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Evaluation of Raw African Yam Bean Meal as Substitute for Soya Bean Meal in the Diet of Weaner Rabbits

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Abstract: The evaluation of substitution of African yam bean for soybean meal in weaner rabbits diet was carried out. Four experimental diets were formulated and designated T_1, T_2, T_3 and T_4. Diet 1 (soybean based) served as control while diets 2, 3 and 4 had African yam bean substituting for soybean meal at 32.26, 64.52 and 96.77%, respectively. A total of 24 weaner rabbits of different sexes and breeds were assigned to those diets in a completely randomized design. The trial consisted of six rabbits per treatment, replicated thrice, with each replicate having 2 rabbits. The trial lasted for 56 days. Data were collected on feed intake, weight gain, organ weights and serum chemistry while feed-to-gain ratio and economics of diet were calculated. The result showed that the feed intake of the control diet differed significantly from those of diets 3 and 4. Weight gain per rabbit per day for diets 1, 2 and 3 was statistically similar, but differed significantly ($p<0.05$) from diet 4. The feed-to-gain ratio followed similar pattern. For mean weight of organs, there was significant ($p<0.05$) difference for liver and heart values only. The liver values followed similar pattern with weight gain and feed-to-gain ratio. Serum chemistry showed significant ($p<0.05$) difference only for globulin values. The globulin values also followed similar pattern like the liver. Economics of diet showed that the gross margin favoured diets 2 and 3. Judging from growth performance especially non-significant feed-to-gain ratio for diet 1, 2 and 3, statistically similar organ weight for 1, 2 and 3, good serum chemistry and better performance of diet 2 and 3 as touching of the economics of the diets. Diet 3 (10% raw African yam bean meal) is recommended for weaner rabbits diet.

Key words: Evaluation, raw African yam bean meal, soybean meal, substitute, weaner rabbits diet

INTRODUCTION

The need to increase livestock production as a means of alleviating the overwhelming shortage of animal protein is very vital to humanity[1]. The problem of protein shortages especially those of animal origin is a perennial one which is so common throughout the country[2]. The demand for protein of animal origin in Nigeria is greater than the supplies[3]. There is therefore acute shortage of animals' protein in the diet of Nigerians, demanding that effort be directed to livestocks that are prolific and have short gestation intervals e.g. rabbit.

Rabbit is of more importance because it provides an inexpensive source of meat that by comparison with beef, lamb, pork etc. is low in cholesterol, low in fat and high in protein[4]. Rabbit has a high slaughter yield of 60 to 75% and its meat is white as in veal or chicken, the meat is easily digestible with slight amount of uric acid which is formed through metabolization[5]. Like other monogastric animals, feed accounts for between 70 and 80% of its production[6], of which conventional protein sources are the costliest. Hence the need to source for alternative protein sources which are cheaper, available and capable of reducing cost of livestock feed[7]. African yam bean (*Sphenostylis stenocarpa*) has been envisaged to be one of the alternatives. Its crude protein content ranges between 21.1-22.5 with lysine and methionine level better than that of soybean. Its yield ranges from 1860 to 2000 kg per hectare. Like other grain legumes, presence of anti-nutritional factors such as phytin, lectin, etc. have been reported[8-10]. Processing increase cost of production.

The objective of this study is to evaluate the effect of raw African yam bean meal as substitute for soya bean meal in the diet of weaner rabbits.

MATERIALS AND METHODS

Environment of study and housing: The study was carried out at the Rabbitory Unit of the Livestock and Teaching Research Farm of Michael Okpara University of

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Agriculture, Umudike, Abia State. Umudike bears the co-ordinates of 5° 28 north and 7° 31' east and lies at an altitude of 122 m above sea level. It is located within the tropical rainforest zone and the environment is characterized with an annual rainfall of 2177 mm. The relative humidity is above 75% monthly ambient temperature ranges from 17°C to 30°C. March is the warmest month with an average temperature range of 22°C-30°C.

The rabbits were housed in a 3-tier rabbit cage, which had a total of 12 hutches, 3 hutches in columns and 4 hutches across the rows, the cage was located inside a rabbit building equipped with vent and windows for proper ventilation. Each hutch had a tray built under it for collection of feaces. Each hutch had a feed trough and water trough for concentrates and water respectively. The cage was housed in a well ventilated high roofed building of asbestos roofing and long windows transversing almost whole length of the wall. This is to facilitate proper dissipation of heat as fast as possible. The floor was made of hard concrete for easy and proper cleaning.

