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# Nutritional Evaluation of *Digitaria iburua* (Black Acha) grains as feed resource in the diet of Broiler Chickens

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***Target Audience**:* Poultry Farmers, Animal Scientists, Poultry Nutritionists, Cereal Researchers

## Abstract

*Feeding trial was carried out to investigate the nutritional value of black acha (Digitaria iburua) grains as feed resource using 240 day old Ross-360 broiler chicks. Four dietary treatments of sixty birds per treatment were randomly allotted to diets composed of unpolished whole black acha (UWBA), polished whole black acha (PWBA), unpolished milled black acha (UMBA) and polished milled black acha (PMBA) grains. At the end of eight weeks, feacal samples and tissues from some organs were collected and analyzed for nutrient digestibility and histopathology parameters respectively. Chemical analysis was also carried out for the different forms of black acha grains. Carcass characteristics were determined. Birds fed PMBA grains had best feed intake, weight gain, FCR. The economics of production showed no significant (P>0.05) difference across the treatments. Nutrient digestibility of birds fed PMBA diet showed significant (P<0.05) difference for all the digestibility parameters. The duodenum, gizzard and liver showed normal histological appearance. The dressed weight showed significant (P<0.05) difference with birds fed PMBA diet weighing more than the other treatments. It could be concluded that PMBA diet can be used in the diets of broiler chickens without adverse effect on performance and health status of the birds.*

***Keywords:*** *Digitaria iburua*, black acha, broiler, performance, digestibility, histology, carcass characteristics.

## Description of Problem

The exorbitant cost of commonly available feedstuffs makes the final feed mixtures to be expensive and unaffordable by poor farmers. This has been a challenge to the livestock industry in Nigeria (1, 2, and 3). Grains account for more than 50 percent in poultry diets, with maize being the most popularly utilized source of energy. The interest in search for alternative feed resources is of paramount importance, mainly because of the global demand for maize, which has exceeded production (4).

The high cost of maize has warranted questions on its continuous incorporation in poultry diets. Moreover, competition for its use in human foods and industrial fuel production limits its use for animal feeds. This has necessitated research into non-conventional energy supplying ingredients that would replace maize without compromising performance and profitability. One of such lesser known feed resources is acha. Research indicates that feeding whole grains can improve starch digestibility (5) and is not detrimental to feed utilization by chicken when fed at low levels (5, 6).

In order to meet the food security goal of providing adequate and affordable food for the people at all times, recent research focus is geared towards the exploitation of locally available , nutritional viable, under-utilized and easy to cultivate feedstuffs which have the highly needed dietary resources that can replace or complement conventional feed ingredients in broiler feeds.

Black Acha (*Digitaria iburua*) is a grain usually abundant in Nigeria, under-utilized and cheaper than maize. *Digitaria iburua* is a member of the family *graminae* and the tribe *Poaceae*. It resembles the wild *Digitaria longiflora* (7) and grows under different soil types suitable for rice production (8). Acha is an annual cereal crop indigenous to West Africa and is cultivated across the savannah.

Black acha can be cultivated anywhere in Nigeria as it grows under varying conditions from poor dry upland soils to hydromorphic valleys suitable for rice production. It has a unique ability to tolerate poor and marginal soils and can withstand drought (9). Large acha production for human consumption is however limited by the drudgery in post-harvest handling especially polishing of the small grains. This tends to become an advantage to exploit the production of the crop as a livestock feed.

It is widely grown in Nigeria in Plateau, parts of Bauchi, Kebbi, Taraba, Kaduna and Niger States. Annually, farmers earmark about 300,000 ha to acha cultivation and yields of 600-700 kg/ ha has been recorded which translates to 180,000- 210,000 tonnes of grains annually (10). Acha is a grain with low toxicity as it contains low amount of anti nutrients (tannins - 0.13mg/100g, phytate - 1.22mg/100g, trypsin inhibitor - 38.45mg/100g, oxalate – 1.14 mg/100g and cyanides - 0.07mg/100g) (11, 12).

