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Research Article

Performance characteristics and digestion of growing rabbits fed Corn Gluten Residue Meal (CGRM), Soybean Gluten Residue Meal (SGRM), and Sorghum Brewer Dry Grain (SBDG)

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Abstract

Context: Grain by-products are nonconventional feed resources that can be used as supplemental diets for rabbits, especially during the dry season when native forages are scarce and limiting in essential nutrients. Hence, this present study is to determine the inclusion of residue, Corn Gluten Residue Meal (CGRM), Soybean Gluten Residue Meal (SGRM), and Sorghum Brewer Dry Grain (SBDG) as a replacement for maize on the performance and digestion coefficient of growing rabbits.

Methods: Forty mixed breeds of rabbits (4 - 6 weeks old) were allotted into four experimental treatments in a completely randomized design. Four experimental diets were then compounded by replacing maize (40% inclusion level) with CGRM, SGRM, and SBDG then fed to the growing rabbits at 3% of their body weight.

Results: The crude protein contents of diets containing grain by-products (19.06% – 20.87%) were better than maize (12.96%). Evidently, the maize diet (55.56%) was higher in carbohydrate fraction than these grain by-product-containing diets (42.20 – 49.98). Rabbits fed diets containing grain by-products had significantly higher ($p < 0.05$) feed intake and final weight compared to rabbits fed maize. Rabbits-fed diets containing CGRM (87.41%) and SGRM (92.09%) were significantly higher ($p < 0.05$) in digestible crude protein than maize (76.79%) and SBDG (74.29%) diets. Also, diets containing maize and SGRM were significantly higher ($p < 0.05$) in the digestible carbohydrate fraction than diets. Whereas, rabbits fed diets CGRM and SBDG had significantly better ($p < 0.05$) nitrogen balance and retention compared to rabbits fed diet SGRM and maize.

Conclusion: It could be concluded that the inclusion of CGRM, SGRM, and SBDG led to better performances and digestion but with inferior carbohydrate fractions and digestion percentages compared to the maize diet.

Abbreviations

CGRM: Corn Gluten Residues Meal; SGRM: Soybean Gluten Residue Meal; SBDG: Sorghum Brewer Dry Grain

Introduction

Rabbit is a veritable way of alleviation animal protein deficiency in Nigeria [1]. The rabbit has immense potential and good attributes which include a high growth rate, high efficiency in converting forage to meet short gestation period and prolificacy, relatively low cost of production, and high nutritional quality of rabbit meat which include low fats, sodium, and cholesterol levels. It also has a high protein level of about 20.8% and its consumption is beneficial for cultural

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and religious basis [2]. The presence of ceacal microbes enables the rabbit to digest a large amount of fibrous feed as most non-ruminant species cannot [3]. Maize is well-accepted as the king of feed ingredients. It is a primary source of energy supplement and can contribute up to 30% protein, 60% energy, and 90% starch in an animal diet [4]. Soya bean gluten residue is a high-quality vegetable protein in animal feed worldwide, its universal acceptability in animal feed has been due to favourable attributes such as relatively high protein content and suitable amino acid profile except for methionine, minimal variation in nutrient content ready available all year-round and relative freedom from intractable anti-nutritive value factor if properly processed [5]. Corn gluten residue, the feed consists mainly of corn bran, which is a source of fermentable fibre in ruminant diets. Its supplies additional energy without negative associative effects on fibre digestion that can occur when high levels of grain were fed [6]. Sorghum brewers grain in West Africa, fresh sorghum brewers' grain is often fed directly to rabbits and appears to be very palatable; rabbits eat them as soon they are distributed [7] this fresh product should be consumed within 12 hours of its production to avoid mould formation, dried sorghum brewers grain can be the only source of protein in complete rabbit diets [8] concluded that SBDG could replace maize up to 30% in the diets of growing rabbits. Having established the potential of these agro-industrial by-products as either energy, protein, and fibre sources for livestock hence this present study is to determine the comparative effects of corn gluten residue, soybean gluten residue and sorghum brewer dried grains as a replacement for maize on the performance and digestion coefficient of growing rabbits.

