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Research Article
Utilization of Duckweed Meal as Replacement for Fish Meal by Broiler Chickens

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Abstract

Background and Objective: Plant proteins have been reported to be useful in poultry nutrition in this era of sincere efforts of reducing cost of production. This study was conducted to investigate how far fish meal (FM) can be replaced with duckweed meal (DWM) in broilers diets at starter (0-4 weeks) and finisher (4-8 weeks) phases. **Materials and Methods:** One hundred and fifty days old unsexed Anak strain of broiler chicks were randomly allotted into (5) dietary treatment groups (T1-T5) with DWM replacing FM at 0, 25, 50, 75 and 100%, respectively in a completely randomized design. Each dietary group was replicated thrice with ten birds. Performance characteristics of the birds were studied over 8 weeks. Blood samples were collected at 28th and 56th day of the experiment for haematology and serum metabolites analyses. Relative weights of the internal organs were determined at the end of the feeding trial. All data generated were subjected to analysis of variance statistically. **Results:** Daily feed intake, weekly body weight and total body weight gain were not significantly ($p>0.05$) improved by the dietary treatments and also feed conversion ratio and feed conversion efficiency at starter and finisher phases with the best results from birds on control diet and least from T5 were not significant. Haematological and serum parameters measured were not significantly ($p>0.05$) improved by the treatments at both phases, so also the relative weights of the internal organs. However, birds on T2 compared favourably with the control group at both phases in all parameters measured. Birds on T5 had the highest rate of mortality at both phases. **Conclusion:** The DWM can be used to replace FM up to 25% at starter phase and 50% at finisher phase beyond which the birds may be negatively affected.

Key words: Aquatic weed, meat-type chickens, performance characteristics, physiological condition, duckweed meal

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Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

Poultry as domesticated birds kept by humans is the second most widely eaten meat in the world accounting for about 30% of meat production after the pork[1]. Apart from supplying meat, poultry is an excellent source of eggs and feather and the industry has grown tremendously in Nigeria especially with a lot of development in areas of eggs and meat production, hatchery, equipment fabrication, feed, drugs and vaccines production[2]. Generally, birds are cheap sources of animal protein for many Nigerians and at the same time sources of livelihood as it was reported by Okonkwo and Akiubuo[3], which about 10% of the Nigerian population is involved in poultry production particularly at subsistence level. However, the industry is being challenged by very high cost of production especially feed cost[4] and this unprecedented increase in the cost of conventional feed ingredients used in formulating feed has necessitated intensive investigations into the use of agricultural and agro-based industrial by-products[5].

Broiler is the most common meat type chickens with fast generation of income because of their faster rate of growth over short period of 42-49 days[6]. However, they depend on high quality feed in terms of energy and protein. Madubuike and Ekenyem[7] recommended 23% crude protein (CP) and 2800 kcal kg^{-1} metabolizable energy (ME) in the diet of broilers at starter phase and CP of 21% and ME of 2700 kcal kg^{-1} for broiler finishers in the tropical environment. However, the energy and protein densities of the broiler diets at both phases may vary with the production target of the farmer but the ME may range from 2600-3200 kcal kg^{-1} and CP, 20-24%[8]. These nutritional requirements demand for energy- rich ingredients such as maize, sorghum and edible oil and protein-rich ingredients such as soybean meal, groundnut meal and fish meal which are relatively expensive and seasonal in availability. Furthermore, the protein-rich ingredients of broiler feeds are critical and attempt to get cheaper substitutes for them will be highly profitable. Fish meal is an excellent source of animal protein for poultry because it contains adequate quantities of all the essential amino acids required by chickens and an excellent source of lysine and methionine. Its crude protein value ranged from 65-72% and thus considered to be of high nutritional importance for the birds[9]. As good as fish meal is for broiler production, it is relatively expensive. In Nigeria, imported fish meal is currently being sold at N1350 ($4.00) kg^{-1} and this is making the feed cost to be very high thereby limiting the income of the poultry farmers.

Many attempts have been made to substitute fish meal with other locally available and cheaper protein-rich ingredients from both animal and plant sources in the diets of broiler and egg-type chickens in low and middle-income countries. Maggot meal, meat meal and feather meal have been identified to be good substitutes for fish meal[10] while a lot of researches have been done to incorporate leaf protein concentrate (LPC) into poultry nutrition[11-14]. LPC are purely amino acids derived from plant cells and they are very nutritious probably because of the high protein content, higher content of unsaturated fats, carotenes, xanthophylls, starch and minerals such as iron, calcium and phosphorus and therefore, will be very good in the nutrition of ruminant and non-ruminant animals including aquatic animals[15]. LPC from plants such as *Telfairia occidentalis* (fluted pumpkins), *Moringa oleifera* have been reported to be of nutritional advantages to the chickens[16,17]. Fasuyi and Nonyerem[18] reported that leaves of *T. occidentalis* have high crude protein (21-37%) while Alabi *et al.*[19] reported that LPC from *T. occidentalis* when administered to broiler finishers orally improved the feed intake, body weight gain and feed efficiency of the chickens best at inclusion level of 15%. Olugbemi *et al.*[20] submitted that *Moringa oleifera* leaf meal can be included in cassava chip based diets for broiler chickens upto 10% of the total diet without any negative effect on the carcass quality and internal organ weights and eventually reduced the abdominal fat deposition. Kakengi *et al.*[21] reported that *Moringa* leaf meal diets were highly preferred by chickens because of its palatability. Furthermore, Foluke and Olufemi[22] reported that wheat bran can be replaced with cassava peel meals fortified with *Moringa* leaf meal up to 75% without adverse effect on the performance characteristics and blood profile of broilers both at starter and finisher phases. Alalade and Iyayi[23] had earlier reported that there was a significant improvement in the yolk pigmentation of eggs from layers fed with xantophylls of *Spirulina.*

