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Effect of Replacement of Maize with Earth Ball (*Icacinia manni*) Meal on the Performance of Broiler Chickens

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Abstract: The aim of the study was to assess the replacement value of earth ball for maize in broiler diets. A feeding trial was conducted for eight weeks using 220 unsexed *Anak 2000* broiler chickens in a completely randomized design to assess the effect of replacement of maize with *Icacinia manni* meal at 0, 15, 30, 45 and 60% on the performance. The diets were isonitrogenous and isocaloric, containing 24% crude protein and 3095 Kcal kg^{-1} ME in the starter ration and 21% crude protein and 3204 Kcal kg^{-1} ME in the finisher mash. The birds were randomly distributed into 5 treatments with two replicates containing 22 birds each making a total of 44 birds per treatment. Results showed that in the starter phase, dietary treatments had significantly ($p<0.05$) least feed intake, body weight gain in the 45 and 60% *Icacinia manni* meal diets, but not significantly ($p>0.05$) different in mortality and feed conversion ratio. Significant differences ($p<0.05$) were also observed in feed intake and body weight gain in the finisher phase. Birds on 0 and 15% *Icacinia manni* meal diets consumed more feed and were heavier ($p<0.05$) than those on 30, 45 and 60% *Icacinia* meal diets. Mortality and feed conversion ratio were not significantly different ($p>0.05$) at the finisher phase. Birds on 0 and 15% *Icacinia meal* inclusion exhibited significantly ($p<0.05$) higher dressed weight, kidney, liver, lung, shank, intestine, neck and gizzard weights. The study concludes that *Icacinia manni* meal could replace maize up to 15% in broiler diets without deleterious effect on performance, which holds great potential as feed ingredient in poultry nutrition.

Key words: *Icacinia manni* meal, feeding trial, performance, carcass, organ mass

INTRODUCTION

Poultry meat production is one of the most dynamic industries in the world (Berri, 2000) and the quickest source of meat whose production involves the least hazardous and arduous process compared to other livestock enterprises (Obioha, 1992; Ojewola *et al*., 2006). An important part of raising chicken is feeding which makes up the major cost of production and good nutrition is reflected in the bird's performance and its products (Cheeke, 1991; Emiola and Ologhobo, 2006). A good quality poultry feed is one that is formulated to provide the appropriate levels of nutrient for the class of birds to which it will be fed. It must be compounded from ingredients that are known to be safe and acceptable. Its physical form must also be acceptable and manageable in terms of handling (Bamedd, 1990).

In Nigeria, the most important factor limiting the expansion of the poultry industry is the shortage and high cost of feed ingredients particularly grains (Oluyemi and Roberts, 2000). The cost of feeding has been put at 60-80% of the total cost of production for intensively reared livestock especially poultry and pigs (Fajimi *et al*., 1993; Tewe, 1997; Durunna *et al*., 2005). Maize is the chief source of energy in diets of monogastric animal in Nigeria and constitutes up to 60% of the ration (Tewe, 1997; Udedibie *et al*., 2004). The use of maize in ration formulation has become expensive because of scarcity following increasing pressure on maize as staple food for human and livestock feeds. As a result, there has been a rise in feed cost. Therefore, the search for some cheaper alternative energy feeds not directly consumed by human is on the increase.

Icacinia manni (Earth ball), a shrub with a well-modified tuber root, which is mainly carbohydrate and not directly consumed by human could be used as an alternative energy source in monogastric feeding. *Icacinia manni* is one out of the thirteen known species of *Icacinia* plant. It is an all season evergreen shrub plant possessing well-defined roots, stem and leaves. The stem arises from an underground tuber and is round in cross section, thin, straight or branched attaining heights varying from 1-2 m at maturity. The leaves are simple and alternate, broadly elliptic, 24-30 cm long and 10-15 cm wide, abruptly acuminate at the apex and rounded at the base. The petiole measures about 1 cm long. The inflorescence bears creamy-white flowers. The fruits when ripe are reddish in colour and are highly relished by children (Akobunda and Agyakwa, 1998).