Needs of the study

This study researched the potential of some agro-industrial such as CGRM, SGRM, and SBDG by-products as feed for growing rabbits to serve as supplemental feedstuffs for rabbits, especially during the dry season.

Hypothesis

Null hypothesis: there were no significant differences in the performance and digestion of growing rabbits fed CGRM, SGRM, and SBDG.

Alternative hypothesis: there were significant differences in the performance and digestion of growing rabbits fed CGRM, SGRM, and SBDG.

Materials and methods

Processing of selected grain by-products and composition of experimental diets

Fresh moist corn gluten residue and soybean gluten residue were collected from local corn pap and soybean milk/cheese producers while sorghum brewer wastes were collected from local brewers in town. These products were sun-dried on a clean concrete floor for 2 days. The products were thereafter milled and stored in polythene bags and stored for subsequent use. Four experimental diets were then compounded by replacing maize (40% inclusion level) with corn Gluten Residue Meal (CGRM), Soybean Gluten Residue Meal (SGRM), and Sorghum Brewer Dry Grain (SBDG) and fed to the growing rabbits at 3% of their body weight (Table 1).

Animal management and experimental design

This study was carried out at the rabbit unit of the Teaching and Research Farm, The Oke-Ogun Polytechnic, Saki Oyo State. The experiment lasted for a period of 10 weeks (where 2 weeks was for an adaptation of the rabbit) and the remaining 8 weeks for a feeding trial. Forty (40) weaners mixed breed of rabbit of both sexes, aged between 4 to 8 weeks were housed on hutches fitted with drinkers and feeders. The forty rabbits were randomly allotted into four treatments (10 per treatment) in a completely randomized design. The animals were weighed before the commencement of the experiment and subsequently weekly during the experimental period. The feed intake was calculated from the feed offer and feed refusal. During the digestion trial (6^{th} week of the experiment), records of the number of faeces voided per day per rabbit were kept. Samples of faeces were voided and per treatment were then oven-dried, ground, sub-sampled, and stored while urine samples were also preserved in the refrigerator at 4 ^{o}C.

Chemical analysis

Proximate composition parameters such as dry matter, crude protein, crude fibre, ether extract, and ash contents of samples of experimental diets, faeces as well as the nitrogen concentration of urine were done in the laboratory according to the method of analysis [9].

Statistical analysis

Data collected were subjected to a one-way analysis of the variance procedure of the general linear mode [10]. The means were therefore separated using Duncan's New Multiple Range Test.

Table 1: Gross composition of the experimental diets.

Ingredient	Maize	CGRM	SGRM	SBDG
Maize	40	-	-	-
Corn Gluten Residue	-	40	-	-
Sorghum Brewer Grain	-	-	40	-
Soya Bean Gluten Residue	-	-	-	40
Wheat	21.5	21.5	21.5	21.5
GNC	25	25	25	25
PKC	10	10	10	10
Bone Meal	2	2	2	2
Lysine	0.25	0.25	0.25	0.25
Methionine	0.25	0.25	0.25	0.25
Vitamin	0.5	0.5	0.5	0.5
Salt	0.5	0.5	0.5	0.5
Total	100 kg	100 kg	100 kg	100 kg

Note: CGRM: Corn Gluten Residue Meal; SGRM: Soybean Gluten Residue Meal; SBDG: Sorghum Brewers Dried Grain.

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Results

The nutritive value of the experimental diets was compared in Table 2 where the dry matter contents were comparable. Notably, the crude protein contents of diets CGRM (20.87), SGRM (19.59), and SBDG (19.06) were better than maize (12.96). Diet CGRM had much crude protein followed by SGRM, SBDG, and the least Maize. Evidently, the Maize diet (55.56) was higher in carbohydrate fraction than these grain by-product-containing diets.

