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Broiler Performance upon Dietary Substitution of Cocoa Husks for Maize

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Abstract: Anack 180 broiler chickens, aged 7 weeks, were used in an experiment to determine the effect of replacement of maize by cocoa husks in a grower-finisher ration. Cocoa husks were substituted for the maize component in the ration (65 g maize/100 g of diet) at levels of either 0, 10, 20 or 30% of the maize. The birds fed the diet with the 10% substitution level showed significantly faster growth than the control animals whose growth rates were not significantly different from the birds fed the diet with 20% maize replacement. When compared with the control birds, low body weight and poor efficiency of feed utilization were observed for the birds fed the diet with 30% maize replacement. Cocoa husks are less expensive than maize, but cost analysis indicated that the feed cost per kg of live broiler was increased after incorporation of cocoa husks into the diet. It is concluded that cocoa husk might be used as an ingredient for poultry grower finisher diets, but various questions need to be addressed prior to practical application.

Key words: Broiler, maize, cocoa husks, substitution, performance

Introduction

In Cameroon, as in many other African countries, the food supply of an increasing human population is a permanent concern for policy makers and planners. In order to intensify livestock production, the problems with regard to feeding the animals have to be solved. In many developing countries, including Cameroon, domestic animals in general, and poultry in particular, consume the same food as man. Thus, there is competition between humans and animals for feed ingredients. This competition is especially crucial in developing countries because agricultural production usually already is insufficient for human feeding. The problem particularly is evident for cereals such as maize, rice, wheat, millet etc., which are traditionally included in poultry feed at levels up to 60-70%. These very products, along with roots and tubers, constitute the principal foods for human feeding. Meat is expensive because of high cereal prices and cereal scarcity and therefore frequently is out of the reach of the average consumer. It thus becomes imperative to find local agricultural residues and by-products that are commonly available, unsuitable for human consumption, are cheap and can provide energy and nutrients for livestock without negatively affecting their health and productivity (Teguia and Beynen, 2004).

The cocoa production in Cameroon has increased continuously over the years. The production was 96,000 metric tons in 1975/1976 and it was above 123,000 tons in 1979/1980. In the process of preparation of cocoa for the market, the pod is completely discarded and is either buried in pits or burnt. According to Branckaert *et al.* (1967), the fresh cocoa pods abandoned each year on the field amount to about 2.42 million kg. With its high crude fibre content, cocoa pods seem to be efficiently used by ruminants (Ndumbe, 1980). However, there is no cattle production in cocoa producing zones while small ruminants are quantitatively insignificant due to the extensive character of their management. Little work had been carried out on the use of cocoa pods in the feeding of monogastric animals, i.e. pigs and chickens. Experiments done in Nigeria and reported by Adeyanju *et al.* (1976, 1977) did not give definite conclusions as to the use of cocoa pods in the diet of chickens. The objective of the present study was therefore to evaluate dried cocoa husk as a substitute for maize in the feeding of growing-finishing broiler chickens.

Materials and Methods

The birds used in this experiment were taken from a stock of one-day-old Anack 180 chicks that were imported from Israel and kept at the research farm of the National Advance School of Agriculture (NASA). They were reared using conventional methods, were fed a commercial diet and were housed on litter. At the age of 7 weeks, when the birds on average weighed 525 g, 200 chickens were randomly selected and divided into 4 groups. The birds were individually identified using wing tags and their individual weights were recorded. There were 50 birds per dietary group. The birds in the same group were housed together in separate sections of the animal house. The groups received one of the four experimental diets described below.

Fresh cocoa pods were collected. At the time of harvest,

Table 1: Ingredient composition, calculated nutrient composition and cost of the experimental diets

	Maize replacement by cocoa husks (%)			
	0	10	20	30
Ingredient (%)				
Maize	65	58.5	52	45.5
Cocoa husks	0	6.5	13	19.5
Cotton seed cake	9	9	9	9
Groundnut cake	13.5	13.5	13.5	13.5
Concentrate[1]	10	10	10	10
Dicalcium phosphate	2	2	2	2
Salt	0.5	0.5	0.5	0.5
Cost (FCFA[2])/kg feed	98.7	93.9	89.0	84.1
Calculated composition (% DM)	7.1	6.9	5.1	5.5
Total ash	1.9	3.8	5.6	7.5
Crude fibre	20.6	20.4	20.3	20.1
Crude protein	1.32	1.33	1.35	1.37
Calcium	0.97	0.96	0.95	0.93
Phosphorus				

[1]The composition of the concentrate has been described earlier (Teguia, 1995). [2]1 Euro = 655.95 FCA

