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COMPARATIVE DIGESTIBILITY OF THREE COMMONLY USED FIBROUS INGREDIENTS IN MAIZE-SOYABEAN MEAL-FISH DIET BY BROILER CHICKS

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Target Audience: Poultry millers and nutritionists.

ABSTRACT

A 3 x 3 factorial experiment combining 3 factors namely WB, RB and BDG at 3 levels of inclusion (10, 20 and 30%) was designed to study effects on growth, feed intake feed conversion ratio and nutrient retention by broiler chicks. Nine diets were fed to 270 day-old chicks for 35 days.

Results showed that feed consumption increased correspondingly with incremental levels of WB, RB and BDG. Broiler chicks on wheat bran based diet consumed more feed and had poorer feed conversion ratio ($P<0.05$) than chicks fed rice bran and brewers' dried grains based diets. The best efficiency of feed conversion and growth rate were in chicks fed brewers' dried grains and least ($P<0.05$) in chicks fed RB based diets. Inclusion levels of fibrous ingredients affected the digestibility of dry matter, crude protein, crude fibre and fat irrespective of the source of dietary fibre. Optimum levels recommended at starter phase were 10-20% rice bran, 10% brewers' dried grains and 10-30% wheat bran.

Key words : Wheat bran, rice bran, brewers' dried grain, broilers, rations.

DESCRIPTION OF PROBLEM

The nutritive value of alternative feed resources and their full-scale utilization in monogastric nutrition have beed recommended (1, 2). However, it was observed that a restricted inclusion of these fibrous ingredients in monogastric diets was recommended in view of their fibrous nature which limited their utilization (3, 4, 5).

Experimentation on comparative utilization of fibrous ingredients in highly nutritive ration are quite scanty (6). Therefore, this study was conducted to determine the comparative performance of broiler chicks fed incremental levels of wheat bran (WB), rice bran (RB) and brewers' dried grains (BDG) in a maize-soyabean - fish meal basal diet starting from recommended optimal inclusion rate of 10% (1, 2).

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MATERIALS AND METHODS

Wheat bran, rice bran and brewers' dried grains were purchased in bulk as a precaution against fluctuating quality of these ingredients because of the inconsistent processing techniques (4). Two hundred and seventy Anak broiler chicks were randomly distributed into nine dietary treatments of three replicates each. They were allotted in groups of ten birds to twenty-seven experimental floor pens in 3x3 factorial experiment of a completely randomised design. Three factors namely; wheat bran, rice bran and brewers' dried grains were incorporated at three levels- 10, 20 and 30 % in the diets. A level constitutes a treatment which was allocated to experimental units in a fully randomised pattern. The chicks were fed starter diets for 35 days. Nine diets were formulated and were made practically isonitrogenous (Table 1). The energy content fell within normal requirements of 2800 kcal /kg ME (8). The chicks were reared on deep litter. During rearing period, routine management and vaccination were carried out. Feed and water were provided *ad lib.*

Two birds per replicate were randomly picked, weighed and placed in metabolic cage compartments to determine their feed intake and faecal output. A three day acclimatization period was allowed prior to four days collection period. Droppings were collected every morning by total collection method, weighed and dried in the oven at temperature of 65^{0}C for 48 hours. Dry droppings of each replicate were pooled according to treatment, ground and sampled for subsequent chemical analysis.

Proximate analysis of test ingredients, diets and faecal samples were determined in accordance with the method of (9). All data collected were subjected to analysis of variance (10). Duncan multiple range test was used to separate significant treatment mean differentials at 5% level of probability.

