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**RESEARCH ARTICLE**

# Growth performance and nutrient digestibility of pullet chicks fed graded levels of Water Hyacinth [*Eichhornia crassipes* (Martius) Solms-Laubach] meal diets at the starter phase (0-8 weeks)

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## *Abstract*

A total of 300 day-old Isa Brown pullet chicks were fed diets containing graded levels of water hyacinth meal (WHM) at 0, 5, 10 and 15 % dietary inclusion levels (to form Diet 1, 2, 3 and 4 respectively) for 8 weeks. Each treatment was divided into three replicates and each replicate was made up of 25 birds. At the end of the 7$^{th}$ week, some of the birds were randomly selected and moved to specially-constructed metabolism cages for a digestibility trial that lasted for one week; made up of four days adjustment period and three days faecal collection period. There were no significant (p>0.05) differences in initial body weight, final body weight, total body weight gain, weekly feed intake, feed conversion ratio, energy efficiency and mortality among the various dietary treatments. There were no significant (p>0.05) differences in digestibility of dry matter and ash; but digestibility of crude protein, crude fibre, nitrogen free extract (NFE) as well as total digestible nutrient (TDN) were significantly (p<0.05) different among the dietary treatments. Hence, for optimum growth performance and nutrient utilization, WHM can be included up to 10 % in the diets of pullet chicks (replacing 50 % of wheat offal), without the addition of any exogenous enzymes. Hence, a noxious weed that is a nuisance to everyone can now serve as a valuable feed resource for pullet chicks.



## Introduction

Water hyacinth [*Eichhornia crassipes* (Martius) Solms-Laubach)] originated from the Amazon River Basin of South America (Brazil); but today, it has spread to all the tropical and subtropical countries of the world (Parsons & Cuthbertson, 2001). It has spread to over 50 countries of the world including USA, China, Argentina, Brazil, India, Sri Lanka, Indonesia, Thailand, Philippines and Egypt; it has also spread to Sudan, Congo, Malawi, Kenya, Uganda, Rwanda, Burundi, South Africa, Tanzania, Zimbabwe and Australia. In fact, water hyacinth is regarded as one of the world's most invasive aquatic weed species. It is known to have significant ecological and socio-economic effects by having adverse effect on water resources, fisheries, irrigation, drainage canals and public health (Hussein, 1992). Mats of water hyacinth limit the productivity of phytoplankton and submerged vegetation such as *Sagittaria kurziana* through the effect of shading (Villamagna & Murphy, 2010). In spite of these disadvantages, however, water hyacinth has a lot of benefits and potential uses; hence the greatest challenge today is developing water hyacinth from its menace status into an asset of national value; by seeing the plant as an opportunity instead of a problem. According to Abdel-sabour (2010), the real challenge is not how to get rid of this weed but how to benefit from it and turn it into a crop.

### 1.1 Review of Literature

Water hyacinth has received much attention in recent years due to its potential benefits as animal fodder, aquafeed, water purification, fertilizer, biogas production, even food for human and other products (Ogle *et al*., 2001). The fibres from the petioles can be used to make rope, baskets, carpets and local furniture (Malik, 2007). Water hyacinth has also been used as fodder to cattle (Tham & Uden, 2013), goats (Dada, 2002), sheep (Abdalla *et al*., 1987), pigs (Men *et al*., 2006), ducks (Jianbo *et al*., 2008), *Clarias gariepinus* fingerlings (Konyeme *et al*., 2006), *Tilapia* fingerlings (El-Sayed, 2003) and *Labeo rohita* fingerlings (Saha & Ray, 2011). The high levels of cellulose and hemicelluloses in water hyacinth could make it a suitable energy source for ruminants (Mukherjee & Nandi, 2004). However, water hyacinth is also characterized by low dry matter and high crude protein and ash contents (22.8 % and 12.4 % respectively; Fasakin, 2002). National Academy of Sciences (1976) claimed that the major constraints for its use as a ruminant feed is the high water and ash contents hence non-ruminants (pigs, rabbits and poultry) can better utilize water hyacinth than cows and goats.

Several studies have been carried out on the utilization of water hyacinth leaf and whole plant meal as feedstuffs for poultry. For eight-week Tegal ducks, fermentation of water hyacinth leaf with *Aspergillus niger* increased the nutrient quality and the nutritive value of the diets in terms of crude protein digestibility, true metabolizable energy and nitrogen retention (Mangisah *et al*., 2010). The objectives of this research work is to determine the growth performance and nutrient digestibility of pullet chicks fed graded levels of water hyacinth [*Eichhornia crassipes* (Martius) Solms-Laubach] meal diets at the starter phase (0-8 weeks).