Recently, incorporation of LPC from aquatic weeds is attracting interests in animal nutrition. The use of LPC either from aquatic or terrestrial plants in the diets of chickens is getting popular because they are readily available in abundance and at relatively reduced price[24]. Ferentinos *et al.*[25] reported that duckweed can be easily cultivated and that the yield can be as high as 50 metric tons per hectare in a year.

Aquatic weeds are commonly found in riverine areas and include duckweed (*Lemnaceae), Azolla pinnata, Hydrodictyon reticulatum, Ceratophyllum demersum, Eleocharis ochrostahys, Potamogeton gramineous, Elodea trifoliate and Muyriophyllum spicatum*[26]. El-Sayed[27], reported that the crude protein of aquatic weeds vary with species. *Ipomea aquatic* Forsk had the highest protein content of 29.4% while

Eleocharis dulcis had the lowest value of 4.3%. However, there may be need for phytase supplementation to make phytic acid-bound minerals available, to reduce the effect of antinutritional factors to protect amino acids from degradation[28]. Duckweed is among the aquatic weeds that are available abundantly in humid tropics and specifically in South-West and South-South regions of Nigeria.

The objective of this research was to investigate the extent to which duckweed meal (DWM) can be utilized by broiler chickens both at starter and finisher phases as a replacement for fish meal (FM).

MATERIALS AND METHODS

The experiment was carried out at the poultry unit of the Teaching and Research farm of Bowen University, Iwo, Osun-State, Nigeria. A total number of 150 unsexed Anakstrain of day old broiler to chicks was purchased from a reputable hatchery farm and used for this experiment. The chicks were randomly allotted into 5 dietary treatments each with 30 chicks and replicated thrice in a completely randomized design. In the experimental feed, DWM was used to replace FM on weight basis but the diets were formulated to be isocaloric and isonitrogenous and the substitution levels were 0% (control), 25, 50, 75 and 100% constituting treatments 1-5 (T1-T5) respectively. Fresh duckweeds were initially harvested and identified at the herbarium section of the Department of Botany of the University before they were cleaned and oven-dried at 60°C for 6 h and later grinded to become DWM. Proximate analysis was later carried out on the resulting DWM with the procedure of AOAC[29]. The diets were given to the experimental birds *ad libitum* and so also water while other management practices such as medication and vaccination were carried out. The experiment lasted 8 weeks (56 days) comprising of starter phase (0-4 weeks) and finisher phase (4-8 weeks). Data were collected in respect of daily feed intake (DFI), weekly body weight (WBW), weekly body weight gain (WBWG), while feed conversion ratio (FCR) and efficiency of feed utilization (EFU) were calculated as follow:

$$\text{FCR} = \frac{\text{Total feed consumed}}{\text{Total weight gain}}$$

$$\text{EFU} = \frac{1}{\text{FCR}}$$

Blood samples were taken at the end of 4th and 8th weeks of age for haematology and serum biochemistry. Samples were carefully taken from the brachial vein of the wing web of each bird in all the replicates. For haematology, about 5 mL of blood sample was taken into bottles containing anticoagulant (EDTA: Ethylenediaminetetraaceticacid) while those taken for serum analyses were allowed to clot inside the bottle prior to use. Haematological parameters studied were packed cell volume (PCV), haemoglobin concentration (Hb), red blood cell (RBC) counts, white blood cell (WBC) counts as described by Lewis *et al.*[30] while blood indices such as mean cell volume (MCV) , mean corpuscular haemoglobin (MCH) and mean corpuscular haemoglobin concentration (MCHC) were calculated as stated below:

$$\text{MCV} = \frac{\text{PCV}}{\text{RBC}}$$

$$\text{MCH} = \frac{\text{Hb}}{\text{RBC}} \times 10$$

$$\text{MCHC} = \frac{\text{Hb}}{\text{PCV}} \times 100$$

Moreover, serum metabolites determined were total protein (TP) using hand refractometer, albumin (Alb) by Bromocresol green method earlier described by Schalm *et al.*[31]. Others were serum glucose, cholesterol, urea, creatinine, bilirubin and calcium. Enzymes of the serum such as aspartate transaminase (AST), acid phosphatase (ACP) and alkaline phosphatase (ALP) were also determined with the enzymatic methods as described by MVM[32].

