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Influence of dietary protein sources on nutrient intake, digestibility and nitrogen balance in growing rabbits

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Target Audience: *Rabbit farmers, Feed millers, Extension staff, Animal Scientist*

Abstract

Fifteen rabbits weighing 501±0.20g were randomly assigned to three dietary treatments, with 5 rabbits per treatment to determine intake, apparent nutrient digestibility and nitrogen economy of three different protein sources i.e poultry litter (PL), blood meal (BM) and cotton seed cake (CSC) in a completely randomized design. PL diet had significantly (P<0.05) higher DMI (54.7g/d), followed by BM (49.38g/d) and the least was observed in rabbits fed CSC diet (39.22g/d). The digestibility of CP was significantly (p<0.05) higher and similar in PL and CSC treatment diets (64.17 and 63.19, respectively), followed by BM (49.21) which is statistically lower. Crude fibre digestibility also followed similar pattern. There was significant (p<0.05) difference in fecal N output in diet containing BM and PL, which were higher and similar (3.29 and 2.89g/day respectively), followed by CSC which had significantly (p<0.05) lower fecal N excretion (2.13g/day). N retained was higher in PL and BM (2.46 and 2.21respectively), followed by CSC (1.18g/d). The result of N retention as % of intake differs (p<0.05) significantly, which is lower in PL diet, followed by BM and was highest in CSC diet. The utilization of PL in the diet of rabbit showed higher nutrient digestibility, nitrogen balance and nutrient intake. The study hereby recommends the inclusion of mixtures of proteins of different solubility in the diet of rabbit for efficient faecal fermentation for improved digestion and nitrogen utilisation.

Keywords: Digestibility, Growing rabbit, Nitrogen balance, Protein sources

Description of problem

Rabbit production is a veritable way of alleviating animal protein deficiency in Nigeria [1] hence reducing under five infant mortality. The rabbit has immense potentials and good attributes which include high growth rate, high efficiency in converting forage to meat, short gestation period, and high prolificacy, high nutritional quality of rabbit meat which includes low fat, sodium, and cholesterol levels. It also has a high protein level of about 20.8% and its consumption is bereft of cultural and religious biases [2].

The main constraint to rabbit and other livestock production among others is feeding. Feeding in livestock production accounts for up to 70% of the total cost of production in Nigeria [3]. The conventional feeds for rabbits made from cereal grain, oil seed by products and fish meal are becoming more expensive due to competition with human or other livestock. An alternative source of ingredients, especially when it encouraged a shift to ingredients for which there is less competition, may help if the latter is sufficiently available [4]. It is therefore imperative to explore other feed materials that are not useful to human [5].

Studies in the area of utilization of agro-industrial by-products in animal feed has increased because of the clear necessity to conserve the conventional feed ingredients for human feeding especially in the less developed countries. A wide array of these industrial by-products and agricultural wastes are used as sources of protein in the diet of farm animals, among which are oil seed cakes, blood meal, feather meal, poultry litter etc.

The unique digestive physiology of rabbit has made it possible to use what other single stomach animals cannot utilize. Rabbits are capable of utilizing urea and other non protein nitrogen compounds as a nitrogen source primarily because of the presence of urea activity in the cecum [6] similar to that in the rumen [7]. Raharjo *et al.*[8 and 9] observed efficient utilization of urea by rabbits. It is therefore with this in mind that the study was conducted to evaluate different protein sources in rabbit nutrition. The objective was to evaluate nutrient intake and digestibility in rabbits fed different protein sources.

Materials and methods

Location of the study

The study was carried out in the Teaching and Research Livestock Farm of the Department of Animal Science at Ahmadu Bello University Zaria, located between latitude 11^0 and 12^0 on an altitude of 640m above sea level [10]. The area falls within the Northern-Guinea Savannah zone of Nigeria, having an average annual rainfall of 1100mm. the maximum temperature varies from 26^0C to 35^0 C depending on the season, while the mean relative humidity during the harmattan period and the wet season are 21% and 72% respectively [11].

Management of experimental rabbit

A total of 15 weaned rabbits at 6 weeks of age, averaging 510 g, were used for the study. Prior to the commencement of the experiments, the rabbits were prophylactically treated against internal and external parasites by subcutaneous injection of Ivomec® (0.2ml/rabbit), and a broad-spectrum antibiotic (Oxytetracycline L.A®) was also given subantaneously at the rate of 0.2ml/rabbit. After balancing for weight, the rabbits were randomly grouped into three (3) dietary treatments with five (5) rabbits per treatment in a completely randomized design.

Experimental Diets

Three isonitrogenous diets were formulated, with Poultry litter (PL), blood meal (BM) and cotton seed cake (CSC) as the main dietary protein sources. Other feed ingredients in the experimental diets were maize offal, maize cobs, salt and bone meal, as presented in the Table 1.