Each plant stand despite the number of shoots arising from base bears a single enlarged wedge-shaped modified tuber root, which tapers at the tip. The tubers

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vary in colour depending on soil type grown and stage of maturation from white to brown. The plant can be propagated from both seeds and tuber sprouts. *Icacinia manni* is a common weed of field crops, forest regrowth, fallow or waste lands and is locally abundant in Nigeria, especially in the humid tropics of Cross River State (Akobunda and Agyakwa, 1998). *Icacinia manni* tubers contain some anti-nutritional factors such as cyanogenic glycosides, phytic acid, oxalates and many others, which limit its use as animal feed (Fassiet, 1973). This study was, therefore, designed to investigate the effect of replacing maize with *Icacinia manni* meal on the performance of broiler chickens.

MATERIALS AND METHODS

Location of the study: The project was undertaken at the Teaching and Research Farm, poultry section of the University of Calabar, Nigeria when the temperature and relative humidity were 21.0-37.9°C and 51-93%, respectively. The average minimum and maximum rainfall were 1174-1486, respectively, while the average solar radiation was 14.70 mg m^{-2} day^{-1} (Meteorological Service, 2005).

Preparation of *Icacinia manni* tuber: The *Icacinia manni* (Earth ball) tubers were harvested from fallow lands in the wild at Akpabuyo Local Government area of Cross River State of Nigeria. The plant was identified by a botanist in the Department of Biological Sciences, University of Calabar, Nigeria. The tubers were peeled, chopped into pieces and fermented in plastic buckets for 48 h. This was to detoxify the substance of some anti-nutrient factors such as cyanogenic glycoside (Bassir, 1969). The materials were rinsed with clean water and sun-dried on cemented floor for 4 days and later milled using a 4 mm mesh-size hammer mill. This was labeled as *Icacinia manni* meal used as the energy source alternative in the experimental rations.

Chickens, diets and management: Ten experimental broiler diets, five each for the starter and finisher phases, were formulated to be isocaloric and isonitrogenous, 3095 Kcal kg^{-1} Metabolizable Energy (ME) and 24% Crude Protein (CP) for starter and 3204 Kcal kg^{-1} ME and 21% CP for the finisher phases. The *Icacinia manni* was used at the rate of 0, 15, 30, 45 and 60%, respectively, at expense of maize, which represented treatments, A, B, C, D and E, respectively as indicated in Table 1. A total of

Table 1: Gross composition of experimental diets

	Level of *Icacinia* meal in diets (%)				
Ingredients	A (0)	B (15)	C (30)	D (45)	E (60)
Starter diets					
Maize	51.04	42.70	34.61	26.77	19.17
Icacinia manni	-	7.53	14.83	21.90	28.76
Soybean meal	26.97	27.51	28.04	28.55	29.05
Crayfish dust	13.49	13.76	14.02	14.28	14.50
Wheat offal	5.00	5.00	5.00	5.00	5.00
Bone meal	2.00	2.00	2.00	2.00	2.00
Salt	0.50	0.50	0.50	0.50	0.50
Vitamin/mineral*	0.50	0.50	0.50	0.50	0.50
Methionine	0.20	0.20	0.20	0.20	0.20
Lysine	0.30	0.30	0.30	0.30	0.30
Palm oil	-	0.44	0.86	1.26	1.64
Total	100.00	100.00	100.00	100.00	100.00
Crude protein	24.00	24.00	24.00	24.00	24.00
ME[1] (Kcal kg^{-1})	3095.00	3095.00	3095.00	3095.00	3095.00
Finisher diets					
Maize	59.15	47.07	38.00	30.36	21.60
Icacinia manni	-	8.60	16.44	23.05	27.90
Soybean meal	21.60	22.60	23.54	25.97	26.20
Crayfish dust	10.30	11.25	11.11	12.12	12.50
Wheat offal	3.00	3.00	3.00	3.00	3.00
Bone meal	4.00	4.00	4.00	4.00	4.00
Salt	-	2.00	2.40	2.90	3.30
Vitamin/mineral*	0.50	0.50	0.50	0.50	0.50
Methionine	0.50	0.50	0.50	0.50	0.50
Lysine	0.20	0.20	0.20	0.20	0.20
Palm oil	0.30	0.30	0.30	0.30	0.30
Total	100.00	100.00	100.00	100.00	100.00
Crude protein	21.00	21.00	21.00	21.00	21.00
ME[1] (Kcal kg^{-1})	3204.00	3204.00	3204.00	3204.00	3204.00

