Performance, blood profile and gut morphology of broiler chickens fed diets supplemented with Yohimbe (Pausynistalia yohimbe) and Larvacide

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ABSTRACT

The need for making livestock products free from antibiotics residue and other synthetic chemicals has resulted to the use of herbal products in livestock production. A 42-day study was conducted to compare the influence of Yohimbe (Pausynistalia yohimbe) and Larvacide on the growth performance, blood profile and gut morphometry of broiler chickens. Two hundred and twenty five 14-day old broiler chickens were randomly allotted into five treatment groups comprising of forty five chicks each. The groups were triplicates of fifteen birds. The five treatment groups consist of Basal (control), Larvacide (5 mg/Kg), three levels of Yohimbe supplementation (60 mg, 120 mg, and 180 mg/Kg) diets. Each supplement was supplied with the specified diets for the two phases of feeding [starter diet (3–4weeks) and the finisher diet (5–8weeks)]. Data collected were subjected to One-way analysis of variance. Results show insignificant effect (p > 0.05) on the growth performance parameters at the starter phase. However, at the finisher phase, supplementation of Yohimbe resulted to a progressive reduction in the feed intake (p < 0.05) without consequential reduction in the body weights. The chickens fed Basal diet + 180 mg Yohimbe had the best Feed Conversion Ratio (FCR). Furthermore, chickens fed basal starter diet + 180 mg Yohimbe had the highest (p < 0.05) total protein, globulin, Red Blood Cell (RBC), White Blood Cell (WBC), and Eosinophil counts while it had the least (p < 0.05) Alanine Transaminase (ALT), uric acid and creatinine. Also, chickens fed basal starter diet + 60 mg Yohimbe had the highest (p < 0.05) Mean Corpuscular Volume (MCV) and Mean Corpuscular Haemoglobin (MCH) while chickens fed basal starter diet + 120 mg Yohimbe had highest (p < 0.05) High Density Lipoprotein (HDL), but lower Very Low Density Lipoprotein (VLDL) and triglyceride. At the finisher phase, chickens fed basal diet + 180 mg Yohimbe had the highest (p < 0.05) Pack Cell Volume (PCV), haemoglobin and basophils while chickens fed basal diet + 60 mg Yohimbe had the highest WBC. Chickens fed basal diet + 120 mg Yohimbe had the least ALT and uric acid. Triglyceride, and cholesterol, HDL and VLDL, were lowered (p < 0.05) in chickens fed basal diet + Larvacide. Also, chickens fed basal diet + 180 mg Yohimbe had the highest (p < 0.05) villi height. The study concluded that feeding broiler chickens basal diet + 180 mg Yohimbe improved optimum growth performance, blood profile and gut morphology.

1. Introduction

The use of growth promoters in feed for animals under intensive management system have been in practice for long (Yang et al., 2018). However, due to animal, human and environmental health issues, antibiotic growth promoters have been restricted in the European Union and other parts of the world. Alternatives to antibiotic growth promoters used in poultry production includes: essential oils, organic acids, herbs, plant extracts and the mixtures of either of them (Ozogul et al., 2015; Gracia et al., 2016). These alternatives to antibiotic growth promoters enhance animal growth by: reducing the incidence and severity of subclinical infections, reducing the microbial use of nutrients, improving absorption of nutrients, reducing the amount of growth depressing metabolites, inhibiting the excretion of cytokines by macrophages, and antimicrobial activities (Humphrey & Klaing, 2003). Also, aside from antibiotic activities, plant extracts do stimulate the secretion of digestive enzymes thereby improving digestion and making nutrients in feeds readily available for absorption (Chao, Young & Oberg, 2000). These synergic activities by plant active substances, may improve health and performance of livestock (Manzanilla et al., 2001).
Larvacide are insect growth regulators which disrupt the development of insect (Graf, 1993). They are used in the control of housefly in the poultry house. They include chemicals like: juvenile hormones, chitin synthesis inhibitors, and triazine derivatives (Retnakaran, Granett & Ennis, 1985). Cyromazine which is a triazine derivative is popularly known for its use as larvacide. However, it has been mentioned amongst the three classes of antibiotics found in water samples from and around poultry farms in Jiangsu, China (Ruicheng, Feng, Siyu, Ming & Ran, 2011) and also as anthelmintic agent (Usui et al., 2019) while other derivates of triazine are known for their antibacterial and antifungal activity against various gram-positive, gram negative bacterial and fungal strains (Dhananjay and Madhav Mane, 2015).