RESULTS

Table 2 shows the chemical compositions of the test ingredients while the chemical composition of the diets is shown in Table 1. At starter phase, dry matter of rice bran based diets varied from 95.54 to 96.92% which were higher than the correponding levels of dry matter in other diets while lowest values of 91.24 to 91.94% (DM) were observed for wheat bran based diets. Starter diets were isonitrogenous. Ether extract ranged between 4.78-6.02% (wheat bran- based diet), 3.86-5.25% (rice bran- based diets) and 3.24-3.97% (BDG-based diets); ash contents of diets ranged between 9.01-97.25 (wheat bran-based diets), 9.11 - 23.62% (rice bran-based diets) and 8.06-12.93% (BDG - based diet). A linear reduction in nitrogen free extract (NFE) content which was proportionate to the incremental levels of dietary fibre sources were observed in all diets and highest value was recorded in BDG- based diets (54.33-48.31%) while RB diets had the lowest values of 48.83 - 31.99%. Metabolisable energy was uniformly high in 10% dietary fibre sources and reduced progressively at incremental levels of each fibrous ingredient (fibre sources).

Table 1. Composition (%) of experimental diets

Ingredients	Wheat bran-based diets			Rice bran-based diet			Brewers' dried grains-based diets		
	10%	20%	30%	10%	20%	30%	10%	20%	30%
Maize	49.51	41.41	33.32	48.77	39.94	36.13	52.94	48.29	43.64
Wheat bran	10.00	20.00	30.00	—	—	—	—	—	—
Rice bran	—	—	—	10.00	20.00	30.00	—	—	—
Brewers dried grains	—	—	—	—	—	—	10.00	20.00	30.00
Soyabean meal	28.49	26.59	24.68	29.23	28.06	26.87	25.06	19.71	14.36
Fish meal	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50
Bone meal	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25
Oyster shell	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50
Salt	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Premix	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Determined chemical composition (g/100g DM).									
Dry matter	91.24	91.81	91.94	95.54	96.58	96.92	95.68	96.40	96.78
Crude protein	24.04	23.98	24.01	24.02	23.98	23.99	23.98	24.01	23.99
Crude fibre	6.03	6.21	8.27	8.33	12.02	13.04	6.07	6.81	7.58
Ash (Total)	9.01	9.37	9.72	9.11	23.58	23.62	8.06	12.20	12.93
Ether extract	4.78	5.86	6.02	5.25	3.86	4.28	3.24	3.91	3.97
Nitrogen free extract	47.40	46.39	43.92	48.83	33.14	31.99	54.33	49.47	48.31
Calculated Composition									
Metabolizable (Kcal /kg)	2857	2789	2510	2654	2506	2401	2758	2658	2547

The following were present per kg of perimix : Vit.A, 10,000 IU; Vit.K, 1,900mg; B_{12}, 19mg; Riboflavin, 7,00mg; Pyridoxine, 3,800mg; Thiamine,2,200mg;d-Pantothenic Acid,11,000mg; National Acid,45,000mg;Folic Acid,1,400mg;Biotin,113mg;Cu,8,000mg; Mn,64,000mg;Zn,40,000mg;Fe,32,000mg; Se,160mg;Iodine,800mg; Cobalt,400mg;Choline,475,000mg;Methionine,50,000mg; Spiranmycin,5,000mg.

Table 2. Proximate composition of test ingredients

Composition %	Wheat Bran	Rice Bran	Brewers dried grains
Dry matter	92.12	92.31	93.01
Crude Protein	15.61	12.98	16.07
Crude Fibre	11.20	11.96	16.18
Ether Extract	5.14	6.62	4.69
Ash	8.22	12.27	10.82
Nitrogen Free Extract (NFE)	51. 95	48.48	45.25

The three factors and their levels of inclusion significantly ($P<0.05$) affected feed intake of the chicks. However, feed consumption increases at incremental dietary level of each fibrous ingredient. A uniformly higher feed intake at all levels were observed in wheat-based diets (WB). Chicks reared on brewers ' dried grains - based diets had similar feed intake ($P>0.05$) and with the exception of 10% rice bran- based diets (RB), feed intake was significantly ($P<0.05$) lower than other treatments.

The three sources of fibre and their levels of inclusion significantly affected ($P>0.05$) efficiency of feed conversion. A similarity ($P>0.05$) was observed in efficiency of feed conversion by broiler chicks fed graded levels of wheat bran-based diets and was significantly higher ($P>0.05$) than BDG -based diets. Brewers' dried grain -based diets were efficiently converted to flesh than other fibrous diets. The best feed conversion efficiency was observed in diets containing 10% BDG. Diet containing 30% RB diet was poorly utilised. 10% and 20% RB-based diets were utilised better than wheat bran-based diets ($P<0.05$).

