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Full Length Research Paper

Biochemical, nutritional and haematological implications of *Telfairia occidentalis* leaf meal as protein supplement in broiler starter diets

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Freshly harvested *Telfairia occidentalis* matured leaves were processed by shredding, sun drying and milling. This product thereafter referred to as *T. occidentalis* leaf meal (TOLM) on analyses revealed (on dry matter basis) 35.14 ± 0.44% crude protein, 9.61 ± 0.01% crude fat, 12.68 ± 0.02% crude fibre, 10.87 ± 0.02% ash, 3.21 ± 0.07 kcal/g gross energy and 31.72 ± 0.57% nitrogen free extracts. Methionine and to a lesser extent, alanine, arginine, leucine, valine and aspartate were remarkably present. Traces of some anti-nutritional factors notably phytates and oxalates were detected. Dietary introduction of TOLM was at graduated levels of 10, 15, 20, 25 and 30%. Birds kept on 15% TOLM dietary inclusion level had the highest average weight gain (WG) of 290.5 ± 12.3 g/chick. The feed conversion (FCR) and protein efficiency (PER) value of birds on 15% TOLM inclusion were similar (P > 0.05) to values obtained for the reference diet. The nitrogen utilization indices were similar (P > 0.05) for all diets. Organs weights, carcass characteristics, hematological parameters, serum and liver metabolites had similar values (P > 0.05). Results of the study suggest that inclusion levels of about 15% TOLM in broiler starter diets may be nutritionally beneficial in poultry feeding and subsequently reduce the use of the expensive animal protein sources in practical feed formulation.

Key words: *Telfairia occidentalis* leaf meal, novel protein ingredient, nitrogen utilization.

INTRODUCTION

Protein from plant leaves sources is perhaps the most naturally abundant and the cheapest potential source of protein. Natural resources are available for the synthesis and polymerization of amino acids into less mobile forms and stored as such in plant leaves. However, the build-up of the amino acids in plant leaves is also accomplished with other anti-nutritional factors that render them less nutritious for consumptive purpose in man and animal. Such factors limiting the nutritive value of leaf protein are the high fibre content and other anti-nutrients (Aletor and Adeogun, 1995).

Telfairia occidentalis (fluted pumpkin) is native to the tropical rainforest of West Africa with the largest diversity in South Eastern Nigeria. *Telfairia* of different species are also grown as leaf vegetables in other tropical regions of the world including India, Bangla-desh, Sri Lanka and the Caribbean. It is also grown to some extent in South East Africa and Latin America. *Telfairia* is classified in the tribe joliffieae of the family cucurbitaceae and commonly referred to as fluted pumpkin.

Telfairia species have been found to be rich in protein (21 - 37% CP), ash (14%), fat (13%) and fibre (13%) (Akoroda, 1990). *Telfairia* species are also known to be rich sources of iron and essential fatty acids making it desirable as cooking oil. The essential amino acids contents compared favorably with those of important legumes (Asiegbu, 1988) and the high content of mineral and vitamin nutrients especially Fe, Mg and K, carotene and vitamin C is remarkable making the leaves potentially useful as food supplements. Another economic and nutritional advantage of *Telfairia* plant is its clear agronomic superiority over many plant protein sources. For instantce, leaf harvesting begins one month after leaf emergence and this continues at 3 - 4 weeks intervals depend-

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Table 1. Proximate composition (g/100 g), gross energy (kcal/g) and amino acid content (%) of *Telfairia occidentalis* leaf meal (TOLM) (means, n = 2).

Composition (g/100g)	TOLM
Dry matter	90.96±0.13
Crude protein	35.14±0.44
Ether extracts	9.61±0.01
Crude fibre	12.68±0.02
Ash	10.87±0.02
Nitrogen free extract	31.72±0.57
Gross energy (kcal/g)	3.21±0.07
Amino acids	
Alanine	1.87
Aspartic acid	1.52
Arginine	2.51
Glycine	1.01
Glutamic acid	0.82
Histidine	0.91
Isoleucine	1.50
Lysine	0.43
Methionine	2.54
Cystine	1.02
Meth. + Cys.	4.83
Leucine	1.93
Serine	1.02
Threonine	1.13
Phenylalanine	1.64
Valine	1.91
Tyrosine	0.84
Tryptophan	0.92

ing on the irrigation facilities. Between 4 - 6 harvests or more are expected (Asiegbu, 1988).