Table 2: Body weights of Anack 180 broiler birds fed diets with increasing levels of cocoa husks

Age (weeks)	Maize replacement by cocoa husks (%)			
	0	10	20	30
8	608±72^{b}	682±127^{a}	609±85^{b}	581±77^{c}
9	789±117^{b}	945±177^{a}	749±122^{b}	681±96^{c}
10	1020±155^{b}	1262±229^{a}	1006±173^{b}	919±123^{c}
11	1309±205^{b}	155±252^{a}	1253±202^{b}	1093±141^{c}
12	1637±263^{b}	1908±238^{a}	1600±243^{b}	1499±182^{c}
13	1860±296^{b}	2234±322^{a}	1903±264^{b}	1686±215^{c}
14	2190±352^{b}	2533±359^{a}	2188±293^{b}	2008±261^{c}
15	2425±414^{b}	2696±386^{a}	2378±336^{b}	2190±304^{c}

Body weights (g) are given as means ± SD for 50 birds per dietary group

abc Means within one row with different superscript letters are significantly different ($P<0.05$)

the water content of pods was about 85%. They were dried using forced draught ovens (65-83°C for 18-24 hours) or using sunlight (2 weeks). The efficiency of drying by the two methods was similar as the dried cocoa pods had water contents ranging from 13 to 14%. After drying, the pods, which were very firm, were easily ground in a normal feed mill producing a brownish powder which was mixed with other ingredients of the rations. Four diets were prepared by substituting the dried ground cocoa husks for maize. Either 0, 10, 20 or 30% of the maize component (65 g maize/100 g of diet) of the control diet was replaced so that the final rations contained either 0, 6.5, 13 or 19.5% cocoa husks (Table 1). The chickens had free access to feed and water. During the experiment, all birds were given water-soluble vitamins (SARB-SOL®), antibiotics (Terramycine anti-stress® and Terramycine croissance®) and coccidiostats (Soludone®).

The broiler birds were individually weighed once a week and the average weekly weight gain was calculated. The weekly feed consumption was calculated by subtracting the remaining feed from the quantity supplied. Feed intake was not measured between the age of 7 and 8 weeks. Feed conversion ratio (FCR) was calculated as g of feed required to produce one g of live weight gain. Birds of the same dietary group were housed together, but individual birds were still considered as experimental units. Feed intake could only be determined as group mean. For statistical analysis, the inter-individual variation in feed intake as based on historical data was used. The data were subjected to ANOVA (Steel and Torrie, 1980) and Duncan's multiple range test was used to compare group means when ANOVA showed a significant treatment effect.

Results

Average weight of the chickens ranged from 581 to 682 g after one week and from to 2190 to 2696 g at the end of the experimental period (Table 2). The lowest body weight was seen in the group fed the highest level of

Table 3: Average daily feed consumption by Anack 180 broiler birds fed diets with increasing levels of cocoa husks

Age (Weeks)	Maize replacement by cocoa husks (%)			
	0	10	20	30
8-9	77[b]	104[a]	100[a]	94[a]
9-10	101[b]	142[a]	140[a]	160[a]
10-11	124[b]	222[a]	151[a]	173[a]
11-12	146[b]	147[a]	162[a]	187[a]
12-13	144[b]	163[a]	207[a]	183[a]
13-14	144[b]	165[a]	202[a]	201[a]
14-15	153[b]	169[a]	198[a]	220[a]

Feed intake data are expressed as g/bird/day.
ab Means within one row with different superscript letter are significantly different (P<0.05)

Table 4: Average weekly feed conversion ratio of Anack 180 broiler birds fed diets with increasing levels of cocoa husks

Age (weeks)	Maize replacement by cocoa husks (%)			
	0	10	20	30
8-9	2.98	2.77	4.98	6.57
9-10	3.05	3.13	3.81	4.71
10-11	3.00	5.04	4.27	6.93
11-12	3.12	2.92	3.27	3.21
12-13	6.48	4.61	6.13	10.28
13-14	3.06	3.86	4.94	4.34
14-15	4.57	7.26	7.29	8.56
8-15	3.75[b]	4.22[b]	4.95[b]	6.37[a]

FCR's are00 expressed as g feed/g body-weight gain
ab Means within one row with different superscript letter are significantly different (P<0.05)

cocoa husks and the birds fed the diet with 6.5% cocoa husks (10% maize replacement) showed the highest body weight. Throughout the experiment, the difference between the controls and the birds fed the diet with 10% maize replacement was statistically significant. The controls and those fed on the 20% level of substitution had similar final body weights.