The major constituents of cereals are the carbohydrates and proteins. Acha is the most nutritious cereals and a good source of cysteine and methionine, which are important to the health of humans and growth of poultry which are not readily found in most cereals. Black acha has high protein content (8.75%) and is found to be rich in leucine, valine and methionine, and the grain has been regarded as best nutritious and testing of all grains (13). There is not much literature on the energy value of black acha grains, though (14) reported that black acha grains contain 19400KJ/kg.

Although few studies on acha production have shown increasing importance of the crop amidst growing utilization as food, (15) highlights the need for more scientific investigation on acha grains. Significant part of literature has focused on land productivity, production forecast, adaptability, evaluation and chemical composition, medicinal and nutritional effects, the area of acha grain utilization as feed for livestock were not considered. It is on the basis of this, therefore, that this research was undertaken to evaluate the feeding potentials and the impacts of either polished whole, unpolished whole, polished milled and unpolished milled black acha grains in broiler chicken diets. This research effort will ultimately result to improve availability of poultry feed, reduce cost of production, increase both efficiency and productivity of broiler chickens and above all increase protein intake among the populace.

## Materials and Methods

### Experimental site

The experiment was conducted at the Poultry Unit of the Teaching and Research Farm, University of Calabar, Calabar, Cross River State, Nigeria. Calabar is located at latitude $4^057^{'}$N and longitude $8^020^{'}$E with an elevation of 38m above sea level (16). It has an annual rainfall of 3000 - 35000mn and relative humidity of 70 – 80 percent with average daily temperature of $25^0$C - $35^0$C (17).

**Collection of the test ingredient**

The polished and unpolished black acha grains used for this study were bought from the Jos Central Market in Jos Plateau State. The unpolished black acha grains were manually cleaned by hand picking of the chaffs. The polished and unpolished black acha grains were then shared into two bags each and one bag each of the polished and unpolished black acha grains were milled and stored in a bag for used in the feed formulation.

**Experimental diets**

Four experimental broiler diets for starter and finisher phases (Tables 1 and 2) respectively were formulated using Unpolished Whole Black Acha (UWBA), Polished Whole Black Acha (PWBA), Unpolished Milled Black Acha (UMBA) and Polished Milled Black Acha (PMBA) as Treatments 1 - 4 respectively in line with (18) nutrient requirements of broiler chicks.

**Experimental birds, design and management**

A total of two hundred and forty (240) day-old *Ross-380* broiler chicks purchased from Crown Hatcheries Entreprises, Issele-Uku, Delta State were used for this experiment. The birds were randomly weighed, divided and allotted to four dietary treatments with sixty birds per treatment. Each treatment was sub-divided into three replicates with twenty birds per replicate.

The experimental birds/treatments were arranged in a completely randomized design. Experimental diets and water were provided *ad-libitum* for the birds throughout the experiment that lasted for 56 days. The birds were raised in a deep litter system with wood shavings as the litter material. Vaccination and medication programs were carried out accordingly and other management practices were provided.

**Data collection**

Data were collected on feed intake and weekly body weight changes while weight gain and feed to body gain ratio were estimated. At the end of the feeding trial (8 weeks), a 7- day digestibility trial was conducted. Two birds per replicate of almost the same weight across the treatment groups were randomly selected and transferred to metabolic cage, allowed to acclimatize to the new environment for four days before their feacals were collected daily for 3 days. The feacal samples were oven dried at $80^0$C, weighed and kept in airtight container for analysis. At the $56^{th}$ day, twelve birds per dietary treatment with mean weight equal or close to the treatment mean weight were randomly selected and sacrificed by severing the carotid arteries followed by exsanguinations after 12 hours feed withdrawal. The carcasses were allowed to bleed freely for 5 minutes, dry de-feathered and then re-weighed to obtain de-feathered weight. They were then decapitated, eviscerated and weighed to obtain the carcass weights. The carcass was subsequently dissected into various primal cuts -breast, wing, thigh, drumstick and shank and expressed as percentage of live weight according to (19) procedure.

