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PERFORMANCE AND CARCASS CHARACTERISTICS OF BROILER CHICKENS FED FORTIFIED-FERMENTED YAM (*Dioscorea alata*) PEEL AS REPLACEMENT FOR ENERGY SOURCE

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ABSTRACT

High cost of feed accounts for about 70% of the production cost in poultry production. Searching for a cheaper and readily available alternative source of energy source will go a long way in reducing the production cost; thereby, increasing the profitability of the business, Therefore, this research focused on Performance and carcass characteristics of broiler chickens fed with fortified-fermented yam (*dioscorea alata*) peel as replacement for energy source with the view of reducing cost of feed. One hundred and sixty-five (165) unsexed Anak broilers were used for the study. The grower broiler chickens (4 weeks old) were randomly allotted to five (5) groups (T1, T2, T3, T4 and T5) with T1 being the control. The birds were fed with diets containing 0, 10, 15, 20 and 25% fortified fermented yam peel meal as a replacement for energy source (Maize). Each group was replicated three times with11 birds per replicate in a completely randomized design (CRD). Feed and water were provided *ad libitum* for the period of five weeks. Results showed a significant difference (p= 0.05) exist among the treatment with respect to body weight gain, feed intake and feed conversion ratio. Mortality was recorded over the period of the trial, particularly in the group with a higher inclusion level. The experimental diets had significant (p= 0.05) effect on the performance and carcass characteristics of the experimental birds. This study revealed that application of fermentation technology on some agricultural waste products (AWPs) can yield products that can replace the costly energy sources (such as maize) and significantly lower the cost of production.However, toxin binders needs to be incorporated to reduce mycotoxins (particularly aflatoxins) concentration in such feed improvised feed.

Keywords: Yam peel, Fortification, Fermentation, Performance, Carcass characteristics

Introduction

In order to avert the imminent protein malnutrition in Nigeria and other developing nations, the problem of animal protein scarcity that has attained a deplorable status, which calls for an urgent remedy has to be given utmost attention (Ekenyem *et al*., 2006). The high cost of conventional ingredients particularly the energy source, used in the formulation of animal feed has made it (animal feed) a major reason for the rising cost in production.(Bamgbose *et al*., 2011).

The poultry sub-sector is the most commercialized of all of Nigeria's agricultural sub-sectors. The livestock sector is vital to the socio-economic development of Nigeria. It contributes about 9-10% of agricultural GDP (FAO, 2016; Alhaji *et al*., 2021). Escalating prices of conventional feed ingredients especially the energy sources such as maize, sorghum and so on, has been attributed to a situation where feeds constitute 70% of the total cost of animal production in Nigeria and other developing nations (Uchewa *et al*., 2014; Afolayan *et al*., 2021). This has brought about the quest for alternative feedstuffs. The generation of different kinds of wastes (solid, liquid or gaseous) on a daily basis is a common feature of farms and food processing industries. These make up a significant proportion (over 30%) of global agricultural and other related industries output (Chinaza, 2020).

Application of inorganic fertilizers, herbicides and pesticides, and adoption of mechanized farming techniques have not only increased yield and positively altered the quality and composition of agricultural outputs, but have also increased the number of agricultural wastes produced annually (Tawakaltu *et al*., 2017). In order to ensure desirable environmental sanitation, proper identification and management of these wastes are very important. Biotransformation of wastes into commercially valuable products is one way by which this can be achieved. Therefore, it is pertinent to devise special efforts to ensure that agricultural and industrial by-products, that are detrimental to man, his animal health, and the environment, are positively utilized by converting them into value-added products (Iyayi and Losel, 2001).

Lignocellulose materials such as yam peels are normally converted into value-added products that have the potential to provide solutions to problems of animal nutrition such as inadequate intake of protein and calories through several processes in which fermentation technology plays a central role. This conversion by fermentation technology will also reduce waste pollution as well increase the quality of animal by-products. Nimgampalle (2019), posited that fermented products contain proteins that can feed both humans and animals thereby replacing expensive conventional sources of protein like fishmeal and soymeal. However, in the application of this technology, it is important to use microorganisms that are generally regarded as safe for fermentation in order to promote its use and safety. Rumem mirobes has for long been employed in traditional fermentation, courtesy its relative safety compared to the soil microbes (Nasseri *et al*., 2011).

Yam (*Dioscorea spp*.) is an important food crop in Africa, the Americas, the Caribbean, South Pacific and Asia.In a paper, entitled: "Status and Prospects of Yam in Nigeria," the expert put the current global production of yam at 73 million metric tonnes. Out of this, it was said that Nigeria accounted for 47 metric tonnes, valued at N57.75 billion annually (Vanguard Newspaper, 8th July, 2021). It is processed into a wide range of products in different parts of Africa and other regions of the world. In tropical Africa, yam flour, Pondo, yam gruel (amala), pounded yam (iyan), fried yam (dundu), fried grated-spiced yam (ojojo) and other products are made from yam resulting in large amounts of yam peels which is very low in protein. Despite the fact that yam peel has been widely employed in feeding ruminant like goats and sheep; also recently pulverised and included in the fish feed, large quantity of it is still either discarded or burnt resulting in pollution of air, land and water.

