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Dietary Effect of Pepper Fruit (*Dennettia tripetala*) on Nutrient Digestibility and Live Weight of Broiler Chickens

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Abstract

An experiment was conducted to determine the proximate composition of pepperfruit and its dietary effect on growth and apparent nutrient digestibility of broiler chickens. A total of one hundred and fifty day-old Hubbard broiler chicks were randomly assigned to five treatment groups containing thirty chicks each. Each treatment was replicated three times, containing 10 birds per replicate. The experiment was arranged in completely randomized design (CRD). Five diets were formulated to represent the treatments (T1 - T5). Treatment one (T1) was the control diet containing no pepperfruit, while T2, T3, T4 and T5 contained 0.25%, 0.50%, 0.75% and 1.0% pepperfruit respectively. The diets were fed to the birds starting from day old for 28 days (starter phase) and 21 days for finisher phase. The birds were allowed access to feed and water *ad libitum*. Results showed that the pepperfruit contained crude protein 15.76%, ether extract 4.95%, crude fibre 14.87% and ash 4.64%. At the starter phase, live weight, feed intake and protein efficiency ratio were not significantly (P>0.05) improved. At the finisher phase, 0.75% and 1.0% depressed live weight, while 0.25% and 0.50% had similar live weight as the control. Total feed intake was reduced (P<0.05) by pepperfruit at all levels. Feed: gain ratio and protein efficiency ratio were not altered. Digestibility of protein and ether extract was improved. In conclusion, 0.25% pepperfruit could be added to diets for broiler chickens to improve apparent protein and ether extract digestibility

Keywords: Growth; Nutrient digestibility; Pepperfruit; Proximate composition

1. Introduction

Global consumption of poultry products especially poultry meat has consistently increased over the years and this trend is expected to continue [1]. The growth in the poultry industry is having a profound effect on the demand for feed and raw materials for feed production. This is coupled with the fact that the major feed ingredients like maize and soya bean are in high demand for human food. Consequently, prices of feeds and feed ingredients have risen astronomically putting pressure on farmers, feed millers and nutritionists. Another pressure which is more profound is the consumer pressure on demand forpoultry products free from antibiotic residues [2]. The issue of antibiotic residues in meat and eggs has raised a serious public health concern due to reported antibiotic resistance [2].

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As a result of these and growing pressure on livestock producers, feed producers are adopting new forms of non-chemical and natural feed additives that are the products of modern science [3]. Hence alternative substances and strategies for animal growth performance and disease prevention are being investigated. In this regard, phytogenics have received increased attention and inclusion since they have acquired more acceptability among consumers as natural feed additives [4]. According to Windisch W [5], phytogenics are plant products which are medicinal in nature such as herbs, spices and essential oils which are used to improve the growth of farm animals. Herbs and spices have always been helpful in human nutrition and health management but have not been extensively used in animal nutrition and health because of use of antimicrobial growth promoters (AGP). However, due to the prohibition of AGP by World Health Organization (WHO), plant extracts have gained interest in animal feeding strategies [6]. Recently, to show the importance of phytogenics in monogastric animal nutrition, [7] advocated a comprehensive study of these plant materials which they termed Phytogenicology. According to Ndelekwute EK, et al. [7], phytogenicology means the study of spices, plants parts, and plant extracts in relation to their application in farm animal nutrition and nutrition-related health challenges. According to them this entails the study and use of extracted bioactive molecules in plants or plant parts in processed form to solving nutrition and nutrition-related health challenges in farm animals. These biologically active products include herbs, roots, barks, woody parts, flowers, seeds, fruits and pods of plants that are medicinal [7]. These contain bio-active ingredients such as alkaloids, bitters, flavonoids, carotenoids, organic acids, glycosides, mucilage, saponins and tannins [8,7]. Herbs and spices are not just appetite and digestion stimulants but have been proven to improve productivity of poultry [9]. Pepperfruit (*Dennettia tripetala)* which is in this group contains phytochemicals which include flavonoids, Saponins, terpenoids and essential oils [10]. The major bio-active compound in pepperfruit is pepperine which is the essential oils. It possesses also antimicrobial and anti-inflammatory properties [11]. Pepperfruit has limited studies but expected high potential in its use as feed additive in poultry nutrition.

