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EVALUATION OF BOILED MANGO KERNEL MEAL AS ENERGY SOURCE BY BROILER CHICKENS IN THE SEMI-ARID ZONE OF NIGERIA

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ABSTRACT
The feeding value of boiled mango kernel meal in broilers was investigated using 225 Anak-2000 broiler chickens from one day to 63 days of age. The birds were randomly allotted to 5 groups/diets with 3 replicates of 15 birds each. The diets (starter and finisher) were formulated to contain 0, 25, 50, 75, and 100% boiled mango kernel meal as a replacement for maize in diets 1, 2, 3, 4, and 5 respectively. The mango kernel was boiled at 100^{oc} for 30 minutes. The results showed a significant (87.26%) reduction of tannin by boiling. Chick growth (daily gain and feed conversion ratio) was depressed when the inclusion exceeded 50 % while during the finisher phase; growth depression was observed only above 75% replacement of maize with the test material. There was no significant effect of the replacement on the carcass parameters measured. A total of 7 birds (1, 3, 0, 1, and 2 in diets 1, 2, 3, 4, and 5 respectively) died during the starter phase; there was no mortality during the finisher phase. It was concluded that boiled mango kernel meal can replace 50% dietary maize in the diet of broiler chicks and up to 75% in the finisher diets. The substitution reduced the feed and thus, the cost of broiler meat production.

KEYWORDS: alternative feeds, processing, broiler chickens, performance.

INTRODUCTION

In recent years maize production has not kept pace with demand. This may be attributed to inadequate production due to climate change coupled with the food-feed competition for this grain and its increased use for bio-fuel production in the developed countries. There is therefore the need to explore alternative cheaper energy sources for poultry feeding.

Mango (*Mangifera indica*) kernel is a good source of soluble carbohydrates (Saadany *et al.*, 1980; Jansman *et al.*, 1995; Teguia, 1995; Diarra and Usman, 2008). The protein of the kernel (7.80 – 8.00%) is comparable to that of maize but it has higher fat (7.80 - 9.00%) than maize (Saadany *et al.*, 1980; Jadhav and Siddiqui, 2010). Mango kernel flour is reported to be equal to rice in food value if tannin-free (Morton, 1987). However, the kernel is very low in minerals and contains some tannin (Morton, 1987) which exerts anti-nutritional effects in poultry (Jansman *et al.*, 1995; Teguia, 1995) and man (Teguia, 1995). Boiling has been reported to be effective in reducing the tannin content of mango kernel (Diarra and Usman, 2008). These authors replaced 20% of dietary maize in broiler chickens with raw or boiled mango kernel meal and observed no significant differences in performance between the control (0% mango kernel) and the boiled kernel meal diets. Because of its abundance and cheap cost in the study area, it would be interesting to investigate higher levels of boiled mango kernel meal in poultry diets. Consequently, this experiment was designed to investigate the utilization of boiled mango kernel meal as a replacement for maize by broiler chickens.

MATERIALS AND METHODS

Study area

The study was conducted at the Poultry Unit of Yobe College of Agriculture Livestock Farm, Gujba, Yobe State, Nigeria. The area is located within latitude 10^0 and 14^0 N and longitude 11^0 30’ and 14^0 45’E with the Sudan-savannah type vegetation which consists of scrubby vegetation interspersed with tall tree woodlands (Ugherughe and Ekedolum ,1986). Mango is extensively grown in the study area mainly for its flesh. April to May is the peak production and during this period, mango seed (containing the kernel) poses a serious environmental problem because it has little food, feed or industrial use.

Source and processing of mango kernel meal

Mango seed was collected in neighbouring villages of the College during the peak production, and cut open using a knife to expose the kernel. The fresh kernel was chopped to reduce the particle size, boiled in tap water at 100^oC for 30 minutes, sun-dried for 72 hours, and ground in a hammer mill to pass through a 2.00mm sieve. Samples of the dried and ground raw and boiled kernels meals were stored for chemical analysis.

Experimental diets

Five diets containing about 23% and 19% protein in the starter and finisher diets respectively were formulated for the experiment (Table 1). Diet 1 which was the control contained no (0.00%) boiled and dried mango kernel meal. In diets 2, 3, 4 and 5 boiled and dried mango kernel meal replaced maize at 25.00 50.00 75.00 and 100% respectively.

Experimental birds and management

Two hundred and twenty five (225) day-old Anak- 2000 broiler chicks were used for the investigation which lasted 63 days. The birds were individually weighed and randomly allotted to five (5) groups (treatments) containing three replicates of 15 birds each. Birds in each replicate were housed in a floor pen measuring $1.95m^2$ with the floor covered with wood shaving as litter material. The birds were vaccinated at the age of 2 and 4 weeks against Gumboro and 3 weeks against Newcastle diseases. The chickens were fed the experimental diets (Table 1) and provided with clean drinking water *ad-libitum* throughout duration of the experiment.