## 2.0 Materials & Methods

The research study was carried out at the Poultry Unit of the Animal Production Teaching and Research Farm, Federal University of Technology, Minna, Nigeria. Minna is the State Capital of Niger State and is located in the South Guinea Savanna Vegetation Zone, between Latitude $9^0\ 37'$ North and Longitude $6^0\ 33'$ East. Its mean annual rainfall and temperature range from 1200 to 1300 mm and 38 to $42^0$ C respectively (2008 Students' Handbook, Federal University of Technology, Minna).

### 2.1 Preparation of the water hyacinth meal (WHM)

Whole plants of water hyacinth were collected from the River Niger in Lokoja, Kogi State. The green plants were harvested freshly from the water surface, manually, and allowed to sun-dry at the bank of the river for about seven days until they were well dried. They were then packaged in polythene sacks and transported to the experimental site at Minna for further processing. Collections of the water hyacinth plant were carried out at two different periods of the year; the first collection period was at the peak of the dry season, during the month of March, and the second was at the peak of the rainy season, during the month of September.

On arrival at the Animal Production Laboratory of the Federal University of Technology, Minna, the sundried plants were subjected to thorough inspection, and foreign matters (river debris, leather wrappings and other extraneous materials) removed. They were then oven dried at $80^0$C for about 24 hours to a moisture content of about 10 %. The dried plants were then milled at the School of Agriculture and Agricultural Technology feed mill using an attrition mill and sieved through a 2 mm sieve to obtain water hyacinth meal (WHM) which was then stored in large plastic containers with tight-fitting lids until needed for use.

### 2.2 Experimental animals and experimental design

A total of 300 day-old Isa Brown pullet chicks collected from the Minna Depot of Avian Specialities, Ibadan, Oyo State, were used for this Study. Seven days before the arrival of the birds, the pens were thoroughly washed and disinfected. A few hours to arrival, all equipment were put in place (feeders, drinkers, bulbs, heat source, etc) and heated to a suitable temperature (about $35^0$C). The experiment was a Completely Randomized Design Experiment made up of four dietary inclusion levels of 0, 5, 10 and 15 % of WHM to form Diet 1, 2, 3 and 4 respectively (Table 1). On arrival, the birds were weighed and allocated randomly into the four dietary treatment groups consisting of 75 birds per treatment and three replicates per diet; with each replicate made up of 25 birds. The experiment lasted for 8 weeks during which time they were managed intensively using the standard code of procedure as recommended for pullet chicks by the Nigerian Institute of Animal Science (NIAS). The birds were fed *ad libitum* with the experimental diets throughout the period of the experiment. Routine management operations such as daily removal of left-over (uneaten) feed, washing of drinkers, provision of clean drinking water and cleaning of the environment were carried out. The birds were also given standard medication and vaccination against the common poultry diseases as recommended for this region by the Nigerian Veterinary Medical Association (NVMA).

### 2.3 Parameters determined

The following parameters were determined using the procedures of Adesida *et al*. (2010) as follows:

(i) Average daily feed intake. This was obtained by subtracting the quantity of the left-over (uneaten) feed from the quantity of feed supplied to the birds per day.

(ii) Weekly body weight gain. This was measured by subtracting the body weight of the birds of the preceding week from the body weight of the birds in the following week.

(iii) Feed conversion ratio (FCR). This was obtained by dividing the average feed intake per bird per week by the body weight gained per bird per week for each treatment.

$$FCR = \frac{\text{Weekly feed intake (g)}}{\text{Weekly body weight gain (g)}}$$ (Isikwenu *et al.*, 2010)

(iv) Energy efficiency (EE)

$$EE = \frac{\text{Body weight gain (kg)}}{\text{Energy intake (kcal/kg)}}$$ (Ayanwale, 2003)