2. Materials and Methods

2.1 Experimental site

The study was carried out at the Teaching and Research Farm of the Department of Animal Science, University of Uyo, Uyo, Nigeria. Uyo lies between latitude 4º31̍E and 45º31'N and 4º45'N and longitude 7º31'E and 45º351'E. The altitude of the area is 38 m above sea level and a mean rainfall of 2000 mm. The estimated relative humidity during the experiment was 79% and average temperature of 28ºC (Meteorology Station, University of Uyo, Uyo, Nigeria).

2.2 Procurement and processing of experimental material

The pepperfruits were purchased from a market in Uyo metropolis. The pepperfruits were washed to be free from debris and dried in an oven at a temperature of 60ºC to a final residual moisture content of 11%. The dried sample was milled and sieved and thereafter it was stored at room temperature in a plastic container.

2.3 Proximate analysis of test material

Proximate analyses of the pepperfruit powder and formulated diets were carried out. The crude protein, crude fibre, ether extract, total ash and nitrogen free extract were determined according to the methods of [12].

2.4 Experimental design

One hundred and fifty day-old chicks of Hubbard strain were used. The birds were allotted to five dietary treatment groups (T1, T2, T3, T4 and T5) containing 0.0%, 0.25%, 0.50%, 0.75% and 1.0% respectively of pepperfruit powder in a completely randomized design (CRD). Each treatment group contained 30 birds. Each dietary group was replicated three times and each replicate contained 10 birds. The statistical model was:

$$Y_{ij} = \mu + T_i + e_{ij}$$

Where: Y_{ij} = Single observation

μ = Overall mean

T_i = Treatment effect (pepperfruit)

e_{ij} = Random error (~iind($0\sigma^2$)

2.5 Management of experimental birds

On arrival to the farm, the day old chicks were weighed as they were allotted to the five dietary treatment groups. Glucose was added to their drinking water. Starter and finisher diets were formulated (TABLES 1 and 2). Feed and water were provided *ad libitum* throughout the experiment. For the first three weeks, extra heat was provided by using kerosene stoves to keep them warm. The birds were housed in an open sided deep litter floor building. Adequate spacing, ventilation and protection against predators and adverse environmental conditions were ensured. The birds were vaccinated against Newcastle and Infectious Bursal diseases which was carried out by a Veterinary doctor. Other routine management of broiler chicks were also carried out.

TABLE 1. **Composition of experimental starter broiler diets**.

Ingredients (%)	**T1 (0.0%)**	**T2 (0.25%)**	**T3 (0.50%)**	**T4 (0.75%)**	**T5 (1.0%)**
Maize	52.0	52.0	52.0	52.0	52.0
Soya bean meal	30.0	30.0	30.0	30.0	30.0
Palm kernel cake	10.0	9.75	9.50	9.25	9.0
Fish meal	4.0	4.0	4.0	4.0	4.0
Bone meal	3.0	3.0	3.0	3.0	3.0
Pepperfruit	0.00	0.25	0.50	0.75	1.0
Salt	0.25	0.25	0.25	0.25	0.25
Lysine	0.20	0.20	0.20	0.20	0.20
Methionine	0.20	0.20	0.20	0.20	0.20
Premix*	0.35	0.35	0.35	0.35	0.35
Total	**100**	**100**	**100**	**100**	**100**
Nutrient Composition (%)					
Crude protein	22.88	22.88	22.87	22.88	22.87
Ether extract	7.78	7.77	7.78	7.77	7.77
Crude fibre	4.87	4.85	4.82	4.79	4.77
Ash	5.63	5.62	5.63	5.63	5.63
Lysine	1.22	1.22	1.22	1.22	1.20
Methionine	0.48	0.48	0.48	0.48	0.47
Calcium	1.21	1.21	1.21	1.21	1.21
Phosphorus	0.95	0.95	0.95	0.94	0.94
Energy KcalME/kg	2879	2879	2888	2879	2879