At the end of the 8th week of the experiment, 15 chickens were sacrificed for the measurement of the internal organ weights. One bird from each replicate group was randomly selected for this. They were weighed, stunned electrically, bled, defeathered and eviscerated and organs such as the gizzard, heart, spleen, liver, intestine, proventriculus and abdominal fat were weighed and expressed as the percentage of the live weight.

Statistical analysis: All data generated were subjected to a one-way analysis of variance (ANOVA) using the statistical analysis software[33] and different means was separated using the Duncan's option of the same software ($p<0.05$).

RESULTS AND DISCUSSION

The result of the proximate composition of the Duckweed meal in Table 1 clearly depicts DWM as a potential protein source comparable with other conventional protein sources especially of plant origins[34,35]. The result therefore, reveals the potential of this aquatic weed for livestock feeding.

Table 2 shows the gross composition of the experimental diets and the resulting calculated values of metabolizable energy (ME) and crude protein (CP). All diets were formulated to be isocaloric and isonitrogenous to annul intake bias with the ME ranging from 2942.60-2992.80 kcal kg^{-1} while the CP ranged from 21.08-21.83%.

Table 3 shows the performance characteristics of broilers at starter phase in response to the dietary treatments. The initial body weights (IBW) at day old were the same which may be attributed to the fact that the chicks tend to have uniform weight at hatch as a factor of the uniformity of the egg set. However, the final body weight (FBW), total body weight gain (TBWG) and daily feed intake (DFI) were significantly ($p<0.05$) affected by the treatments.

The values of the parameters followed the same trend with birds on control group having the highest and the least from birds on T5 (100% DWM). The FBW, TBWG and DFI were decreasing as the level of substitution of FM with DWM got increased although for FBW and TBWG, birds on T1 and T2 had similar results. The trend of the DFI might be linked with the poor aroma and palatability of DWM when compared to that of FM while FBW and TBWG are DFI dependents. Results of the feed conversion ratio (FCR) and Feed conversion efficiency (FCE) revealed that the birds on control group had the best FCR and FCE implying that with DWM inclusion, broilers will eat more feed to gain a unit of life body weight and that as the level of inclusion increased, the feed were poorly utilized. The mortality rate showed that birds on T5 died more than others and that the rate increased with the level of DWM inclusion and this rate may be linked to the presence of some anti-nutritional factors in DWM.

Table 4 shows the effect of replacing FM with DWM in diets of broiler chickens at finisher phase. Birds on T2

Table 1: Proximate composition of duckweed meal

Composition (g/100 g)	Duckweed meal
Moisture content	7.40
Ether extract	5.60
Ash content	1.04
Crude fibre	1.24
Crude protein	14.96
Metabolizable energy (kcal kg^{-1})	1326.40

Table 2: Gross composition of the experimental diets

	Treatments (%)				
Ingredients	T1	T2	T3	T4	T5
Maize	65.00	65.00	65.00	66.00	67.00
Wheat offal	2.00	2.00	1.00	1.00	0.50
Palm kernel cake	2.00	2.00	1.50	0.75	0.50
Soya bean meal	16.50	17.50	18.50	18.50	18.50
Fish meal	10.00	7.50	5.00	2.50	-
Duck weed meal	-	2.50	5.00	7.50	10.00
Oyster shell	1.00	1.00	1.00	1.00	1.00
Bone meal	3.00	3.00	3.00	3.00	3.00
Salt	2.50	2.50	2.50	2.50	2.50
*Broiler premix	2.50	2.50	2.50	2.50	2.50
Lysine	0.05	0.05	0.05	0.05	0.05
Methionine	0.05	0.05	0.05	0.05	0.05
Calculated value ME (kcal kg^{-1})	2992.80	2962.75	2952.70	2942.60	2932.60
CP (%)	21.83	21.42	21.21	21.08	20.98

*Premix to provide the following per kg of feed, Vitamin A: 700 iu, Vitamin D3: 1400 mg, Vitamin E: 11 mg, Vitamin K: 2 mg, Riboflavin: 15 mg, Nicotinic acid: 10 mg, Pantothenic acid: 7 mg, Cobalamin: 0.08 mg, Choline chloride: 900 mg, Folic acid: 1.8 mg, Biotin: 1.5 mg, Iron: 25 mg, Manganese: 90 mg, Copper: 2 mg, Zinc: 50 mg, Cobalt: 1.20 mg, Selenium: 0.1 mg

Table 3: Effect of replacing fish meal (FM) with duckweed weed meal (DWM) on performance characteristics of broiler chicken at starter phase

	Treatments					
Parameters	T1	T2	T3	T4	T5	SEM
Initial body weight (kg)	0.04	0.04	0.04	0.04	0.04	0.001
AFBW (kg)	0.55^{a}	0.55^{b}	0.45^{c}	0.42^{d}	0.36^{e}	0.01
TBWG (kg)	0.51^{a}	0.51^{a}	0.41^{b}	0.38^{c}	0.32^{d}	0.01
ADFI (kg)	32.50^{a}	33.09^{b}	35.35^{c}	35.33^{c}	32.55^{d}	0.03
FCR	1.78	1.82	2.41	2.60	2.85	
FCE	0.56	0.46	0.42	0.39	0.35	
Mortality (%)	0.00	2.50	2.50	5.00	10.00	

