets, which were replicated three times in a CRD, received fifteen rabbits each. In a unit of the hutch of 50 x 40 x 40cm in size, five rabbits were each kept individually. Routine management practices including medication were carried out during the feeding trial in accordance to [9]. These were done to ensure optimum performance of the rabbits

Diet 1 (control) had a level of 0% of RSM, while RSM was used to replace soya bean meal in Diets 2, 3, and 4 at inclusion levels of 25, 50, and 75%, respectively (SBM). The diet composition is as presented in Table 1.

TABLE 1 GROSS COMPOSITION OF THE EXPERIMENTAL DIETS (% DM)

Ingredients	*Experimental diets*			
	Diet 1	*Diet 2*	*Diet 3*	*Diet 4*
Maize	45.00	45.50	45.00	45.50
SBM	16.00	12.00	8.00	4.00
RSM	0.00	8.00	8.00	12.00
Fish meal	2.50	2.50	3.00	3.50
Rice offal	17.50	17.30	16.80	16.30
PKC	13.50	13.20	13.20	13.20
Oyster shell	1.30	1.30	1.30	1.30
Bone meal	3.20	3.20	3.20	3.20
Salt	0.40	0.40	0.40	0.40
Premix	0.60	0.60	0.60	0.60
Calculated analysis:				
ME (Kcal/kg)	2530.00	2530.00	2531.00	2531.00
CP (%)	16.74	16.67	16.60	16.54

Note: SBM = Soya bean meal; RSM = Rubber seed meal; PKC = Palm kernel meal; ME = Metabolizable energy; Diet 1 = 0% RSM; Diet 2 = Diet containing 25% RSM; Diet 3 = Diet containing 50% RSM; Diet 4 = Diet with 75% RSM

For the duration of the trial, the rabbits in each treatment duplicate received 200g of *Pueraria phaseoloides* forage daily at noon. During the feeding session, the rabbits had unlimited access to the experimental meals and water. .

The proximate components and metabolizable energy of RSM was determined according to standard procedures [10].

D. Performance study

Weekly feed intake and weight changes were noted. Feed intake and weight changes were noted. during the feeding study, while weight gain and feed conversion ratio (FCR) were estimated. To calculate daily feed consumption, the weight of leftover feed was removed from the original weight of feed provided. (i.e. Feed intake = Feed given – feed oft). The weekly weight gain was calculated as the difference between the weights at the beginning and conclusion of each week. . Below is the formula for calculating the feed conversion ratio:

$$\text{FCR} = \frac{\text{Feed Intake}}{\text{Weight gain}}$$

E. Blood profile study

Two sets of fresh blood samples were taken at the conclusion of the feeding trial via the lateral saphenous vein [11], using a sterile disposable syringe and needle from one animal randomly designated from each replicate into two sample bottles/animal. One bottle laden with ethylene diamine tetra acetic acid (EDTA) for the hematology study, while the second bottle did not contain EDTA for the serum biochemistry investigation. Blood samples in EDTA-containing bottles were used to analyze for full blood count using an automatic Hematology Analyzer (DxH 900). The biochemical indices were determined using automatic serum kits (Gold Analisa Ltda, Belo Horizonte, Minas Gerais, Brazil).

ANOVA was used to analyze the data, which were presented as averages of three separate determinations. The significant differences between the samples were determined using the Duncan multiple range test at a significance level of 5%. Statistical Analysis System software [12] was used to analyze the data.

III. .RESULTS ANDNDISCUSSION

A. Proximate composition of rubber seed meal (Table 2)

In this investigation, higher levels of CP and ether extract (EE) were detected than in previous [3] and [8] respectively. Agricultural practices, specie differences, soil type, climatic condition, and level of applied fertilizer could be responsible for the variation in the proximate components of the RSM. [13] also noted that RSM obtained using the solvent extraction approach may have a lower nutritional composition than RSM acquired using the mechanical extraction method. RSM is lower in dietary energy than yellow maize, however, the high protein content and total digestible nutrients may makes it a potential protein source in animal feeds.