The histological studies on the liver, gizzard and duodenum were carried out at the Anatomy Diagnostic Laboratory of the University of Calabar Teaching Hospital (UCTH), Calabar. The excised organs were placed in 10% of formalin and cut sections of the different tissues were collected and placed in tissue cassette and dehydrated in ascending grades (70%, 90% and 100%) of alcohol for 2hours each, four changes of absolute alcohol for ihour to ensure proper dehydration and dealcoholized in three changes of xylene for 15minutes each. The tissues were then embedded into two changes of molten paraffin wax for 10minutes each. The sections of the

organs were trimmed using rotary microtone at 5µ and later stained using Hematoxylin and Eosin method. Drying and mounting was done using dibutyl phthalate polyesterone xylene and the slides were viewed at x10 and x40 objective.

**Statistical Analysis**

Data obtained in this study were subjected to analysis of variance procedures (20) and significant means were separated using the Duncan's Multiple Range Test (DMRT).

**Chemical Analysis**

The test ingredient and experimental diets were analyzed for proximate composition according to (20). Metabolizable energy (ME) was calculated using the formula ME (Kcal/kg) = 37 x %CP + 81 x %EE + 35.5 x % NFE. Where CP = crude protein, EE = ether extract and NFE = nitrogen free extract (21).

## Results and Discussion

The result of the proximate analysis of the different forms of black acha grains showed that PMBA has the highest CP and ME content of 9.13% and 3290.00Kcal/kg respectively (Table 3). The CP value was the same as maize (9.00%) as reported by (22) and (23). The CP values obtained in this study are comparable to values 8.75%, 8.05% and 8.02% as reported by (24, 25 and 26) respectively. This indicates that black acha is a good source of plant protein as it can meet the required range of protein necessary for broiler chickens. The ME values obtained were comparable to values of 3288.00Kcal/kg for guinea corn (27) and 3300.00Kcal/kg for maize (22) but higher than 2560.00Kcal/kg for millet (27) and 2650.00kcal/kg for sorghum (28). The performance characteristics of starter broiler chickens fed different forms of black acha diets are shown on Table 4. Broiler starters fed PMBA diets had the highest final body weight, weight gain and the best feed conversion ratio. The same performance was recorded for finisher broilers fed different forms of black acha diets (Table 5). Birds fed PMBA had the lowest feed intake but highest final body weight, weight gain and best feed conversion ratio. The final body weight gain recorded significant ($P<0.05$) differences between treatments with range values of 2194.00 - 2729.00g. These values were higher than range values of 2251.80 – 2472.10g and 2185.00 - 2372.00g documented by (29, 30). The feed conversion ratio was significantly affected by the treatments with range values of 2.68 – 2.33. The result showed PMBA as the best diet since the birds were able to convert the feed into muscles. The range value in this study was similar to range values of 2.79 – 4.83 and 2.49 – 3.38 as reported by (31, 32). The high value for final body weight observed from both starter and finisher broilers fed PMBA diets indicated that black acha has a good potential as feed resource in broiler diets.

The carcass characteristics of broiler birds fed different forms of black acha diets showed significant ($P < 0.05$) difference in the live weight and dressed weight with birds fed PMBA weighing 2650.00g and 2012.00g respectively (Table 6). The values obtained in this study (2133.00 - 2650.00g) were higher than values of 1900.00 - 2350.00g and 1750.00 - 2220.00g reported by (30, 32). The percent live weight of carcass cut-up parts showed no significant ($P > 0.05$) difference for the breast, wings, thigh, drumstick and shank.

The results of nutrient digestibility study (Table 7) showed that all the parameters were significantly influenced by the dietary treatments with PMBA having the highest values. This showed that PMBA diets were more digestible than the other diets. On the other hand, UWBA showed low values for all the digestibility parameters. The decrease in nutrient digestibility and the observed increase feed conversion ratio of UWBA diets may be

attributed to the fact that since black acha is not polished, it may have obstructed nutrient absorption and complete utilization of the diets. (33) reported that hazardous residues in the diet of any livestock species may have negative effects such as reduction in palatability, digestibility and utilization of ration.