This research is therefore set to investigate the changes that may occur in the proximate composition of yam peel subjected to anaerobic fermentation and its value as a replacement for maize as an energy source in the feed of broiler chicks.

Materials and Methods

Experimental Site

The research was conducted at the teaching and research farm of federal college of wildlife Management, New- Bussa Niger State. New-Bussa The experimental station (New Bussa) sits at9^{o}53'N ,9.883^{o}N and 4^{o}31'E, 4.517^{o}E(NIPOST Archives, 2009). The researchwork was carried out between the Months ofMay to July (early part of rainy season)

Source of the Yam Peel

About 100 Kg of dried yam peel was collected from volunteer donors in Kpakungu (Minna) and Wawa village (New Bussa) all in Niger State. It was then washed three times to eliminate the dust and minimise fungal contamination as much as possible. It was dried at room temperature and constantly monitored until when the Moisture content was found to be 0.7%. It was then packaged in clean polythene bags until required for use.

Source of Rumen Microbes

Rumen contents were obtained from the freshly slaughtered animals (Cows in particular) at the New Bussa abattoir. The rumen content was diluted with secured distilled water in the ratio of 1: 5 v/v. It was vigorously shaken then filtered through a sieve of pore size 0.5mm. The filtrate was placed into an appropriate container and securely tied and stored in the refrigerator at 4^{o}C until required for use.

Anaerobic Fermentation of the Sample

The sample material (Yam peel) was pulverised using a hammer miller into smaller sizes that can pass through a sieve of pore size of 1.0mm. A twenty-kilogram weight (20Kg)of the sample was then placed into a plastic paint container of 25 L capacity. It was then made into a paste by adding a sufficient quantity of water. To the paste was then added 1 L of the rumen filtrate and thoroughly mixed by stirring with a clean and sterilized stick. More water was further added until it completely becomes submerged and was fortified with 10g urea granules. Thereafter, a relatively large-sized double-folded polythene sheet was used to tightly cover the mouth of the container. It was kept and allowed to ferment anaerobically for a period of seven days.

Experimental birds

One hundred and sixty-five (165) unsexed Anakbroilers were used for the study. Broiler chickens were obtained at day-one age; they were vaccinated for Marek's disease at the hatchery and for Newcastle disease and infectious bronchitis at the test site on the study start day. Water and feed were available for *ad libitum* consumption throughout the experiment.

The birds were grouped into 5 treatments (that is, A – E) with 3 replicates per treatment and 11 birds in each replicate (that is, 3x11x5). The replicates were randomly allotted using the lottery method into fifteen pens under a deep litter system and raised to finisher level.

Experimental diets

Diets were formulated to meet or exceed Nutrient Requirements of Poultry (NRC 1994) values for broiler chickens. A coccidiostat, salinomycin (Sacox, Intervet Inc., Millsboro, DE), was included in all diets at a level of 50 g/ton.

Experimental Design and Data Analysis

One hundred and sixty-five (165) day old broiler chicks were randomly allocated to five groups (A-E). The experimental design adopted for this experiment is a CRD with 5 treatments and 33 replicate. Each bird serves as a replicate

Data pertaining to various parameters obtained during the experiment was analyzed as Completely Randomized Design according to the methods described by Douglas (1994). The significance level was set at P=0.05.

Treatment 1- was the standard control substituted with 0% fermented yam peel as a replacement of energy source.at the finisher stage

Treatment 2-was the standard control substituted with 10% fermented yam peel as a replacement of energy source.at the finisher stage

Treatment3- was the standard control substituted with 20% fermented yam peel as a replacement of energy source.at the finisher stage

Treatment 4- was the standard control substituted with 30% fermented yam peel as a replacement of energy source.at the finisher stage

Treatment 5- was the standard control substituted with 40% fermented yam peel as a replacement of energy source.at the finisher stage

Body weight measurements

Individual body weights were recorded at the beginning of the experiment and further bodyweight increments were recorded at the end of each week to monitor the pattern of body weight changes. Feed and water were supplied *ad-libitum* for about 4 weeks before the commencement of the experiment.

Feed consumption

The daily amount of the supplied diet was weighed and offered to the 11 bird replicate group. The feed consumption in each replicate was recorded weekly by subtracting the weight of residual fed from the total quantity of feed supplied during the respective week.