Water intake was measured throughout the experimental, evaporative water loss was determined by placing similar water through in the rabbit house to monitor evaporative water loss, which was subtracted from the water offered to get the actual water intake.

Table 1. Gross composition of experimental diets

Parameters	Dietary protein sources		
	PL	BM	CSC
Maize offal	12.66	48.93	12.3
Poultry Litter	45.34	-	-
Blood meal	-	9.077	-
Cotton seed cake	-	-	45.7
Maize cobs	40	40	40
Bone meal	0.5	0.5	0.5
Salt	1.5	1.5	1.5
Total	100	100	100

PL- Poultry litter, BM- Blood meal, CSC- Cotton seed cake

Digestibility trial

The apparent digestibility of dry matter (DM) crude protein (CP), crude fiber (CF) were determined following a fifteen days adaptation period of feeding the experimental diets, the feed intake and total faecal output (caecotrophy was not prevented) were recorded for 7 days from each rabbit. Total feces voided were collected daily for five days. The feces were weighed daily and oven-dried in a oven at 105°C for 24 h. The dried feces were bulked and milled; and the representative samples for each group were stored in sealed bottles for laboratory analysis. Urine was collected over H_2SO_4. The total urine collected was stored in a deep freezer until when required for nitrogen determination.

Laboratory analysis

The proximate composition of experimental diets, fecal and urine samples were analyzed for dry matter, crude protein, crude fibre, ether extract and ash using the conventional methods of [12]. Protein was determined by the Macro-Kjeldah technique and fat was determined using Soxhlet ether extractor apparatus. Ash was determined by igniting the samples in a muffle furnace.

Statistical Analysis:

Data on feed intake, nutrient digestibility and nitrogen balance were subjected to analysis of variance, using the General Linear Model (GLM) procedure of SAS program [13]. Treatment means were compared using the method of Least Square Difference (LSD) of SAS software, using the following model:

$$Yij = \mu + Ti + eij$$

Where;

Yij= the observation of the parameter measured.

μ = the overall mean.

Ti = the i^{th} treatment effect (PL, BM and CSC).

eij= the experimental random error.

Results and discussion

Chemical Composition of experimental diets

The result of the proximate composition of the experimental diets are presented in Table 2, in which the blood meal (BM) diet had the highest dry matter (92.11%), followed by poultry litter (PL) and cotton seed cake (CSC) diets (90.27 and 90.06% respectively). Organic matter level is higher in BM and CSC diets (88.74 and 85.81 respectively) but lower in PL diet. The crude protein is higher in PL and CSC diets as follows 13.46 and 13.40% respectively, followed by BM (12.53%). CSC diet had higher crude fiber (23.15%), followed by PL and BM (22.30 and 20.55% respectively). Ash content of the experimental diets is similar across diets.The proximate composition of all the experimental diets fell within the range recommended for growth of weaned rabbits [14, 15].

Table 2. Proximate composition of experimental diets

Parameters	Dietary protein sources		
	PL	BM	CSC
Dry matter	90.27	92.11	90.06
Organic matter	77.58	88.74	85.81
Crude protein	13.46	13.53	13.40
Crude fiber	22.30	20.55	23.15
Ash	3.91	3.37	4.25
Ether Extract	10.45	11.85	11.77

PL- Poultry litter, BM- Blood meal, CSC- Cotton seed cake

Effect on Nutrient Intake

Nutrient intake results are presented in Table 3. Intake by the rabbits showed significant (P<0.05) differences across dietary treatments. Animals fed with PL diet had significantly (P<0.05) higher DMI, followed by BM (49.38g) and the least was observed in rabbits fed CSC diet (39.22g). Similar result was obtained for CP and CF intakes. While organic matter intake was similar and significantly (P<0.05) higher in PL and BM diet and was least in CSC diet. The DM intake PL diet in this study is higher than 44.3g reported by [16] in poultry litter diet. This may be as a result of the age, source and the type of litter material used. The high intake recorded in this study may be associated with an improved pattern of caecal fermentation. Oluokun, [17] reported improvements in both intake and live weight gains in rabbit fed urea treated cowpea husk.

Table 3. Effect of dietary protein sources on nutrient intake by rabbits

Parameters	Dietary protein sources			SEM
	PL	BM	CSC	
Dry Matter Intake (g/d)	54.7^{a}	49.38^{b}	39.22^{c}	1.9*
Organic Matter Intake (g/d)	47.01^{a}	47.57^{a}	37.37^{b}	1.95*
Crude Protein Intake (g/d)	8.16^{a}	7.25^{b}	5.83^{c}	0.27*
Crude Fiber Intake (g/d)	13.51^{a}	11.07^{b}	10.08^{c}	0.42*
Ash Intake (g/d)	2.36^{a}	1.85^{b}	1.8^{b}	0.07*
Water intake (ml/d)	169^{b}	142^{c}	187^{a}	3.78*

a,b,c – Means with different superscript on the same treatment differ significantly (p<0.05) SEM- Standard Error Mean * significant at 0.05