There were no significant differences ($p < 0.05$) among the performance parameters except for feed intake and final weight gains of rabbits (Table 3). Rabbits fed diets containing grain by-products had significantly higher ($p < 0.05$) feed intake and final weight compared to rabbits fed maize. However, the weight, daily weight gain, and feed conversion ratio of rabbits were comparable across the diets.

There were significant differences ($p < 0.05$) in the means of the digestion parameters of the experimental rabbits (Table 4). Rabbits fed diets maize (69.31) and SGRM (67.90) had significantly higher ($p < 0.05$) digestible dry matter than diets CGRM (41.65) and SBDG (48.65). Diets containing maize, CGRM, and SGRM were significantly higher in digestible crude protein than diet SBDG. In contrast, rabbits fed a diet of SBDG had significantly higher ($p < 0.05$) digestible crude fibre and ash contents compared to rabbits fed diets containing maize, CGRM, and SGRM. However, diets containing maize (80.12) and SGRM (76.88) were significantly higher ($p < 0.05$) in the digestible carbohydrate fraction than diets CGRM (50.16) and SBDG (51.67). There were no significant differences ($p > 0.05$) among the means of nitrogen faecal, nitrogen loss, and nitrogen retention (Table 4). However, diets containing CGRM (3.42) and SBDG (3.05) had significantly higher ($p < 0.05$) nitrogen intake than diets SGRM (2.97) and maize (1.92). Whereas, rabbits fed diets CGRM and SBDG had significantly better ($p < 0.05$) nitrogen balance and retention compared to rabbits fed diet SGRM and maize.

Table 2: Proximate composition of the experimental diets.

Parameter (%)	Maize	CGRM	SGRM	SBDG
Dry matter	88.00	85.52	83.91	87.10
Crude Protein	12.96	20.87	19.59	19.06
Fat	5.44	5.72	7.25	5.75
Crude fibre	13.17	10.12	15.56	11.23
Ash	4.10	4.55	6.99	14.11
Carbohydrate	55.56	49.98	42.20	49.85

Note: CGRM: Corn Gluten Residue Meal; SGRM: Soybean Gluten Residue Meal; SBDG: Sorghum Brewers Dried Grain.

Table 3: The performance characteristics of rabbits fed the experimental diets.

Parameters	Maize	CGRM	SGRM	SBDG	SEM	*p* value
Feed intake (g)	55.96^{b}	63.08^{ab}	69.98^{a}	70.18^{a}	2.40	0.1016
Initial weight (g)	808.00	824.00	924.00	952.00	29.43	0.0219
Final weight (g)	1606.60^{b}	1587.20^{b}	1764.50^{ab}	1896.20^{a}	49.78	0.0801
Weight gain (g)	798.60	763.20	840.60	944.20	4.53	0.4759
Daily weight gain (g/day)	13.20	12.72	14.01	15.74	0.73	0.4759
Feed conversion ratio	4.80	5.06	5.06	4.54	0.29	0.9189

^{abc} Means with different superscripts are significantly different ($p < 0.05$).
Note: CGRM: Corn Gluten Residue Meal; SGRM: Soybean Gluten Residue Meal; SBDG: Sorghum Brewers Dried Grain.

Table 4: Digestion parameters of rabbits fed the experimental diets.

Parameters	Maize	CGRM	SGRM	SBDG	SEM	*p* value
Digestible nutrients						
DDM	69.31^{a}	41.65^{b}	67.90^{a}	48.65^{b}	4.83	0.0259
DCP	76.79^{b}	87.41^{a}	92.09^{a}	74.29^{b}	2.56	0.0056
DEE	85.33^{b}	80.62^{b}	93.11^{a}	69.57^{c}	3.27	0.0015
DCF	37.18^{b}	43.27^{b}	42.66^{b}	83.29^{a}	7.01	0.0002
DASH	37.52^{b}	46.01^{b}	40.14^{b}	64.86^{a}	4.23	0.0181
DCHO	80.12^{a}	50.16^{b}	76.88^{a}	51.72^{b}	5.27	0.0005
Nitrogen utilization						
N_2 intake	1.92^{c}	3.42^{a}	3.05^{b}	2.97^{a}	0.08	0.0008
N_2 balance	0.75^{c}	1.92^{a}	1.33^{ab}	1.53^{a}	0.17	0.0393
N_2 retention (%)	37.35^{c}	56.12^{a}	43.29^{b}	51.67^{a}	3.48	0.0123