$^{a-d}$Means along the same row with different super script are significantly different ($p<0.05$)

Table 4: Effect of replacing fish meal (FM) with duckweed weed meal (DWM) on performance characteristics of broiler chicken at finisher phase

	Treatments					
Parameters	T1	T2	T3	T4	T5	SEM
IBW (kg)	0.55^{a}	0.55^{a}	0.45^{b}	0.42^{c}	0.36^{d}	0.01
AFBW (Kg)	2.25^{a}	2.25^{a}	2.20^{b}	1.81^{c}	1.78^{d}	0.05
TBWG (Kg)	1.70^{a}	1.70^{a}	1.75^{b}	1.39^{c}	1.38^{d}	0.05
ADFI (g)	164.27^{b}	165.15^{b}	171.85^{a}	150.55^{c}	148.60^{d}	2.00
FCR	2.71	2.72	2.75	3.03	3.02	
FCE	0.49	0.48	0.36	0.38	0.36	
Mortality (%) 0.00	0.00	0.00	1.50	2.50		

$^{a-d}$Means along the same row with different superscript are significantly different (p<0.05)

Table 5: Effect of replacing fish meal (FM) with duckweed weed meal (DWM) on hematological parameters of broiler chicken at starter phase

	Treatments					
Parameters	T1	T2	T3	T4	T5	SEM
Packed cell volume (%)	28.45^{a}	26.15^{b}	25.23^{c}	20.10^{d}	17.87^{e}	2.00
Heamoglobin (g dL^{-1})	9.85^{a}	9.77^{a}	7.42^{b}	6.85^{c}	4.96^{d}	0.50
Red Blood cell (10×µL)	1.36^{a}	1.28^{b}	1.26^{b}	1.15^{c}	1.08^{d}	0.05
WBC (10×µL)	1850.00^{e}	1985.00^{d}	2088.00^{c}	2142.00^{b}	2200.00^{a}	15.00
MCV (fl)	20.92	20.43	20.02	17.48	16.54	
MCH (pg)	72.43	76.33	58.89	59.56	45.93	
MCHC (%)	3.46	3.74	2.94	3.41	2.76	

$^{a-d}$Means along the same row with different superscript are significantly different (p<0.05)

Table 6: Effect of replacing fish meal (FM) with duckweed weed meal (DWM) on hematological parameters of broiler chicken at finisher phase

	Treatments					
Parameters	T1	T2	T3	T4	T5	SEM
Packed cell volume (%)	30.05^{a}	27.52^{b}	25.58^{c}	22.15^{d}	19.86^{e}	2.50
Heamoglobin (g dL^{-1})	10.05^{a}	9.65^{a}	8.50^{b}	8.06^{c}	6.45^{d}	1.00
Red Blood cell (10×µL)	1.45^{a}	1.37^{b}	1.34^{b}	1.20^{c}	1.10^{d}	0.08
WBC (10×µL)	1800.00^{e}	1990.00^{d}	2100.00^{c}	2160.00^{b}	2275.00^{a}	20.00
MCV (fl)	20.72	20.08	19.09	18.46	18.06	
MCH (pg)	69.31	70.44	63.43	67.17	58.64	
MCHC (%)	3.34	3.51	3.32	3.64	3.25	

$^{a-d}$Means along the same row with different superscript are significantly different (p<0.05)

compared favourably well in terms of FBW, TBWG, FCR and EFU although with slight increase in their DFI. There are strong indications for the presence of growth stimulating factor in (DWM) which may be traced to its well -balanced amino acid profile[36]. The result corrobates previous works of Liebert and Portz[37], that the plant protein are better for the growth and production of broilers. Feed intake result agreed with previous works carried out on high fibre diets[38-40] that the presence of high fiber level in diets can cause intestinal irritation, lower digestibility and overall decreased nutrient utilization. The FCR and EFU which are important feed quality indices revealed that birds on T2 (25%) and T3 (50%) were found comparable with control diet T1. This trend is in agreement with the earlier report of Islam *et al.*[41]. However, the increase in mortality rate of birds from T4 and T5 at finisher phase as well could be due to anti-nutritional factors present in DWM.

Table 5 shows the haematological parameters of broiler starters in response to the dietary treatments. The packed cell volume (PCV), haemoglobin concentration (Hb), red blood cell counts (RBC) and white blood cell counts (WBC) were significantly (p<0.05) affected by the treatments. Early studies by Oladele[42] and Ademola *et al.*[43] showed that blood variables most commonly affected by dietary treatments include RBC, PCV, WBC and Hb. The value of the PCV decreases from T1-T5, although values observed fell within the range of 25.9-45.2% as earlier reported for healthy chicken[44] except for T4 and T5 with values less than average 25% which may indicate anaemic condition.