(v) Digestibility trial

At the end of the 7$^{th}$ week, three birds per replicate were randomly selected, removed from the floor and placed in the digestibility cages for 4 days for them to adjust to the conditions in the cages. A total of 36 birds were used for the digestibility trial. Before the commencement of the faecal sample collections, the birds were kept off feed for 12 hours and given only water. This was to evacuate the residual content of their gut. Fresh feed of known weight were then given to the birds; and faecal collection commenced the following day, using the total collection method, following the procedures of Lamidi *et al*. (2008). Collection lasted for 3 days. Faecal samples collected per day were oven dried at 80$^0$C for about 24 hours when a constant weight was obtained. The oven dried droppings collected for 3 days were then pooled together, packaged in plastic containers and stored in the freezer until needed for analysis. Apparent digestibility of nutrients (ADN) was calculated using the procedure of Isikwenu *et al*. (2010) thus:

$$ADN = \frac{\text{(Nutrient in feed consumed)} - \text{(Nutrient in voided droppings)}}{\text{Nutrient in feed consumed}} \times 100\%$$

Total digestible nutrient (TDN) was calculated using the formula:

TDN = Digestible crude protein + Digestible NFE + 2.25 x Digestible ether extract (Church and Pond, 1988).

## 2.4 Chemical analysis

The proximate composition of the water hyacinth meal (WHM), the four experimental diets and the faecal samples collected during the digestibility trial were determined using the procedures of AOAC (1990). The mineral composition of WHM was determined using the procedures of Yan *et al*. (2005) while the fibre composition of WHM was determined using the procedure of Van Soest and Wine (1968). The components of the anti-nutritional factors in WHM were determined as follows: the method of Lucas and Markakes (1975) was used for phytic acid; the method of Maga (1982) was used for the determination of tannin while oxalate and saponin were determined using the standard procedures of AOAC (1984).

## 2.5 Statistical analysis

Data collected were statistically analyzed using the SAS (2000) Package. Where means were significant ($p< 0.05$), they were separated using the Duncan's Multiple Range Test (Duncan, 1955).

**Table 1: Composition of the pullet chicks' diets**

| **Ingredients (%)** | **Water hyacinth meal inclusion levels (%)** 0 | 5 | 10 | 15 |
|---|---|---|---|---|
| Maize | 47.20 | 47.20 | 47.20 | 47.20 |
| Ground nut cake | 20.00 | 20.00 | 20.00 | 20.00 |
| Fish meal | 3.00 | 3.00 | 3.00 | 3.00 |
| Blood meal | 2.00 | 2.00 | 2.00 | 2.00 |
| Wheat offal | 20.00 | 15.00 | 10.00 | 5.00 |
| Water hyacinth meal (WHM) | 0.00 | 5.00 | 10.00 | 15.00 |
| Palm oil | 2.00 | 2.00 | 2.00 | 2.00 |

| | | | | |
|---|---|---|---|---|
| Bone meal | 3.25 | 3.25 | 3.25 | 3.25 |
| Limestone | 1.00 | 1.00 | 1.00 | 1.00 |
| Lysine | 0.50 | 0.50 | 0.50 | 0.50 |
| Methionine | 0.50 | 0.50 | 0.50 | 0.50 |
| Common salt | 0.30 | 0.30 | 0.30 | 0.30 |
| *Premix | 0.25 | 0.25 | 0.25 | 0.25 |
| Total | 100.00 | 100.00 | 100.00 | 100.00 |
| **CALCULATED VALUES** | | | | |
| Crude protein (%) | 20.11 | 19.94 | 19.77 | 19.60 |
| Metabolizable energy (kCal/kg) | 2806 | 2813 | 2819 | 2826 |
| Crude fibre (%) | 4.10 | 4.64 | 5.18 | 5.72 |
| Calcium (%) | 1.55 | 1.54 | 1.55 | 1.55 |
| Phosphorus (%) | 1.17 | 1.15 | 1.16 | 1.17 |
| Lysine (%) | 1.45 | 1.42 | 1.45 | 1.45 |
| Methionine (%) | 0.83 | 0.82 | 0.83 | 0.83 |

*Each 2.5 kg of the premix contains 10,000,000 IU of vitamin A; 2,000,000 IU of vitamin D3; 23,000 mg of vitamin E; 2,000 mg of vitamin K3; 1,800 mg of vitamin B1; 5,500 mg o vitamin B2; 27,500 mg of niacin (B3); 7,500 mg of pantothenic acid (B5); 3,000 mg of vitamin B6; 15 mg of vitamin B12; 750 mg of folic acid; 60 mg of biotin H2; 300,000 mg of choline chloride; 200 mg of cobalt; 3,000 mg of copper; 1,000 mg of iodine; 20,000 mg of iron; 40,000 mg of manganese; 200 mg of selenium; 30,000 mg of zinc and 1,250 mg of antioxidant.