TABLE 2 PROXIMATE COMPOSITIONS OF RUBBER SEED MEAL (RSM)

Components	(%)
Moisture	9.63
Crude protein	30.90
Ether Extract	11.07
Crude fiber	9.92
Ash	5.78
Nitrogen free extract	32.70
Metabolizable energy (Kcal/kg)	3200.82

B. *Performance characteristics*

Table 3 displays the performance traits of rabbits as impacted by dietary interventions. All the growth performance indices were significantly (P<0.05) influenced by the dietary treatments. The live weight was highest in diet 2 (25% RSM) with the value of 2.15kg and least in diet 4. The total weight gain in the control diet was similar (P > 0.05) to those obtained at 25 and 50% replacement levels, and better than that of 75% replacement levels. The similar weight gain of up to 50% replacement level may indicate that the energy and nutrient values were as high as the control, highlighting the iso-caloric and iso-nitrogenous nature of the diets. The FCR were similar (P > 0.05) in all the diets. However, the best FCR was recorded in the diet containing 25% RSM. The trend of the live weight, weight gain and FCR followed the same trend as the reports of [11] in which RSM replaced SBM in the diets of broiler chicks. The higher growth performance indices recorded in this trial may be a validation of the opinion of [14] that RSM has better essential nutrients than SBM and can serve as a protein supplement.

The control diet had the highest feed consumption, and when RSM was added to the diets, the value generally fell. The anti-nutritive components of RSM may have significantly influenced the palatability of the feed, which may have contributed to the reduced feed intake linked to the increasing amount of RSM. The decrease in the performance of rabbits at 75% level of RSM could be due to higher fibre content in RSM than SBM. Thus, as RSM content increased, the fibre content also increased

TABLE 3 PERFORMANCE CHARACTERISTICS OF RABBITS FED THE EXPERIMENTAL DIETS CONTAINING RUBBER SEED MEAL

Parameters	*Experimental diets*				
	Diet 1	*Diet 2*	*Diet 3*	*Diet 4*	*± SEM*
LW (kg)	2.02^{b}	2.15^{a}	2.15^{a}	1.65^{ab}	0.05
DFI (g)	104.25^{a}	99.76^{ab}	101.25^{ab}	97.98^{b}	1.70
TFI (kg)	7.30^{a}	6.98^{b}	7.09^{ab}	6.86^{b}	0.09
DWG (g)	17.00^{a}	17.45^{a}	17.50^{a}	16.65^{b}	0.76
TWG (kg)	1.19^{a}	1.22^{a}	1.23^{a}	1.17^{b}	0.04
FCR	6.13	5.72	5.76	5.86	0.02

abc = Means in the same row but with varying alphabets differ significantly (P<0.05) according to DMRT

SEM = standard error of mean; LW = Live weight; DFI = Daily feed intake; TFI = Total feed intake; DWG = Daily weight gain; TWG = Total weight gain; FCR = Feed conversion ratio; Diet 1 = Diet with 0% RSM; Diet 2 = Diet with 25% RSM; Diet 3 = Diet with 50% RSM; Diet 4 = Diet with 75% RSM

C. *Haematological characteristics*

Table 4 displays the haematology of rabbits on diets with various addition levels of RSM. The haematological parameters analyzed (with the exception of RBC, MCHC and platelets) were impacted (P < 0.05) by the test ingredient. Generally, the inclusion of the RSM tends to increase the haematological values. Although, there was no significant effect on the RBC, highest value was observed in diet containing 50% RSM. The Hb, PCV, MCH, MCV and WBC were highest (P<0.05) in rabbits fed 75% RSM based diet. The control diet recorded the lowest Hb, PCV, and RBC levels. Nevertheless, there was similarity (P>0.05) in the Hb values measured in rabbits fed Diets 1, 2, and 3. Similarly, the PCV and WBC levels were comparatively similar in rabbits fed Diets 2 and 3. As the replacement value increased, the Hb and WBC levels increased.

Superior values for haematological indices may imply that RSM is of higher protein quality in terms of blood parameters than SBM, as it has been observed that farm animal haematological indices correlate favourably with diet quality [15]. [5] found that when RSM was used to replace groundnut cake (GNC) in broiler diets, the serological and haematological parameters of broilers decreased as levels of RSM inclusion in the diets increased. Because RSM was used instead of GNC in this study, the correlation between the quality of GNC and SBM protein could not be readily ascertained.