The Hb and RBC values observed for T1- T3 fell within the range of values for normal chicken (7.5-13.5 g dL^{-1})[44]. The values of MCV, MCHC fell within the range of values for normal chicken[44] and comparable to report of chicks fed soyabean in place of fish meal[44]. The significant increase in values of WBC from T1-T5 which is an indication of increase in antibodies production may be due to presence of anti-nutritional factors in DWM and the toxicity got increased with increase in supplementation with DWM.

Table 6 shows the effect of DWM on haematological parameters of broiler chickens at finisher phase. The value of

Table 7: Effect of replacing fish meal (FM) with duckweed meal (DWM) on serum metabolites of broiler chickens at starter phase

	Treatments					
Parameters	T1	T2	T3	T4	T5	SEM
Total protein (TP) ($g\ dL^{-1}$)	5.24[d]	5.50[c]	5.52[c]	5.80[b]	6.01[a]	0.15
Albumin ($g\ dL^{-1}$)	1.82[a]	1.96[cd]	2.01[c]	2.24[b]	2.40	0.10
Globulin ($g\ dL^{-1}$)	3.42[c]	3.54[b]	3.51[b]	3.56[b]	3.61[a]	0.05
Alb/globulin ratio	0.53	0.55	0.57	0.63	0.66	
Creatinine ($Mg\ dL^{-1}$)	1.84[e]	1.95[d]	2.18[c]	2.26[b]	2.40[a]	0.07
Bilirubin	0.84[d]	0.92[c]	0.93[c]	1.04[b]	1.15[a]	0.05
Urea	2.80[bc]	2.94[b]	2.95[b]	2.98[b]	3.12[a]	0.06
AST ($IU\ L^{-1}$)	10.01[d]	10.24[c]	10.45[b]	110.56[b]	10.92[a]	0.20
ACP ($IU\ L^{-1}$)	4.02[d]	4.18[c]	4.19[c]	4.64[b]	4.86[a]	0.10
ALP ($IU\ L^{-1}$)	44.12[d]	46.04[c]	46.05[c]	48.15[b]	49.74[a]	1.00
Cholesterol ($mg\ d^{-1}$)	155.40	155.80	156.20	155.80	155.70	3.50

[a-d]Means along the same row with different superscript are significantly different ($p < 0.05$)

Table 8: Effect of replacing fish meal (FM) with duckweed meal (DWM) on serum metabolites of broiler chickens at finisher phase

	Treatments					
Parameters	T1	T2	T3	T4	T5	SEM
Total protein (TP) ($g\ dL^{-1}$)	6.05[d]	6.62[c]	6.85[c]	7.21[b]	7.50[a]	0.85
Albumin ($g\ dL^{-1}$)	2.05[d]	2.10[c]	2.12[c]	2.18[b]	2.25[a]	0.25
Globulin ($g\ dL^{-1}$)	4.00[d]	4.52[c]	4.63[c]	5.03[b]	5.25[a]	0.30
Alb/globulin ratio	0.51	0.46	0.46	5.03	5.25	
Creatinine ($Mg\ dL^{-1}$)	1.72[e]	1.85[d]	2.15[c]	2.23[b]	2.50[a]	0.50
Bilirubin	0.90[d]	0.95[c]	0.94[c]	1.10[b]	1.50[a]	0.06
Urea	2.70[d]	2.85[c]	2.87[c]	3.15[b]	3.23[a]	0.09
AST ($IU\ L^{-1}$)	9.85[c]	9.82[c]	9.84[c]	10.50[b]	10.75[a]	0.80
ACP ($IU\ L^{-1}$)	4.05[d]	4.11[c]	4.12[c]	4.75[b]	4.90[a]	0.50
ALP ($IU\ L^{-1}$)	40.05[d]	44.22[c]	44.40[c]	46.55[b]	47.24[a]	1.00
Cholesterol ($mg\ d^{-1}$)	130.45	130.68	131.42	130.40	130.00	2.50

[a-d]Means along the same row with different superscript are significantly different ($p< 0.05$)

the parameters followed the same trend across the treatment groups as reported for the birds as starter phase.

Furthermore, the result of the influence of DWM on the serum metabolites of broiler chickens at starter phase is as shown in Table 7. All parameters investigated except serum cholesterol were significantly ($p<0.05$) affected by the dietary treatments. Metabolites such as total protein (TP), albumin (Alb), globulin (Glb), creatinine, bilirubin, urea and serum enzymes such as aspartate transaminase (AST), acid phosphatase (ACP) and alkaline phosphatase (ALP) got increased with increase in DWM level of the diets. TP, Alb, Glb are indirect indices for measuring the nutritional protein adequacy[42]. Values are higher in experimental birds on (AW) supplementation to that of control but are still within the range recorded for normal chicken by Thrall *et al.*[44]. Albumin/globulin ratios were not significantly affected by the treatments. Creatinine and urea are parameters used to measure the function of kidney[44]. The values of both significantly increased from T1-T5 ($p<0.05$) along the treatments, but are still within the range recorded by Thrall *et al.*[44] for normal chickens.