*1kg of premix contains: Vitamin A (10,000,000iu), vitamin E(16,000mg), vitamin k3 (800mg), vitamins B_{12} (22,000mg), niacin (22,000mg), vitamin B_2 (10mg), folic acid (400mg), biotin (32mg), chlorine chloride (200,000mg) zinc (32,000mg) iodine (600mg), cobalt (120mg), selenium (40mg), antioxidant (48,000mg).

TABLE 2. **Composition of experimental finisher broiler diet.**

Ingredients	T1 (0.0 %)	T2 (0.25 %)	T3 (0.50 %)	T4 (0.75 %)	T5 (1.0 %)
Maize	52.00	52.00	52.00	52.00	52.00
Soya bean meal	28.0	28.0	28.0	28.0	28.0
Palm kernel cake	14.30	14.05	13. 80	13.55	13.30
Fish meal	2.0	2.0	2.0	2.0	2.0
Bone meal	3.0	3.0	3.0	3.0	3.0
Pepperfruit	0.00	0.25	0.50	0.75	1.0
Salt	0.25	0.25	0.25	0.25	0.25
Lysine	0.10	0.10	0.10	0.10	0.10
Methionine	0.10	0.10	0.10	0.10	0.10
Premix*	0.25	0.25	0.25	0.25	0.25
Total	**100**	**100**	**100**	**100**	**100**
Determined composition (%)					
Crude protein	20.0	20.0	20.0	20.0	19.95
Crude Fibre	5.64	5.62	5.59	5.57	5.54
Ether Extract	4.70	4.69	4.70	4. 69	4.69
Ash	5.23	5.27	5.27	5.27	5.27
Lysine	0.95	0.95	0.94	0.93	0.93
Methionine	0.38	0.38	0.38	0.38	0.38
Calcium	1.06	1.06	1.06	1.06	1.06
Phosphorus	0.71	0.71	0.71	0.71	0.71
Energy KcalME/kg	2926	2926	2926	2926	2926

*1kg premix contained: vitamin A (10,000,000 iu), vitamin D3 (1,000,000 iu), vitamin E (16,000 mg), vitamin k3 (800 mg), vitamins B_2 (22,00 mg), niacin (22,00 mg), vitamin B_{12} (10 mg), Folic Acid (400 mg) Biotin (32 mg), Chlorine chloride (200,00 mg), Zinc (32,000 mg) iodine (600 mg), cobalt (12 mg), selenium (40 mg), antioxidant (48,000 mg).

2.6 Determination of growth performance

During the feeding trial, initial body weight (g/bird) were obtained before the administration of experimental treatments. Weekly live body weight was measured using a 20 kg capacity Camry scale. Average daily weight gain per bird was calculated as total final body weight - total initial body weight divided by the number of birds in a replicate. The value was further divided by seven (7) to obtain the average daily weight gain per bird/day. Daily feed intake (g) was obtained as the difference between quantity of feed given the previous day and the left over. The figure was divided by the number of birds in a replicate. Feed: gain ratio (FGR) was calculated as the ratio of daily feed intake and daily weight gain. Daily protein intake was calculated by multiplying daily feed intake with percent protein of the feed.

2.7 Digestibility trial

A total collection method by Ojewola GS [13] modified by Ndelekwute EK [14] was used. At the end of the feeding trial (that is end of finisher phase) one bird from each replicate (all males of similar live weight) were used for this trial. A week to the end of the experiment, the metabolism room and the metabolism cages were thoroughly washed and disinfected. The birds were housed one in a cage and were fed the experimental diets for four days for acclimatization. At the end of the acclimatization period, a known quantity of the diet was fed to each bird. These quantities were their *ad-libitum* quantity, but was fed thrice daily (8 am, 12 noon and 6 pm) making sure the birds, lack no feed. This was to reduce feed wastage according to [14].