This study therefore investigated the chemical, amino acids and anti-nutritional constituents in the processed *T. occidentalis* leaf meal (TOLM) as a prelude to harnessing its nutritional potentials in poultry diets. The performance characteristics, nitrogen utilization, carcass characteristics, relative organs weights, muscle development, haematological indices, serum and liver metabolites of experimental birds fed varying levels of TOLM were all determined as a preliminary measure of nutritional acceptability in poultry feed.

MATERIALS AND METHODS

Production of *T. occidentalis* leaf meal

T. occidentalis (fluted pumpkin) leaves were harvested fresh from maturing stems at about 20 – 30 days after leaf emergence. The fresh leaves were immediately subjected to sun drying in an open cleaned concrete floor space until moisture content became constant at 13%. The sun-dried leaves were later milled using a commercial feed milling machine (Artec, model 20). The proximate analysis, amino acid profile and mineral content were determined to chemically evaluate the nutritional potentials of the TOLM. Thereafter, the TOLM was used to formulate diets along with other ingredients purchased locally.

Proximate gross energy, amino acids and mineral content determination

Proximate composition of the ACLM was determined by AOAC (1995) method while the amino acids were determined using amino acid analyzer model 80-2107-07 Auto Loader. The sodium and potassium contents were determined by flame photometry while phosphorus was determined by the vanado-molybdate method (AOAC, 1995). The other mineral elements were determined after wet digestion with a mixture of nitric, sulphuric and hydrochloric acid using Atomic Absorption Spectrophotometer (AAS model SP9). Gross energy of the TOLM sample and the 6 formulated diets were determined against thermo-couple grade benzoic acid using a Gallenkamp ballistic bomb calorimeter (Model CBB-330-0104L). The results showing the above determinations are presented in Tables 1 and 2.

Determination of anti-nutrients (phytin, oxalate, tannin and cyanide)

The extraction and precipitation of phytin in the fresh fluted pumpkin leaves were done by the method of Wheeler and Ferrel (1971) while iron in the precipitate was determined as described by Makower (1970). Phytin was determined by using a 4:6 Fe/P ratio to calculate phytin phosphorus and multiplying the phytin phosphorus by 3.55 as suggested by Young and Greaves (1940). Oxalate content was determined by the titrimetric method of Moir (1953) as modified by Ranjhan and Krishna (1980). Where extracts were intensely coloured, they were decolourised with activated charcoal (Balogun and Fetuga, 1980). The polyphenols (tannic acid) were determined by extracting the finely milled TOLM sample (250 mg in 10 ml of 70% aqueous acetone) for 2 h at 30°C using Gallenkamp orbital shaker (Survey, UK). Pigments and fats were first removed from the leaves by extracting with diethyl ether containing 1% acetic acid. Thereafter, the total polyphenols (as tannic equivalent) were determined in 0.05, 0.2 or 0.5 ml aliquot using Folin Cocalteu (Sigma) and standard tannic acid (0.5 mg/ml) as described by Makkar and Goodchild (1996). The HCN (cyanide) was determined (after an initial extraction for 2 - 3 min of 5 – 8 g material in 0.1 M H_3PO_4 by a 2 M H_2SO_4 (100°C for 50 min) hydrolysis followed by reaction with chloramine-T pyridine barbituric acid (Konig Reaction). KCN dried over concentrated H_2SO_4 was used to calibrate the standard curve from a stock solution containing 75 mg KCN/00 ml.

Site preparation

The poultry house was thoroughly disinfected, fumigated with 1 part of potassium permanganate pellets to 3 parts of formalin. Thereafter, the house was rested for 2 weeks before the arrival of the experimental broiler starter chicks.

Experimental rations formulation

The feed ingredients used in ration formulation were purchased locally from a reputable commercial feed miller (Adedom Investment Holdings) located at Km 3, Ondo Road, Akure. The TOLM

Table 2. Mineral composition of *Telfairia occidentalis* leaf meal (TOLM) (means, n = 2).

Mineral	Ca (g/100 g)	P (g/100 g)	K (g/100 g)	Na (g/100 g)	Mg (g/100 g)	Fe (ppm)	Mn (ppm)	Cu (ppm)	Zn (ppm)
Amount	2.6	1.2	6.2	5.1	4.7	5875	182	136	1036

was sourced as earlier discussed. The results of the proximate compositions earlier determined were used as guides in the manual ration formulation of the six experimental diets. The experimental diets were prepared in Adedom Feed mill with adequate mixing of the diets in the mixer. All diets were compounded to contain identical crude protein content (isonitrogenous) and gross energy (isocaloric). Diet 1 was the control diet and was formulated without the inclusion of TOLM. Diets 2, 3, 4, 5 and 6 were formulated such that TOLM was incorporated at 10, 15, 20, 25 and 30% respectively and replaced other protein sources in the formulated diets. All diets were also supplemented with feed grade methionine and lysine.

