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Ground maize cob as a dietary ingredient for broiler chickens in the tropics

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ABSTRACT

Ground maize cob (GMC) was characterized with respect to proximate, energy, fibre and mineral profile. The crude protein, fat, crude fibre, ash, NDF and ADF contents were, in g kg^{-1} DM: 25, 4, 347, 24, 687 and 480, respectively, with metabolizable energy of 4.82 MJ kg^{-1} DM. In a feeding trial, diets containing GMC (25, 50 and 75 g · kg^{-1}) were fed *ad libitum* to 4 groups of 14-day-old commercial broiler chickens (n = 240) for a period of 6 weeks. Birds had free access to water. Growth performance data of birds fed diets containing GMC did not differ significantly from those on the control diet. Carcass yields were similar. No deaths nor health-related problems were recorded during the study. Haematological and blood biochemical indices were unaffected by the level of inclusion of the test ingredient. Dietary treatments had no impact on liver, gizzard and intestinal weights. It seems that in the tropics partial replacement of cereal and cereal by-products (maize and wheat bran) with GMC up to 75 g · kg^{-1} diet was possible.

KEY WORDS: maize cob, nutrient composition, broilers, growth performance

INTRODUCTION

The survival of the poultry industry in most developing countries in the future will, undoubtedly depend on the ability of poultry to compete with humans for the available food supply. Cereal demands for direct human use is expected to increase as more than half of the human race is undernourished and the world population is still increasing. Attention should therefore be given to the ability of poultry to utilize alternative, cheaper feedstuffs which are unacceptable to man. Such feedstuffs include fibrous cereal by-products as maize bran, rice bran, brewer's spent grains and wheat bran.

However, the availability of these by-products fluctuates seasonally due to the unavailability of the main items from which these by-products are obtained. One potential feed ingredient that might be used to replace the more common, low energy, high fibre feedingstuffs in poultry diets is maize cob, a farm waste in several of the maize producing areas. Its utilization as animal feed at relatively low concentrations will minimise the pollution problem as well as reduce cost of feeding.

Regardless of its economic and nutritional status, it is important that investigations of the feeding potential of maize cob should take account of contaminants such as pathogenic bacteria. The level of spoilage microorganisms can be used to predict the potential shelf-life of the product (Bainbridge et al., 1996)

The aim of this study, therefore, was to assess the nutritive value of ground maize cob and the effect of replacing a portion of the maize and wheat an in broiler diets by ground maize cob on growth performance. The kinds and numbers of the microflora present in ground maize cob were also assessed.

MATERIAL AND METHODS

Source of maize cob and processing method

The maize cob used in the study was obtained from KNUST Commercial Farm, Kumasi (Ghana) after shelling. The cobs were further sun-dried to a moisture content of about 100 g · kg^{-1}, ground in a hammer mill and stored in sacks until used in formulations.

Dietary treatments

Four experimental diets (Table 1) were formulated: a control diet containing no ground maize cob (GMC) and others in which GMC was incorporated at 25, 50 and 75 g · kg^{-1}.

Microbiological procedure

Ten grams (10 g) of the GMC were homogenized and diluted in 90 ml sterile maximum recovery diluent to obtain 1 x 10^{-1} suspensions. The diluted suspensions of the GMC were subjected to surface viable microbial counts and isolation (Bainbridge et al., 1996) and identification (ICMSF, 1978). For microbial count and isolation, 1 g of GMC were inoculated onto selective agar (Nutrient agar for bacteria, McConkey agar for coliforms and Sabouraund agar for fungi), and the plates were incubated at 37ºC for 48 h. The number of colonies on the agar was counted. Plates supporting approximately 30-300 colonies were counted and the mean