Table 3 summarizes the data on feed consumption. During the second week of the experiment (age, 8-9 weeks), feed intake ranged from 77 to 104 g/day/bird for controls and for those given the diet with the 10% level of substitution. During the last week of the experimental period, the range was 153 to 220 g for the controls and for the birds fed on the diet with 30% substitution level. The control group consistently had the lowest feed consumption. For the entire experimental period, feed consumption increased in a dose-dependent fashion with higher levels of maize replacement by cocoa husks.

During the first week of the experiment, FCR varied between 2.77 and 6.57 for the birds fed on the diets with either 10 or 30% level of substitution (Table 4). The range was 4.57 to 8.56 during the last week of the experimental period for the control group and for the birds fed on the 30% level of substitution, respectively. There were aberrant FCR values during the course of the experiment, but for the entire experiment the FCR increased when the level of cocoa husks in the diet was increased. Statistical analysis showed that the birds fed on the diet with the 30% level of substitution had a significantly higher FCR than did the other groups of birds whose values were not significantly different.

The cost of 1 kg of feed decreased as the level of cocoa husks in the diet was increased (Table 1) because 1 kg of cocoa husks cost about 16 times less than 1 kg of maize. At the beginning of the experiment, the average weekly cost of feed per bird ranged from 53.5 FCFA for the controls to 68.2 FCFA for the group fed the diet with 10% level of substitution. For the period of 8-15 weeks of age, it can be calculated that per kg of weight gain the feed costs were 370 and 396 FCFA for the control birds and for those fed the diet with 10% maize replacement.

Discussion

The main outcome of the present study is that a dietary cocoa husk level of 6.5%, added at the expense of maize, raised weight gain of the broiler chickens. However, a cocoa husk level of 13% did affect growth, whereas an inclusion level of 19.5% reduced weight gain of the broilers. The inhibition of growth seen in the group receiving the diet with 30% maize replacement could be due to the high dietary concentration of theobromine present in the husks (Day and Dilworth, 1984). The growth-depressive effect of a high inclusion level of cocoa husks was also reported by Adeyanju *et al.* (1976, 1977). In contrast, Branckaert *et al.* (1967) showed that poultry performed equally well as controls when fed diets with cocoa husks at inclusion levels up to 20%. However, those diets were fortified with synthetic amino acids and this might have boosted performance of the birds. Recent studies by Olubamiwa *et al.* (2002) confirm the present data in that adding cocoa husks to the diet at a level above 10% significantly depresses body-weight gain and raises the FCR.

As mentioned above, the birds fed on the diet containing 6.5% cocoa husks (10% maize replacement) showed a higher weight gain than their counterparts fed on the control diet without cocoa husks. The better performance was seen in spite of the higher crude fibre content of the diet with cocoa husks. In contrast, previous findings did not show improved performance, but rather unchanged performance, when broilers were fed a diet containing cocoa husks (Adeyanju *et al.*, 1977, Olubamiwa *et al.*, 2001, 2002). It is not clear why in our hands replacement of 10% of the maize component by cocoa husks improved growth performance.

Feed intake for the entire experimental period was increased by increasing levels of cocoa husks in the diet. This observation corroborates reports by Adeyanju

et al. (1976, 1977) and Branckaert *et al.* (1967) and is most likely the result of a decrease in metabolizable energy content of the ration as a consequence of high amount of crude fibre in cocoa husks. In order to satisfy their energy requirements (Leeson and Summers, 1997), the birds fed the diets with cocoa husks had to consume more than did those fed on the control diet. This reasoning is in contradiction with Olubamiwa *et al.* (2002) who reported that an increased crude fibre content of diets containing cocoa husks was associated with depression of feed intake. The discrepancy could be related to the source and variety of cocoa husks as these characteristics could affect palatability of the diet. The results obtained on efficiency of feed utilization are in concordance with those of others also showing that the FCR tended to increase as the amount of cocoa husks in the diet was increased (Olubamiwa *et al.*, 2001, 2002).

The use of cocoa husks instead of maize reduced cost of feed. However, the use of coca husks raised the feed costs per kg of live weight. More research is necessary with regard to the use of cocoa husks. The reproducibility of this study needs to be verified. It is also important to know the effect of cocoa husk feeding on carcass quality, in particular the weight of the gastrointestinal tract. High fibre intakes associated with cocoa husk ingestion may increase weight of the gastrointestinal tract. Effects on growth and mortality of cocoa husk feeding as from the age of one day have to be documented. It might be possible that with certain diet compositions high inclusion levels of cocoa husks can be applied without negative effects on production.

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