Bird husbandry and experimental design

A total of 540 day-old broiler chicks of the *anak* heavy strain were used for the experiment. All chicks were electrically brooded at the Gabof Research Farms, Aule Government Residential Area, Akure, Ondo State, Nigeria. They were fed a 24% crude protein broiler starter commercial ration ad *libitum* for the first 3 days after arrival from the hatchery prior to the commencement of the experiment. The chicks were also sexed on the second day of brooding as described by Laseinde and Oluyemi (1997). Water was also provided *ad libitum* with a mixture of appropriate antibiotics and glucose as an anti-stress factor. Standard routine medications were administered. The experimental design was the completely randomized type. After the uniform brooding of 3 days, the sexed chicks (15 males and 15 females) were randomly distributed into 18 experimental units. The chicks were assigned at the rate of 90 chicks/diet in 3 replications of 30 chicks/replicate such that the mean group weights were similar at the beginning of the experiment. The chicks were fed the experimental diet *ad libitum* for 21 days during which rec-ords on daily feed consumption and 3 days periodic weight changes were recorded.

Estimation of nitrogen retention, nitrogen digestibility and protein efficiency ratio

Total faeces voided during the last 5 days were collected, weighed, dried at 65 - 70°C in an air circulating oven for 72 h and preserved while the corresponding feed consumed was also recorded for nitrogen studies. The nitrogen contents of the samples were determined by the method of AOAC (1995). Nitrogen retained was calculated as the algebraic difference between feed nitrogen and fecal nitrogen (on dry matter basis) for the period. Nitrogen digestibility was computed by expressing the nitrogen retained as a fraction of the nitrogen intake multiplied by 100. The protein efficiency ratio was calculated as the ratio of weight gain to total protein consumed.

Blood collection for analysis

At the end of the feeding trial, a male chick per replicate was randomly selected, weighed and scarified by severing the jugular vein and blood allowed to flow freely into labeled bottles one of which contained a speck of EDTA while the other without EDTA was processed for serum. The serum was kept deep frozen prior to analysis. The packed cell volume (PCV%) was estimated in heparinized capillary tubes in an haematocrit micro centrifuge for 5 min while the total red blood cell (RBC) count was determined using normal saline as the diluting fluid. The haemoglobin concentration (Hbc) was estimated using cyanomethaemoglobin method while the mean corpuscular haemoglobin concentration (MCHC), mean corpuscular haemoglobin (MCH) and the mean corpuscular volume (MCV) were calculated.

Carcass, muscle and organ measurements

After slaughtering, the carcasses were scalded at 75°C in a water bath for about 30 s before defeathering. The dressed chicks were later eviscerated. The measurement of the carcass traits (dressed weight %, eviscerated weight %, thigh, drumstick, shank, chest, back, neck, wing, belly fat and head) were taken before dissecting out the organs. The organs measured were the liver, kidneys, lungs, pancreas, heart, spleen, bursa of fabricus and gizzard. The following muscles: inner chest muscle (*Supracoracoideus*) outer chest muscle (*Pectoralis major*) and thigh (*Iliotibialis*) were carefully dissected out from their points of origin and insertion. Measurements of the fresh weight, length and breadth of these muscles were taken. All the carcass traits, except the dressed and eviscerated weights, were expressed as percentages of the live weight while the organs and muscles were expressed in g kg^{-1} body weight, while the length and breadth of the muscles were expressed in cm kg^{-1} body weight.

Statistical analysis

The various data collected on the different parameters were actually analysed using the ANOVA (SPSS 11.0 for Windows) (SPSS Inc., Chicago IL, USA).

RESULTS AND DISCUSSION

The results of proximate composition, gross energy and amino acids contents are presented in Table 1 while the mineral composition is presented in Table 2. The *T. occidentalis* leaf meal (TOLM) was remarkably high in crude protein (for a plant source) at 35.14 ± 0.44%, ether extracts (fat) at 9.61 ± 0.01, nitrogen free extracts (sugar + starch) at 31.72 ± 0.57% and ash minerals at 10.87 ± 0.02%. The ash content of TOLM was analysed to contain 2.6, 1.2, 6.2, 5.1 and 4.2 g/100 g of Ca, P, K, Na and Mg, respectively. It also contained 5875, 182, 136 and 1036 ppm of Fe, Mn, Cu and Zn, respectively (Table 2).