**Table 2: Proximate composition of water hyacinth meal (WHM) and the pullet chicks' diets (%)**

| Parameters (%) | Water hyacinth meal inclusion levels (%) 0 | 5 | 10 | 15 | Water Hyacinth Meal (WHM)* |
|---|---|---|---|---|---|
| Dry matter (DM) | 93.33 | 93.02 | 93.46 | 93.49 | 93.28 |
| Crude protein (CP) | 20.88 | 20.75 | 20.25 | 20.23 | 13.88 |
| Crude fibre (CF) | 4.11 | 4.60 | 4.67 | 5.67 | 21.43 |
| Ether extract (EE) | 8.20 | 4.60 | 4.67 | 5.67 | 4.89 |
| Ash | 13.45 | 9.80 | 10.40 | 11.50 | 24.16 |
| NFE | 46.69 | 16.00 | 18.75 | 19.90 | 28.92 |

*Result obtained is the average of both the dry season and rainy season determinations.

**Table 3: Mineral, crude fibre and anti-nutritional factors composition of water hyacinth meal (WHM)**

| Mineral composition | | Crude fibre composition (%) | | Anti-nutritional factors (mg/100g) | |
|---|---|---|---|---|---|
| Potassium (%) | 1.02 | NDF | 63.54 | Saponin | 0.26 |
| Calcium (%) | 3.03 | ADF | 37.46 | Tannin | 1.44 |
| Magnesium (%) | 2.01 | Cellulose | 24.60 | Oxalate | 2.24 |
| Zinc (ppm) | 0.14 | Hemi-cellulose | 26.08 | Phytate | 0.27 |
| Copper (ppm) | 0.46 | Lignin (ADL) | 12.86 | | |
| Iron (ppm) | 5.87 | | | | |
| Manganese (ppm) | 0.76 | | | | |
| Lead (ppm) | 0.10 | | | | |

NDF = Neutral detergent fibre
ADF = Acid detergent fibre
ADL = Acid detergent lignin

ppm = Parts per million

**Table 4: Growth performance of pullet chicks fed graded levels of water hyacinth meal diets**

| Parameters | Water hyacinth meal inclusion levels (%) | | | | SEM |
|---|---|---|---|---|---|
| | 0 | 5 | 10 | 15 | |
| Initial body weight (g/bird) | 29.67 | 30.67 | 30.67 | 29.00 | 0.60ns |
| Final body weight (g/bird) | 409.37 | 386.21 | 389.62 | 390.20 | 5.43ns |
| Total body weight gain (g/bird) | 379.70 | 355.54 | 358.96 | 361.20 | 5.73ns |
| Weekly body weight gain (g/bird) | 47.46 | 44.44 | 44.87 | 45.15 | 0.72ns |
| Total feed intake (g/bird) | 1083.50 | 1081.50 | 1093.80 | 1107.00 | 8.70ns |
| Weekly feed intake (g/bird) | 135.44 | 135.18 | 136.72 | 138.37 | 1.09ns |
| Feed to gain ratio (FCR) | 2.86 | 3.05 | 3.06 | 3.07 | 0.05ns |
| Energy efficiency | 0.41 | 0.41 | 0.41 | 0.41 | 0.002ns |
| Mortality (%) | 18.67 | 14.67 | 13.33 | 10.67 | 2.53ns |

$^{a\,b}$Means in the same row with different superscripts were significantly ($p<0.05$) different

SEM = Standard error of the means

**Table 5: Digestibility of pullet chicks fed graded levels of water hyacinth meal diets (%)**

| Parameter | Diet 1 | Diet 2 | Diet 3 | Diet 4 | SEM |
|---|---|---|---|---|---|
| Dry matter | 83.33 | 84.46 | 82.70 | 82.91 | 0.70ns |
| Crude protein | $78.97^{a}$ | $73.84^{ab}$ | $69.57^{b}$ | $68.70^{b}$ | 1.57* |
| Crude fibre | $64.86^{a}$ | $69.79^{a}$ | $31.80^{b}$ | $33.20^{b}$ | 5.66* |
| Ether extracts | $90.32^{a}$ | $91.64^{a}$ | $92.58^{a}$ | $85.04^{b}$ | 0.99* |
| Ash | 57.04 | 62.57 | 66.38 | 65.93 | 2.01ns |
| Nitrogen free extracts | $91.05^{c}$ | $94.01^{b}$ | $95.78^{ab}$ | $97.54^{a}$ | 0.78* |
| Total digestible nutrient (TDN) | $79.45^{a}$ | $81.20^{a}$ | $78.92^{a}$ | $72.91^{b}$ | 1.03* |