Processing of feedstuff: The raw African yam bean seed was sun-dried and milled for use in compounding the experimental diets.

Experimental animals, diet and procedure: Twenty-four (24) weaner rabbits of mixed sexes and breeds of chinchilla, New Zealand White, New Zealand Black and Dutch were used for the experiment. They were randomly assigned to 4 dietary treatment groups designated as T_1, T_2, T_3 and T_4. Diet T_1 was the soybean meal based diet, which served as the control while T_2, T_3 and T_4 had quantitative replacement of soybean meal by raw African yam bean meal at 32.26, 64.52 and 96.77%, respectively. Each treatment had three replicates of two rabbits per replicate. The experiment lasted for fifty-six (56) days. Feed and water were given *ad-libitum*. Medications against ecto and endo parasites were administered to each rabbit prior to introduction to the rabbit house.

- Feed conversion ratio (g) feed / g gain = $\frac{\text{Quantity of feed consumed}}{\text{Weight gain}}$
- % Mortality = $\frac{\text{Number died}}{\text{Number purchased}} \times \frac{100}{1}$

Data collection and method: Data were collected on initial and final weights of the animals, feed intake, weight gain and the number of animals that died during the experiment in each replicate. The values obtained were used to obtain the following parameters:

- Feed intake/rabbit/day (g) $= \frac{\text{Quantity of feed given (g) - refusal (g)}}{\text{2X56 days}}$
- Daily weight gain / bird (g) $= \frac{\text{Final live weight - initial weight}}{\text{56 days}}$

Gross margin: This reveals the profitability of the test diets, gross margin was calculated using the method of Sonaiya[11].

Organ weight expressed as percentage dressed weight was determined as reported by Akinmutimi[12] while serum chemistry was carried out as described by Dacie and Lewis[13].

Chemical and statistical analysis: The test ingredient and the experimental diets were analysed for proximate composition and gross energy according to the method. The test ingredient was also analysed for anti-nutritional factors such as tannin, trypsin inhibitors, hydrogen cyanide, saponnin and phytin as described by Maga[14-18], respectively.

The experiment was carried out in a Completely Randomized Design (CRD). Data collected were subjected to analysis of variance (ANOVA) according to Steel and Torrie[19]. Significant means were separated using Duncan's Multiple Range Tests as described by Duncan[20].

RESULTS AND DISCUSSION

The proximate composition of experimental diets and the gross energy values is as shown in Table 2. The value for the proximate composition especially crude protein content and gross energy determined fall within the range of nutrient requirement for rabbit[21].

Table 1: Percentage composition of experimental diet

Constituents (%)	T1	T2	T3	T4
Maize	45	45	45	45
Soybean	15.5	10.5	5.5	0.5
AYB	-	5	10	15
PKC	11	11	11	11
Wheat offal	23	23	23	23
Blood meal	2.0	2.0	2.0	2.0
Bone meal	3.0	3.0	3.0	3.0
Salt	0.25	0.25	0.25	0.25
Vitamin premix	0.25	0.25	0.25	0.25
Total	100	100	100	100
Crude protein (%)	18.5	1765	16.8	15.69
ME (kcal kg^{-1})	2634.7	2663.2	2691.7	2708.05

Table 2: Proximate composition and gross energy of experimental diets

Constituents (%)	T1	T2	T3	T4
Dry matter	90.5	89.8	89.51	89.77
Crude protein	16.58	16.73	15.96	16.88
Crude fibre	6.55	6.66	4.3	6.92
Ash	8.1	8.21	7.87	8.49
Ether extract	3.58	3.61	3.55	3.7
Gross energy (kcal g^{-1})	3.06	3.05	3.04	3.06

Table 3: Proximate composition and gross energy of the test feedstuff

Constituent	Proximate value (%)
Dry matter	90.55
Crude protein	21.6
Crude fibre	5.4
Ether extract	2.37
Ash	2.9
GE (Kcal kg^{-1})	3.53

