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# Performance of Finisher Broiler Chickens Fed Diets Containing Graded Levels of Rumen Digesta Filtrate Fermented Earth Ball (*Icacinia manni*) Meal

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***Authors' contributions***

*This work was carried out in collaboration between both authors. Author OOE designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Author VEA managed the analyses of the study. Author VEA managed the literature searches. Both authors read and approved the final manuscript.*

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## ABSTRACT

This study was designed to evaluate the proximate composition and feeding value of rumen digesta filtrate (RDF) fermented earth ball meal on finisher broilers. The RDF was prepared by weighing 1kg of the fresh rumen digesta into a bucket containing one litre of water, stirred, filtered and incubated for 48 hours. The incubated RDF was used to ferment earth ball which had been previously grated into paste. After fermentation, the RDF and water fermented earth ball meals were sundried and their proximate composition determined. Five broiler finisher diets were formulated, using RDF fermented earth ball meal to replace maize in the control diet at four levels. One hundred and fifty, 28 days old broiler birds were divided into five groups and each assigned to one of the five diets in a completely randomized design and fed for 28 days. Water and RDF fermentation medium increased ($P<0.05$) the crude protein content of the earth ball meal from 3.06% to 7.33 and 5.21%, respectively. The gross energy was reduced to 2.28 kcal/g by water fermentation media, while the crude fibre was reduced by RDF media to 9.64%. Water fermentation reduced the concentration of nitrogen free extract to 51.26%. The ether extract

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digestibility increased significantly from 54.17% in birds on control diet to 68.47% in birds fed 10% RDF earth ball meal diet. The cost of producing a kilogram of control diet (₦132.98) was higher relative to treatment diets (₦115.49- ₦118.86). Birds fed treatment diets had the lowest cost of feed consumption (₦ 14.54 - ₦16.70) relative to those on control diet (₦ 19.22). It was relatively cheaper to produce a kilogram of meat on diet containing 10% RDF fermented earth ball meal. It was concluded that RDF fermented earth ball meal could replace maize at 20% in broiler finisher's diet, during maize scarcity.

*Keywords: Earth ball; fermentation; rumen digesta filtrate; incubation; digestibility.*

## 1. INTRODUCTION

In Nigeria, the most important factor limiting against expansion of poultry industry is the shortage and high cost of feed ingredients, particularly grains [1]. [2] reported that the use of maize in ration formulation is becoming expensive because of scarcity following increasing pressure on it as staple food for human, feed for livestock and industrial raw materials; thus, there is a concomitant increase in the cost of poultry products.

This obviously calls for more research into other non-competitive feed resources. The earth ball could be an alternative choice of raw material for animal nutrition since it is not consumed by man. Earth ball is a shrub with modified tuber root which is mainly carbohydrate and is one out of the thirteen species of earth ball plant [2]. It is an all season evergreen shrub with a well-defined root, stem and leaves. According to [3] the stem arises from an underground tuber and is round in cross section, thin, straight or branched attaining height varying from 1-2m at maturity. The tubers weigh up to 20kg and vary in shape and colour, depending on the soil type and stage of maturity. The earth ball plant is commonly found in wild field, fallow or wasteland and is abundant in the humid tropical regions of Akwa Ibom and Cross River States of Nigeria [4]. The tuber contains some anti-nutritional factors such as hydrogen cyanide, alkaloids, phytate, oxalates and tannins which limit its use as animal feed [5]. Processing methods, such as toasting [6,7] and plain water fermentation [8,3] have been employed in improving the nutritive value of earth ball, allowing for an optimum inclusion level of 15% in broiler diets [3], and 10% in laying birds ration [6]. Low utilization of the earth ball meal by birds, despite the various processing techniques employed by these authors could be attributed to high fibre contents of processed meal. Since monogastric animals, including poultry lacks the capacity to digest fibre, it is imperative to utilize processing methods that would reduce the fibre level in the feedstuff. [9] noted that incubating rumen digesta filtrate anaerobically for 48 hours, increased the population of bacteria, protozoa and fungi, which are known to produce enzymes, capable of degrading fibre and certain anti-nutrients. [9] reported a significant reduction in crude fibre level of rumen digesta filtrate fermented earth ball meal relative to water fermented earth ball meal. There is no information in the literature stating the feeding value of rumen filtrate fermented earth ball meal, hence the need of this research.

### 1.1 Objective of the Study

It is on premise that this study was designed to evaluate the feeding value of rumen digesta filtrate fermented earth ball meal as energy source using finisher broiler chickens.