The result obtained from the determinations of anti-nutrients is presented in Table 3. HCN, tannic and oxalic acids levels were 61.2 ± 0.02, 43.0 ± 0.07 and 80.7 ± 5.01 mg/100 g, respectively. The phytic acid and phytin-P contents were 189.2 ± 1.27 and 12.01 ± 0.27 mg/100 g respectively. The phytin-P as a percentage of total phosphorus was 8.05%. The composition of experimental diets is depicted in Table 4. The performance characteris-

Table 3. Phytic acid, phytin-P, oxalate, tannic acid and cyanide contents of *Telfairia occidentalis* leaf meal (TOLM) (means, n = 2).

Antinutrional factor	Phytic acid (mg/100 g)	Phytin-P (mg/100 g)	Phytin-P (% of total P)	Oxalate (mg/100 g)	Tannin (mg/100 g)	HCN (mg/100 g)
Amount	189.2±1.27	120.1±0.27	8.05	80.7±5.01	43.0±0.07	61.2±0.02

Table 4. Composition of experimental diets (g/100 g).

Ingredients	Diets (% inclusion levels of TOLM)					
	1 (0)	2 (10)	3 (15)	4 (20)	5 (25)	6 (30)
Maize (11.0% CP)	50.35	47.85	45.85	44.85	43.85	40.85
Groundnut cake (45.0% CP)	33.50	26.00	23.00	19.00	15.00	11.00
Palm kernel cake (18.8% CP)	10.00	10.00	10.00	10.00	10.00	10.00
Fish meal (68.0% CP)	2.00	2.00	2.00	2.00	2.00	2.00
TOLM* (23.0% CP)	0.00	10.00	15.00	20.00	25.00	30.00
Bone meal	2.50	2.50	2.50	2.50	2.50	2.50
Oyster shell	0.50	0.50	0.50	0.50	0.50	0.50
Nacl	0.50	0.50	0.50	0.50	0.50	0.50
DL-methionine	0.15	0.15	0.15	0.15	0.15	0.15
L-Lysine	0.15	0.15	0.15	0.15	0.15	0.15
Premix**	0.50	0.50	0.50	0.50	0.50	0.50
Total	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**
Analysed composition						
Crude protein (%)	23.06	23.07	23.06	23.06	23.05	23.04
Crude fibre (%)	4.54	5.64	5.82	6.02	7.85	9.24
Ether extract (%)	7.21	6.41	6.40	6.71	7.02	8.24
GE*** (kcal/g)	4.62	4.62	4.62	4.62	4.62	4.62

*TOLM, *Telfairia occidentalis* leaf meal.
**contained vitamins A (10,000,000 iu); D(2,000,000 iu); E (35000 iu); K (1900 mg); B12 (19 mg); Riboflavin (7,000 mg); Pyridoxine (3800 mg); Thiamine (2,200 mg); D Pantothenic acid (11,000 mg); Nicotinic acid (45,000 mg); Folic acid (1400 mg); Biotin (113 mg); and Trace elements as Cu (8000 mg); Mn (64,000 mg); Zn (40,000 mg); Fe (32,000 mg) Se (160 mg); I_2 (800 mg) and other items as Co (400 mg); Choline (475,000 mg); Methionine (50,000 mg); BHT (5,000 mg) and Spiramycin (5,000 mg) per 2.5 kg.
GE*** (kcal/g) calculated based on 5.7 kcal/g protein; 9.5 kcal/g lipid; 4.0 kcal/g carbohydrate (Ng and Wee, 1989).

tics data are presented in Table 5. The average weight gain (WG) values of birds on all diets (1 - 6) including the control diet 1 had similar weight gain (P > 0.05). The average feed intake for chicks fed control diet 1 was lowest at 795.9 ± 0.87 g/chick but similar (P > 0.05) to value obtained for chicks on diet 3 (15% TOLM dietary inclusion). Birds on diet 6 expectedly displayed the highest feed intake value of 919.8 ± 1.15 g/chick although similar (P > 0.05) to value obtained for diet 5 (890.4 ± 0.65 g/chick). The feed conversion ratio (FCR) of birds on control diet 1 was the lowest at 2.74 ± 0.18 but similar (P > 0.05) to FCR obtained for birds on diet 3. The protein efficiency ratio (PER) also indicated that birds on control diet 1 had the highest PER value of 1.44 ± 0.21 but also similar (P > 0.05) to PER values obtained for birds on diet 3 (1.42 ± 0.09). The PER values obtained for birds on diets 2 and 6 were similar (P > 0.05). The PER values obtained for birds on diets 4 and 5 were similar (P > 0.05) and lowest at 1.07 ± 0.07 and 1.02 ± 0.10, respectively.