*Vitamin/mineral premix containing the following per kg of diet. Vit. A 7500 IU, Vit. D_3 1000 IU, Vit E 1.0IU, Vit K 2.0 mg, riboflavin 4.0 mg, pantothenic acid 5.0 mg, niacin 20 mg, choline 150 mg, Vit. B_{12} 100.0 mg, cobalt 0.2 mg, copper 2.0 mg, iodine 1.2 mg, zinc 50.0 mg, manganese 80.0 mg, iron 25.0 mg. (NRC, 1994)

220 unsexed *Anak 2000* broiler chicks were divided into the five treatment groups of 44 birds. Each treatment was replicated twice with 22 birds per replicate. The birds were managed in the conventional deep litter system for eight weeks. Birds were weighed at day old for the initial mass thereafter on weekly basis for mass gains. Feeds and water were served *ad libitum* and mortality record kept. Feed intake was obtained by difference between the quantity of feeds given and the leftover for a specific period of time.

Measurements, chemical and statistical analyses: Proximate nutrients composition of the feeds and *Icacinia manni* meal was determined using official methods (AOAC, 1990). Metabolizable energy was calculated from the proximate chemical composition data using formula:

ME Kcal kg^{-1} = 37 + % CP + 81.8 × % EE + 35.5 × % NFE (AOAC, 1990).

On the 52nd day of experiment, four birds per treatment were humanely slaughtered for carcass analysis. The birds were defeathered and weighed after evisceration to obtain the carcass mass. The organs such as the liver, intestine, heart and gizzard were removed and weighed to obtain the organ mass. All data were subjected to a one-way analysis of variance using Statistical Package for Social Sciences (SPSS, version 10) and the significantly different means were separated using the Duncan's multiple range test (Steel *et al*., 1997) at 5% level.

RESULTS AND DISCUSSION

Proximate composition: The various parameters did not differ (p>0.05) significantly in the starter and finisher phases (Table 2). The metabolizable energy values were statistically (p>0.05) similar in the starter and finisher phases. Except for ether extract and fibre with slightly higher values, every other parameter had value within recommended levels for broilers in the tropics (Oluyemi and Roberts, 2000).

Performance at the starter phase: Average weekly feed intake varied significantly (p<0.05) among the different treatments (Table 3). However, the feed consumption decreased from 15% *Icacinia* meal diet (Diet B) through to

Table 2: Proximate composition and metabolizable energy of the experimental diets and *Icacina manni* meal

	Level of *Icacinia* meal in diets (%)					
Constituents	A (0)	B (15)	C (30)	D (45)	E (60)	*Icacina manni*
Starter diets						
Moisture	10.15	9.75	9.11	10.00	8.50	12.05
Crude protein	24.05	23.98	23.99	24.00	24.00	5.69
Ether extract	6.00	7.00	7.50	8.00	8.00	3.60
Ash	6.50	7.50	8.00	8.00	8.50	12.00
Crude fibre	5.00	5.72	6.50	6.25	7.25	16.00
NFE	48.30	46.05	46.05	44.90	43.75	51.26
ME (Kcal kg^{-1})	3095.30	3094.64	3095.08	3095.43	3095.40	2276.86
Finisher diets						
Moisture	9.00	8.50	8.50	8.00	7.00	
Crude protein	21.40	21.30	21.30	21.00	21.00	
Ether extract	9.50	9.00	9.00	9.00	9.00	
Ash	4.00	5.50	6.50	7.00	7.01	
Crude fibre	6.50	6.50	5.50	6.00	6.75	
NFE	50.90	50.90	49.20	50.00	49.90	
ME (Kcal kg^{-1})	3203.80	3203.80	3203.60	3204.40	3202.80	