## 2. MATERIALS AND METHODS

### 2.1 Experimental Site

The chemical analyses and the biological evaluation were conducted at the Department of Animal Science laboratory and Poultry unit at the Teaching and Research farm, University of Calabar- Nigeria, respectively.

### 2.2 Processing of the Experimental Materials

Fresh rumen digesta was obtained, immediately following the slaughter of cattle at Anantigha abattoir in Calabar South Local Government Area of Cross River State, Nigeria and conveyed to the laboratory in an air tight polyethene bag. One kilogram of the fresh rumen digesta was weighed into a bucket and one litre of water added, stirred for 10 minutes, filtered and incubated in a capped plastic bucket at room temperature (23-24°C) for 48 hours.

The earth ball roots, harvested from the wild of Ikot Nakanda, Akpabuyo Local Government Area, Cross River State, were peeled, washed in clean water, grated and packed into two (2) capped plastic buckets. The cultured rumen digesta filtrate was added to the earth ball meal in the first bucket, while small amount of water was added to the earth ball meal in the second plastic bucket, mixed thoroughly and allowed to ferment at 24°C for 48 hours. The fermented and raw samples of earth ball meals were packed into jute bags, pressed using stone to drain out water and sun dried to moisture level of 12%. The sun dried samples were stored in an air tight plastic containers prior to proximate analysis.

**Fig. 1. Earth ball root**

### 2.3 Proximate Analysis of the Processed Earth Ball Meals

The proximate analysis of the raw, rumen digesta filtrate and plain water fermented earth ball meals were carried out at the Department of Animal Science Laboratory, University of Calabar, using the method described by [10]. The fractions determined were %Crude protein, %Crude fibre, %Ether extract, while Nitrogen free extract was determined by a difference. The gross energy contents of the two samples were equally determined using Gallenkamp ballistic bomb calorimeter.

### 2.4 Experimental Diets

Five (5) isocaloric broiler finisher diets were formulated to supply between 19.6% and 20.27% of crude protein and 3,000 kcal/kg of metabolizable energy. The control diet (1) contained 100% of maize as main energy source, while diets 2, 3, 4 and 5 had maize replaced by RDF fermented earth ball meal at 10, 20, 30, and 40%, respectively. Palm oil was used to balance the energy differences at 0.50, 1.25, 2.00, 2.75 and 3.50% for diets 1, 2, 3, 4 and 5, respectively.

### 2.5 Experimental Birds and Management

One hundred and fifty, 28 days old broiler chickens (Abor acre breed) were purchased from Agritech hatchery in Ibadan, Nigeria for the experiment. The birds were divided into five groups on weight equalization basis with thirty (30) birds per group. Groups were further divided into three replicates of ten (10) birds and assigned to one of the five experimental diets described earlier, in a completely randomized design. The birds were provided with feeds and water *ad libitum* with necessary vaccinations and medications administered appropriately throughout the experimental period of 28 days.

### 2.6 Data Collection

The average daily feed intake per bird was obtained by weighing feed offered and the left over, 24 hours-post feeding and the difference divided by the number of birds.

The body weight was taken weekly and the value divided by the number of birds per replicate to obtain the average daily weight per bird per replicate. The difference in weight at the beginning and at the end of each week gave the average weekly body weight gain.

Feed conversion ratio was obtained by dividing the average daily feed intake per bird by the average daily weight gain.

Feed digestibility was carried out by selecting four (4) birds from each treatment and placed on individual metabolic cages and fed with 120g of experimental diet per day for five days. The corresponding faecal droppings from the feed consumption were collected on treatment basis, dried in an oven at 60°C for 72 h, bulked and milled to obtain representative samples for chemical analyses. Laboratory analysis of the experimental diets and the faecal droppings were carried out. The crude protein, ether extract, nitrogen free extract and gross energy of the feeds and faecal droppings of birds from each treatment were determined and values used in calculating Apparent nutrient retention as follows:

Apparent nutrient digestibility (%) = (Quantity of nutrient in feed consumed - Quantity of nutrient in faeces voided / Quantity of nutrient in feed consumed) x (100 / 1)

## 2.7 Data Analysis

Data generated were subjected to analysis of variance (ANOVA) as outlined by [11] based on completely randomized design (CRD). Where ANOVA detected significant treatment effects, means were compared using the New Duncan's Multiple Range Test (NDMRT) as outlined by [12].

# 3. RESULTS AND DISCUSSION

## 3.1 Proximate Composition of Earth Ball (*Icacinia manni)* Meal

The results of the proximate composition of the raw and fermented earth ball meals are shown in Table 2.