Table 1: ingredient composition and calculated analysis of the experimental diets

Ingredients (%)	Replacement level of boiled mango kernel meal for maize (%)									
	Starter diets					Finisher diets				
	0	25	50	75	100	0	25	50	75	100
Maize	37.37	28.02	18.69	9.35	0.00	40.48	30.36	20.24	10.12	0.00
Boiled mango kernel meal	0.00	9.34	18.68	28.02	37.37	0.00	10.12	20.24	30.36	40.48
Wheat bran	9.46	9.46	9.46	9.46	9.46	20.24	20.24	20.24	20.24	20.24
Soybean meal (full-fat)	39.61	39.61	39.61	39.61	39.61	23.53	23.53	23.53	23.53	23.53
Sesame seed meal (Full-fat)	10.31	10.31	10.31	10.31	10.31	12.00	12.00	12.00	12.00	12.00
Bone ash	2.50	2.50	2.50	2.50	2.50	3.00	3.00	3.00	3.00	3.00
Salt	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30
Premix*	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Lysine	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Calculated analysis										
ME[1] (Kcal/kg)	2,920.25	2,950.10	2,963.00	2,971.12	2,984.40	3,080.30	3,120.08	3,128.18	3,133.20	3.149.51
Protein (%)	22.87	22.91	22.89	22.88	22.90	19.25	19.25	19.26	19.29	19.31
Tannin (%)	0.00	0.12	0.24	0.35	0.47	0.00	0.13	0.26	0.38	0.51

Vitamin/ mineral premix from Bio-mix Finisher supplied/kg: Vit A = 4,000,000.00 IU; Vit D_3 = 800,000.00 IU; Vit E = 9,200.00mg; Niacin = 11,000.00mg; Vit B_1 = 720.00mg; B_6 = 1,200.00mg; B_{12} = 6.00mg; Pantothenic acid = 3,000.00mg; Biotin = 24.00mg; Folic acid = 300.00mg; Choline Chloride = 120,000.00mg; Cobalt = 80.00mg; Copper = 1,200.00mg; Iodine = 400.00mg; Iron = 8,000.00mg; Manganese = 16,000.00mg; Selenium = 80.00mg; Zinc = 12,000.00mg; Anti oxidant = 500.00mg.

[1]Metabolizable energy calculated according to the formula of Ichaponani (1980) as ME (Kcal/Kg) = 432 + 27.91 (CP + NFE + 2.25 × EE)

Data collection

Data were collected on growth parameters (feed intake, weight gain, feed conversion ratio and the feed cost per weight gain), and carcass measurements.

A weighed quantity of feed was supplied daily and the left over weighed the next day. Feed intake was calculated by difference between the left over and the quantity fed the previous day. The birds were weighed weekly and weight gain calculated by difference between two consecutive weighings. Feed conversion ratio (FCR) was calculated as the ratio of the feed consumed to the weight gained (feed: gain). The cost of the feed (₦/kg) was calculated using the market price of the ingredients and multiplied by the FCR to determine the feed cost of meat production (₦/kg gain).

At the end of the experiment, five birds were randomly selected from each replicate and used for carcass measurements. The birds were fasted overnight, individually weighed early in the morning (6.00 am) and slaughtered. Slaughtered birds were scalded in hot water (about 50°C) for one (1) minute, plucked and eviscerated manually. The eviscerated chicken was dressed by removing the neck and shanks and the dressed chicken (carcass) weighed and expressed as a percentage of the weight of the chicken before slaughter (live weight).

$$\text{Carcass yield (\%)} = \frac{\text{Weight of dressed chicken}}{\text{Weight of live chicken (g)}} \times 100$$

Some cut-up parts (breast muscle, thighs, drumsticks,) and the abdominal fat were also removed, weighed and expressed as percentage of their respective live weights.

Data analyses

The raw and boiled mango kernel meals were analyzed for proximate composition according to AOAC (1990) and tannin content using the methods described by (McCance and Widdowson, 1935) as modified by Stewart (1974). The metabolizable energy (ME) content was calculated according to Ichaponani (1980) as ME (Kcal/Kg) = 432 + 27.91 (CP + NFE + 2.25 × EE).

Growth, and carcass data were analysed for variance (Steel and Torrie, 1980) using the SPSS statistical package of (SPSS, 2001).

