African Journal of Biotechnology Vol. 6 (6), pp. 818-825, 19 March 2007
Available online at http://www.academicjournals.org/AJB
ISSN 1684–5315 © 2007 Academic Journals

*Full Length Research paper*

# Performance of broiler chickens served heat-treated fluted pumpkin (*Telfaria occidentalis*) leaves extract supplement

**F. C. Nworgu*, A. A. O. Ekemezie, A. O. Ladele and B. M. Akinrolabu**

Federal College of Animal Health and Production Technology, Institute of Agricultural Research and Training, Obafemi Awolowo University, Moor Plantation, P.M.B 5029, Ibadan, Nigeria.

Accepted 25 January, 2007

**Performance of broiler chickens served heat-treated fluted pumpkin (*Telfaria occidentalis*) leaves extract (FPLE) was investigated. The experiment was carried out during the early rainy season of 2005. One hundred and twenty five day-old chicks of Anak 2000 were weighed and randomly distributed to five dietary treatments A, B, C, D and E which contained no FPLE (control), fluted pumpkin leaves (FPL) no heat treatment, FPL immersed in hot water (100°C) for 1, 3 and 5 min, respectively. Each treatment was replicated 3 times in a completely randomized design. The broiler starters were fed the same starter diet, while broiler finishers were equally fed the same finisher diet. Water and feeds were served *ad-libitum.* The FPLE is a valuable protein and mineral supplement for broiler chickens. One to five minutes heat treatment of FPLE reduced the concentrations of phytate and tannin by 13.51 - 24.32 and 5.26 - 7.89%, respectively, but had no effect on the reduction of saponin. The results revealed that FPLE served to the birds had significant (P<0.05) effect on feed intake, weight gain, feed conversion ratio, protein efficiency ratio, water intake and cost of feed per kilogramme live weight. Birds served FPLE in both phases had reduced feed intake which was 7.30 and 21.89% for broiler starters and broiler finishers, respectively. The best weight gain was in treatment D in both phases which was 594.55 and 1350.53 g/bird, respectively, for broiler starters and broiler finishers compared to control (565.00 and 1287.03 g/bird). The cost of feed per kilogramme live weight was best for the birds in treatments D and E for broiler starters and treatments B, C and D for broiler finishers. The feed conversion ratio for birds in treatments B, C and D was averagely 2.77 compared to control (3.11) and treatment E (2.90) for broiler finishers. It is advisable to serve broiler chickens 1 - 3 min heat treated FPLE for improved weight gain, feed conversion ratio and cost of feed per kilogramme live weight during early rainy season in humid tropical environment.**

**Key word:** Performance, broiler chicken, heat treated fluted pumpkin leaves extract.

## INTRODUCTION

The poor state of economy in developing countries has made consumption of high protein foods out of reach of more than 65 - 70% of the people (Nworgu, 2004). One of the ways of solving this problem is to use unconventional sources of protein and leaf protein to supplement the diets of man and farm animals. Studies on leaf protein have shown their potential for supplying good quality food proteins greater than would be obtained with cereal, legumes and oil seeds (Subba et al., 1972). The authors noted that not all leaf proteins are good quality and that those that produce a weight gain of 25 g in four weeks when fed to laboratory animals are generally regarded as good quality protein. One of such vegetables is fluted pumpkin (*Telfaria occidentalis*) which is widely cultivated in the tropics and sub-tropics. The protein from leaves may be recovered and fed to farm animals as solution in form of protein concentrates (Farinu et al., 1992).

*T. occidentalis* leaves extract is regarded as blood tonic in Nigeria, where it is taken either solely or with addition of honey, or milk for stressed and anaemic patients

*Corresponding authors E-mail: fcnworgu@yahoo.com.

(Nworgu, 2004). Nutritive values of the leaves of fluted pump-kin (FP) have been evaluated chemically and found to contain (g/100 g DM) 30.5 ± 2.50 crude proteins, 3.0 ± 0.15 crude lipid, 8.3 ± 0.50 crude fibre and 8.4 ± 0.50 total ash (Ladeji et al., 1995). The authors noted that the leaves of FP had low levels of tannic acid (0.05 g/100 g DM), oxalate (0.005 g/100 gDM) and phytic acid (0.020 g/100 gDM). These authors further reported that FP leav-es were rich in potassium, calcium and magnesium, whose values were 0.594, 0.144 and 0.100%, respect-tively. Leafy vegetables supply minerals, proteins and vitamins, thereby complementing the inadequacies of most foodstuffs (Ifon and Basir, 1980). Fluted pumpkin is a leafy vegetable called ugu in Igbo, gbaroko in Yoruba and umeke in Edo.