The inclusion levels of fibrous ingredients significantly ($P<0.05$) affected the growth rate of broiler chicks. Higher weight gains ($P<0.05$) were observed in all diets containing 10% of each fibre source. Weight gain was progressively reduced as dietary inclusion level of test ingredients (WB, RB and BDG) increased in the rations. Significantly higher ($P<0.05$) weight gains were observed in all BDG based diets and the growth of birds on 20% and 30% BDG -based diets were significantly higher ($P<0.05$) than the corresponding levels on RB and WB-based diets. Weight gain of broiler chicks on RB- based diets were not significantly different ($P>0.05$) from weight of chicks on 20 and 30% WB- based diets, but they were significantly lower ($P<0.05$) than weight gain of chicks in other treatments. Liveweight of the birds followed the same trend as daily weight gain (Table 3).

Nutrient retention of birds on the three dietary fibre sources are presented in Table 4 from which it was evident that dietary fibre levels affected the digestibility of the nutrient constituents irrespective of the source. Digestion of dry matter constituent was superior ($P<0.05$) in rice bran-based diets. A similarity ($P>0.05$) was observed for apparent dry matter digestibility of 20 and 30% RB- based and BDG-based diets respectively. Dry matter digestibility

Table 3. Performance of broilers fed starter diets

Parameter	Wheat bran			Rice bran			Brewers' dried grains		
	10%	20%	30%	10%	20%	30%	10%	20%	30%
Initial liveweight (g/bird)	40.00	40.0	39.79	40.03	40.00	40.00	40.00	40.00	40.00
Liveweight gain (g/bird)	1074.83^{c}	1061.33^{cd}	1057.67^{cd}	1013.77^{de}	1003.40^{de}	995.33^{e}	1408.30^{a}	1236.67^{b}	1190.53^{b}
Liveweight gain(g/day)	29.5c	29.20^{cd}	29.07c^{d}	27.80^{d}	27.53^{d}	27.30^{d}	39.10^{a}	34.20^{b}	32.1^{d}
Feed intake (g/day)	90.87^{ab}	91.77^{ab}	92.73^{a}	72.37^{d}	80.27^{c}	90.07^{b}	71.33^{d}	70.57^{d}	72.17^{d}
Feed conversion ratio (feed:gain)	3.10^{b}	3.17^{b}	3.20^{b}	2.60^{d}	2.93^{c}	3.33^{c}	1.83^{e}	2.03^{c}	2.23^{de}
Mortality (%)	0.00	0.00	0.00	0.00	1.00	1.00	0.00	0.00	0.00

^{abcde} Treatment means on the same row with a different superscript are significantly different (P<0.05)

Table 4: Nutrient retention of experimental birds

Parameters	Wheat bran			Rice bran			Brewers dried grains		
	10%	20%	30%	10%	20%	30%	10%	20%	30%
Dry matter digestibility	82.41^{c}	81.52^{c}	85.21^{b}	86.25^{ab}	87.93^{a}	87.31^{c}	82.37^{c}	86.90^{c}	85.55^{b}
Crude protein retention	81.98	82.25^{e}	85.56^{d}	86.24^{c}	87.88^{a}	8.27^{ab}	82.54^{c}	86.30^{c}	87.45^{b}
Crude fibre digestibility	53.97^{g}	52.68^{f}	71.60^{e}	73.09^{e}	82.61^{e}	83.24^{e}	78.94^{d}	85.89^{b}	88.19^{a}
Ether extract digestibility	91.46^{d}	91.94^{d}	94.04^{b}	94.57^{b}	93.27^{c}	94.01^{b}	87.94^{g}	87.13^{f}	89.09^{e}
Protein efficiency ratio	1.0^{a}	0.90^{b}	0.80^{c}	0.77^{d}	0.70^{e}	0.70^{e}	1.20^{a}	0.93^{b}	0.83^{c}
App. metabolizable energy (Kcal/g)	2.30^{d}	2.35^{cd}	2.39^{c}	3.12^{a}	2.87^{b}	2.80^{b}	2.32^{cd}	2.86^{b}	3.10^{a}
Efficiency of energy utilization (%)	92.44^{c}	91.27^{d}	91.64^{d}	93.64^{a}	93.25^{a}	93.23^{c}	90.45^{e}	93.00^{b}	92.96^{b}

= Treatment means on the ... with different superscripts are significantly different (P<0.05)

of 30% WB-based diet did not differ significantly (P>0.05) from the corresponding level in RB and BDG-based diets.