Though values increased with the rate of supplementation which could be due to increase in level of some anti-nutritional factors present in DWM. AST and ALT which are enzymes used to test liver function followed the same trends, increases with supplementation of DWM, which can be attributed to same reason aforementioned indicating hepatic and renal cell degeneration[22]. The significance increase in value of ALP with increase in supplementation suggests caution on the quantity of DWM that should be fed to broilers. The value of cholesterol was not significantly ($p>0.05$) affected by the treatments which gave a good indication that birds are not suffering from hypercholesterolemia or hypercholesterolemia as values are within the range for normal chicken as recorded by Thrall *et al.*[44].

Table 8 shows the effect of DWM on the serum metabolites of broiler chickens at finisher phase.

The results revealed that the parameters followed the same trend as in the starter phase.

The effect of DWM on the relative weight of the internal organs of broiler chickens at the end of the dietary trials is shown in Table 9.

Table 9: Effect of replacing fish meal (FM) with duckweed meal (DWM) on the relative weight of some internal organs of broiler chickens

	Treatments					
Parameters	T1	T2	T3	T4	T5	SEM
Gizzard	3.45^{e}	3.50^{d}	3.70^{c}	3.85^{ab}	3.90^{a}	0.05
Heart	0.41	0.42^{d}	0.46^{c}	0.54^{b}	0.56^{a}	0.02
Spleen	0.10	0.15^{c}	0.18^{b}	0.19^{a}	0.19^{a}	0.09
Liver	1.95^{e}	2.10^{d}	2.18^{c}	2.23^{b}	2.55^{a}	0.05
Abdominal fat	0.05	0.04	0.04	0.03	0.00	0.001
Intestine	8.50^{c}	7.48^{e}	7.50^{d}	8.65^{ab}	8.68^{a}	1.00
Proventriculus	0.66	0.60	0.60	0.62	0.63	0.001

$^{a-d}$Means along the same row with different superscript are significantly different ($p < 0.05$)

The weight of the individual organ was expressed as the percentage of the live weight of the respective chicken before dressing. Internal organs such as the gizzard, heart, spleen, liver and the intestine were significantly ($p<0.05$) affected by the dietary treatments. For gizzard, the values increased progressively from T1 (3.45)-T5 (3.90). The percentage weight of heart and spleen of birds were also significantly ($p<0.05$) affected .In both parameters, the values increased progressively. Proventriculus shows no significant ($p>0.05$) difference for all the treatment, while the percentage intestinal weight was significantly ($p<0.05$) affected in all the treatments. All significant increase in the values of internal organs from in all the dietary treatment groups may be due to presence of some anti-nutritional factors in DWM. These results are in agreement the findings of Eruvbetine and Oguntona[45] that when cassava leaf meal was fed to broilers, an increase in organ weight was noticed due to hydro cyanide (HCN) an anti-nutritional factor present in cassava. The value of percentage abdominal fat across the treatment groups suggest that the DWM inclusions did not allow fat build up by the birds but rather all nutrients are been converted to lean meat, as the values decreases from T_1 (control) to T_5 (100% DWM).

CONCLUSION

DWM can be used to replace FM in the diets of broilers at starter and finisher phases. However, the inclusion must not exceed 25% at starter phase and 50% at finisher phase. Also, more works must be done to identify the anti-nutritional factors present in DWM and their pathological effects on chickens so as to design ways to detoxify these factors.

SIGNIFICANCE STATEMENTS

This study discovers the possible use of using duckweed meal to replace fish meal in the diets of broiler starter and finisher chickens. This study will help the researchers to uncover important area of alternative feed ingredients for effective and least cost broiler diet formulations that many researchers were not able to investigate. Thus a new theory on the use of duckweed meal and other aquatic weeds may be arrived.

REFERENCES

1. Esonu, B.O., 2000. Animal Nutrition and Feeding: A Functional Approach. Rukzeal and Ruksors Associates Memory Press, Owerri, Nigeria.
2. Okereke, C.O., 2012. Utilization of cassava, sweet potato and cocoyam meals as dietary sources for poultry. World J. Eng. Pure Applied Sci., 2: 63-68.
3. Okonkwo, W.U. and C.O. Akubuo, 2004. Thermal analysis education of heat requirement of a passive solar energy poultry chick brooder in Nigeria. J. Renew. Energy, 9: 115-119.
4. Esonu, B.O., 2009. Unconventional feed resources for livestock development and food security prodigies for Nigerian livestock. 14th Inaugural Lecture, Federal University of Technology, Owerri, Nigeria, pp: 21-32.
5. Uchegbu, M.C., A.A. Omede, P.C. Adimorah and G.A. Anyawu, 2008. Performance and carcass characteristics of finisher broiler chicken fed dietary dried plantain peel meal. Proceedings of the 42nd Annual Conference of the Agricultural Society of Nigeria, October 19-23, 2008, Ebonyi State University, Abakaliki, Nigeria, pp: 630-634.
6. Nosim, M.O., 2003. Economics analysis of broiler production in Nigeria. A case study of Ibadan. M.Sc. Thesis, Department of Agriculture Economics, University of Ibadan, Nigeria.
7. Madubuike, F.N. and B.U. Ekenyem, 2001. Non-ruminant livestock production in the tropics. Gust-Chuks Graphic Centre, Owerri, Nigeria, pp: 110-202.
8. Oluyemi, J.A. and F.A. Roberts, 2000. Poultry Production in Warm Wet Climates. 2nd Edn., Spectrum Books, Ibadan, Nigeria, ISBN: 9789780290979, Pages: 190.
9. Miles, R.D. and J.P. Jacob, 2011. Fishmeal: Understanding why this feed ingredient is so valuable in poultry diets. IFAS Extension Publication PS30, University of Florida, USA.