^{abc} Means with different superscripts are significantly different ($p < 0.05$).
Note: CGRM: Corn Gluten Residue Meal; SGRM: Soybean Gluten Residue Meal; SBDG: Sorghum Brewers Dried Grain; DDM: Digestible Dry Matter; DCP: Digestible Crude Protein; DEE: Digestible Ether Extract; DCF: Digestible Crude Fibre; DASH: Digestible Ash; DCHO: Digestible Carbohydrate Fraction.

Discussion

The nutritive value of gluten residues is dependent on the different processing methods and fermentation periods used. So also, the chemical composition of BSG varies according to grain variety, harvest time, malting and mashing conditions, and the quality and type of adjuncts added in the brewing process [11]. The crude protein of these products is rich in protein and dietary fibre, which account for around 20 % and 70 % of its composition, respectively [12]. The main components of the dietary fibre fraction are cellulose, lignin, and hemicellulose. The crude protein and fibre contents of the by-products were more than 18% and 10% -12% recommended for growing rabbits respectively [13]. It is therefore evident that the grain by-products used in this study had potential as sources of protein and fibre for rabbits. The carbohydrate fraction for grain by-products in this study was higher than 38.30% – 47.86% reported [14] for different fibre ingredients but similar to values reported [15]. However, their values were a bit lower than maize in this study. Hence, value addition to these grain by-products might make their carbohydrate content more comparable and could totally replace maize in rabbit diets.

There have been wide variations in the responses of rabbits to the use of Agro-industrial by-products. These were attributed to differences in quality, varieties, storage periods and climatic conditions to mention but a few. However, there are several literature reports on the inclusion levels of these unconventional, agro by-products in rabbit diets without adverse effects on performance in Nigeria [16]. In this present study, the feed intake was higher than 32.78 – 39.13 [8] for rabbits fed pawpaw seed meal but fell within the range

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reported [17]. The daily weight gain and feed conversion ratio were within the range reported [18] for growing rabbits fed diets containing some agro-industrial by-products. However, rabbits fed CGRM, SGRM, and SBDG had better feed intake than maize which could be attributed to the effect of fermentation and reconstitution during the processing of the various products.

A balanced ratio according to [19] promotes better digestibility. Also, high fibre in rabbit diets depressed digestibility as it reduces the period of exposure of food to the digestive enzymes and absorptive surface [20]. The digestible dry matter of rabbits fed maize and soybean gluten residue meal was similar to 65.94% – 68.25% reported [21] for rabbits fed straw berry by-products while rabbits fed CGRM and SBDG were far lower. The digestible crude protein content of all diets was higher than 60.49% – 71.27% reported [22] for agro-industrial by-product-based diets. The digestible crude fibre of maize, CGRM, and SGRM were similar to 39.42 – 54.88 [23] for rabbits fed bovine blood-rumen content mixture while SBDG was excellently digested. The carbohydrate (NFE) fraction of maize and SGRM were slightly higher than 61.05% – 77.79% [24] while CGRM and SBDG were lower [25] reported that caeca microbiota is able to use non-protein compounds and also that caecotrophy contributes to improving N digestion and retention in rabbits. These could contribute to the N utilization in this study. The N intake of grain by-products used in this study was higher than the 2.15 – 2.80 recorded [26]. Also, The N retention of CGRM, SGRM, and SBDG was higher than the values reported [27] and were within 40.24 – 62 [20] for rabbits fed dried strawberry by-products.

Conclusion

It could be concluded that the inclusion of corn gluten residue meal, soybean gluten residue meal and sorghum brewers dried grain led to better performances and digestion but with inferior carbohydrate fractions and digestion percentages compared to the maize diet

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