TABLE 1

Chemical composition of experimental growth diets

Ingredients, g kg^{-1}	Level of ground maize cob, g kg^{-1}			
	0	25	50	75
Maize	590	585	580	575
Fish meal	190	190	190	190
Soyabean meal	60	65	70	75
Wheat bran	130	105	80	55
Ground maize cob	0	25	50	75
Oyster shell	20	20	20	20
Vitamin and mineral premix[a]	5	5	5	5
Salt (NaCl)	5	5	5	5
Chemical analysis, g kg^{-1}DM				
crude protein	223.0	221.3	222.4	221.1
crude fibre	33.6	40.3	46.9	53.4
Ether extract	36.3	36.2	35.9	35.8
Ca	15.2	15.2	15.2	15.2
P	8.2	7.9	7.7	7.5
ME, MJ kg^{-1}[b]	12.19	12.04	11.91	11.78

[a] vitamin-premix supplied (kg^{-1} diet): vit. A, 10,000 IU; vit. D_3, 2000 IU; vit. E, 10 IU; vit. K, 3 mg; riboflavin, 4.4 mg; cobalamin, 0.05 mg; pantothenic acid, 8 mg; niacin, 16.5 mg; choline, 175 mg; folic acid, 0.5 mg; Mg, 2.3 mg; Fe, 30.5 mg; Zn, 50 mg; Co, 0.27 mg

[b] calculated from National Research (1994) and the ME value of maize cob estimated by the method of Sibbald (1986)

of triplicate plates noted. If growth was present after incubation, colonies were selected for identification. These procedures involved examination of colonial characteristics, morphology, motility, staining and biochemical properties using the guidelines of ICMSF (1978).

Experimental animals and management

A total of 240 unsexed 14-day-old commercial broiler chickens, with an initial body weight of 0.21 kg, were allotted randomly to the four dietary treatments, in a completely randomized design. Each treatment group, consisting of 60 birds, was replicated in three deep litter pens of 20 birds per pen at a density of 0.26 m^2 per bird. The study was conducted for 42 days (2-8 weeks of age). Birds had free access to feed and water.

Parameters measured

Among the traits measured were feed intake, growth rate, feed conversion efficiency (feed:gain ratio) and carcass parameters. Feed consumption and body weight were measured weekly for individual replicates of each dietary treatment. Mortalities were also recorded. For carcass yield, four broilers from each of the 12 replicates were randomly selected at 56 days of age, starved of feed for about 18 h, killed by cutting the jugular vein, exsanguinated, defeathered and eviscerated. Carcass yield was calculated from eviscerated weight and liveweight.

Four 6-week-old broiler chickens were used to determine the nitrogen-corrected true metabolizable energy (TME_n) content of the GMC. Birds were fed *ad libitum* on a broiler finisher diet for 1 week prior to force-feeding (Sibbald, 1986). The birds were housed in individual cages with collection trays, fasted for 24 h and force-fed 30 g of the test ingredient. Four broilers were kept fasted during the assay to measure endogenous losses. Excreta were collected daily for 48 h after force-feeding, oven-dried at 60ºC for 48 h, equilibrated to ambient conditions, weighed and ground (Dale and Fuller, 1983). The GMC and the faecal samples were analysed for gross energy by bomb calorimetry. The ME_n values for the experimental diets were, however, calculated from values given by the NRC (1994) and the determined ME_n content of GMC.

Chemical analysis

Conventional methods (AOAC, 1990) were used to analyse the GMC and diets for their dry matter, crude protein, ether extract, ash and crude fibre contents. Acid detergent fibre (ADF), neutral detergent fibre (NDF) and hemicellulose (Goering and Van Soest, 1970) were also estimated on the GMC samples. Calcium, phosphorus, magnesium and potassium analyses followed the procedure of Fick et al. (1979).

Blood collection and assays

Blood samples were collected only at 6 and 8 weeks of age between 09.00 and 11.00 h. Four birds from each of the 12 replicates were fasted for 12 h prior to the collection of blood specimens to avoid post-prandial lipemia (Kirk et al., 1990). Blood parameters studied included: red blood cell count (Maxwell, 1981), haemoglobin (Henry et al., 1974) and haematocrit or packed cell volume (Dacie and Lewis, 1975). The series of blood tests were performed on blood collected by vein or jugular venapuncture with ethylenediaminetetraacetic acid (EDTA, 1.5 mg ml^{-1} blood) as anticoagulant. Blood samples for serum cholesterol were allowed to clot to obtain serum and assayed in duplicate for total cholesterol by the method described by Varley (1962).