Adedapo et al. (2002) used FP and *Sorghum bicolor* extracts as potent haematinics in domestic rabbits and reported that the rabbits served these extracts had the highest values of packed cell volume (PCV), haemo-globin (Hb), red blood and white blood cells and respon-ded faster to theraphy. Bashar and Abubakar (2001) observed that feed intake and weight gain of broilers decreased with increase in FP seed meal dietary inclu-sion. Nworgu et al. (2006) reported that broiler chicken served 60 ml FPLE/litre of water had improved feed intake, higher weight gain, elevated PCV, Hb and RBC over control and 120 ml FPLE/litre of water.

The major problem of leaf meal and leaves extract utilization in monogastric nutrition is the presence of dele-terious substances such as lectins, alkaloids, tannins, saponins, protease inhibitors, phytate, among others (D'Mello, 1995). Mendoza and del Rosario (1988) recom-mended soaking the leaves in water at 70°C for 10 min, while Abeke et al. (2003) recommended 20 min cooking beans of *Lablab purpureus*. Oduguwa et al. (1999) reported that autoclaved whole pods of *Samanea saman* (Jacq Merill) at a temperature of 100°C for 15 min and fed to domestic rabbits 100 g/kg resulted to improve feed intake and weight gain compared to the rabbits fed 100 g/kg raw *S. saman* diet. Cooking improves nutritive values of legume seeds and brings the values close to that of meat and milk products by destroying some of the anti-nutritional factors (Ogundipe, 1980; Amaefute and Obioha, 2001). Furthermore, processing improves the utilization of protein and energy of legumes and vegeta-bles (Omeje, 1999; Kaankute et al., 2000).

Eggs and poultry meats are beginning to make a substantial contribution in relieving the protein insuffi-ciency in African countries (Daghir, 1995). Capital invest-ed in poultry business is quickly realized, most especially in broiler production. However, feed accounts for 65-75% of the total production cost in poultry production in Nigeria (Nworgu, 2006). Utilization of FP leaves extract in poultry nutrition for protein and mineral supplement during the dry and rainy seasons is not common in our environment. Hence, the experiment was conducted to evaluate the growth performance of broilers served fluted pumpkin leaves extract (FPLE).

## MATERIALS AND METHODS

One hundred and twenty five day-old broiler chicks of Anak 2000 were purchased from Amino Breeder Farm, Ibadan for the research work. The experiment was carried out at Bora Poultry Unit of Federal College of Animal Health and Production Technology, Institute of Agricultural Research and Training (IAR and T) Ibadan, Nigeria. The experiment was carried out during the early rainy season (April-June) of 2005 with mean annual rainfall of 1200 mm and mean monthly temperature of 25.40°C. The chicks were weighed and randomly allotted to five dietary treatments A, B, C, D and E which contained no fluted pumpkin leaves extract (FPLE) (control), fluted pumpkin leaves (FPL) no heat treatment, FPL immersed in hot water (100°C) for 1 min, FPL immersed in hot water (100°C) for 3 min and FPL immersed in hot water (100°C) for 5 min, respectively. The FPLE was served at three days interval throughout the period of the experiment (8 weeks, i.e. 4 weeks for each phase) at a concentration of 60 ml per litre of water. The birds were served the FPLE according to the treatments per litre of water and later water was served *ad-libitum* as well as feed (Table 1).

The birds were fed the same starter diet, while the birds in all the treatments at finisher phase were equally fed the same finisher diet (Table 1). Each treatment was replicated three times in a completely randomized design and the finisher phase was a direct carry over from the starter phase. Routine management practices, vaccinations and drugs were administered as at when due.

### Data collection

Data on the feed and water intake were taken on daily basis, while weight gain was determined on weekly basis and feed conversion ratio was calculated at the end of each phase. The protein efficiency ratio (PER) was obtained by dividing mean body weight gain by the mean protein consumed.

### Preparation of fluted pumpkin leaves extract

One kilogramme of freshly cut fluted pumpkin leaves with stalk was divided into four at the rate of 250 g per treatment. It was washed, drained and tied with a string and immersed in hot water at 100°C for one, three and five minutes and later drain and chopped and pounded in a mortar with pestle. This was then squeezed and filtered with a sieve to obtain a homogenous extract of the FPL. The homogenous FPLE was prepared at three days interval and served the birds fresh according to the treatments. The FPL is an exotic vegetable in Nigeria, which the women avoid boiling, they rather steam it to avoid nutrients loss.