$^{a\,b}$Means in the same row with different superscripts were significantly ($p<0.05$) different

SEM = Standard error of the means

## 3.0 Results

The proximate composition of WHM is shown in Table 2; indicating that it has a high fibre (21.43 %), intermediate crude protein (13.88 %), low ether extract (4.89 %) and high ash content (24.16 %). It also has appreciable quantities of minerals such as potassium (K), calcium (Ca) and magnesium (Mg) containing 1.02, 3.03 and 2.01 % respectively; with low levels of zinc (Zn), copper (Cu), iron (Fe), manganese (Mn) and lead (Pb) with 0.14, 0.46, 5.87, 0.76 and 0.10 ppm respectively (Table 3). WHM has high cellulose, hemi-cellulose and lignin content (24.60, 26.08 and 12.86 % respectively), with NDF and ADF values of 63.54 and 37.46 respectively. In terms of the anti-nutritional factors, the saponin, tannin, oxalate and phytate present are 0.26, 1.44, 2.24 and 0.27 mg/100g respectively (Table 3).

Proximate composition of the experimental pullet chicks' diets shows that they were roughly isoproteinous (Table 2), with crude protein content ranging from 20.23 % in Diet 4 to 20.88 % in Diet 1; while the crude fibre content increased as the dietary level of WHM increased (from 4.11 % in Diet 1 to 5.67 % in Diet 4).

Result of the growth performance trial is shown in Table 4. Initial body weight, final body weight, total body weight gain, weekly body weight gain, total feed intake, weekly feed intake, feed conversion ratio (feed to gain ratio), energy efficiency and mortality were not significantly ($p>0.05$) different among the various dietary treatments. However, initial body weight was highest in Diet 2 and 3 (30.67 g) and lowest in Diet 4 (29.00 g); final body weight was highest in Diet 1 (409.37 g) and lowest in Diet 2 (386.21 g); total body weight gain was highest in Diet 1 (379.70 g) and lowest in Diet 2 (355.54 g); weekly body weight gain was highest in Diet 1 (47.46 g) and lowest in Diet 2 (44.44 g); total feed intake was highest in Diet 4 (1107.00 g) and lowest in Diet 2 (1081.50 g); weekly feed intake was highest in Diet 4 (138.37 g) and lowest in Diet 2 (135.18 g); feed to gain ratio was highest in Diet 4 (3.07) and lowest in Diet 1 (2.86); energy efficiency was approximately the same for all the diets; while mortality was highest in Diet 1 (18.67 %) and lowest in Diet 4 (10.67 %).

Result of the digestibility trial is shown in Table 5. Dry matter (DM) and ash digestibility values were not significantly (p>0.05) different among the dietary treatments. Crude protein (CP), crude fibre (CF), ether extract (EE) and nitrogen free extracts (NFE) digestibilities were significantly (p<0.05) different among the dietary treatments. For CP, digestibility value for Diet 1, the Control Diet (78.97 %), was not significantly (p>0.05) different from that of Diet 2 (73.84 %) but was significantly (p<0.05) higher than those for Diet 3 (69.57 %) and Diet 4 (68.70 %), with 10 % and 15 % water hyacinth meal (WHM) respectively. For CF, the digestibility for Diet 1(64.86 %) and Diet 2 (69.79 %), with 0 % and 5 % WHM respectively, were not significantly (p>0.05) different from each other but were significantly (p<0.05) higher than those for Diet 3 (31.80 %) and Diet 4 (33.20 %), with 10 % and 15 % WHM respectively.

## 4.0 Discussion

The high fibre (21.43 %), intermediate crude protein (13.88 %), low ether extract (4.89 %) and high ash content (24.16 %) obtained for WHM agrees with the report of FAO (2009) that like most aquatic macrophytes, the crude lipid content of water hyacinths is usually low and varies between 2-4 % on dry matter basis regardless of whole plant or leaves; the ash content of whole plants varies between 15-34 % while it is between 10-18 % for leaves; crude fibre content is usually high in water hyacinths and ranges between 17-32 %, irrespective of whole plant or leaves. The NDF and ADF values of 63.54 and 37.46 obtained for WHM in this study compares favourably with the values of 62.3 and 29.0 respectively obtained by Dung (2001) for whole shoot water hyacinth collected from the river in the Mekong Delta of Vietnam; it also agrees with the findings of Jantrarotia (1991) that water hyacinth has a low ADF of 33 %.