Organ weights and histological studies

The possible effects of GMC on the weight of some body organs were also assessed at 56 days of age. Four chickens from each treatment were randomly selected and killed by cervical dislocation. The liver, gizzard and intestine were excised, weighed immediately and expressed as g · kg^{-1} body weight. The liver was examined to determine whether the diets had resulted in any gross pathological changes. Liver sections were cut before staining with haematoxylin and eosin (Humason, 1979) and examined microscopically for any abnormalities in the cells.

Statistical analysis

The growth performance data measured were analysed using the general linear models procedure of SAS (1987). The data were subjected to regression analysis to show the effect of including GMC on performance.

RESULTS AND DISCUSSION

Results of the chemical analysis of the ground maize cob are shown in Table 2. The protein concentration and crude fat content as well as the metabolizable energy

TABLE 2

Chemical composition of ground maize cob[1], mean total viable count (x 10^2) g^{-1}, kinds and numbers (x 10^2) g^{-1} of microflora isolated from ground maize cob[1]

Item	Dry matter, g · kg^{-1}
Proximate analysis	
dry matter	896.0
crude protein	25.0
ether extract	4.0
crude fibre	347.0
ash	24.0
nitrogen-free extractives	496.0
starch+sugars+soluble polysaccharides	749.0
neutral detergent fibre	687.0
acid detergent fibre	480.0
hemicellulose	207.0
Ca	4.0
P	0.2
Mg	2.4
K	0.013
[2]Metabolizable energy, MJ kg^{-1}	4.82
Microbiological assay	
mean viable count	2.55
species	
Proteus spp.	1.65
Mucor spp.	0.95

[1] values are the means of three samples

[2] estimated according to the procedure of Sibbald (1986)

value are lower but the crude fibre content is higher than other high fibre low energy feed ingredients used in poultry feeds, for example, brewer's spent grains, rice bran and wheat bran (NRC, 1994). Although diets high in fibre can limit energy intake (Lee et al., 1971), bulky diets may be more appropriate in the tropics where food (and energy) requirements are low. This is a consequence of high ambient temperatures (Howlinder and Rose, 1989). In this regard, GMC may be used to replace part of the high fibre ingredients, such as wheat bran and brewer's spent grains.

Ground maize cob contained 4.0 g Ca kg^{-1} DM (Table 2) which is higher than that reported for brewer's spent grains (2.9 g kg^{-1} DM), rice bran (0.8 g kg^{-1} DM) and wheat bran (l.4 g kg^{-1} DM). It appears GMC can make moderate contributions to the calcium requirements of poultry.

The mean total viable microflora count of the GMC sample was 2.55 x 10^2 g^{-1} (Table 2). Microflora isolated from the GMC sample included *Proteus* spp. and *Mucor* spp. The GMC sample was, however, free from pathogenic bacteria such as, faecal coliform bacteria, *Salmonella, Staphylococcus* spp. and *Escherichia coli.*

The results for the broiler feeding trial (Table 3) indicated no significant effects of dietary treatments on feed intake. Feed intake per bird for the 6-week period ranged from 3.34 to 3.45 kg. The non-significant effect of GMC inclusion in the diet on feed intake suggests broiler chickens will consume diets containing up to 75 g GMC kg^{-1}

TABLE 3

Effect of ground corn cob on broiler chicken performance from 14 to 56 days of age and blood components[1] and organ weights determined at 56 days of age

Indices	Level of ground maize cob, g. kg^{-1}				SEM	r
	0	25	50	75		
Feed intake, kg	3.38	3.45	3.34	3.36	0.11	-0.46
Weight gain, kg	1.81	1.89	1.79	1.74	0.07	-0.52
Food: gain ratio	1.87	1.82	1.87	1.93	0.04	0.56
Carcass yield, %	80.0	81.0	79.0	80.0	0.70	-0.32
Mortality, %	0	0	0	0	-	-
Red blood cell count, millions m^{-3}	2.62	2.78	2.66	2.70	0.06	0.23
Haemoglobin, g 100 ml^{-1}	13.60	13.90	13.70	13.80	0.11	0.40
Haematocrit, %	34.40	34.90	34.55	34.70	0.18	0.33
Serum cholesterol, mg 100 ml^{-1}	88.45	88.86	87.95	88.65	0.34	-0.06
Liver weight, g kg^{-1} LBW	24.82	25.35	24.96	24.90	0.20	-0.08
Gizzard weight, g kg^{-1} LBW	22.62	23.15	22.95	23.00	0.19	0.54
Intestinal weight, g kg^{-1} LBW	120.96	121.75	121.18	121.49	0.30	0.38