### Proximate and chemical analyses

Proximate and mineral composition of the test ingredient were determined according to the procedures of Boehringer (1979) and AOAC (1990) and proximate composition of the diets was deter-mined by the methods of AOAC (1990), while the metabolizable energy was determined by the method outlined by Panzenga (1985) and the gross energy was estimated by the procedures of AFRC (1990). Phytate was determined by the technique of Igbedioh et al. (1994), while tannin was evaluated by the method outlined by Hagerman and Ler (1983), oxalate by the procedures of Talapatra and Price (1948), while saponin was determined according to the procedures of Sofowora (1996).

**Table 1.** Gross composition of experimental diets of broilers served heat treated fluted pumpkin leaves extract (FPLE).

| Ingredients (%) | Starter phase | Finisher phase |
|---|---|---|
| Maize | 50.00 | 51.00 |
| Corn bran | 7.10 | 10.50 |
| Palm kernel cake | 5.00 | 6.10 |
| Soyabean meal | 19.50 | 17.90 |
| Groundnut cake | 10.50 | 7.65 |
| Fish meal (72%) | 4.00 | 3.00 |
| Bone meal | 3.00 | 3.00 |
| Vitamin premix (+) | 0.30 | 0.30 |
| Salt | 0.30 | 0.30 |
| Lysine | 0.20 | 0.15 |
| Methionine | 0.10 | 0.10 |
| **Calculated Analysis** | | |
| Crude protein (%) | 22.02 | 19.99 |
| Crude fibre (%) | 4.29 | 4.58 |
| Metabolizable energy (Kcal/kg) | 2921 | 2950 |
| **Determined Analysis** | | |
| Crude protein (%) | 22.56 | 20.40 |
| Crude fibre (%) | 3.96 | 4.30 |
| Metabolizable energy (Kcal/kg)* | 2992 | 3003 |

*Determined by Panzenga (1985). (+) To provide the following per kg of diet: Vit. A = 10,000 iu, Vit. $D_3$ = 2000 iu, Vit. E = $5_{iu}$, Vit.K = 2 mg, Riboflavin = 4.20mg, Nicotinic acid = 20 mg, Vit. $B_{12}$ = 0.01 mg, Pantothenic acid = 5 mg, Folic acid = 0.5 mg, Choline = 3 mg, Mg = 56 mg, Fe = 20 mg, Cu = 10 mg, Zn = 50 mg, Co = 125 mg and Iodine = 0.08 mg.

### Statistical analysis

Data collected were subjected to analysis of variance (ANOVA) and the errors were calculated as standard errors of the mean (SEM). Significant treatment means were compared using Duncan's New Multiple Range Test as outlined by Obi (1990). Significance was accepted at the 0.5 level of probability.

## RESULTS AND DISCUSSION

The results of the proximate chemical composition of the heat treated fluted pumpkin leaves extract (FPLE) are presented in Table 2. The results depicted FPLE as rich in crude protein (19.96 – 20.74%), ash (12.43 - 12.69%) and low in crude fibre (5.62 - 5.71%). The FPLE was rich in minerals, most especially phosphorus, potassium, calcium and sodium whose concentrations were 0.44 - 0.57, 0.36 - 0.42, 0.24 - 0.33 and 0.21 - 0.28%, respectively, but moderate in iron (mg/kg DM) (12.80 - 13.70). The heat treatment significantly ($P<0.05$) increased the concentrations of phosphorus and iron. The concentrations of phytate and tannin (g/100 gDM) were significantly ($P<0.05$) affected by the heat treatment (Table 2). One to five minutes heat treatment reduced the concentrations of phytate and tannin by 13.51 - 21.62 and 5.26 - 7.89% respectively, while the concentrations of oxalate and saponin were not significantly ($P>0.05$) reduced by heat treatment (Table 2). Broiler starter (BS) and broiler finisher (BF) diets presented in the present study met the nutritional requirement of the birds and are in line with the standards of NRC (1994). The FPLE either heat-treated or not in this study is rich in crude protein (CP), phosphorus potassium, sodium, iron and calcium and the concentrations of crude fibre (CF) (5.62 - 5.74%), tannin, oxalate and phytate are very low when compared to leguminous leaves. Hence the FPLE is a very good feed/food supplement for farm animals/man. In Nigeria, anaemic patients and pregnant women are recommended to take the leaves extract by the medical personnels. As an exotic vegetable, in order to improve its nutritive value, we decided to apply 1 – 5 min heat at 100°C. Heat treatment increased the concentration of CP and CF though not significant ($P<0.05$). Heat treatment significantly ($P<0.05$) increased the concentrations of phosphorus and iron. The CP value of the FPLE in the present study agrees with the values reported by Okoli and Mgbeogba (1983) (21.80%), Akwaowo et al. (2000) (22.40%) and Nworgu et al. (2006) (21.31%), but lower than the submission of Ladeji et al. (1995) (30.50%). The CF (5.62 - 5.74%) is in harmony with Nworgu et al. (2006) (6.41%), but lower than the results of Ladeji et al. (1995) (8.50%) and Akwaowo et al. (2000) (10.10%). The ash content of FPLE in the present study (12.36 - 12.69%) is in agreement with the reports of Akwaowo et