The nitrogen utilization data are presented in Table 6. The nitrogen intake (NI) values of birds on diet 1 and 2 were similar (P>0.05) while NI value for birds on diet 2 was also similar (P>0.05) to other diets 3, 4, 5 and 6. Nitrogen retention (NR) values of birds on all diets except control diet 1 were similar (P>0.05). However, the control diet 1 also had similar NR value with diets 2, 3 and 5. The nitrogen digestibility (ND) followed the same pattern for NR. The control diet 1 had the highest ND value of 70.92 ± 11.48 for its birds. This value was significantly higher (P<0.05) than all other ND values. ND values for birds on

Table 5. Performance of chicks fed varying dietary levels of TOLM.

Parameters	Diets (% inclusion levels of TOLM)					
	1 (0)	2 (10)	3 (15)	4 (20)	5 (25)	6 (30)
Average Weight Gain, g	290.0±43.7[a]	289.1±23.1[a]	290.5±12.3[a]	256.1±9.9[a]	272.9±30.7[a]	272.1±8.9[a]
Average Feed intake, g	795.9±0.87[a]	819.0±1.11[b]	810.4±1.31[a]	827.4 ±0.4[c]	890.4±0.65[d]	919.8±1.15[d]
Feed conversion (feed/gain)	2.74±0.18[a]	2.83±0.10[b]	2.79±0.13[a]	3.23±0.13[c]	3.26±0.32[d]	3.38±0.15[d]
Protein Efficiency (PER)	1.44±0.21[a]	1.32±0.36[b]	1.42±0.09[a]	1.07±0.07[c]	1.02±0.10[c]	1.25±0.04[b]

Means are for 15 chicks/diet.
Means with different superscripts in the same horizontal row are significantly different (P < 0.05).

Table 6. Nitrogen utilization of broiler chicks fed varying dietary inclusionlevels of TOLM.

Parameters	Diets					
	1	2	3	4	5	6
	% Inclusion levels of TOLM					
	0	10	15	20	25	30
Nitrogen Intake (gN/chick/day)	1.97 [a]±0.28	2.09 [ab]±0.12	2.28 [b]±0.18	2.13 [b]±0.08	2.39 [b] ±0.02	2.20[b]±0.12
Nitrogen Retention (gN/chick/day)	1.57 [a]±0.19	1.23 [ab] ±0.24	1.16 [ab]±0.19	1.01[b]±0.31	1.23[ab]±0.14	0.92[b]±0.27
Nitrogen Digestibility	70.92[a]±11.48	66.56[b]±1.83	55.69[bc]±2.40	55.51[bc]±3.36	53.27[c]±9.28	49.59[c]±4.39

Means with different superscripts in the same horizontal row are significantly different (P < 0.05).

Table 7. Haematological indices of broiler chicks fed varying dietary levels of TOLM.

Parameters	Diets					
	1	2	3	4	5	6
	% Inclusion levels of TOLM					
	0	10	15	20	25	30
PCV (%)	27.4±1.5	26.9±2.4	26.7±3.1	27.0±2.1	26.6±2.3	27.1±0.4
RBC count (x10^6/m^3)	2.1±2.2	2.0±2.1	2.2±1.6	2.1±2.3	2.1±1.3	2.2±0.5
Hbc(g/100ml)	2.1±2.1	2.1±1.3	2.2±0.3	2.1±2.4	2.1±2.2	2.1±2.3
MCHC	7.3±1.9	7.2±2.3	7.2±0.9	7.1±2.2	7.2±1.4	7.3±1.5
MCH(pg)	9.2±2.3	9.3±2.4	9.1±2.3	9.2±1.5	9.2±1.7	9.3±1.8
MCV	132.5±13.0	129.9 ±12.4	129.1±11.8	130.9±13.2	129.8±14.2	131.1±10.8
ESR (mm)	4.4±1.6	4.3 ±2.5	4.2±1.4	4.2±2.3	4.3±2.4	4.2±1.7

TOLM = *Telfaria occidentalis* Leaf Meal; PCV = Packed Cell Volume; RBC = Red Blood Cell; WBC = White Blood Cell; Hbc = Haemoglobin Concentration; MCHC = Mean Cell Haemoglobin Concentration; MCH = Mean Cell Haemoglobin; MCV = Mean Cell Volume; ESR = Erythrocyte Sedimentation Rate.

diets 2, 3 and 4 were similar (P>0.05). However, ND values for birds on diets 3, 4, 5 and 6 were also similar (P>0.05) with ND value obtained for birds on diet 6.

The haematological indices, serum and liver metabolites of experimental birds are presented in Tables 7, 8 and 9, respectively. All haematological indices investtigated showed no significant differences among their treatment mean values (P > 0.05). The serum and liver metabolites measured were statistically determined to be similar without significant differences (P > 0.05) among the treatment means.