RESULTS

Results of chemical analysis Table 2 showed a slight reduction in the levels of crude protein, ash and nitrogen-free extract and increase in ether extract and crude fibre in the boiled mango kernel. Similarly, boiling reduced the tannin content of the kernel from 9.89 to 1.26%, representing about 87.26% reduction.

Dietary tannin (calculated on the assumption that mango kernel meal is the only contributor to tannin) increased steadily as the proportion of the kernel increased. The growth performance data (Table 3) showed a reduced ($P<0.05$) feed intake in the starter phase above 25%, while weight gain, feed conversion ratio and the weight at 28 days were depressed ($P<0.05$) only above 50% replacement of maize with the test ingredient. Despite the reduction in the cost of the Kg feed as the level of substitution increased, the feed cost of broiler production (₦/kg gain) was markedly ($P<0.05$) increased above 50% level of substitution.

During the finisher phase feed intake did not differ ($P>0.05$) amongst treatments but weight gain was depressed (P<0.05) and feed conversion ratio (FCR) and the feed cost of broiler production increased (P<0.05) on the 100% substitution diets. A total of 7 birds (1, 3, 0, 1, and 2 in diets 1, 2, 3, 4, and 5 respectively) died during the starter phase. No mortality was recorded during the finisher phase. Carcass data (Table 4) showed no significant (P>0.05) dietary effects on any of the carcass parameters measured (carcass yield and the yield of the thighs, drumsticks, breast muscle and abdominal fat).

TABLE 2: Analysed composition of mango kernels and maize

Constituents (%)	Raw mango kernel	Boiled mango Kernel	Maize*
Dry matter	91.50	90.21	91.80
Crude protein	8.01	7.72	8.80
Ether extract	7.87	9.22	4.10
Crude fibre	1.11	1.23	2.10
Ash	0.45	0.29	1.00
Nitrogen-free extract	82.56	81.54	75.80
[1]Metabolizable energy (ME: Kcal/Kg)	3,454.03	3,502.24	3,310.00
Tannin	9.89	1.26	NR

*adopted from Olomu (1995)
NR= not reported
[1] Calculated according to Ichaponani (1980) as
ME (Kcal/Kg) = 432 + 27.91 (CP + NFE + 2.25 × EE)

TABLE 3: Growth performance of broiler chickens fed graded levels of mango kernel meal as a replacement for maize.

Parameter	Replacement level of boiled mango kernel meal for maize (%)					
	0	25	50	75	100	SEM
1-28 days						
Initial body weight (g/bird)	95.50	94.70	96.00	96.10	96.50	0.31^{NS}
Body weight at 28 days (g/bird)	578.78^{a}	560.62^{a}	512.36^{ab}	428.18^{bc}	400.86^{c}	35.26*
Daily feed intake (g/bird)	43.87^{a}	41.12^{ab}	40.57^{bc}	38.97^{bc}	37.61^{c}	1.06*
Daily weight gain (g/bird)	17.26^{a}	16.64^{a}	14.87^{ab}	11.86b^{c}	10.87^{c}	1.27*
FCR (feed: gain)	2.54^{c}	2.47^{c}	2.73b^{c}	3.29^{ab}	3.45^{a}	0.20*
Feed cost (₦/kg)	67.20	63.80	61.20	58.00	56.30	NA
Feed cost of gain (₦/kg gain)	170.69^{ab}	157.59^{b}	167.08^{b}	190.82^{a}	194.24^{a}	7.06*
Mortality (%)	1	3	0	1	2	NA
29-63 days						
Daily feed intake (g/bird)	143.15	141.72	138.80	135.48	130.74	2.23^{NS}
Daily weight gain (g/bird)	41.43^{a}	40.97^{a}	39.81^{ab}	37.72^{b}	25.72^{c}	2.92*
FCR (feed: gain)	3.46^{b}	3.46^{b}	3.49^{b}	3.59^{b}	5.08^{a}	0.32*
Feed cost (₦/kg)	63.00	60.21	57.00	54.50	49.10	NA
Feed cost of gain (₦/kg gain)	217.98^{b}	208.33^{b}	198.93^{b}	195.66^{b}	249.43^{a}	9.64*
Mortality (%)	0	0	0	0	0	NA
1-63 days						
Final body weight (g/bird)	2028.83^{a}	1994.57^{a}	1905.71^{a}	1748.38^{a}	1301.06^{b}	132.60*
Daily feed intake (g/bird)	93.51^{a}	91.42^{a}	89.69^{ab}	87.23^{bc}	82.18^{c}	1.95*
Daily weight gain (g/bird)	29.35^{a}	28.81^{a}	27.34^{a}	24.79^{a}	18.30^{b}	2.01*
FCR (feed: gain)	3.00^{b}	2.97^{b}	3.11^{b}	3.44^{ab}	4.27^{a}	0.24*
Feed cost (₦/kg)	66.10	62.01	59.10	56.25	52.70	NA
Feed cost of gain (₦/kg gain)	194.45^{b}	182.96^{b}	183.01^{b}	193.24^{b}	221.84^{a}	7.10*