**Table 2**. Proximate chemical composition of fluted pumpkin leaves extract (FPLE) (%DM basis).

| Fraction | Fresh FPLE | Fluted pumpkin leaves immensed in hot water for 1 min | Fluted pumpkin leaves immensed in hot water for 3 min | Fluted pumpkin leaves immersed in hot water for 5 min |
|---|---|---|---|---|
| Dry matter | 86.84 | 87.96 | 87.28 | 86.16 |
| Crude protein | 19.96 | 20.74 | 20.48 | 20.65 |
| Crude fibre | 5.62 | 5.74 | 5.68 | 5.71 |
| Crude fat | 1.19 | 1.26 | 1.21 | 1.18 |
| Ash | 12.69 | 12.48 | 12.36 | 12.43 |
| Nitrogen free extract | 60.54 | 59.78 | 60.27 | 60.03 |
| Gross energy (Kcal/kg)* | 4032 | 4056 | 4055 | 4053 |
| Phosphorus | $0.47^{b}$ | $0.53^{a}$ | $0.44^{c}$ | $0.57^{a}$ |
| Pottassium | 0.37 | 0.42 | 0.39 | 0.36 |
| Calcium | 0.27 | 0.31 | 0.24 | 0.33 |
| Sodium | 0.26 | 0.21 | 0.25 | 0.28 |
| Iron (mg/kg DM) | $12.80^{d}$ | $13.30^{c}$ | $13.50^{b}$ | $13.70^{a}$ |
| Phytate (g/100g DM) | $0.037^{a}$ | $0.032^{b}$ | $0.029^{c}$ | $0.030^{c}$ |
| Oxalate (g/100g DM) | $0.039^{d}$ | $0.043^{c}$ | $0.047^{a}$ | $0.045^{b}$ |
| Tannin (g/100g DM) | $0.038^{a}$ | $0.036^{b}$ | $0.036^{b}$ | $0.035^{c}$ |
| Saponin (g/100g DM) | $0.250^{c}$ | $0.280^{a}$ | $0.281^{a}$ | $0.270^{b}$ |

*Estimated by AFRC (1990).
abcd: Means with different superscripts on the same horizontal row differ significantly (P<0.05)

al. (2000) (12.4 ± 40%) and Nworgu et al. (2006) (10.92%), but higher than the result of Ledeji et al. (1995) (8.40 ± 0.50%) and does not corroborate with the result of Oyolu (1978) (16.00%). The ether extract reported here (1.18 - 1.26%) is lower than the submission of Ladeji et al. (1995) (3.0 ± 0.15%), while the nitrogen free extract in the present study is similar to that reported by Ladeji et al. (1995) (52.5 ± 2.60%). The concentration of potassium (0.59%) reported by Ladeji et al. (1995) and calcium (0.40%) according to Ifon and Basin (1980) are slightly higher than reported in this work. The concentration of phosphorus and iron reported in the present study are similar with the results of Ladeji et al. (1995) (12.0 mg/kg DM) for iron and Nworgu et al. (2006) (0.40%) for phosphorus and 18.50 mg/kg DM for iron. The concentrations of the minerals reported in this study are higher than the value of Akwaowo et al. (2000). Variations in the concentrations of the CP, CF, ether extract and minerals could be ascribed to age of cutting, season and variety of *T. occidentalis* used.