The haematological results gotten in this investigation are higher than those reported by [16] in their investigation of *Parkia biglobosa* seed meal as a replacement for SBM. In addition, the current study found greater Hb, PCV, and lymphocyte levels, as well as lower RBC and WBC values, as compared to values reported by [17] in a study where *Cola rostrata* seed meal was included in the meals of growing rabbits. The current study's trend in the haematological pattern is comparable to that of [18], where sheabutter nut meal was used in place of SBM.

MCV increased as RSM inclusion in rabbit diets increases, which is similar with prior research with broilers [5]. MCV is a crucial feature that influences the size of erythrocytes and, as a result, an animal's capacity to survive in low-oxygen environments. . As a result, the greater MCV seen in rabbits fed Diet 4 may imply that the animal will be able to endure prolonged oxygen deprivation if RSM is included up to 75% in the rabbit's diet. In this study, a rise in WBC with increasing amounts of RSM in rabbit diets could imply the presence of potentially harmful microorganisms. However, studies have shown that this is not always the case, as rabbits, unlike other animals, respond differently to inflammation and microbial infections, resulting in clinically visible leucopenia, leukocytosis, or normal levels [11]. All of the haematological traits, on the other hand, are within [11] normal range for developing rabbits. The presence of a normal range of haematological indices may indicates that the diets had no adverse effects on haematological parameters.

The inclusion of the forage *Pueraria phaseoloides* may have also contributed to the study's normal haematological range. In previous studies, [19] found that rabbits in cages given commercial concentrate had lower haematological values than

rabbits maintained on natural diets or a mix of concentrate and forages.

TABLE 4 HAEMATOLOGICAL PARAMETERS OF RABBITS FED THE EXPERIMENTAL DIETS

Parameters	*Experimental diets*				
	Diet 1	*Diet 2*	*Diet 3*	*Diet 4*	*± SEM*
Hb (g/dl)	11.65^{b}	12.50^{b}	12.95^{b}	14.00^{a}	0.61
RBC	5.23	5.55	6.04	6.01	0.19
PCV (%)	34.60^{b}	36.65^{ab}	38.05^{ab}	41.00^{a}	1.58
MCV (fl)	66.16^{ab}	66.04^{ab}	63.00^{b}	68.23^{a}	0.94
MCH (pg)	22.28^{ab}	22.25^{ab}	21.44^{b}	23.29^{a}	0.35
MCHC (g/dl)	33.67	34.11	34.03	34.14	0.31
WBC	4.10^{b}	4.75^{b}	5.20^{b}	6.45^{a}	0.36
Platelets (fl)	5.60	5.47	5.50	5.27	0.22

abc = Means in the same row but with differing alphabets differ significantly (P< 0.05) according to DMRT

Diet 1 = 0% RSM; Diet 2 = Diet containing 25% RSM; Diet 3 = Diet containing 50% RSM; Diet 4 = Diet containing 75% RSM; RBC = erythrocytes (x 10^{6}/ml); Hb = Haemoglobin; PCV = Hematocrit; WBC = Leucocytes (x 10^{3}/ml); MCH = Mean corpuscular haemoglobin; MCV = Mean corpuscular volume; MCHC = Mean corpuscular haemoglobin concentration.

D. The serum biochemical indices

The findings showed that the treatment diets significantly (P<0.05) influenced all biochemical indicators, with the exception of albumin, urea, and bilirubin (Table 5). Rabbits fed a diet consisting of 75% RSM had significantly greater levels of total protein (P<0.05), while those fed a control diet had the lowest levels. Rabbits given Diets 3 and 4 produced total proteins that were statistically comparable (P>0.05). When compared to rabbits fed the control diet, the RSM inclusion meals resulted in significantly higher levels of total protein and albumin in the blood serum, which may be explained by the improved protein digestion, absorption, or utilization in the diets. According to [20], serum protein could be used to predict hepatic and renal disorders. Reduced serum albumin synthesis can be caused by protein-calorie malnutrition, intestinal malabsorption syndrome, and end-stage liver disease.