Records on carcass traits are presented in Table 10. All carcass traits measured showed similarity in their treatment mean values (P > 0.05). The relative organs weights records are presented in Table 11. All organs measured were statistically similar (P > 0.05). The relative weight and relative breadth of some muscles are presented in Tables 12 and 13. The inner chest muscle

Table 8. Serum metabolites of experimental birds.

Parameters	Diets					
	1	2	3	4	5	6
	% Inclusion levels of TOLM					
	0	10	15	20	25	30
Total Serum Protein (g/100g)	9.8±0.4	9.6±1.4	9.7±1.2	9.3±1.3	9.4±1.2	9.5 ±1.3
Albumin (g/100g)	0.6±0.1	0.7±0.2	0.6±0.2	0.7±0.3	0.7±0.4	0.6 ±0.5
Globulin (g/100g)	9.1±0.5	9.2±0.4	9.0±0.2	9.1±0.2	9.3±0.3	9.2 ±0.4
Albumin/Globulin Ratio	0.1±0.2	0.1±0.2	0.1±0.1	0.1±0.1	0.1±0.1	0.1±0.1

Means with different superscripts in the same horizontal row are significantly different (P < 0.05).

Table 9. Liver metabolites of experimental birds.

Parameters	Diets					
	1	2	3	4	5	6
	% Inclusion levels of TOLM					
	0	10	15	20	25	30
Total Liver Protein (g/100g)	10.1±0.4	9.9±0.1	10.0±0.4	10.1±0.2	9.9±0.1	10.0±0.2
Albumin (g/100g)	2.6±0.1	2.7±0.2	2.6±0.3	2.6±0.1	2.5±0.1	2.6±0.1
Globulin (g/100g)	7.4±0.4	7.3±0.3	7.5±0.3	7.5±0.2	7.4±0.1	7.3±0.2
Albumin/Globulin Ratio	0.3±0.1	0.3±0.2	0.4±0.1	0.3±0.2	0.3±0.1	0.4±0.1

Means with different superscripts in the same horizontal row are significantly different (P < 0.05).

Table 10. Carcass traits of broiler starter chicks fed TOLM-based diets.

Parameters	Diets					
	1	2	3	4	5	6
	% Inclusion levels of TOLM					
	0	10	15	20	25	30
Live weight (g)	421.5±31.9	401.7±24.1	416.2±23.7	408.9±70.11	389.2±28.8	401.8±28.2
Dressed weight (%)	90.5±2.8	90.4±2.5	90.2±1.0	90.0±3.4	90.2±1.2	90.0±1.7
Eviscerated weight (%)	82.0±0.8	81.9±0.5	81.5±0.7	82.0±0.5	81.5±0.4	82.1±0.7
Thigh (gkg^{-1} body weight)	46.8±3.5	46.1±2.8	46.3±2.7	46.1±1.3	46.5±1.7	46.1±1.6
Drumstick (gkg^{-1} body weight)	102.1±2.7	101.5±1.8	101.3±2.1	102.0±1.8	101.8±1.8	102.2±1.9
Back (gkg^{-1} body weight)	81.2±0.5	81.3±2.9	79.8±3.4	80.5±3.3	79.8±02.4	79.5±45.3
Backfat (gkg^{-1} body weight)	2.7±0.7	2.5±0.1	2.3±0.3	2.6±1.1	2.5±1.4	2.6±1.0
Shank (gkg^{-1} body weight)	29.9±3.7	30.1±2.1	30.3±1.8	30.8±1.8	31.0±1.9	30.4±1.7
Wing (gkg^{-1} body weight)	39.1±3.3	40.1±3.5	39.7±4.3	39.9±5.4	40.0±1.7	40.4±1.2
Head (gkg^{-1} body weight)	42.9±5.9	43.1±6.0	43.0±6.3	42.9±6.1	43.1±7.4	43.0±6.8
Neck (gkg^{-1} body weight)	63.4±2.6	63.0±3.4	63.1±3.5	62.9±7.0	61.9±0.4	62.0±0.8

Means with different superscripts in the same horizontal row are significantly different (P < 0.05); TOLM, *Telfairia occidentalis* leaf meal. Chicks used for this study are subsets of the initial 90 chicks/treatment.

(*Supracoracoideus*), outer chest muscle (*P. major*) and thigh muscle (*Iliotibialis*) were all similar in their treatment means for all chicks investigated. The length and breadth of the inner (*Supracoracoideus*) and outer (*P. major*)

Table 11. Relative organs weights (gkg^{-1} body weight) of broiler starter chicks fed TOLM-based diets.