[1] determined at 6 and 8 weeks of age
SEM - standard error of means
r - correlation coefficient
LBW - live body weight

The inclusion of varying levels of GMC in broiler diets did not have any significant impact on weight gains. Birds fed the diet which contained the highest amounts of GMC (50 and 75 g kg^{-1}), had slightly lower weight gains compared to those fed the control and 25 g GMC kg^{-1} diets. Feed conversion efficiency declined with increasing levels of GMC. A declining feed conversion efficiency with the highest inclusion of GMC might be due to the increasing content of fibre and decreasing energy concentration in GMC diets. McDonald et al. (1995) reported that the fibre fraction of a food is one of the factors which have the greatest influence on its digestibility, and both the amount and chemical composition of the fibre are important. Higher amount of fibre in a diet decreases digestibility and consequently the performance. However, in this trial, the crude fibre content could not have been high enough to have significant impact on the performance of birds. The crude fibre level in the experimental diets (Table 1) ranged from 33.6 to 53.4 g kg^{-1}. The similar growth performance attained by birds on the GMC-based diets, as compared with those on the GMC-free despite the possible undesirable effect with feeding diets containing high amounts of fibre may be attributed to the fact that as animals become older, they adapt to high fibre diets and digest them better (Sikka, 1990).

There was also no influence of GMC level on the carcass yield of broiler chickens processed at 56 days of age. No mortality or morbidity was observed in any of the treatment groups during the course of this study.

Blood haemoglobin concentration, PCV, serum cholesterol and liver, heart and intestinal weights were not significantly affected by added dietary GMC (Table 3). The findings under the conditions of this study showed no toxic effects in terms of gross tissue changes in the liver. The histological characteristics of the liver from birds on the controll diet were similar to those from birds on the GMC-containing diets.

It may be concluded that small amounts of GMC, in combination with other dietary ingredients, can be used in broiler diets to cut down on the use of maize and other ingredients such as wheat bran without sacrificing performance.

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STRESZCZENIE

Mielone osadki kukurydziane - jako składnik diety dla kurcząt brojlerów w warunkach tropikalnych

Oznaczono podstawowy skład chemiczny, zawartość składników mineralnych oraz wartość energetyczną mielonych osadków kukurydzianych (GMC); ilość białka ogólnego, tłuszczu, włókna, popiołu, NDF i ADF wynosiła, g . kg^{-1} s.m.: 25, 4, 347, 24, 687 i 480, odpowiednio, przy zawartości energii metabolicznej 4,82 $MJkg^{-1}$ s.m.

W doświadczeniu żywieniowym, przeprowadzonym na 240 kogutach podzielonych losowo na 4 grupy, udział GMC w dietach doświadczalnych wynosił 25, 50 lub 75 g . kg^{-1}; dieta kontrolna nie zawierała GMC. Pasze podawano do woli, a ptaki miały zapewniony stały dostęp do wody.

Nie stwierdzono istotnego wpływu diet doświadczalnych na pobranie paszy, przyrosty oraz wykorzystanie paszy w porównaniu z dietą kontrolną. Nie było również różnic w wydajności rzeźnej oraz wskaźnikach hematologicznych i biochemicznym krwi, a także masie wątroby, żołądka mięśniowego i przewodu pokarmowego. Nie wystąpiły żadne problemy zdrowotne.

Na podstawie otrzymanych wyników stwierdzono, że w warunkach tropikalnych można zastąpić część zbóż i zbożowych produktów ubocznych (otręby kukurydziane i pszenne) mielonymi osadkami kukurydzianymi do 75 g . kg^{-1} diety.