Fermentation process increased (P= .05) the protein content of the raw earth ball meal from 3.06% to 5.69% and 7.73% for water and rumen digesta filtrate (RDF) methods, respectively. The RDF method caused a significant reduction in the crude fibre content of the earth ball relative to the water fermented method. The two fermentation methods reduced the gross energy content of the earth ball with the highest reduction observed in the water fermented sample. The RDF method significantly reduced the ether extract of the raw earth ball meal from 3.90% to 1.12% whereas, water fermentation method increased the concentration of ash but reduced that of nitrogen free extract significantly.

The increase in the crude protein content of the RDF fermented earth ball meal may be attributed to increase in the microbial activities of the rumen digesta filtrate. The microbes fed on the earth ball and converted the poor quality protein to high protein quality [13,9]. [14,15] reported the potentials of bacterial fermenters as

**Table 1. Ingredient composition of experimental diets**

| | Levels of earth ball meal | | | | |
|---|---|---|---|---|---|
| **Ingredients** | **0%** | **10%** | **20%** | **30%** | **40%** |
| Maize | 61.34 | 55.21 | 49.08 | 42.95 | 36.82 |
| Earth ball meal | - | 6.13 | 12.26 | 18.39 | 24.52 |
| Soybean meal | 28.86 | 28.86 | 28.86 | 28.86 | 28.86 |
| Fish meal | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 |
| Wheat offal | 5.00 | 5.00 | 5.00 | 5.00 | 5.00 |
| Bone meal | 2.50 | 2.50 | 2.50 | 2.50 | 2.50 |
| DL-Methionine | 0.10 | 0.10 | 0.10 | 0.10 | 0.10 |
| L-Lysine | 0.10 | 0.10 | 0.10 | 0.10 | 0.10 |
| *Vitamin premix | 0.30 | 0.30 | 0.30 | 0.30 | 0.30 |
| Salt | 0.30 | 0.30 | 0.30 | 0.30 | 0.30 |
| **Total** | **100** | **100** | **100** | **100** | **100** |
| **Analysis** | | | | | |
| Crude Protein (%) | 20.27 | 20.19 | 20.11 | 20.04 | 19.96 |
| Crude fibre (%) | 3.56 | 4.03 | 4.5 | 4.95 | 5.49 |
| Metabolizable energy (kcal/(g) | 3000 | 3.000 | 3.000 | 3.000 | 3.000 |

**Vitamin/mineral premix containing the following per kg. Vitamin A 8,000000 I.U; Vitamin D3 1,600000 IU; Vitamin E 5,000 IU; Vitamin K 2,000 mg; Thiamine 1,500 mg; Riboflavin B2 4,000 mg; Pyridoxine B6, 1,500mg; anti-oxidant 125 g; Niacin1,500 mg; Vitamin B12 10 mg; Pantothenic acids 5,000 mg; Folic acid 500 mg; Biotin 20 mg; Choline chloride 200 g, manganese 80 g; Zinc 50 g; 1 ron 20 g; copper 5 g; Iodine 1.2 g; Selenium 200 mg; Cobalt 200 mg*

**Table 2. Chemical composition of earth ball**

| **Parameters** | **Raw earth ball meal** | **RDF fermented earth ball meal** | **PW fermented earth ball meal** | **±SEM** |
|---|---|---|---|---|
| Dry Matter (%) | $97.00^{a}$ | $91.20^{b}$ | $83.32^{c}$ | 3.96 |
| Crude Protein (%) | $3.06^{c}$ | $7.73^{a}$ | $5.71^{b}$ | 1.35 |
| Crude Fibre (%) | $15.90^{a}$ | $9.64^{c}$ | $12.36^{b}$ | 1.81 |
| Ether extract (%) | $3.90^{a}$ | $1.12^{b}$ | $3.61^{a}$ | 0.88 |
| Ash (%) | $1.50^{c}$ | $5.91^{b}$ | $10.38^{a}$ | 2.56 |
| NFE (%) | $75.64^{a}$ | $66.80^{b}$ | $51.26^{c}$ | 7.13 |
| Gross Energy (kcal/g) | $3.12^{a}$ | $2.75^{b}$ | $2.28^{c}$ | 0.24 |

*Means of the same row with different superscript are significantly different (p<0.05)* a means of improving nutritive value of feed resources. [3,16] noted an improvement in the nutritive value of water fermented earth ball meal.