Parameters	Diets					
	1	2	3	4	5	6
	% Inclusion levels of TOLM					
	0	10	15	20	25	30
Liver	18.7±2.8	19.1± 2.4	19.1±2.1	19.0±1.8	18.9±2.7	19.1±1.9
Kidney	6.5±2.1	6.3±1.6	6.4±2.4	6.2±2.2	6.5±2.5	6.2±2.3
Heart	7.5±2.3	7.6±3.8	7.6±3.4	7.5±2.3	7.6±2.5	7.5±3.2
Spleen	1.1±2.4	1.1±2.2	1.2±2.4	1.1±2.1	1.2±1.4	1.2±1.2
Pancreas	2.9±2.3	2.8±3.4	3.0±1.5	3.0±2.6	2.9±2.6	3.0±1.2
Bursa	2.4±3.4	2.5±2.1	2.4±1.2	2.4±1.6	2.5±2.1	2.5±3.1
Gizzard	38.1±4.1	37.5±5.2	38.0±2.4	38.4±4.1	37.6±2.6	37.4±2.5
Lung	7.2±2.3	7.1±3.1	7.0±2.4	7.1±3.2	7.0±2.3	6.9±3.2

Means with different superscripts in the same horizontal row are significantly different (P < 0.05); TOLM, *Telfairia occidentalis* leaf meal.

Table 12. Relative weight (gkg^{-1} body weight) of chest and thigh muscles of broiler starter chicks fed TOLM-based diets.

Muscle	Diets					
	1	2	3	4	5	6
	% Inclusion levels of TOLM					
	0	10	15	20	25	30
Inner chest muscle (*Supracoracoideus*)	9.1±2.7	8.9± 3.2	8.5±2.9	9.0±3.6	8.9±1.6	8.5±2.8
Outer chest muscle (*Pectoralis major)*	25.2±3.4	24.7±4.3	24.5±3.1	24.8±3.1	24.5±2.7	24.8±3.2
Thigh muscle (*Gastrocnemius*)	32.3±2.5	32.4±2.4	31.5±2.0	31.6±1.7	32.0±2.4	31.5±3.8

Means with same superscripts or no superscripts in the same horizontal row are not significantly different (P > 0.05).

Table 13. Relative length and breadth (cmkg^{-1} body weight) of chest muscle of broiler starter chicks fed TOLM-based diets.

Muscle	Diets					
	1	2	3	4	5	6
	% Inclusion levels of TOLM					
	0	10	15	20	25	30
Length of inner chest muscle (*Supra coracoideus*)	20.1±5.2	20.3± 6.3	19.8±6.7	20.0±4.6	20.2±5.6	19.7±8.2
Length of outer chest muscle (*Pectoralis thoracicus*)	22.4±7.7	22.5±5.1	21.7±6.3	22.0±4.8	21.8±5.3	21.5±7.2
Breadth of inner chest muscle (*Supra coracoideus*)	3.2±2.2	3.4±4.3	3.3±3.4	3.2±3.2	3.1±2.8	3.1±3.2
Breadth of outer chest muscle (*Pectoralis thoracicus*)	7.0±1.8	7.2±1.5	7.2±2.8	7.1±2.6	7.0±2.4	7.0±2.7

Means with same superscripts or no superscripts in the same horizontal row are not significantly different (P > 0.05); TOLM, *Telfairia occidentalis* leaf meal.

chest muscles also showed similar (P > 0.05) values in their treatment means for chicks investigated.