Creatinine levels were significantly higher in rabbits fed Diet 4, followed by comparable levels in those fed Diets 1 and 3, and the lowest levels in those fed Diet 2. The outcomes here are within the expected range and this could imply that optimal protein was available for tissue muscle building. Because high creatinine is a sign of muscle mass metabolism, this finding also implies that there was no muscular atrophy arising from addition of RSM to the diets.

Rabbits fed 75% RSM had the highest cholesterol level and this was lowest in rabbits fed 25% RSM diet. The reduced serum cholesterol levels seen in rabbits fed 25% and 50% RSM might be attributable to low quantities of anti-nutrients in the RSM at these levels, which might have not interfered with dietary cholesterol and lipid absorption [21]. This observation is comparable to [3] findings. The cholesterol levels measured in this study, however, are within [22] normal range.

The highest glucose value was obtained in rabbits fed the control diet, with a mean value of 121.00mg/dl, followed by a similar value of 104.50mg/dl in rabbits fed 50 % RSM, and lowest but equivalent values of 96.50 and 85.50mg/dl in rabbits fed Diets 2 and 4, respectively. [23] found that stressed and anorexic rabbits had higher blood glucose levels. Blood glucose was also devised as a metric for determining the severity of rabbit's ailment. The glucose and cholesterol trends seen in this study are comparable to those obtained by [18], who found lower values of these parameters with increasing levels of *Cola rostratae* seed meal inclusion.

The enzymes decreased as the amount of RSM in the meal rose. In rabbits fed Diets 3 and 4, alanine amino transferase (ALT) readings of 72.00 and 64.50 u/L were found to be similar. This finding contrasts with [17] that reported no discernible pattern in the levels of ALT and aspartate amino transferase (AST). In this investigation, the values of both parameters decreased as the inclusion level rose but were within the normal range [24]. The normal liver biomarkers activity suggests that the animals are unlikely to develop liver infections that result in extensive cell death, viral hepatitis, toxicity, or renal impairment. As a result, providing dietary RSM to growing rabbits has no negative impact on the function of important organs, including the liver and kidney.

TABLE 5 SERUM BIOCHEMISTRY OF RABBITS FED THE EXPERIMENTAL DIETS

Parameters	*Experimental diets*				
	Diet 1	*Diet 2*	*Diet 3*	*Diet 4*	*± SEM*
TP (mg/dl)	7.25^{b}	7.90^{ab}	8.27^{a}	8.47^{a}	0.23
Albumin (mg/dl)	4.65^{c}	5.30^{a}	5.17^{a}	4.87^{b}	0.05
Globulin (mg/dl)	2.60	2.60	3.10	3.60	0.37
Creatinine (mg/dl)	0.90^{b}	0.80^{b}	0.90^{ab}	1.00^{a}	0.05
Urea (mg/dl)	37.50	35.00	35.00	43.50	2.76
Cholesterol (mg/dl)	63.00^{ab}	33.50^{b}	41.00^{b}	70.50^{a}	11.05
Glucose (mg/dl)	121.00^{a}	96.50^{b}	104.50^{ab}	85.50^{b}	6.10
ALT (u/L)	121.00^{a}	101.00^{ab}	72.00^{b}	64.50^{b}	13.42
AST (u/L)	73.00^{a}	55.50^{b}	52.00^{c}	48.00^{d}	1.01

a, b, c = Means in the same row but with different letters in superscripts differ significantly (p<0.05) according to DMRT

Diet 1 = Diet with 0% RSM; Diet 2 = Diet with 25% RSM; Diet 3 = Diet with 50% RSM; Diet 4 = Diet with 75% RSM; TP Total protein; ALT= Alanine aminotransferase; AST = Aspartate aminotransferase.

IV. CONCLUSION

Rubber seed meal might potentially replace up to 50% of soya bean meal in growing rabbits without compromising growth, limiting haematopoiesis, or significantly affecting blood biochemistry. The research demonstrated that RSM is an effective substitute ingredient option for raising rabbits. . Hence, its use could be encouraged among rabbit farmers.

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