Significant reduction in crude fibre content of the fermented earth ball meals suggest the role of microbes in dietary fibre degradation. Microbes have the capacity to colonize, degrade and ferment structural carbohydrate to provide volatile fatty acid for animals [17]. The reduction in the level of ether extract could be attributed to the fact that microbes converts the ether extract to energy for use during fermentation process. The decrease in gross energy on water and RDF fermented earth ball meals as compared to raw earth ball meal, with the gross energy value of 3.12 kg/g may be due to the increase in microbial amylase activity. [18] noted a sharp decrease in glucose and carbohydrate content of pearl millet after 24 hours fermentation and attribute it to utilization of glucose by the microorganisms. The report of this author agreed with the findings of this research.

Ash content was least in the raw earth ball meal but increased with water and rumen digesta filtrate fermentations.

### 3.2 Performance of Broiler Chickens Fed Diets with Varying Levels of RDF Fermented Earth Ball Meal

The result of the average daily weight gain of birds fed diets containing varying levels of RDF fermented earth ball meal are presented in Table 3.

There were no variation (P=.05) in the average daily weight gain among the treatment groups. It was however observed that the average daily weight gain decreased with increasing dietary level of the RDF fermented earth ball meal. High fibre content of the test ingredient, relative to maize may have contributed to a decrease in the weight gain of birds fed test diets. The trend observed in this work is in line with the findings of [3,7].The two authors reported a decline in weight gain of broiler birds with increasing dietary levels of processed earth ball meal.

The average daily feed intake (Table 3) showed no significant difference between birds fed control diet and those fed diets with different levels of earth ball meal. Average daily feed intake was observed to reduce as the level of earth ball meal kept on increasing in the diets. According to [19] factors, such as feed quality (freshness, palatability, and mould), animal factors and environmental factors have influence on feed intake of birds. Nutrient imbalance can also influence feed intake by reducing the activity of microbes in the gastrointestinal tract. High concentration of dietary energy and fibre can as well depress feed intake due to energy density and bulkiness of the feed. The above characteristics were observed in the experimental diet containing 40% RDF fermented earth ball meal, having 5.49% as a crude fibre content. [3,7] reported a reduction in the average daily feed intake of broiler birds with elevated level of water fermented and toasted earth ball meals, respectively.

The feed conversion ratio (Table 3) showed that birds fed control diet and those on diets containing different levels of earth ball meal had similar feed conversion ratio (FCR) values. The result implies that birds on treatment diets were able to convert their feed into muscular tissues as those fed control diet. [20] reported a FCR of 2.56 with a range of 1.91-3.49 at 53 days, yielding 2.18 kg live weight for broiler birds raised under tropical region, depending on the level of management, feeding and housing conditions. The FCR of 3.18 recorded in birds fed diet containing 20% RDF fermented earth ball meal was within the range reported by this author. [16,7] reported an increase in FCR values in birds with an increase in the dietary inclusion of moist heat treated and toasted earth ball meal.

There was no mortality among birds fed the treatment diets, implying that the RDF earth ball meal did not contain any substance that could impact negatively on the animal survivability.

### 3.3 Apparent Nutrient Digestibility

The result of apparent nutrient digestibility presented in Table 4 revealed that broiler birds fed RDF fermented earth ball meal diets had significantly (P = .05) higher ether extract digestibility than those fed control diet. The result suggest that the levels of dietary inclusion of RDF fermented earth ball meal did not influenced the rate of ether extract digestibility by birds. For instance, 68% of the ether extract digestibility recorded for birds on 10 % RDF fermented earth ball meal diet was not statistically different from those on diets containing, 20%, 30% and 40%, RDF fermented earth ball meals, respectively. [21] reported a decrease in ether extract digestibility in broiler birds fed cassava root-leaf meal. According to [22], the age of birds and the dietary fat sources can affect ether extract digestibility. [23] observed that dietary fat could increase the energy content of feed, improve the absorption of fat soluble vitamin as well as reduce the passage rate of the digesta through the gastrointestinal tract, thereby allowing for better nutrient digestion absorption and utilization. It is also established that unsaturated fats are better utilized leading to a higher metabolizable energy than saturated fats.

The results of nitrogen free extract (NFE) and the gross energy digestibility showed no significant difference among the treatment groups. Similarities in the gross energy digestibility between birds fed control and treatment diets indicate that birds on treatment diets were efficient in utilizing the energy of earth ball meal as those fed maize based diet.

### 3.4 Cost Implication of Feeding Graded Levels of RDF Fermented Earth Ball Meal Diets to Broiler Chickens at Finisher Phase

Table 5 show the cost implication of feeding graded levels of RDF fermented earth ball meal diets to broiler chickens at finisher phase.