Collections of faeces were done for four days by placing a metabolism tray under the cages. Collected faeces samples were taken to the laboratory, the wet weight was determined and oven dried at a temperature of 70ºC. At the end of drying, each treatment samples were pooled, mixed, ground and proximate analysis determined according to [12].

2.8 Statistical analysis

The data obtained from the study were subjected to one-way analysis of variance (ANOVA) using SPSS software (IBMSPSS Statistics version 20) according to [15]. Duncan Multiple Range Test was used for separation of treatment means that were significant.

3. Results and Discussion

3.1 Proximate composition of dried pepperfruit powder

The result of proximate composition of dried pepperfruit powder is presented in TABLE 3. The result showed that the values of moisture, crude protein and crude fibre were higher than the values reported by [16]. Nevertheless, the dry matter content, ether extract and ash were lower than the values reported by [16]. The variations that occurred could be as a result of differences in soil and agronomic practices [16] The crude protein, crude fibre and ether extract of the pepperfruit showed potential for use as feed additive.

TABLE 3. **Proximate composition of pepperfruit powder.**

Composition	Percentage (%)
Moisture	7.50
Dry matter	92.50
Crude protein	15.76
Ether extract	4.95
Crude fibre	14.86
Ash	4.64

3.2 Performance of starter broilers fed diets supplemented with dried pepperfruit powder

The performance of starter broiler chickens fed diet supplemented with dried pepperfruit powder is presented in TABLE 4. There were no significant differences ($P>0.05$) in all the parameters measured. This is an indication that at this phase of production pepperfruit powder did not impact negatively on the growth performance of the starter birds.

Though Elekwa I [10] reported that pepperfruit contained anti-nutrients such as tannins and saponins which caused poor performance, the result of this work was at variance. This could be as a result of the short period of feeding of the pepperfruit. Also, since the inclusion levels of pepperfruit did not significantly affect the feed intake of the experimental birds, it implies that the quantities were not sufficient to negatively depress feed consumption.

TABLE 4. **Effect of pepperfruit (%) on growth performance of starter broilers.**

Parameters	T1 (0.0)	T2 (0.25)	T3 (0.50)	T4 (0.75)	T5 (1.0)	SEM
Initial live weight (g)	49.70	50.00	49.50	49.30	49.60	5.11
Final live weight (g)	1175	1145	1141	1149	1168	40.01
Daily weight gain (g)	40.19	39.11	38.98	39.38	39.94	4.08
Total feed intake (g)	1770	1756	1770	1696	1730	61.21
Daily feed intake (g)	63.21	62.71	63.21	60.57	61.79	6.11
Feed: gain ratio	1.57	1.60	1.62	1.54	1.55	0.56
Daily protein intake (g)	14.10	14.01	13.88	13.50	13.84	2.12
Protein efficiency ratio	2.85	2.79	2.81	2.92	2.89	0.75

SEM: Standard error of means

3.3 Performance of finisher broilers fed diet supplemented with dried pepperfruit powder

Performance of finisher broilers fed diets supplemented with dried pepperfruit powder is presented in TABLE 5. Feeding of pepperfruit to the finisher broilers resulted to significant effect ($P<0.05$) on the parameters measured except daily feed intake, feed: gain ratio, daily protein intake and protein efficiency ratio.