Effects on nutrient Digestibility

The results (Table 4) showed that nutrient digestibility were significantly (p<0.05) different across the treatments. PL (poultry litter diet) treatment had the higher dry matter digestibility, which was followed BM (Blood meal diet) and CSC (cotton seed cake diet), which were similar and significantly (p<0.05) lower (55.07 and 55.05 respectively). The digestibility of CP was significantly ($p<0.05$) higher and similar in PL and CSC treatment diets (64.17 and 63.19, respectively), followed by BM (49.21) which is statistically lower. Crude fibre digestibility also follow similar pattern. This is in agreement with the observation of [18] who reported high crude protein digestibility values in urea-fed rabbits and also [17] in rabbits fed urea treated cow pea husk.

Table 4. Effect of dietary protein sources on nutrient digestibility by rabbits

Parameters	Dietary protein sources			SEM
	PL	BM	CSC	
Dry Matter Digestibility	66.7^{a}	55.07^{b}	55.05^{b}	1.91*
Organic Matter Digestibility	63.54^{a}	49.95^{c}	57.99^{b}	2.19*
Crude Protein Digestibility	64.17^{a}	49.21^{b}	63.19^{ab}	2.68*
Crude Fiber Digestibility	66.86^{a}	48.51^{b}	66.77^{ab}	2.98*

a,b,c – Means with different superscript on the same treatment differ significantly ($p<0.05$) SEM-Standard Error Mean * significant at 0.05

The lower digestibility observed in the CSC diet, compared to the PL and BM diets may be attributed to the solubility of these protein sources and the high contents of indigestible plant materials, lignin and silica probably accounted for its low digestibility. This also concur with [19], who reported that feeding rabbits diets with higher dietary fibre levels not only provides nutrient substrates, but also has the function of maintaining micro-ecological balance. The result obtained might be explained by a higher availability of substrates for microbial growth, as proteolytic activity has been proven to be relevant in the caecum of rabbits [20], promoting digestive system development and consequently improving the productive performance which help in increasing the digestibility in poultry litter diet.

Effects of protein source on nitrogen balance

The result of the nitrogen balance is presented in Table 5. Nitrogen intake showed significant ($p<0.05$) difference. Animal fed with diets containing PL and BM had significantly ($p<0.05$) higher and similar nitrogen intake (8.15 and 7.92g/d respectively), while animals fed with diet containing CSC had lower nitrogen intake (5.83g/d). There was significant ($p<0.05$) difference in fecal N output in diet containing BM and PL, which were higher and similar (3.29 and 2.89g/day respectively), followed by CSC which had significantly ($p<0.05$) lower fecal N excretion (2.13g/day). This agrees with [21], who reported differences in ileal digestion, which was attributed to type of fiber among protein sources as occurs in pigs [22]. Also the urinary N excreted was significantly ($p<0.05$) different, PL has the highest (2.8g/d) followed by CSC which had the lowest (1.18g/d). N retained was higher in PL and BM (2.46 and 2.21, respectively), followed by CSC (1.18g/d). The result of N retention as % of intake differs ($p<0.05$) significantly, which is lower in PL diet, followed by BM and was highest in CSC diet. This is attributed to the urease activity. The result of this study concur with the finding of [23], who attributed positive effect of urea feeding on nitrogen retention to tissue synthesis of non-essential amino acids from absorbed ammonia, also similar result was reported by [17] in rabbits fed urea treated cow pea husk. Better utilization of nitrogen in group receiving PL based diet may reflect greater absorption of ammonia resulting from the hydrolysis of urease in PL from the digestive tracts of rabbits in that group.

Table 5. Effect of dietary protein sources on nitrogen balance in rabbits

Parameters	Dietary protein sources			SEM
	PL	BM	CSC	
Nitrogen intake (g/d)	8.15[a]	7.92[b]	5.83[c]	0.08*
Fecal Nitrogen (g/d)	2.89[b]	3.29[ab]	3.33[a]	0.13*
Urine Nitrogen (g/d)	2.8[a]	2.42[b]	1.32[c]	0.09*
Nitrogen retained (g/d)	2.46[a]	2.21[b]	1.18[c]	0.12*
Nitrogen absorbed (g/d)	5.26[a]	4.63[b]	2.50[c]	0.08*
N retained (%)	69.81[c]	72.09[b]	79.75[a]	1.91*

a,b,c – Means with different superscript on the same row differ significantly ($p<0.05$) SEM- Standard Error Mean * significant at 0.05

Conclusion and Applications

1. The likely effect of the mixture of protein from different sources can be associated with the higher bacterial and protozoa mass in the ceacum with the PL based diet because of the urease activity.
2. The results reflect differences in fermentation process among the diets, because of the differences in their solubility in supplying of substrate for fermentation in the caecum by microflora.
3. The study hereby recommend the inclusion of mixture of proteins of different solubility in the diet of rabbit for efficient ceacal fermentation.

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