Plates 1 – 3 showed the histopathology of the duodenum, gizzard and liver of broiler chickens fed different forms of black acha diets. The duodenum of broiler chickens fed UWBA and PWBA (Plates 1a and 1b) showed normal appearance of the duodenum mucosa. The architecture patterns of the section were maintained with no noticeable distortion. There was no noticeable colonic perforation and degradation of the intestinal lining. The lamina muscularis of the gizzard tissue had normal thin lining that was not thickened across the treatment groups (Plates 2a - b). Liver section of birds fed different forms of black acha diets (Plates 3a - d) showed liver tissue with normal appearance of the central vein, the sinusoids and hepatocytes. This result has shown that the use of black acha grains in broiler diets does not have deleterious effect and rather high nutritional potentials as alternative energy source.

**Conclusion and Applications**

This study revealed that:

i. Polished milled black acha has high nutritional potentials and could serve as alternative energy source; and
ii. There is need for aggressive cultivation of acha grains across all the zones of the country so as to make the crop readily available;

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**Table 1: Percentage composition of experimental diets for broiler starters**

| Ingredients (%) | UWBA | PWBA | UMBA | PMBA |
|---|---|---|---|---|
| Black acha | 54.00 | 54.00 | 54.00 | 54.00 |
| Soybean meal | 34.00 | 34.00 | 34.00 | 34.00 |
| Fish meal | 4.00 | 4.00 | 4.00 | 4.00 |
| Wheat offal | 5.00 | 5.00 | 5.00 | 5.00 |
| Bone meal | 2.00 | 2.00 | 2.00 | 2.00 |
| Salt | 0.30 | 0.30 | 0.30 | 0.30 |
| Vit-Min Premix * | 0.50 | 0.50 | 0.50 | 0.50 |
| Methionine | 0.10 | 0.10 | 0.10 | 0.10 |
| Lysine | 0.10 | 0.10 | 0.10 | 0.10 |
| **Total** | **100.00** | **100.00** | **100.00** | **100.00** |
| **Calculated values** | | | | |
| Cost per kg (₦kg$^{-1}$) | 306.08 | 318.80 | 341.44 | 354.16 |
| Crude protein (%) | 23.03 | 24.05 | 23.43 | 24.13 |
| ME (Kcal/kg) | 2966.20 | 3125.09 | 3001.05 | 3212.77 |
| **Analyzed values** | | | | |
| Crude protein (%) | 22.98 | 22.91 | 23.01 | 23.34 |
| ME (Kcal/kg) | 2860.30 | 3040.10 | 3009.70 | 3102.00 |

Vitamin - mineral premix; *Bio-Super Premix provided: "vitamin A, 1,500,000IU; vitamin $D_3$, 300,000IU; vitamin E, 400mg; vitamin $K_3$, 100mg; vitamin $B_{12}$, 2000mcg; Nicotinamide, 2,000mg; Calcium D-Pantothenate 800mg; Choline Chloride, 40,000mg; Ferrous Sulfate, 2,000mg; Manganese Sulfate, 5,000mg; Copper Sulfate, 80mg; Zinc Oxide, 3,000mg; Cobalt Sulfate, 10mg; Potassium Iodide, 120mg; Magnesium Sulfate, 1,000mg; DL –Methionine, 10,000mg; Antioxidant, 18,000mg".

**Table 2: Percentage composition of experimental diets for broiler finishers**

| Ingredients (%) | UWBA | PWBA | UMBA | PMBA |
|---|---|---|---|---|
| Black acha | 58.00 | 58.00 | 58.00 | 58.00 |
| Soybean meal | 27.00 | 27.00 | 27.00 | 27.00 |
| Fish meal | 3.00 | 3.00 | 3.00 | 3.00 |
| Wheat offal | 9.00 | 9.00 | 9.00 | 9.00 |
| Bone meal | 2.00 | 2.00 | 2.00 | 2.00 |
| Salt | 0.30 | 0.30 | 0.30 | 0.30 |
| Vit-Min Premix * | 0.50 | 0.50 | 0.50 | 0.50 |
| Methionine | 0.10 | 0.10 | 0.10 | 0.10 |
| Lysine | 0.10 | 0.10 | 0.10 | 0.10 |
| **Total** | **100.00** | **100.00** | **100.00** | **100.00** |
| Cost per kg (₦kg$^{-1}$) | 297.03 | 310.70 | 332.39 | 346.06 |
| Crude protein (%) | 20.30 | 20.62 | 20.72 | 21.08 |
| ME (Kcal/kg) | 2857.08 | 3013.10 | 2861.14 | 3030.50 |
| **Analyzed values** | | | | |
| Crude protein (%) | 19.92 | 19.68 | 18.02 | 22.09 |
| ME (Kcal/kg) | 2558.20 | 2960.00 | 2935.90 | 3099.10 |