The inclusion levels of fibre sources significantly (P<0.05) affected crude protein digestibility of broiler chicks. Digestibility of crude protein content in 20% RB diet was greater (P<0.05) than the digestibility of crude protein in the corresponding levels of other dietary fibre sources. Birds on 30% RB-based and BDG-based diets digested similar amount (P>0.05) of crude protein while significant lower apparent crude protein digestibility (P<0.05) were observed in all WB-based diets.

A linear increase (P<0.05) in crude fibre digestibility (DCF) which was proportionate to the incremental levels of dietary fibre sources was observed in RB-based and BDG-based diets. Crude fibre was poorly digested (P<0.05) in WB-based diets. Significantly higher digestibility of crude fibre (P<0.05) was observed in 30% BDG-based diets than in other treatments. Though, DCF of 20 and 30% RB-based diets were similar (P>0.05), they were much higher significantly (P<0.05) than the corresponding level in WB-based diets.

Digestion of fat was superior in 10% RB-based diet (P<0.05) than other dietary level of fibre sources and a linear increase of ether extract digestibility (DEE) which was proportionate to the incremental levels of dietary fibre sources were observed in both WB-based and BDG-based diets. DEE of 30% WB-based and RB-based diets were identical (P>0.05). However, fat digestibility of chicks fed BDG-based diets at maximum level was comparably lower (P<0.05) than other fibre sources.

The three sources of fibre and their levels of inclusion significantly affected (P<0.05) protein efficiency ratio (PER). A progressive reduction in PER as inclusion level of dietary fibre sources increased in the diet were observed. A similarity (P>0.05) was observed in PER by chicks fed WB-based and BDG based diets at all levels and were significantly higher (P<0.05) than corresponding level in RB-based diets.

Comparatively, higher ME (P<0.05) were recorded in 10 % RB-based and 30% BDG based diets. Significantly, lower (P<0.05) ME was observed in 10 % WB-based diets. All fibrous ingredient and their various levels significanly (P<0.05) influenced efficiency of energy utilization (EEU). Higher significant EEU (P<0.05) was recorded in 10 and 20% RB-based diets. However, lower value of EEU was recorded in 10% BDG based diets than was observed in other diets.

DISCUSSION

Crude protein content of diets were appreciably close to previously published values. The higher crude fibre contents obtained in respect of 20 and 30% RB-based diets were higher than the value recommended by (11). However, gross energy of rice bran diets were considerably reduced when compared with other diets. This result contradicted the report of (1) who stated that rice bran is rich in oil and , hence, is a good source of energy when fed between 5-20% level to growers and adult birds. Direct depression of gross energy

proportionately with incremental level of dietary fibre sources was observed in all diets. This was probably caused by dilution effect of fibre sources in diets (3, 12).

Performance of broiler chicks was in agreement with some previous studies on monogastric animals (7, 13, 14). Feed intake improved as levels of inclusion of each fibrous ingredients increased in the diets. This implied that sources of fibre and levels of inclusion influenced feed intake of chicks. The increased consumption could be attributed to an attempt by the bird to satisfy energy need due to effect of dilution by fibre on nutrient and energy concentrations (7,14, 15) of diets. Feed consumption was not significantly ($P>0.05$) affected by the inclusion of BDG in diet, as such chicks did not increase feed intake at all dietary levels of BDG. Also they could not compensate for reduced energy and nutrient concentrations when 30% level of brewers' dried grains was included in diets. This result supported the report of (7) that feed consumption was not affected by the inclusion of 10% BDG in broiler starter diets.