Of all the anti-nutritional factors found in WHM, only oxalate was found to be present in sufficient quantities exceeding the critical limit recommended by Kumar *et al*. (2010). The saponin, tannin and phytate content were insignificant. The oxalate content of WHM obtained in this study (2.24 mg/100g) agrees with the value of 24 g/kg DM reported by Ha and Kim (2004). Ingestion of forage containing a large quantity of soluble oxalate can result in Ca deficiency in animals due to formation of calcium oxalate in the intestines and the blood (Rahman *et al*., 2010). However, WHM contains considerable amount of Ca (3.03 %, comparable to 32 g/kg DM obtained by Tham & Udeh, 2013), which may compensate for losses caused by oxalate.

The growth performance of pullet chicks fed graded levels of water hyacinth meal diets is shown in Table 4. Though there were no significant (p>0.05) differences in feed intake among the different diets, but generally, average feed intake increased as the dietary level of WHM increased. This is similar to the result obtained by Esonu *et al*. (2008) when they fed graded levels of oil palm (*Elaeis guinensis*) leaf meal containing 12.79 % CP and 18 % CF to day-old broiler chicks. The high fibre content of the meal tends to increase the total fibre content of the diets and dilute other nutrients. The birds therefore ate more to meet their energy requirements to sustain rapid growth and development, hence the increased feed intake. This also agrees with the reports of Egbewande *et al.* (2011) for African mistletoe (*Tapinanthus bagwensis*) leaf meal.

Average body weight gain (g/bird) of the pullet chicks reared for 8 weeks under varying dietary inclusion levels of WHM were not significantly (p>0.05) different from that of the control diet. This result differs from that obtained by Nworgu and Fasogbon (2007) when they fed 0 %, 2.5 % and 5 % *Centrosema* leaf meal to day-old pullet chicks for 6 weeks, resulting in significant reduction in body weight gain as the dietary inclusion level of the *Centrosema* leaf meal increased. But the result is in agreement with that of Esonu *et al*. (2008) when they obtained apparent reduction in average body weight gain as the level of oil palm leaf meal increased from 0 – 5 %; but the body weight gain were not significantly (p>0.05) different among the various dietary treatments.

Feed conversion ratio increased as the dietary inclusion level of WHM increased, though the values obtained were not significantly (p>0.05) different among the dietary treatments. Energy efficiency by the pullet chicks were similar for all the diets, showing that the energy in the WHM diets were as efficiently utilized as the energy in the WO diet (Control Diet). This may be an indication of the capability of WHM to effectively and efficiently replace WO in pullet chicks' diets.

There were no significant (p>0.05) differences in the digestibility of dry matter (DM) and ash among the dietary treatments; but the digestibility of CP, CF, EE and NFE were significantly (p<0.05) different among the various dietary treatments. Crude fibre digestibility decreased significantly (p<0.05) as the dietary WHM increased, showing decreased utilization. This might be due to the highly fibrous nature (over 20 % CF) of the test ingredient showing decreased digestibility as the dietary inclusion level increased. This result is similar to the result obtained by Lamidi *et al.* (2008) when they fed pineapple (*Ananas comosus*) crush waste (containing 23.83 % CF and 9.13 % CP) to day-old broiler chicken at 0, 2.5. 5.0, 7.5 and 10 % dietary inclusion levels for 8 weeks as a replacement for wheat offal, and obtained 17.02, 13.58, 12.28, 5.89 and 6.99 digestible crude fibre respectively. WHM is known to contain high lignin (12.86 %); and lignin, followed by silica and cutin, are the primary limiting factors of digestibility (Van Soest, 1981).

## 5.0 Conclusion

WHM can be included up to 10 % in the diets of pullet chicks (replacing 50 % of wheat offal), without the addition of any exogenous enzymes, for optimum growth performance and nutrient digestibility. Hence, a noxious weed that is a nuisance to everyone, with millions of Dollars spent every year towards its eradication can now be converted into an important feed resource for poultry.

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