Vitamin - mineral premix; *Bio-Super Premix provided: "vitamin A, 1,500,000IU; vitamin $D_3$, 300,000IU; vitamin E, 400mg; vitamin $K_3$, 100mg; vitamin $B_{12}$, 2000mcg; Nicotinamide, 2,000mg; Calcium D-Pantothenate 800mg; Choline Chloride, 40,000mg; Ferrous Sulfate, 2,000mg; Manganese Sulfate, 5,000mg; Copper Sulfate, 80mg; Zinc Oxide, 3,000mg; Cobalt Sulfate, 10mg; Potassium Iodide, 120mg; Magnesium Sulfate, 1,000mg; DL –Methionine, 10,000mg; Antioxidant, 18,000mg".

**Table 3: Proximate composition (determined analysis) of different forms of black acha grains (dry matter basis)**

| Parameters (%) | UWBA | PWBA | UMBA | PMBA | Maize* |
|---|---|---|---|---|---|
| Protein | 8.35 | 8.79 | 8.52 | 9.13 | 8.5 |
| Fat | 2.13 | 2.77 | 2.45 | 2.82 | 3.67 |
| Moisture | 6.85 | 7.10 | 8.08 | 8.44 | 11.60 |
| Ash | 1.60 | 1.46 | 2.22 | 2.35 | 2.95 |
| Crude Fibre | 1.75 | 1.85 | 1.89 | 1.32 | 3.10 |
| Gross Energy (Kcal/kg) | 3098.10 | 3105.05 | 3260.20 | 3290.00 | 3432.00** |

*Enyisi *et al*. (2014), **FUNAAB Lab (2015)

**Table 4: Performance characteristics of broiler starter chickens fed different forms of black acha diets**

| Parameters | UWBA | PWBA | UMBA | PMBA | SEM |
|---|---|---|---|---|---|
| Av. initial body weight (g) | 48.33 | 48.33 | 48.33 | 48.33 | 0.00 |
| Av. final body weight (g) | 847.20$^{b}$ | 870.40$^{ab}$ | 893.50$^{ab}$ | 921.30$^{a}$ | 27.07 |
| Av. daily weight gain (g) | 28.74$^{b}$ | 29.36$^{ab}$ | 30.19$^{ab}$ | 31.17$^{a}$ | 0.95 |
| Av. daily feed intake (g) | 43.03$^{a}$ | 33.44$^{b}$ | 35.90$^{a}$ | 32.45$^{b}$ | 0.47 |
| Total feed intake (g) | 1204.70$^{a}$ | 936.40$^{b}$ | 1005.30$^{a}$ | 908.60$^{b}$ | 9.31 |
| FCR | 1.48 | 1.14 | 1.19 | 1.04 | 0.03 |
| Cost/kg feed (₦kg$^{-1}$) | 297.03 | 310.70 | 332.38 | 346.05 | 9.01 |
| Feed cost/kg gain (₦) | 458.20$^{a}$ | 363.70$^{b}$ | 452.40$^{a}$ | 442.20$^{a}$ | 25.14 |

$^{abc}$ means with different superscripts on the same row differ significantly ($P< 0.05$)
FCR= Feed Conversion Ratio