Application of 1 - 5 min heat (100°C) had positive and significant effect on the reduction of concentrations of phytate (13.51 - 24.32%) and tannin (5.26 – 7.89%) unlike oxalate and saponin. The concentrations (g/100 gDM) of phytate, oxalate, tannin and saponin in this study varied from 0.029 – 0.037, 0.039 - 0.047, 0.035 – 0.038 and 0.250 - 0.281, respectively. Akwaowo et al. (2000) reports on the concentrations (g/100 gDM) of oxalate (0.010), tannin (0.040) and phytate (0.039) are in agreement with the results in the present study. However, Ladeji et al. (1995) reported lower concentrations of these chemicals whose values were 0.005, 0.05 and 0.020 g/100 gDM, respectively for oxalate, tannin and phytate, respectively. Low concentration of these deleterious substances accounts for low heat treatment (steaming) of this vegetable before eating unlike the seeds of the same vegetable that requires 2 - 3 h of cooking before consumption. Akanji et al. (2003) reported that aqueous heating destroyed 92.6 and 84.91% of heamagglutinin and trypsin inhibitor in jackbean (*Canavalis ensiformis*) seeds. The reduction of the concentrations of phytate (13.15 – 24.32%) and tannin (5.21 7.89%) in this study is similar with the observation of Akanji et al. (2003) who noted that phytate and tannin contents of jack bean were partially affected by heat treatment, whose reduction values varied from 13.84 – 23.08 and 33.33 – 41.03% respectively. These authors highlighted that phytate was more heat stable, although 41.03% loss of tannin was due to 48 h soaking in excess cold water followed by decortications and cooking for 2 h. Tannin and phytate have been reported to be heat stable (Apata, 1990). The lower percentage loss in phytate (13.51 – 24 .32) of the aqueous – heated FPLE could be ascribed to the strong electrostatic force that existed between oxygen atoms of contiguous phosphate radicals within the phytate structure, as earlier confirmed by O'Dell and de Boland (1976). The lower percentage loss of tannin (5.26 – 7.89) content of the FPLE could be attributed to a likely leaching of a small fraction of hydrolysable phenolic compounds located in the cell walls of the FPL. Similar observation was made by Bressani et al. (1982) about fermented and aqueous – heated jack bean. Reduction of tannin in this study is in line with observation of Ologhobo (1980) for lima bean, Oke et al. (1995) for cowpea and Kaankuta et al. (1996) for soybean. Bawa et al. (2003) reported a linear significant (P< 0.05) decrease in the concentration of tannic acid with increase in the duration of cooking. Bawa et al. (2003) reported that the rate of destruction of phytic acid in lablab seeds was very low (17.52%) at 15 min cooking and 31.33% at 30 min cooking. The reduction of concentrations of phytate and tannin corroborates with the findings of Apata (1990). Fagbemi et al. (2005) reported that fermentation is the most effective processing methods of reducing phytic acid and trypsin inhibitor, while boiling is most effective in reducing the tannic acid content. Ologhobo and Fetuga (1984) reported that loss of phytic acid was due to its solubility in processing water during cooking. One to five minutes heat treatment (100°C) had no effect on the oxalate and saponin concentrations. This could be associated with little time of heat application. Hence, the bitterness of saponin can not be reduced by 1 - 5 min heat treatment, maybe soaking the leaves in cold water or hot water for longer time will lead to the reduction of the concentration of saponin, as soaking in cold water with squeezing is commonly used to reduce drastically the concentration of saponin in *Vernonia amygdalina* (Akindahunsi and Salawu, 2005).

The performance indices of broiler starters and finishers served heat treated (HT) FPLE are presented in Table 3 and Figure 1. The final body weight (FBW), weight gain (WG), feed intake (FI) and protein efficiency ratio (PER) were significantly (P<0.05) affected in both phases, while only total water intake (TWI) and feed conversion ratio (FCR) were significant (P<0.05) at finisher phase (FP). At starter phase (SP), the best FBW (629.55 g/bird) and WG (594.55 g/bird) were observed on the birds served 3 min heat treated FPLE, while the least of these parameters were obtained in control Table 3 and Figure 1. Similar scenario was observed at FS. Birds served the FPLE either heat treated or not had reduced feed intake in both phase. Increased water intake (WI) was only recorded on the broiler finishers served 3 - 5 min heat treated FPLE. Dietary inclusion of FPLE significantly (P<0.05) improved the PER in both phases. The cost of feed per kilogramme live weight gain (CFPKLWG) was best on the birds served 3 - 5 min heat treated FPLE (treatments D and E) at SP (₦141.09 - ₦142.18/kg) as against ₦154.37/kg in control. Similar trend was also observed at FP. The relative cost advantage was also best in treatments D and E (5.63 - 6.14%) compared to no heat treatment (1.60%), while the best of this parameter at finisher phase was in treatment C (14.37%) compared to 5.83% in treatment E. Mortality of 8 - 12% was recorded at starter phase (Table 3). The utilization of heat treated FPLE had significant (P<0.05)