Feed conversion ratio

The feed conversion ratio (FCR) wasdetermined through the relationship betweenamount of feed consumed (FC) to the body weight gain(BWG) under each group of birds.

$$FCR = \frac{FC(g)}{BWG(g)}$$

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Livability

Mortality in respective group was recorded at occurrence in starter and finisher period.

Results

Fermentation has the deleterious effect of incorporating into the product, some bacterial and fungal toxins that may hamper or grossly retard the overall performance of the animal to which it is fed. Changes in the proximate composition of yam peel, when subjected to the fermentation process, is shown in Table 1.

Table 1: Proximate Composition of the Fermented and Unfermented Yam peel

	FYM	UFYM
%Moisture	3.19 ± 0.23	10.56 ± 0.13
%Ash	3.80 ± 0.26	1.581 ± 0.03
%Crude protein	6.81 ± 0.59	4.60 ± 0.35
%Crude fiber	2.98 ± 0.7	1.513 ± 0.012
%Crude fat	3.04 ± 0.13	0.432 ± 0.09
%Nitrogen free extract	80.35 ± 0.9	80.664 ± 0.20

The values are the mean of triplicate measurements ± Standard deviation (SD).

FYM = Fermented Yam Peel, **UFYM =** Unfermented Yam Peel

The composition of the experimental diet is such that, it ensures the presence of all the nutrients required for the fast and healthy growth of the experimental birds as indicated in Table 2

Table 2 Percentage of Composition of Experimental Diet At Finisher Phase

Ingredient	T1 0% (In Kg)	T2 10 % (In Kg)	T3 15% (In Kg)	T4 20% (In Kg)	T5 25% (In Kg)
Maize	50.2	45.18	42.67	40,16	37.65
Fish Meal	10	10	10	10	10
GNC	6.0	6.0	6.0	6.0	6.0
Soya Beans	20	20	20	20	20
Wheat Offal	9.7	9.7	9.7	9.7	9.7
Bone Meal	3	3	3	3	3
Methionine	0.25	0.25	0.25	0.25	0.25
Lysine	0.25	0.25	0.25	0.25	0.25
Vitamins Premix	0.25	0.25	0.25	0.25	0.25
Salt	0.25	0.25	0.25	0.25	0,25
Powder coccidiostart	0.05	0.05	0.05	0.05	0.05
Growth Enhancer	0.05	0.05	0.05	0.05	0.05
FYP	0.00	5.02	7.53	10.04	12.55

Total	100	100	100	100	100

FYP = Fermented Yam Peel

The ability of the animal to breakdown and efficiently convert the food supplied into a functional protein is usually measured to determine to what extent the component of the feed supplied contributed to the meat formation in the animal in question.. The best performance in all the treatments occurred in T4 with 20% inclusionwhile the least performance with a high FCR value manifests in T2 at 5% inclusion. Treatments 3 and 5 compares favourably with the standard control T1. Table 3

Table 3: Performance of broiler finisher chicken fed diet **containing fortified fermented yam peel as a substitute for energy source**

Parameters	T1	T2	T3	T4	T5	SEM
Mean initial body weight(g)	335.59[a]	275.77[d]	325.78[b]	304.91[c]	303.55[c]	8.51
Mean final body weight(g)	1367.22[c]	949.50[d]	1434.08[b]	1530.13[a]	1370.83[c]	57.78
Mean body weight gain(g)	1036.63[b]	673.80[a]	1108.30[c]	1225.22[d]	1067.28[a]	43.27
Mean feed consumed	1440.9[c]	950.10[a]	1440.80[c]	1531.53[d]	1387.46[b]	57.78
Feed conversion ratio (FCR)	1.39	1.41	1.30	1.25	1.30	

Values on the same row with different superscripts are significantly different (P= 0.05)

In normal organisms, each organ has been determined as to what percentage of the entire weight of the organism it constitutes. Therefore measurement of the individual organ's weight has two-fold perspective: either as to portray the quality of the experimental feed offered through its conversion into a meat product or indicates toxicity induced to a particular organ consequent upon consumption of the same experimental diet.Table4

Table 4: Carcass Analysis of grower broiler fed fortified-fermented yam peel as a substitute for an energy source