**Table 5: Performance characteristics of broiler finisher chickens fed different forms of black acha diets**

| Parameters | UWBA | PWBA | UMBA | PMBA | SEM |
|---|---|---|---|---|---|
| Av. initial body weight (g) | 847.20$^{b}$ | 870.140$^{ab}$ | 893.50$^{ab}$ | 921.30$^{a}$ | 27.07 |
| Av. final body weight (g) | 2194.00$^{c}$ | 2525.00$^{b}$ | 2420.00$^{b}$ | 2729.00$^{a}$ | 77.00 |
| Av. daily weight gain (g) | 48.10$^{c}$ | 59.10$^{ab}$ | 54.51$^{bc}$ | 64.55$^{a}$ | 15.40 |
| Av. daily feed intake (g) | 194.97$^{b}$ | 178.29$^{a}$ | 182.48$^{a}$ | 172.53$^{b}$ | 2.29 |
| Total feed intake (g) | 5459.00$^{a}$ | 4992.00$^{b}$ | 5109.00$^{b}$ | 4831.00$^{c}$ | 64.10 |
| FCR | 4.06$^{a}$ | 3.04$^{bc}$ | 3.35$^{b}$ | 2.68$^{c}$ | 0.08 |
| Cost/kg feed (₦kg$^{-1}$) | 297.03 | 310.70 | 332.38 | 346.05 | 9.01 |
| Feed cost/kg gain (₦) | 1241.00$^{b}$ | 979.00$^{c}$ | 1380.00$^{a}$ | 1137.00$^{b}$ | 56.20 |

$^{abc}$ means with different superscripts on the same row differ significantly (P< 0.05)

**Table 6: Effects of different forms of black acha diets on carcass characteristics of broiler chickens**

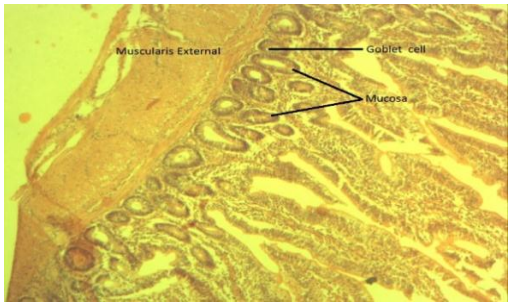
| Parameters (g) | UWBA | PWBA | UMBA | PMBA | SEM |
|---|---|---|---|---|---|
| Live weight | 2133.00$^{c}$ | 2517.00$^{ab}$ | 2375.00$^{b}$ | 2650.00$^{a}$ | 112.90 |
| Dressed weight | 1542.00$^{c}$ | 1908.00$^{ab}$ | 1750.00$^{bc}$ | 2012.00$^{a}$ | 107.70 |
| **Carcass cut-up parts (% live weight)** | | | | | |
| Breast | 23.88 | 26.07 | 25.55 | 26.99 | 1.67 |
| Wings | 8.14 | 8.13 | 8.00 | 8.11 | 0.24 |
| Thigh | 11.19 | 11.60 | 11.03 | 11.93 | 0.43 |
| Drumstick | 10.02 | 9.94 | 10.17 | 10.22 | 0.34 |
| Shank | 3.99 | 4.05 | 3.50 | 3.59 | 0.33 |

$^{abc}$ means with different superscripts on the same row differ significantly (P< 0.05)

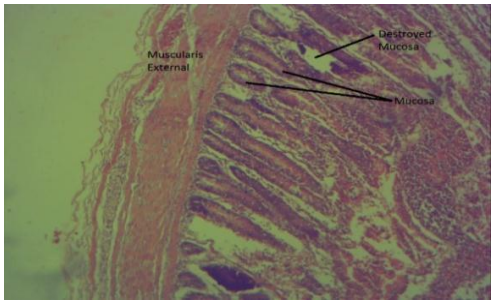
**Table 7: Effects of different forms of black acha diets on apparent nutrient digestibility of broiler chickens**

| Parameters (%) | UWBA | PWBA | UMBA | PMBA | SEM |
|---|---|---|---|---|---|
| Dry matter | 91.54 | 94.50 | 93.55 | 95.56 | 0.18 |
| Crude protein | 89.41$^{b}$ | 92.41$^{ab}$ | 91.44$^{ab}$ | 93.56$^{a}$ | 1.64 |
| Crude Fibre | 79.93$^{a}$ | 79.89$^{a}$ | 76.71$^{b}$ | 78.66$^{a}$ | 0.56 |
| Ash | 87.28$^{bc}$ | 87.67$^{b}$ | 85.53$^{c}$ | 91.00$^{a}$ | 0.85 |
| Ether Extract | 92.32$^{a}$ | 86.93$^{b}$ | 92.52$^{a}$ | 94.19$^{a}$ | 1.84 |