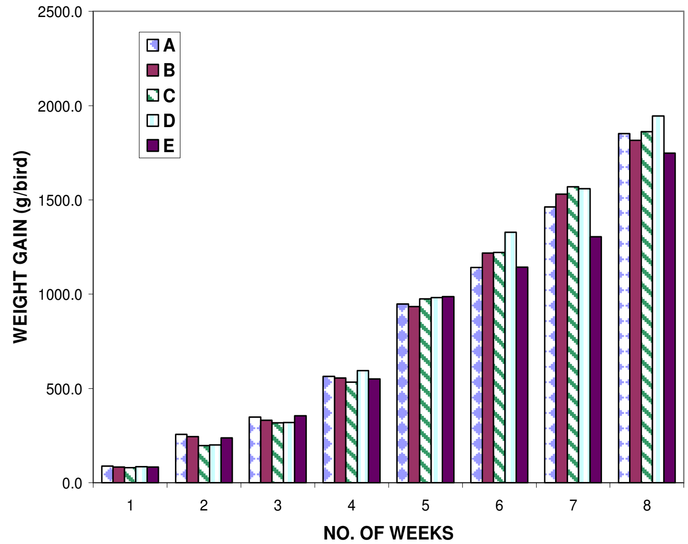


**Figure 1.** Effecct of heat treated fluted pumpkin leaves extract weight gain of broiler chickens. A= Control (No fluted pumpkin leaves extract. B = Fluted pumpkin leaves (FPL) (No heat treatment). C = FPL immersed in hot water for 1 min. D = FPL immersed in hot water for 3 min. E = FPL immersed in hot water for 5 min.

effect on the FI, FBW, WG, FCR, PER, TWI and CFPKLWG of the broiler chickens. The FI in this study at starter phase (SP) (1331.07 – 1498.21 g/bird) is similar with the reports of Nworgu et al. (2001) (1136 –1375 g/bird) and lower than that reported by Ayanwale (1999) (1003 – 1004 g/bird). At finisher phase (FP), the FI in this study (3089.29 – 3621.43 g/bird) is in harmony with the submission of Nworgu et al. (2003) (3120.60 – 3262.10 g/bird) but lower than reports of Esonu et al. (2002) (3668 - 4200 g/bird). The WG in the present study for BS (550.00 –594.55 g/bird) is slightly lower than the submission of Nworgu et al. (2001) (676.50 – 751.50 g/bird), while at FP, the WG (1198.50 –1350.53 g/bird) is slightly higher than the results of Etuk et al. (2004) (1000.00 – 1100.00 g/bird) and within the average value (1261.33 g/bird) reported by Esonu et al. (2002). The FCR in both phases is lower than the revelation of Etuk et al. (2004) (1.50 – 2.07). The FI in both phases decreased with the inclusion of FPLE in both non-and heat treated. This indicates the presence of deleterious substances (tannin, saponin, phytate and oxalate). The best WG in both phases was observed on the birds served 3 min heat treated FPLE. Bashar and Abubakar (2001) reported decreased FI and depressed WG when broiler chickens were fed 30% fluted pumpkin seed meal. Utilization of PFLE improved FCR and PER. The PER in this study is similar with the reports of Akanji et al. (2003) (1.84 – 2.51) and Etuk et al. (2004) (1.50 – 2.07) for broiler chicks and BF, respectively.