The cost of feed production varied significantly (P = .05), with the cost of producing a kilogram of control diet being the highest. The cost of feed production reduced significantly with increasing level of RDF fermented earth ball meal in the diets. The cost of producing diets with 30% and 40% earth ball meal were observed to be similar. The result obtained from this work was in agreement with the reports of [24,25,26]. The authors observed a reduction in the cost of feed production, due to the inclusion of non-

**Table 3. Performance of broiler birds fed earth ball meal diets at finisher phase**

| | Levels of earth ball meal | | | | | |
|---|---|---|---|---|---|---|
| **Parameters** | **0%** | **10%** | **20%** | **30%** | **40%** | **±SEM** |
| Initial weight/bird(g) | 999.33 | 998.00 | 990.00 | 1000.00 | 996.67 | 1.77 |
| Final body weight/bird(g) | 2300.00 | 2270.00 | 2180.00 | 1980.00 | 1930.00 | 74.80 |
| Average daily weight gain/bird(g) | 46.67 | 45.43 | 42.50 | 35.00 | 33.32 | 19.76 |
| Average daily feed intake/bird(g) | 144.52 | 140.74 | 135.03 | 130.48 | 125.93 | 0.96 |
| Feed conversion ratio | 3.10 | 3.10 | 3.18 | 3.73 | 3.78 | 0.15 |
| Mortality (%) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **±SEM** – Standard error of mean | | | | | | |

*RDF – Rumen digesta filtrate, PWF – Plain water, SEM – Standard error of mean*

**Table 4. Apparent nutrient retention of broiler chickens fed RDF fermented earth ball meal diets**

| | Levels of earth ball meal | | | | | |
|---|---|---|---|---|---|---|
| **Parameters** | **0%** | **10%** | **20%** | **30%** | **40%** | **±SEM** |
| Crude Protein (%) | 49.38 | 49.28 | 47.44 | 44.86 | 42.28 | 1.37 |
| Ether Extract (%) | $54.17^{b}$ | $68.47^{a}$ | $62.37^{ab}$ | $67.55^{a}$ | $67.91^{a}$ | 2.71 |
| Nitrogen Free Extract (%) | 18.77 | 16.90 | 18.34 | 18.07 | 18.75 | 0.34 |
| Gross Energy (%) | 29.62 | 29.75 | 30.91 | 31.59 | 32.75 | 0.59 |

*Means of the same row with different superscript are significantly different (p<0.05)*
*SEM – Standard error of mean*

**Table 5. Cost implication of feeding graded levels of RDF fermented earth ball meal diets to broiler chickens at finisher phase**

| | Levels of earth ball meal | | | | | |
|---|---|---|---|---|---|---|
| **Parameters** | **0%** | **10%** | **20%** | **30%** | **40%** | **±SEM** |
| Cost of feed (₦ /kg) | $132.98^{a}$ | $118.68^{b}$ | $117.74^{b}$ | $116.6^{c}$ | $115.49^{c}$ | 2.63 |
| Daily cost of feed consumed/bird (₦) | $19.22^{a}$ | $16.70^{b}$ | $15.90^{b}$ | $15.21^{b}$ | $14.54^{c}$ | 0.73 |
| Cost/kg weight gain (₦) | $411.83^{b}$ | $367.60^{c}$ | $405.43^{b}$ | $434.57^{a}$ | $436.37^{a}$ | 12.56 |

*Means of the same row with different superscript are significantly different (p<0.05)*
*SEM – Standard error of mean*

conventional energy sources in broiler birds' diets. Non-conventional energy feed resources have been considered as the cheapest energy source in complementing the most expensive and scarce conventional sources like maize, millet and sorghum.

The replacement of maize with RDF fermented earth ball in the broiler finisher's diet as energy source reduced ($P<0.05$) the cost of daily feed consumption per bird from ₦19.22 in the control diet to ₦14.54, ₦16.70, ₦15.90 and ₦15.21, respectively for 10, 20 and 30% and 40% RDF fermented earth ball meal diets.

The cost of producing a kilogram of meat was least on diet containing 10% RDF fermented earth ball meal and highest on diet with 40% RDF fermented earth ball meal. The cost of producing a kilogram of poultry meat with control diet (₦436.37) was statistically similar to that of producing a kilogram of poultry meat on diet with 20% RDF fermented earth ball meal. The implication here is that during the period of scarcity, maize can be replaced by 20% of RDF fermented earth ball meal in broiler finishers' diet.

## 4. CONCLUSION

From the result of this study, it was concluded that during maize scarcity, RDF fermented earth ball meal could replace maize at 20% in broiler finisher's diet.

Further research, involving the use of exogenous enzyme to improve on the digestibility of fermented earth ball meal is recommended.

## COMPETING INTERESTS

Authors have declared that no competing interests exist.

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