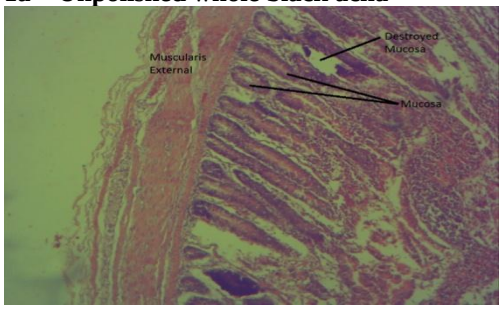
$^{abc}$ means with different superscripts on the same row differ significantly (P< 0.05)



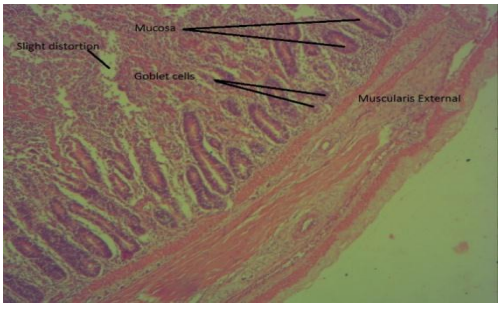

**1a – Unpolished whole black acha**




**1b –Polished whole black acha**

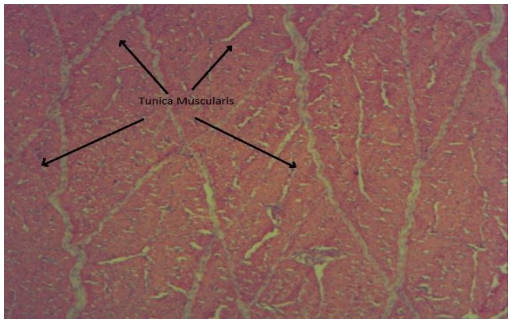



**1c – Unpolished milled black acha**

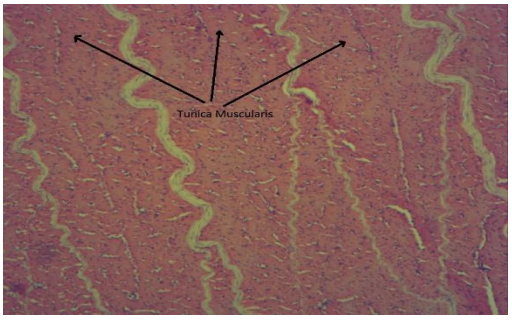



**1d– Polished milled black acha**

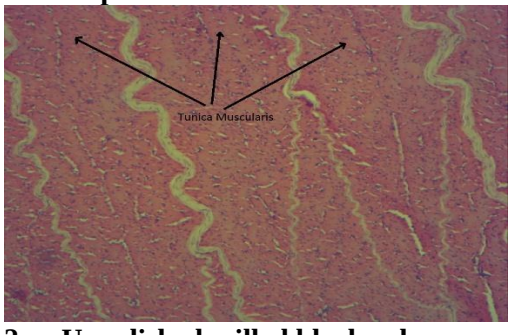
**Plate 1:** Photomicrographs (x 400) of duodenum of broiler chickens fed different forms of black acha diets