Better performance of the broiler chickens served 3 min heat treated FPLE could be attributed to the availability of

**Table 3.** Performance of broilers served heat treated fluted pumpkin leaves extract.

| Parameter | Starter Phase | | | | | Finisher Phase | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | A | B | C | D | E | A | B | C | D | E |
| Initial live weight (g/bird) | 35.00 | 35.00 | 35.00 | 35.00 | 35.00 | 565.00$^{b}$ | 555.91$^{c}$ | 534.55$^{e}$ | 594.55$^{a}$ | 550.00$^{d}$ |
| Final body weight(g/bird) | 600.00$^{b}$ | 590.91$^{c}$ | 569.56$^{e}$ | 629.55$^{a}$ | 585.00$^{d}$ | 1852.03$^{c}$ | 1815.7$^{d}$ | 1862.29$^{b}$ | 1945.08$^{a}$ | 1748.50$^{e}$ |
| Mean body weight gain (g/bird) | 565.00$^{b}$ | 555.91$^{c}$ | 534.56$^{e}$ | 594.55$^{a}$ | 550.00$^{d}$ | 1287.03$^{c}$ | 1259.79$^{d}$ | 1327.74$^{b}$ | 1350.53$^{a}$ | 1198.50$^{e}$ |
| Average daily weight gain (g/bird/day | 20.81$^{b}$ | 19.85$^{c}$ | 19.09$^{d}$ | 21.23$^{a}$ | 19.65$^{cd}$ | 41.57$^{b}$ | 39.72$^{d}$ | 40.50$^{c}$ | 42.62$^{a}$ | 38.00$^{e}$ |
| Total feed intake (g/bird) | 1498.21$^{a}$ | 1421.43$^{c}$ | 1352.93$^{d}$ | 1450.00$^{ab}$ | 1331.07$^{e}$ | 3621.43$^{a}$ | 3087.98$^{d}$ | 3117.86$^{c}$ | 3323.21$^{b}$ | 3089.29$^{d}$ |
| Average daily feed intake (g/bird) | 53.51$^{a}$ | 50.77$^{c}$ | 48.32$^{d}$ | 51.79$^{b}$ | 47.54$^{e}$ | 129.34$^{a}$ | 110.29$^{c}$ | 111.35$^{c}$ | 118.69$^{b}$ | 110.33$^{c}$ |
| Feed conversion ratio | 2.65 | 2.56 | 2.53 | 2.44 | 2.42 | 3.11$^{a}$ | 2.78$^{c}$ | 2.75$^{c}$ | 2.78$^{c}$ | 2.90$^{b}$ |
| Total water intake ml/bird) | 2239.36 | 2191.68 | 2175.39 | 2238.14 | 2165.15 | 7260.72$^{c}$ | 7251.79$^{c}$ | 7292.86$^{c}$ | 7341.07$^{b}$ | 7525.00$^{a}$ |
| Av. Daily water intake (ml/bird) | 79.97 | 78.27 | 77.69 | 79.93 | 78.04 | 259.31$^{d}$ | 258.99$^{d}$ | 260.46$^{c}$ | 262.18$^{b}$ | 268.75$^{a}$ |
| Feed water intake ratio | 1:1.49 | 1:1.54 | 1:1.61 | 1:1.54 | 1:1.64 | 1:2.00 | 1:2.35 | 1:2.34 | 1:2.21 | 1:2.44 |
| Mortality (%) | 0.0 | 12.00$^{(3)}$ | 8.00$^{(2)}$ | 12.00$^{(3)}$ | 16.00$^{(4)}$ | - | - | - | - | - |
| Protein efficiency ratio | 1.90$^{b}$ | 1.97$^{ab}$ | 1.99$^{ab}$ | 2.07$^{a}$ | 2.08$^{a}$ | 1.91$^{b}$ | 2.19$^{a}$ | 2.29$^{a}$ | 2.18$^{a}$ | 2.09$^{a}$ |
| Cost of 1kg of feed (₦/kg) | 58.30 | 58.30 | 58.30 | 58.30 | 58.30 | 55.45 | 55.45 | 55.45 | 55.45 | 55.45 |
| Cost of fluted pumpkin leave extract (₦/bird) | - | 3.09 | 3.39 | 3.69 | 3.99 | 0.00 | 3.09 | 3.39 | 3.69 | 3.99 |
| Cost of feed/kg live weight gain (CFPKLIWG) (₦/kg) | 154.57 | 149.02 | 147.55 | 142.18 | 141.09 | 156.02 | 135.92 | 130.21 | 136.44 | 142.93 |
| Relative cost advantage of CFPKLWG plus cost of FPLE (%) | - | 1.60 | 2.35 | 5.63 | 6.14 | - | 10.90 | 14.37 | 10.18 | 5.83 |

abcde: Means with different superscripts on the same horizontal row differ significantly (P<0.5). A= Control (No fluted pumpkin leaves extract. B = Fluted pumpkin leaves (FPL)
(No heat treatment) C = FPL immersed in hot water for 1 min. D = FPL immersed in hot water for 3 min. E = FPL immersed in hot water for 5 min.$^{()}$ = Number of birds that died. ₦ = Naira i.e. Nigerian Currency.