Table 4: Anti-nutritional factors in test feedstuff

Anti-nutritional factors	Value
Tannin (%)	1.81
Trypsin inhibitor (TIU mg $protein^{-1}$)	19.2
HCN (mg/kg)	12.3
Saponin (%)	0.89
Phytate (%)	2.5

Table 5: Mean value for growth performance of rabbit fed raw african yam bean meal

Parameter	T1	T2	T3	T4	SEM
Initial weight	650.0	650.0	658.0	653.3	109.1
Final weight (g)	1591.6^{a}	1300.00^{ab}	1275.00^{ab}	1100.00^{b}	119.5
Total weight /rabbit/day	783.3^{a}	641.6^{a}	625.00^{a}	433.33^{b}	50
Feed intake (g)	98.296^{a}	94.1033^{ab}	93.436^{b}	92.886^{b}	158.9
Feed- to- gain ratio	7.1533^{b}	8.3000^{b}	8.3967^{b}	12.4800^{a}	1.02
Weight gain /rabbit/day	13.9833^{a}	11.4567^{a}	11.1367^{a}	7.7333	0.89

a-b treatment means in the same row with different superscripts are significantly different ($p<0.05$)

Table 6: The mean weight of organ expressed as percentage dressed weight

Parts	T1	T2	T3	T4	SEM
Liver	60.2^{b}	61.5^{b}	61.08^{b}	71.5^{a}	1.64
Kidney	15.9000	17.1333	17.6333	16.9000	1.29
Spleen	1.6600	2.4433	2.3600	2.3900	0.55
Heart	3.4667^{c}	4.9667^{b}	6.1200^{a}	3.8000^{c}	0.26

a-c treatment means in the same row with different superscripts are significantly different ($p<0.05$)

Table 7: Serum chemistry of rabbits fed african yam bean in place of soybean meal

Parameters	T1	T2	T3	T4	SEM
Total Protein (g L^{-1})	60.6667	54.0000	50.3333	43.333	5.82
Albumin (g L^{-1})	30.0000	29.3333	28.000	27.3333	1.21
Globulin (g L^{-1})	30.6667^{a}	24.6667^{a}	23.000^{a}	8.000^{b}	4.35
Urea (mg dL^{-1})	30.0000	33.6667	32.6667	35.3333	2.62
Creatinine (mg dL^{-1})	-4500	.5333	.5000	.5000	0.3
Alkaline phosphatase	65.000	71.0000	70.0000	79.000	5.5

a-c treatment means in the same row with different superscripts are significantly different ($p<0.05$)

Table 8: Economics of diets

Parameters	T1	T2	T3	T4	SEM
Cost per kg of feed expenditure	25.15	23.09	21.03	18.97	0.00
Revenue	138.4133^{a}	121.9000^{b}	110.8200^{c}	98.5800^{d}	1.96
Gross margin	360.8333^{a}	375.0000^{a}	362.50000	275.0000^{b}	16.6
	222.4200^{ab}	23.1000^{a}	251.6800^{a}	176.4200	15.7

a-d treatment means in the same row with different superscripts are significantly different ($p<0.05$)

The proximate composition and the gross energy value for the test feedstuff is as shown in Table 3. They are as follows (%): D.M 90.59, CP 21.6, CF 5.4, of Ash 2.9, E.E 3.52. The 21% crude protein content is in agremen with earlier reporters Ene-Obong and Casara[22] who reported that African Yam Bean crude protein content ranges from 21.1 to 22.5%. The crude protein content value of 21.6% also fall within the range of values obtained for other envisaged legumes: lima bean (20.13%), bambara groundnut and cowpea[23,24]. This supports its potentiality as an alternative protein source for livestock and poultry.

Table 4 shows the anti-nutritional factors present in the raw African yam bean. This confirms the report of earlier workers[24,25] who reported the presence of tannin, phytate, saponin etc. in raw African yam bean.

Table 5 reveals the growth performance of rabbit fed raw African yam bean meal. There were significant ($p<0.05$) differences for all the parameters measured. For feed intake, there was general decrease as the quantity of African yam bean meal increased in the diets, it became significantly different ($p<0.05$) from control diet, from diet 3 and above. The decrease in the feed intake is due to the effect of anti-nutritional factors such as tannin, saponin etc. Tannin for example, has been reported to cause poor palatability in diets containing high content of it, due to its astringent property, as a result of its ability to bind with protein of saliva or mucosa membrane[7]. Saponin also has been reported to cause decrease in feed intake through the irritating effect on the lining of the mouth and gut and through its bitter taste[24].