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Organs	T1	T2	T3	T4	T5	SEM
Live Weight(kg)	1.60^{b}	1.30^{a}	1.33^{a}	1.40^{ab}	1.40^{ab}	0.43
Slaughter weight(kg)	1.50^{b}	1.25^{a}	1.20^{a}	1.20^{a}	1.30^{a}	0.98
Dressed weight (Kg)	1.27^{a}	1.01^{a}	0.97^{a}	0.95^{a}	1.13^{a}	0.82
Dressing percentage (%)	71.95^{ab}	66.20^{a}	66.25^{a}	79.15^{bc}	82.30^{c}	2.06
Back weight(g)	266.90^{b}	180.60^{a}	174.85^{a}	234.85^{b}	237.45^{b}	10.31
Thigh(g)	179.95^{b}	177.70**a**	145.65^{ab}	140.55^{ab}	139.30^{ab}	7.21
Wing(g)	113.10^{c}	83.80^{a}	78.00^{a}	93.95^{b}	100.50^{b}	3.45
Drum stick(g)	134.10^{c}	95.50^{ab}	88.00^{a}	117.65^{bc}	111.25^{b}	4.90
Breast(g)	255.65^{b}	7.91^{a}	5.54^{a}	2.63^{a}	208.83^{a}	10.89
Neck(g)	93.85^{b}	59.20^{a}	54.65^{a}	64.40^{a}	62.65^{a}	4.02
Liver(g)	43.10^{ab}	41.65^{ab}	30.60^{a}	35.85^{ab}	50.00^{b}	2.49
Heart weight(g)	8.90^{bc}	7.05^{ab}	6.70^{a}	8.05^{ab}	10.25**c**	0.41
Spleen(g)	1.90^{c}	1.50^{bc}	0.85^{a}	1.80^{c}	1.25^{ab}	0.11
Gizzard(g)	63.85^{b}	46.45^{a}	44.80^{a}	48.15^{a}	48.95^{a}	2.50
Intestine weight(g)	90.40^{b}	87.35^{b}	59.90^{a}	93.90^{b}	107.60^{b}	4.85
Head(g)	39.05^{a}	38.40^{a}	34.85^{a}	43.45^{a}	45.00^{a}	1.58
Proventiclus(g)	13.80^{b}	9.20^{ab}	6.65^{a}	11.20^{ab}	12.60^{b}	0.86
Intestinal weight(g)	75.00^{b}	76.00^{b}	62.50^{a}	75.50^{b}	83.00^{b}	2.043

Values on the same row with different superscripts are significantly different (P= 0.05)

Discussion

As it appeared in Table 1, there has been a decrease in moisture content, but, with a concomitant increase in the crude protein, fibre, crude fat and ash contents. These observed increases are of great importance as it clearly reflects the increase in the nutritional quality of the sample material (Christi, 2010). However, as fermentation harbours both harmful and beneficial fungal organisms, such effects are revealed in the carcass characteristics of the sample organisms Table 6 and also on the performance of the experimental birds Table 5.

A high concentration of protein and vitamins (about 200% higher than in the whole plant) has been obtained in a similar work reported by Kazimierz, (2010)). It was also reported that in fermented alfalfa leaf fraction, the content of protein increases from 27 to 32% and that of fibre content rose from 12 to 13%; and also the value of carotene rose from 120 to 150 mg (Wenxiang *et al.*, 2017). Such reports on the positive impact of fermentation on the nutritional content of agricultural by-products are corroborated by this research findings in Table 1

As reflected in Table 3, there is a progressive increase in the amount of feed consumed as the weeks progress, this could be due to initial rejection, and then subsequent acclimatisation to the taste and aroma of the substituted energy source (Akinmutimi and Onen, 2008). As a natural principle, animal's tendency to gain an increase in body size is dependent not solely on the quantity of the feed supplied, but partly due to the quality of the nutrients it is composed of. The ability of the supplied diet to provide nutrients that support body immunity, enhance growth, guarantee the repair of the worn-out tissues, support the strength and development of the body's skeletal and nervous systems and suppress the spread and proliferation of microbial pathogens are what qualifies feed as standard rather than just the quantity supplied (Ekenyem *et al.*, 2006). The growth pattern shown by Table 4 seems to be in tune with the aforementioned attributes of a good feed/diet.

The ability of the animal to breakdown and efficiently convert the food supplied into a functional protein is usually measured to determine to what extent the composition of the feed supplied contributed to the meat formation in the animal in question (Kamal and Abo, 2012) and this has been pictured out in Table 3. Treatments 4, 3, 5 and 1 were observed to display higher weight gain in descending order when compared with the control. Similarly, a similar scenario that played out in weight gain was observed on the pattern of feed consumption.

On the overall note, It suffices to state that, considering the feed conversion ratios values across all the treatments (control inclusive), the performance of the experimental birds has not been encouraging and raises the question of the genetic purity of the breed used and/or effect of environment where the fermentation and the trial was performed.

Conclusion

From the result obtained in this study, it suffice to conclude that, application of local fermentation technology on some agricultural waste products (AWPs) can yield products which can replace the costly energy sources (such as maize) and hence, significantly lower the cost of production. However, considering the unsatisfactory food conversion ratio (FCR) values, toxin binders needs to be incorporated to reduce mycotoxins (particularly aflatoxins) concentration in such improvised feed as a mitigation strategy against the stunted growth and poor FCR.

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