more nutrients and minerals due to the breaking of cell walls of FPL. The 5 min heat treatment (100°C) could not have positive effects on FI and WG due to erosion or leaching of some nutrients, which made saponin and other deleterious substances more available. Cheeke and Skull (1985) concluded that reduction in FI in poultry, rabbits and swine occurred due to unpalatability and poor acceptability of alfalfa leaf meal, which contained saponin that had pronounced bitter taste and irritating effect on the membranes of the mouth and throat of the animals. Reduction in growth has also been noted when *Sesbania sesban* leaf meal (saponin 7.1 $gkg^{-1}$) (0.71 g/100gDM), was incorporated in chicks diet (Shqueir et al., 1989). Bawa et al. (2003) noted that cooking lablab seeds beyond 45 min resulted to protein denaturation. Hence, to maintain the nutritive values of FPL, it is not advisable to steam it or to heat treat (100°C) it more than 3 min. However, tannin and phytate have been reported to form complexes with dietary protein, thereby inhibiting protein metabolism and utilization in monogastric animals (Vaithiyanathan and Kumar, 1993). Tannin strongly inhibits digestive enzymes and birds praline rich proteins in the saliva (Olomu, 1976; Kurmar, 1992). Phytic acid has been reported to cause reduced absorption of Ca from the gastrointestinal tract. Oke (1969) reported that zinc and iron deficiency symptoms have occurred in man and chicken when fed diets high in phytic acid. Akindahunsi and Salawu (2005) reported that only tannins and saponins are present in 14 tropical green leafy vegetables screened. These authors noted that saponin though non-toxic exhibits cytotoxic effects and growth inhibition against a variety of cells making it to have anti-inflammatory and anticancer properties. AICR (1997) noted that saponin showed turmour – inhibiting activity in animals.

Daily water intake (DWI) in this study varied from 77.69 – 79.97 and 258.99 –268.75 ml/bird for BS and BF, respectively. The DWI, for BS is in harmony with the report of Sainsbury (1992) (70 - 100 m/bird/day), but for BF his result is lower (140 ml/bird/day). Variations could be attributed to type of bird, season, test ingredients and environment the experiment was carried out. The feed water intake ratio reported here agrees with the submission of Oluyemi and Roberts (1979). The best PER in the birds served FPLE was as a result of availability of both micro and macro elements which aided digestion, absorption and utilization (Oluyemi and Roberts, 1979; D'Mello, 1995). The results of CFPKLWG in this study are higher than the report of Nworgu (2004) for BS (₦114.79 g/kg) and ₦ 90.66-₦94.70 /kg for BF. Higher CFPKLWG is due to increased cost of feeds and feed ingredients in Nigeria, most especially the season the experiment was conducted. The best relative cost advantage of CFPKLWG plus cost of FPLE was on treatment D and E for SP and treatments B, C and D for FP. Reduction of FI in both phases for the broilers served FPLE could be associated with the presence of antt- nutritional factors (D'Mello, 1995) and it could be attributed to the availability of more nutrients as the FPLE is rich in protein and minerals (Ladeji et al., 1995; Nworgu et al., 2006). However, the increased water intake in the birds served 3 – 5 min heat treated FPLE at FP could be due to availability of more minerals (Oluyemi and Roberts, 1979) and the heat at that level was able to break down more cell walls of the FPL. The mortality recorded at SP was as a result of *Aspergilosis* caused by *Aspergilus falvus*.

## Conclusion

The FPLE is a good protein and mineral supplement for broiler chicken. Heat treatment made more phosphorus and iron more available. Heat (100°C) treatment of FPLE for 1 - 5 min reduced the concentration of phytate and tannin by 13.51 – 2432 and 5.26 – 7.89%, respectively. One to five minutes heat (100°C) treatment had no effect on the concentrations of oxalate and saponin. Generally, broiler chickens offered FPLE with or without heat treatment performed better than control in terms of WG, PER and FCR. The broiler chickens served FPLE either heat treatment or not had reduced feed intake in both phases. If BF are to be offered 3 min heat (100°C) treated FPL, more cool drinking water needs to be provided for the birds. Base on the parameters on the FI, WG, FCR, PER, CFPKLWG, it is advisable to serve broiler starters 3 min heat (100°C) treated FPLE, while for broiler finishers 1 – 3 min heat (100°C) treated FPLE.

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