Depressing action of fibre on growth was highly conspicious at highest inclusion rates of fibre sources. Increased feed intake had a depressing effect on growth rate of chicks and feed utilization. The findings was consistent with the reports of 13, 14, 16. This observation might be due to the fact that fibre sources in basal diets dilute concentrations of available nutrients for growth (14). Depressed growth observed in RB-based diets was probably caused by reduction in utilization of basal dietary protein due to presence of trypsin inhibitor in rice bran (13, 17). Similarity observed in the performance of chicks on WB-based and RB-based could probably be due to similar physical characteristics of WB and RB. However, BDG-based diets were efficiently utilised for growth. Good nutritional value of BDG at starter phase was indicated by the superior feed conversion efficiency (FCE) of BDG-based diets compared with FCE of other dietary treatments. Quality of protein and amino acids namely; lysine, methionine, cystine and trytrophan in BDG diets are superior to protein and amino acids of other dietary treatments. This observation might be responsible for good performance of the birds fed BDG-based diets (7).

The implication of the above findings was that dietary fibre can be fed in a ration containing 7.5% fish meal with 24% crude protein content to starter chicks. Presumably, supplementation of fibrous diets especially BDG with high quality protein improved efficiency of utilization and spared the diluting effect on energy (6). The results also confirmed the fact that each source of dietary fibre has an intrinsic property, based on its chemical composition and physical characteristics which determines the biological and fermentative properties (18).

High percentage digestibility of nutrients (with the exception of crude fibre) obtained in this study were not in agreement with (19) who reported the reduction in apparent digestibility of proximate constituents with each increased intake of unavailable carbohydrate. The increased dry matter (DM) digestibility with increasing fibre levels could be attributed to supplementation

of fibrous diets with high quality animal protein source and soyabean meal which probably improved amino acid balance with consequent improved utilization of such diets (6).

Presence of trypsin inhibitor might have probably been responsible for inability of broiler birds on RB-based diets to utilise digested protein for body growth as indicated by lower protein efficiency ratio in RB-based diets (21).

Dietary fibre source and the levels of inclusion in diets significantly affected protein efficiency ratio (PER). A progressive reduction in PER at each incremental level was observed. This could have been due to binding effect which rendered protein unavailable for growth (15, 21) or increased faecal nitrogen excretion (22). The performance of the birds on WB-based diets showed that WB improved the growth and nitrogen utilization (20). The progressive increase in crude protein digestibility (DCP) at each incremental level of dietary fibre sources contradicted the assumption that there was a reduction in apparent protein digestibility in higher fibre diets as measured by nitrogen digestibility and endogenous fecal nitrogen excretion (20, 22, 23). High digestibility of 30% BDG diet could have been due to balanced amino acid composition of brewers' dried grains which enhanced its utilisation by chicks (7).

It is likely that high fat retention in 10% RB-based diet must have been utilised for energy production while high fat retention in 30% BDG based diet must have resulted from increased absorption of volatile fatty acids by the intestinal wall which, therefore, make up a potential energetic source for the animal (24). With the exception of RB-based and BDG based diets, digestibility of crude fat decreased as dietary fibre sources increased. This findings confirmed the earlier findings by (22) that digestibility of crude fat dercreased as cellulose level increased. Except for RB-based diets with decreased apparent metabolisable energy, increased apparent ME were observed in WB-based and BDG based diets. High crude fibre and ligno-cellulose contents of rice bran might be responsible for lower apparent metabolisable energy in RB-based diets (17).

CONCLUSION AND APPLICATION

1. Feed intake increased correspondingly with incremental levels of WB, RB and BDG.
2. Average body weight, feed conversion ratio became poorer and depressed at higher levels of WB, RB and BDG.
3. Broiler chicks on wheat bran-based diets consumed more feed and had poorer feed conversion ratio than chicks on rice bran and brewers dried gains.
4. Supplementation of brewers' dried grain-based diets with high quality animal protein inproved efficiency of utilization of such diets for growth by broiler chicks.
5. The study indicated that supplementation of WB, RB and BDG based diets with adequate amounts of animal and plant protein could improve utilisation by broiler chicks.

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