TABLE 5. **Effect of pepperfruit (%) on growth performance of finisher broiler.**

Parameters	T1 (0.0)	T2 (0.25)	T3 (0.50)	T4 (0.75)	T5 (1.0)	SEM
Initial live weight (g)	1175	1145	1141	1149	1168	40.01
Final live weight (g)	2246^{a}	2199^{ab}	2192^{ab}	2175^{b}	2176^{b}	56.44
Daily weight gain (g)	51.00^{a}	50.19^{ab}	50.05^{ab}	47.86^{b}	48.00^{b}	3.01
Total feed intake (g)	3579^{a}	3427^{c}	3506^{b}	3521^{b}	3431^{c}	50.14
Daily feed intake (g)	170.43	163.19	166.95	167.67	163.38	10.16
Feed: gain ratio	3.34	3.25	3.34	3.50	3.40	0.85
Daily protein intake (g)	34.78	33.29	34.09	33.29	32.62	3.76
Protein efficiency ratio	1.47	1.51	1.47	1.44	1.47	0.07

abc: Means along the same row with different superscripts are significantly difference ($P<0.05$). SEM: Standard error of means.

The final live weight was significantly ($P<0.05$) affected by dietary treatments. Inclusion of 0.75 and 1.0% pepperfruit powder negatively affected final live weight compared to the control. However, there was no significant difference ($P>0.05$) between the final live weight of broilers fed control, 0.25% and 0.50% pepperfruit powder. In the same vain, there was no significant difference ($P>0.05$) among broilers fed different levels of pepperfruit powder. It was observed that the daily weight gain followed similar pattern as the final live weight. The total feed intake was significantly reduced ($P<0.05$) at all the levels of inclusion of pepperfruit powder which was highest at 1.0%. The significant effect on some parameters at the finisher phase could be as a result of long feeding period of the pepperfruit as none of the parameters was significantly influenced at the starter phase.

The differences observed ($P<0.05$) in final live weight could have been influenced by the test ingredient which agreed with the reports on several spices as growth promoters [17-19]. Also the negative effect of dried pepperfruit powder at higher levels could be attributed to the presence of anti-nutritional factors such as tannins, terpenoids, saponins, alkaloids and steroids reported to be contained in pepperfruit which resulted in reduction in feed intake and poor growth [20].

3.4 Effect of pepperfruit supplemented diets on apparent nutrient digestibility of broilers

Effect of pepperfruit on apparent nutrient digestibility of broilers are presented in TABLE 6. Effect of pepperfruit on digestibility of dry matter, crude fibre and ash were not significant (P>0.05). Nevertheless, protein and ether extract were influenced (P<0.05) and took similar trend. All the levels of pepperfruit improved the digestibility of protein and ether extract. This result agreed with the report of Javed M, et al. [21] who indicated that plants extracts at certain levels improved digestibility.

Table 6: **Effect of pepperfruit (%) on apparent nutrient digestibility of broilers.**

Parameters	T1 (0.0)	T2 (0.25)	T3 (0.50)	T4 (0.75)	T5 (1.0)	SEM
Dry matter (%)	68.06	70.02	67.98	69.46	71.00	5.77
Crude protein (%)	60.01^{b}	66.13^{a}	67.55^{a}	66.43^{a}	68.24^{a}	5.43
Ether extract (%)	69.43^{b}	81.62^{a}	80.73^{a}	82.09^{a}	81.86^{a}	10.35
Crude fibre (%)	40.46	40.77	39.71	41.11	41.46	4.06
Ash (%)	66.37	67.14	67.77	64.81	65.89	4.89

abc: Means along the same row with different superscripts are significantly difference (P<0.05). SEM: Standard error of means.

Another report by Lee KW, et al. [22] suggested that spices and essential oils could be used to aid digestion in monogastric animals. Also Jang IS, et al. [23] reported similar result in black pepper and essential oils. Ejechi BO [24] reported that essential oil and phenolic extract of pepperfruit can inhibit the growth of micro-organisms in the gut thereby improving nutrient digestibility. Elsewhere, reports have attributed the better nutrient digestion to anti-inflammatory properties of pepperfruit [25]. This result confirmed similar reports by Sirinivasan K [26] on black pepper which they attributed to the ability of black pepper and spices in general to induce secretion of saliva, hydrochloric acid and mucus. Improved digestibility of ether extract has been further suggested to be due to positive effect of spices on secretion of bile [27]

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