Values are means of duplicate determinations

Table 3: Growth performance of broiler chickens fed different experimental diets

	Level of *Icacinia* meal in diets (%)					
Parameters	A (0)	B (15)	C (30)	D (45)	E (60)	±SEM
Starter phase						
Av. weekly feed consumption/bird/g	304.70^{a}	301.22^{a}	299.70^{a}	295.76^{bc}	289.93^{c}	2.27
Av. weekly mass gain/bird/g	99.00^{a}	94.20^{a}	89.98^{b}	87.14^{bc}	84.66^{c}	2.29
Feed conversion ratio	0.30	0.31	0.30	0.29	0.29	0.00
Mortality (%)	4.20	3.95	5.00	4.25	3.85	1.80
Finisher phase						
Av. weekly feed consumption/bird/g	1082.22^{a}	882.85^{b}	845.68^{c}	835.00^{c}	815.57^{d}	43.71
Av. weekly mass gain/bird/g	852.00^{a}	744.25^{b}	632.75^{c}	624.00^{c}	597.73^{d}	42.70
Feed conversion ratio	0.79	0.84	0.77	0.73	0.66	0.00
Mortality (%)	3.90	3.55	3.90	4.10	2.98	0.18

Values within the same row followed by different superscripts are significantly different (p<0.05)

60% *Icacinia* meal diet (Diet E). Feed intake significantly ($p<0.05$) decreased with increased level of *Icacinia manni* meal in the diet. The highest value was 304.70±6.46 g in diet A, while the lowest value of 289.93±6.78 g was recorded in diet E. This condition might suggest a decreased palatability of all the *Icacinia* meal diets which agrees with published report that wild tubers are unpalatable (Akobunda and Agyakwa, 1998). On the other hand, Moody and Benson (1991) contended that poultry are highly adaptable to maize-based diets, but tend to perform poorly on unconventional diets which suggests the need for further processing of the *Icacinia manni* plant to enhance acceptability.

Average weekly mass gain varied significantly ($p<0.05$) among the different diets. The parameter followed the same trend of decreasing with increasing *Icacinia* meal inclusion as the feed intake. The highest value of 99.00±4.52 g was recorded on treatment A, while the least value of (84.66±5.12 g) was recorded for birds on 60% *Icacinia* meal diet. The depression in growth rate which resulted among the birds on 30, 45 and 60% *Icacinia manni* meal inclusion, suggested a low utilization of these diets. Experience has also shown that at higher inclusion levels, unconventional feedstuff may alter the texture, colour, taste and odour of diets (Fajimi *et al.*, 1993) and this supports the findings in the current study. Feed consumption and the ultimate utilization might have been affected by the texture (Ander, 1992) colour (Nir *et al.*, 1994) and the taste and odour (Odunsi *et al.*, 1996) or a combination of these factors.

Feed conversion ratio did not vary significantly ($p>0.05$) among the various dietary treatment groups. These values were not surprising because the starter phase (0-4 weeks) is generally too short a period to allow for full expression of a feed potential. Broilers take quite some time to get used to a non-conventional feed (Odunsi *et al.*, 1996). Percentage mortality at the starter phase did not follow any particular trend and did not differ significantly ($p>0.05$) among the various diets (Table 3). However, the highest, mortality of 5% was obtained on birds fed the 30% *Icacinia* meal diet, while the lowest was in diet E. The fact that increased levels of *Icacinia* meal did not cause death of the birds, even at this tender age, indicates that the diets were safe. The mortality recorded in this study was within the limits of 5% recommended by Oluyemi and Roberts (2000) under good management practice in the tropics.

Performance at the finisher phase: The average weekly feed intake varied significantly ($p<0.05$) among the various treatments (Table 3). Highest value of 1082.22±12.60 g was recorded in diet A, while the lowest (815.57±9.40 g) was in birds eating 60% *Icacinia* diet. Feed intake significantly decreased with increase *Icacinia manni* meal levels in the diet. It was noted that as more *Icacinia* meal was included in the diet, palatability apparently reduced which probably explained the depressed feed intake observed at the starter phase. Poultry naturally do not consume feeds of unfamiliar texture and odour (Ander, 1992). The *Icacinia* diets were rather very coarse in texture and somehow repulsive in odour which may require further processing.

Average weekly mass gain of birds differed significantly ($p<0.05$) among the various dietary treatments. Highest value (852.00±10.13 g) was recorded in the control, while the lowest value of 597.73±9.16 g was in diet E. Mass gain followed the same trend of decreasing feed consumption, with increasing level of dietary *Icacinia* meal inclusions. The birds gained mass in ratios commensurate with the amount of feed consumed, which is to say, high feed consumption corresponded with a high body mass gain and vice versa. While this observation may be apparently satisfactory, the observed decreased feed intake and mass gain in birds on the 45 and 60% *Icacinia manni* meal diets at the starter phase could be attributed to the progressive reduction of maize in the diets (Ojewola *et al.*, 2006), the added high dietary fat (palm oil) to produce isocaloric diets and a possible anti-nutrient factor (Fassiet, 1973).