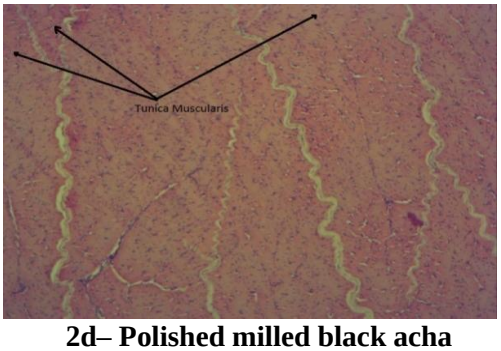

**2a – Unpolished whole black acha**




**2b –Polished whole black acha**

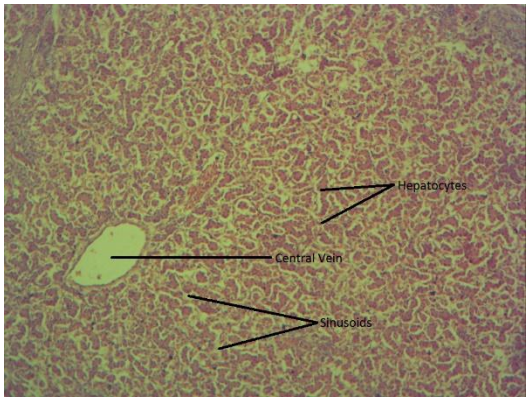



**2c – Unpolished milled black acha**

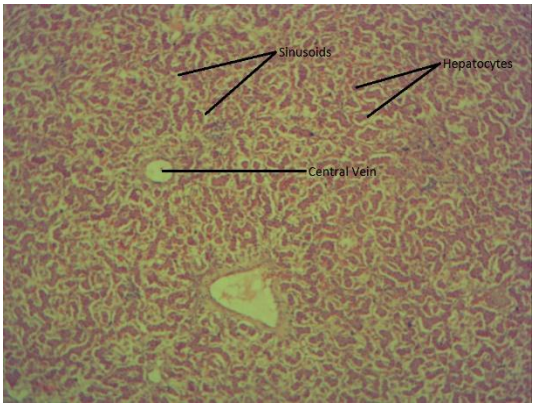



**2d– Polished milled black acha**

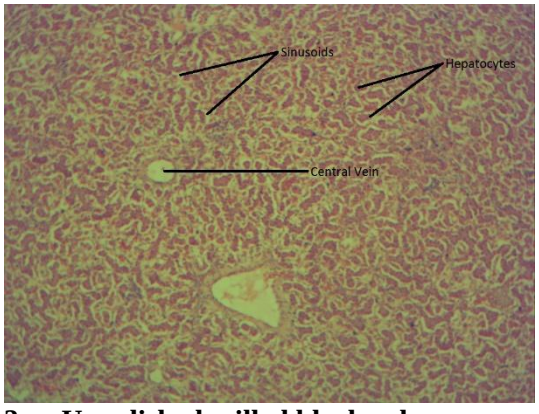
**Plate 2:** Photomicrographs (x 400) of gizzard of broiler chickens fed different forms of black acha diets



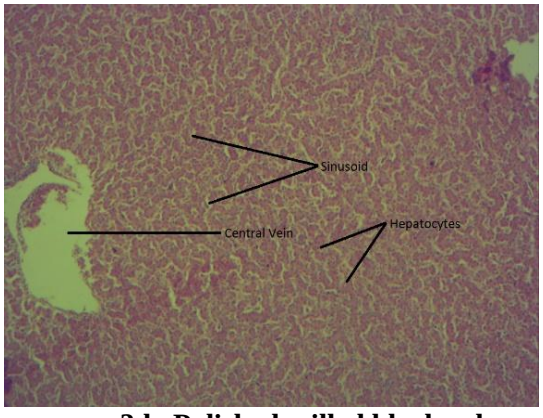

**3a – Unpolished whole black acha**




**3b –Polished whole black acha**




**3c – Unpolished milled black acha**




**3d– Polished milled black acha**

**Plate 3: Photomicrographs (x 400) of liver of broiler chickens fed different forms of black acha diets**

FIG. 1: Acha plant

Source: CIRAD (2006)

FIG. 2: Part of Acha raceme

Source: CIRAD (2006)

FIG.3: Polished whole black acha grains

FIG. 4: Unpolished whole black acha grains