Total weight gain and weight gain per rabbit per day followed similar pertain in that it decrease as the quantity of raw African yam bean meal increased in the diets unlike feed intake, the test diet became significantly different ($p<0.05$) from the control diet only for diet 4.

The poor performance of diet four could be attributed to the increase in the quantity of anti-nutritional factors e.g. HCN, trypsin inhibitors, as a result of high percentage of raw African yam bean in the diet (Table 4).

Aletor[26] reported that hydrolysis of cyanogenic glycosides releases hydrogen cyanide, a substance reported to have the ability to cause marked weight reduction due to the use of methionine or cystine for its detoxification and hence attendant poor growth because of deficiency of cystine or methonine in the diet[26,27]. Trypsin inhibitors also inhibits trypsin, an enzyme needed for breakdown of protein and hence poor digestibility of protein resulting in poor growth[12], phytin chelates proteins forming compounds that are not readily broken down, hence loss of protein as well as its component amino acids leading to poor growth[26]. Feed-to-gain ratio increased as the quantity of raw African yam bean meal increased in the diet and became significantly different ($p<0.05$) from the control diet for diet 4. These could be

attributed to the effect of poor weight gain due to anti-nutritional factors discussed above and hence poor feed-to-gain ratio when the weight is compared to the feed intake.

All these above reasons cumulatively affect the final live weight making diet 4 to be significantly ($p<0.05$) lower than the control diet. From above discussion, diet 3 is chosen due to its statistically similar final life weight and feed-to-gain ratio. This is in agreement with earlier reporters who reported 15% raw sword bean[28], 25% raw lima bean Onwukwe[29] and 25% raw soya bean Akinmutimi[30] as a safe level in rabbits diet.

The lower percent (10%) of African yam bean may be due to specie differences and hence different anti-nutritional factors and its attendant problems[31].

Table 6 shows the mean weight of organ expressed as percentage dressed weight. There was no significant difference ($p<0.05$) for all the treatment means except for liver and heart. The higher value of diet four that was significantly ($p<0.05$) different from other diets could be attributed to the effect of the increase quantity of anti-nutritional factors and hence increase in the metabolic activities of the liver being a major detoxification organ, these probably leads to enlargement and weight of liver[32,12].

The values for heart did not follow any specific pattern that could be attributed to the test diet but generally the values for the test diets were numerically higher than that of control probably due to the reason given above.

Table 7 shows the serum chemistry of rabbits fed African yam bean meal in place of soybean meal. There was no significant ($p>0.05$) difference for all the parameters except globulin. The non-significant difference between the control diet and test diets for all these parameters implies that the anti-nutritional factors are still within a tolerable level[33]. The globulin level decreased as the quantity of the test ingredients increased in the diets and became significantly ($p<0.05$) different for the control diet for diet 4 only, this implies that rabbit fed diet 4 may have low ability to fight against infection[34].

The economics of the diet is as shown in Table 8. There was significant ($p<0.05$) difference for all the parameters considered with the exception of cost per kg of feed. The test diets had lower cost/kg of fed than that of control diet, although not statistically significant. The implication of this is that they are economically better since it's monetary.

For expenditure, the cost of control diet was significantly ($p<0.05$) higher than all the test diets; these may be the product of feed intake and cost per/kg of feed. The revenue values where significantly ($p<0.05$) the same for diet 1, 2 and 3 but differ from diet 4. The poor revenue for diet 4 may be due to poor weight gain. The gross margin values showed that diet 1, 2 and 3 were statistically the same, but diets 2 and 3 differ significantly ($p<0.05$) from diet 4, diet 2 and 3 had higher numerical values than diet 1, these may be the product of good cost/kg of feed, moderate expenditure and good weight gain making them more economically important.

CONCLUSION

Judging from growth performance especially non-significant feed-to-gain ratio for diet 1, 2 and 3, statistically similar organ weight for 1, 2 and 3, good serum chemistry and better performance of diet 2 and 3 as touching of the economics of the diets. Diet 3 (10% raw African yam bean meal) is recommended for weaner rabbits diet.

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