a, b, c= means within the row with different superscripts are significantly different (P<0.05)
SEM= Standard error of the mean; NA= not analysed; *= significantly different (P<0.05)
FCR = Feed conversion ratio; NS = Not significant (P>0.05); ₦ 1= $0.006 at the time of the experiment (2010).

TABLE 4. Carcass measurements of broiler chickens fed boiled mango kernel meal for maize

Parameter(% live weight)	Replacement level of boiled mango kernel meal for maize (%)					
	0	25	50	75	100	SEM
Carcass	64.41	65.20	64.12	62.70	63.33	0.43^{NS}
Thigh	13.11	12.96	12.98	11.89	10.91	0.43^{NS}
Drumstick	11.35	11.22	11.02	10.80	10.76	0.11^{NS}
Breast	17.03	16.95	17.11	16.81	15.97	0.21^{NS}
Abdominal fat	1.88	1.95	1.86	1.89	1.82	0.02^{NS}

SEM= standard error of the mean; NS = Not significant (P>0.05)

DISCUSSION

The protein in the kernel used for the study is similar to that of maize, but the kernel has higher fat, higher soluble sugar and lower fibre contents than maize. The values for protein and ether extract of the kernel are comparable to those (7.80 and 9.00% crude protein and ether extract respectively) reported in mango kernel by Jadhav and Siddiqui (2010), but the crude fibre of the experimental kernel is lower than the 6.70% by these authors. The tannin and ash contents of the kernel in this experiment are lower than the values of 12.10% and 3.24% tannin and ash respectively reported in mango kernel by Diarra and Usman (2008). These results suggest varietal differences in the chemical composition of mango kernel.

The reduced protein in the boiled kernel may be attributed to the denaturing of protein by heat (Parsons *et al.*, 1992) or the leaching of soluble proteins in the boiling water as observed by Mbajunwa (1995). The higher fat in the boiled kernel was reflected in its higher energy content compared to the raw kernel as fat is a concentrated form of energy.

The reduction of tannin content in this study (87.26%) is in agreement with the findings of Mbajunwa (1995), Teguia and Beynen (2005) and Diarra and Usman (2008). These authors observed that cooking is an efficient method of reducing the tannin content of feeds. This level is however, higher than the 75% reduction obtained by Diarra and Usman (2008) under the same conditions of heat and time, probably due to differences in the solubility of the tannins in mango kernel varieties.

The reduced feed intake above 25% replacement may be related to the increasing dietary energy as chickens are known to consume feed to meet their energy requirement. Tannin contents of the 75 and 100% replacement diets were above the 0.30% reported to be tolerated by chicks (Jansman *et al.*, 1989). This may be the reason for the poor performance in terms of weight gain, and feed conversion on these diets. However, despite the reduction in the cost of the Kg feed the cost of broiler production was increased as a result of the poorer feed conversion on these diets.

During the finisher phase, the depression in growth performance was observed only above 75% replacement diet (0.38% dietary tannin), suggesting that the threshold of tannin in chickens is age dependent with older birds tolerating more than younger ones. Similar results have been reported by earlier workers. Douglas *et al.* (1993) observed that increasing dietary tannins significantly reduced weight gain in young turkeys while there were no adverse effects of tannins on performance once the turkeys were 57 days old or older. The improvement in the performance during the finisher phase was reflected in the overall growth performance (1-63days) of the chickens. The mortality results were not traceable to dietary effects.

All the carcass measurements in this experiment were within ranges reported in literature (Jourdain, 1980; Oluyemi and Roberts, 1988). As protein quality is an important factor in muscle deposition, the lack of significant differences in the yield of carcass and cut-up parts may indicate that protein utilization was not significantly affected by the level of mango kernel meal. This corroborates the observations of Douglas *et al.* (1993) who found no significant interaction between dietary protein and tannin and concluded that the toxic effects of tannins may be due to factors other than amino acid availability.

At the end of the experiment it was concluded that boiled mango kernel meal can replace 50% of maize in the diets of broiler chicks and up to 75 % in the finisher diets. The optimum inclusion levels in diets for other classes of poultry however, needs to be investigated as well as other processing methods that could enhance the utilization of the product by poultry.

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