The results of the proximate composition, gross energy and amino acids composition clearly depict *T. occidenttalis* leaf meal (TOLM) as a potential protein source comparable with other conventional protein sources especially of plant origins (Schmidt, 1971). The performance characteristics investigated such as weight gain, feed consumption, feed efficiency and protein efficiency ratio all validated the nutritional potency of *T. occidentalis* leaf meal (TOLM). It is noteworthy that the weight gain values for all experimental birds including the control diet 1 without TOLM inclusion were statistically similar even though birds on diet 3 at 15% TOLM dietary inclusion had the numerically highest weight gain value. There is a strong indication of a growth stimulating factor in the TOLM which may be traced to its well balanced amino acid profile (Leung et al., 1968). The only limiting amino acid in the laboratory analysed TOLM was lysine and this was corroborated by previous works (Leung et al., 1968; Asiegbu, 1988). Other contributory growth stimulating characteristics of TOLM as a vegetable protein source may be adduced to its rich contents of minerals, vitamins and essential fatty acids. Oleic and linoleic acids constitute over 63% of the fatty acid composition of *Telfairia* leaf (Asiegbu, 1988). Akoroda (1990) further confirmed the superiority of the nutrients composition when compared with other commonly consumed leafy vegetables in Nigeria. The seed kernel oil derived from *T. occidentalis* plant was found to be composed of 27% protein, 53% fat and 18% carbohydrate (Asiegbu, 1988; Akoroda, 1990). The fatty acids composition was predominantly oleic and linoleic acids and was therefore strongly recommended as a useful cooking oil. However, the average feed intake increased numerically with the birds on diet 6 (30% TOLM dietary inclusion) predictably having the highest feed intake value. Feed intake result is in agreement with previous works carried out on high fibre diets (Aletor and Adeogun, 1995). The presence of high fibre levels in diets can cause intestinal irritation, lower digestibility and overall decreased nutrient utilization. Fasuyi (2005) asserted in his study with broiler starter birds fed cassava leaf protein concentrate that there was a consequent increase in feed intake as cassava leaf protein concentrate dietary inclusion increased resulting in decreased nutrients digestibility. The protein efficiency ratio which is an important protein quality index revealed that birds on various inclusion levels of TOLM especially 15% TOLM dietary inclusion were found comparable with the control diet 1 without TOLM inclusion. These values were also comparable with conventional values reported in various literatures (Nwokolo et al., 1985; Fasuyi, 2005).The similarity in nitrogen intake by birds on all diets except diet 2 indicated a considerable and favorable nitrogen intake by birds fed TOLM based diets. There was a decline in ND values as dietary TOLM inclusion increased. This is supported by Nwokolo et al. (1985) who recognized high dietary fiber as one of the factors militating against nitrogen utilization in chicks. The least NR and ND values obtained for birds on diet 6 (30% and highest TOLM dietary inclusion) was in agreement with previous reports that as the intake of dietary fibre increases, digestibility of the dietary constituents decreases (Fasuyi, 2005).

The mean cell volumes (MCV) obtained for all birds were in agreement with standard values of 2.30 x $10^6/mm^3$ and 2.54 - 3.50 x $10^6/mm^3$ reported by Aletor and Egberongbe (1992), respectively. The blood variables most often affected by dietary influences were identified as Packed Cell Volume (PCV), plasma protein, glucose and clotting time (Ologhobo et al., 1986). These values in the experimental birds were found to be consistently higher than most values earlier reported and comparable with the report for chicks fed Soya bean in place of fish meal (Aletor and Egberongbe, 1992). On a similar note, the mean cell haemoglobin concentration (MCHC), mean cell haemoglobin (MCH) and haemoglobin concentration (Hbc) were not significantly affected by the dietary treatments. The erythrocyte sedimentation rates (ESRs) of the test diets were similar to the control diet indicating that the test diets (2 - 6) did not predispose the birds to any known general infections or malformation of any kind. Frendson (1986) reported that ESRs are increased in cases of acute general infection, malignant tumors and pregnancy.

The total serum protein (TSP), albumin, globulin and albumin/globulin ratio did not vary significantly in all diets. Also the total liver protein (TLP), albumin, globulin and albumin/globulin ratio were not significantly affected by the dietary treatments. The TSP and TLP are indirect indices for measuring the nutritional protein adequacy (Eggum, 1985; Tewe, 1985). The similar TSP and TLP values with the experimental control diet and with other standard values reported in literature (Frendson, 1986; Aletor and Egberongbe, 1992) suggests that the nutritional quality of TOLM as a protein source may be acceptable since it compared favourably with other known conventional sources.

The relative weights of the chest and thigh muscles of the experimental birds did not vary significantly neither did the relative length and breadth of the chest muscle indicating a uniform growth pattern and muscle development in all birds on the TOLM based diets compared with the control diet without TOLM. This uniform growth rate and muscle development compared favorably with many previous standard growth pattern and muscle development of birds of the same age and strain (Oluyemi and Roberts, 1979; Rodehutscord et al., 2004).

Conclusions

The proximate, gross energy, amino acids content and mineral composition of TOLM revealed a potentially viable source of nutrients in monogastrics especially poultry feeding. The processing effects of sun drying continuously in the open air seemed to have significantly reduced the anti-nutritional factors (ANFs) to innocuous levels that enhanced appreciable inclusion levels in the broiler diets without any physical and haematological malformation. The inclusion level of 15% of TOLM in broiler starter ration was found to be most nutritionally suitable considering the performance characteristics. The nitrogen utilization, muscle development and haematological indices were all in favour of a TOLM dietary inclusion level of 15% in broiler starter diets.

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