The values for feed conversion during the finisher phase as presented in Table 3 did not differ significantly ($p>0.05$) among the treatments. However, the highest numerical value (0.84) was recorded in the 15% *Icacinia* meal diet, while the lowest figure (0.66) was in diet E (60% *Icacinia* meal). Generally, the feed conversion ratio values were higher in the finisher than starter phase, which suggests that finisher broilers could tolerate, adapt and utilize higher levels of *Icacinia manni* meal in their diets better than the starter birds. Mortality did not follow any particular trend and was not significantly ($p>0.05$) different. Mortality was surprisingly low on all diets, much lower than the recommended 5% under good management in the tropics (Oluyemi and Roberts, 2000).

Carcass and organ mass: Carcass and organ mass of the finished broilers are summarized in Table 4. Since carcass yield is an indication of the quality and utilization of the ration (Isika *et al.*, 2006), it would seem that birds on 30, 45 and 60% *Icacinia manni* meal inclusion diets poorly utilized their feed as evidenced by the significantly ($p<0.05$) lower dressed mass, shank and neck. Significantly ($p<0.05$) lower values were observed for intestine in all groups on *Icacinia manni* meal diet. This could be due to decreased bulk and lower volume of

Table 4: Carcass and organ weights of broiler chickens fed the experimental diets

	Level of *Icacinia* meal in diets (%)					
Parameters	A (0)	B (15)	C (30)	D (45)	E (60)	±SEM
Live mass (kg)	2.20^{a}	2.10^{a}	2.05^{a}	1.80^{b}	1.70^{b}	0.09
Dressedmass (kg)	2.05^{a}	2.05^{a}	1.95^{b}	1.70^{c}	1.60^{c}	0.09
Kidney (g)	3.44^{a}	3.00^{a}	3.02^{a}	2.27^{b}	2.07^{b}	0.20
Proventriculus (g)	10.07	10.40	10.13	10.70	10.00	0.13
Liver (g)	55.80^{a}	55.38^{a}	40.84^{b}	40.66^{b}	39.71^{c}	3.72
Heart (g)	10.87	10.56	10.67	10.66	10.00	0.15
Lung (g)	10.39^{a}	10.31^{a}	9.32^{b}	8.32^{c}	8.03^{c}	0.49
Head (g)	44.20	43.27	40.27	40.30	40.08	0.78
Shank (g)	72.40^{a}	70.86^{a}	65.20^{b}	65.50^{b}	49.37^{c}	4.07
Intestine (g)	80.31^{a}	71.61^{b}	66.70^{c}	60.11^{c}	53.17^{c}	4.66
Gizzard (g)	35.86^{a}	31.47^{b}	31.09^{b}	30.49^{b}	29.00^{c}	1.15
Neck (g)	73.12^{a}	66.48^{b}	50.91^{c}	50.91^{c}	51.17^{c}	4.72

Means within the same row followed by different superscripts are significantly different ($p<0.05$)

digesta staying in the gastrointestinal tract during enzymatic digestion (Savory and Gentle, 1976; Longe and Fagbenro-Byron, 1990; Ander, 1992).

There were no significant differences ($p>0.05$) between the percentage mass of proventriculus, heart and head of birds on the control diet and those on the different treatment diets. However, values were higher in birds on the 0 and 15% *Icacinia* meal compared with 30, 45 and 60% inclusion. Also the weights of kidney, liver, lung and gizzard of 0 and 15% *Icacinia manni* meal inclusion diets were significantly ($p<0.05$) higher than those of 30, 45 and 60% inclusion. The significantly higher values of these organs could probably be due to higher physiological and metabolic activities consequent on increased feed intake of birds on those diets. As shown in the study, *Icacinia manni* meal could replace maize up to 15% in broiler diets without any adverse effect on performance. Increases beyond 15% level resulted in reduced performance and will require further investigations to identify any possible nutritional constraints for optimal utilization of the potential alternative feed substance.

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