10. Al-Harthi, M.A., 2001. Efficacy of vegetable diets with antibiotics and different types of spices or their mixtures on performance, economic efficiency and carcass traits of broilers. J. Agric. Sci. Mansoura Univ., 27: 3531-3545.
11. Aji, L.P., 2011. The use of algae concentrates, dried algae and algal substitutes to feed bivalves. Makara J. Sci., 15: 1-8.
12. Skrede, A., L.T. Mydland, O. Ahlstrøm, K.I. Reitan, H.R. Gislerod and M. Overland, 2011. Evaluation of microalgae as sources of digestible nutrients for monogastric animals. J. Anim. Feed Sci., 20: 131-142.
13. Becker, W., 2004. Microalgae for Aquaculture: The Nutritional Value of Microalgae for Aquaculture. In: Handbook of Microalgal Culture: Biotechnology and Applied Phycology, Richmond, A. (Ed.). Chapter 21, John Wiley and Sons, Oxford, UK., ISBN-13: 9780632059539, pp: 380-391.
14. Akter, M., S.D. Chowdhury, Y. Akter and M.A. Khatun, 2011. Effect of duckweed (*Lemna minor*) meal in the diet of laying hen and their performance. Bangladesh Res. Publ. J., 5: 252-261.
15. Carrillo, S., E. Lopez, M.M. Casas, E. Avila and R.M. Castillo *et al*., 2008. Potential use of seaweeds in the laying hen ration to improve the quality of n-3 fatty acid enriched eggs. J. Applied Phycol., 20: 721-728.
16. Fasuyi, A.O., 2006. Nutritional potentials of some tropical vegetable leaf meals: Chemical characterization and functional properties. Afr. J. Biotechnol., 5: 49-53.
17. Nworgu, F.C., S.A. Ogungbenro and K.S. Solesi, 2007. Performance and some blood Chemistry indices of broiler chicken served fluted pumpkin (*Telfaria occidentalis*) leaves extract supplement. Am. Eurasian J. Agric. Environ. Sci., 2: 90-98.
18. Fasuyi, A.O. and A.D. Nonyerem, 2007. Biochemical, nutritional and haematological implications of *Telfairia occidentalis* leaf meal as protein supplement in broiler starter diets. Afr. J. Biotechnol., 6: 1055-1063.
19. Alabi, O.M., F.A. Aderemi, M.O. Ayoola, T.E. Lawal, A.A. Adewumi, A.O. Oguntunji and O.B. Alabi, 2009. Performance characteristics and gut Morphology of broiler chickens fed with oral supplementation of *Telfairia occidentalis* leaf extract at finisher phase. Proceedings of the 14th Annual Conference of the Animal Science Association of Nigeria, September 14-17, 2009, Ladoke Akintola Univeristy of Technology, Oyo State, Nigeria, pp: 354-356.
20. Olugbemi, S.T., T.S. Mutayoba and F.P. Lekule, 2011. Evaluation of *Moringa oleifera* leaf meal inclusion in cassava chip-based broilers diets on carcass and organoleptic indices. Proceedings of the 36th Annual Conference of Nigeria Society for Animal Production, March 13-16, 2011, University of Abuja, Nigeria, pp: 451-455.
21. Kakengi, A.M.V., J.T. Kaijage, S.V. Sarwatt, S.K. Mutayoba, M.N. Shem and T. Fujihara, 2007. Effect of *Moringa oleifera* leaf meal as a substitute for sunflower seed meal on performance of laying hens in Tanzania. Livest. Res. Rural Dev., Vol. 19, No. 8.
22. Foluke, A. and A. Olufemi, 2013. Effects of graded levels of cassava peels fortified with *Moringa* as a replacement to wheat bran on performance, digestibility and blood profile of broilers. J. Agric. Sci. Technol. A, 3: 210-215.
23. Alalade, O.A. and E.A. Iyayi, 2006. Chemical composition and the feeding value of azolla (*Azolla pinnata*) meal for egg-type chicks. Int. J. Poult. Sci., 5: 137-141.
24. Onyimonyi, A.E. and O. Ernest, 2009. An assessment of pawpaw leaf meal as protein ingredient for finishing broiler. Int. J. Poult. Sci., 8: 995-998.
25. Ferentinos, L., J. Smith and H. Valenzula, 2002. *Azolla*. Sustainable Agriculture Green Manure Crops, August 2002, SA-GM-2, Cooperative Extension Service, College of Tropical Agriculture and Human Resources, University of Hawaii at Manoa, Honolulu, HI., USA.
26. Landolt, T.E., 2000. Lemnaceae. In: Flora of North America: Volume 22: Magnoliophyta: Alismatidae, Arecidae, Commelinidae (in part) and Zingiberidae, Flora of North America Editorial Committee (Eds.). Oxford University Press, New York and Oxford, ISBN-13: 9780195137293, pp: 143-153.
27. El-Sayed, A.F.M., 1992. Effects of substituting fish meal with *Azolla pinnata* in practical diets for fingerling and adult Nile tilapia, *Oreochromis niloticus* (L.). Aquacult. Res., 23: 167-173.
28. Heindl, U., A. Kliangpradit and W. Phromkunthong, 2004. The effect of phytase on the utilization of plant phosphorus in sex-reversed tilapia (*Oreochromis niloticus*). Proceedings of the 11th International Symposium on Nutrition and Feeding in Fish, May 2-7, 2004, Phuket Island, Thailand.
29. AOAC., 1980. Official Methods of Analysis. 11th Edn., Association of Official Analytical Chemist, Washington, DC., USA.
30. Lewis, S.M., B.J. Bain and I. Bates, 2006. Dacie and Lewis Practical Haematology. 10th Edn., Churchill Livingston/Elsevier, USA., ISBN-10: 9780443066603, Pages: 722.
31. Schalm, O.W., N.C. Jain and E.J. Caroll, 1975. Veterinary Hematology. 3rd Edn., Lea and Febiger, Philadelphia, PA., USA., ISBN-13: 978-0812104707, pp: 129-250.
32. Arello, S.E., 1998. The Merck Veterinary Manual. 8th Edn., Merck and Co. Inc., Philadelphia, USA., ISBN-13: 978-0911910292, pp: 11-21.
33. SAS., 2002. SAS User's Guide. SAS Institute Inc., Carry, NC., USA.
34. Mishra, K. and S. Kastrui, 2000. Nutritive value of six microalgae. Proceedings of the 5th Indian Fisheries Forum, January 17-20, 2000, Bhubaneswar, Orissa, India, pp: 57.
35. Sheeja, B.D., R. Narayanan and J. Ebanasar, 2003. Digestibility of hydrophytes and survival of grass carp *Ctenopharyngodon idella* exposed to microbial probiotic *Lactobacillus*. Indian J. Camp. Anim. Physiol., 21: 5-10.

36. Konyeme, J.E., A.O. Sogbesan and A.A.A. Ugwumba, 2006. Nutritive value and utilization of water hyacinth (*Eichhornia crassipes*) meal as plant protein supplement in the diet of *Clarias gariepinus* (Burchell, 1822) (Pisces: Clariidae) fingerlings. Afr. Scientist, 7: 127-133.
37. Liebert, F. and L. Portz, 2004. Nutrient utilization of Nile tilapia *Oreochromis niloticus* fed plant-based low phosphorus diets supplemented with graded levels of different sources of microbial phytase. Proceedings of the 11th International Symposium on Nutrition and Feeding in Fish, May 2-7, 2004, Phuket Island, Thailand.
38. Nworgu, F.C., K.A. Akintola, O.D. Njoku, B.O. Omosowon, P.L. Ozor, O.P. Olatidoye and A.G. Adekola, 2012. Performance of pullet chicks served fluted Pumpkin (*Telfairia occidentalis*) leaves extract supplement and the effects on their blood parameter. Eur. J. Scient. Res., 87: 254-266.
39. Aderemi, F.A., O.O. Tewe, E.A. Iyayi and O.A. Ladokun, 2003. Metabolizable energy and nutrient digestibility of growing pullets fed enzyme supplemented Cassava Root Sieviate (CRS) as a replacement to wheat bran in cassava based diet. Trop. Anim. Prod. Invest., 6: 135-142.
40. Ekwe, C.C., S.N. Ukachukwu and K.C. Ekwe, 2007. Performance and Nitrogen retention of Weaner rabbits fed graded level of composite cassava meals. Proceedings of the 41st Annual Conference of the Agricultural Society of Nigeria, October 22-26, 2007, Institute for Agricultural Research, Samaru, Zaria, pp: 200-202.
41. Islam, K.M.S., Shakjalal, A.M.M. Traeque and M.A.R. Howlider, 1997. Complete replacement of dietary fish meal by duckweed and soybean meal on the performance of broilers. Asian-Aust. J. Anim. Sci., 10: 629-634.
42. Oladele, S.B., 2000. Haematological parameters of some apparently healthy and some clinically sick indigenous poultry species in Zaria. M.Sc. Thesis, Ahmadu Bello University, Zaria, Nigeria.
43. Ademola, S.G., G.O. Farinu and G.M. Babatunde, 2009. Serum lipid, growth and haematological parameters of broilers fed garlic, ginger and their mixtures. World J. Agric. Sci., 5: 99-104.
44. Thrall, M.A., D.C. Baker and E.D. Lassen, 2004. Veterinary Hematology and Clinical Chemistry. Lippincott Williams and Wilkins, Philadelphia, USA., ISBN-13: 9780781768504, pp: 412-560.
45. Eruvbetine, D. and E.B. Oguntona, 1997. Unpeeled cassava root meal in diets for laying hens. Trop. Agric., 774: 299-302.