_Pausinystalia yohimbe_ is a medicinal plant which grows in tropical West Africa. It is found within the span of south-west Nigeria, extending to Gabon and Congo. It has been used in trado-medicine for the treatment of erectile dysfunction and as aphrodisiac (Jacks, Asala & Priasad, 2015). In addition, the use of _Pausinystalia yohimbe_ bark in poultry feed can help evaluate its Larvacidal properties along-side with its growth promoting properties. Hence, this study was aimed at investigating the effect of 

2. Materials and methods

The test ingredient (_Pausinystalia yohimbe_ bark) used for the experiment was purchased from a commercial market at Abeokuta after which it was cleaned and sundried until a constant weight was achieved. The dried bark was pounded using wooden mortar and pestle until it is reduced to small particles. The particles were sieved using metal sieve with sieve size of 3 mm. The sifting was added to the compounded diet at appropriate levels of inclusion while the shaft was discarded. Also, Larvacide was purchased from the veterinary store and compounded diet at appropriate levels of inclusion while the shaft was discarded. Also, Larvacide was purchased from the veterinary store and was added to the feed at the prescribed level by the manufacturer.

2.1. Ethical permit

The practices adopted in the conduct of the study according to the guidelines as approved by the project review committee of the College of Animal Science, Federal University of Agriculture, Abeokuta, Ogun state, Nigeria.

2.2. Proximate composition of test ingredients

Proximate composition which includes: moisture, crude protein (CP), ether extract (EE), carbohydrate and ash content of _Pausinystalia yohimbe_ and the test diets were determined by method described by (AOAC 2005).

2.3. Experimental animals and management

A total of 250 unsexed day old broiler chicks of Abore acre strains were collected from a reputable hatchery in Abeokuta. Prior to the arrival of the birds, the brooding house and rearing house with their equipment were washed with disinfectants. During the brooding period, chicks were floor brooded together for two weeks and brooding temperature was monitored using a digital room thermometer and maintained close to the standard broiler chickens brooding temperature regime as described by Gerry (2007). Test ingredients were not administered during the brooding period so that the birds may be physiologically stable and vaccines would be given prior to the introduction of the antibiotic growth promoter. After two weeks of brooding two hundred and twenty five chicks were selected and divided into five experimental groups. Each group has 45 chicks assigned to it with a relatively similar average weight. The treatment groups were made up of triplicates of fifteen birds each. Vaccination and medication were administered which include: vitamin, antibiotics; Infectious Bursal Disease and Newcastle diseases vaccines were given at prescribed dosage at intervals. Dry wood shavings were used as the litter bedding and the environment was routinely cleaned to keep it conducive and hygienic. Experimental diets were fed to chicks after two weeks of brooding. The chicks were fed formulated starter mash (3-4 weeks) and finisher mash (5-8 weeks).

2.4. Experimental diets and layout

Table 1 shows the gross composition of the experimental diet at the starter and finisher phase. Each of the diets contained varying levels of _Pausinystalia yohimbe_ and Larvacide according to the treatment groups they were ascribed.

| Treatment | Description |
|-----------|-------------|
| T1 | Feed without additives |
| T2 | Feed with 5 mg/Kg Larvacide |
| T3 | Feed with 60 mg/Kg of Yohimbe bark meal |
| T4 | Feed with 120 mg/Kg of Yohimbe bark meal |
| T5 | Feed with 180 mg/kg of Yohimbe bark meal |

2.5. Data collection

2.5.1. Performance evaluation

Records of feed intake, weight gain and mortality were taken on weekly basis. Also, the Feed conversion ratio (FCR) was obtained by the ratio of feed intake to weight gain. The following formulae were used for calculations.

\[
\text{Total Feed intake (g)} = \text{Total Feed supplied (g)} - \text{Total Feed left over (g)}
\]
2.5.5. Gut morphometry

On the 42nd day of the experiment, a bird per replicate were randomly selected, slaughtered and the gastrointestinal tract were excised. The small intestine were divided into 3 segments: duodenum (from gizzard outlet to the end of the pancreatic loop), jejunum (from the pancreatic loop to Meckel’s diverticulum), and ileum (from Meckel’s diverticulum to the caecal junction) according to (AVMA 2007). Approximately 2 cm lengths of the duodenum, jejunum and ileum segments were removed for gut morphological measurements. The gut samples were flushed with ice-cold buffered PBS at pH 7.4 and immediately placed in 10% formalin solution. Thereafter, the samples were stained with the Feulgen reaction: hydrolysed in 1 N HCl at 60 °C for 6 min, it was rinsed three times with distilled water and stained with Schiff reagent for 30 min. The samples were rinsed in distilled water and stored in acetic acid/water (45/55, v/v) at 4 °C until further analysis. Intestinal villi with their crypts were separated individually under a dissecting microscope as described by Goodlad et al. (1991). The length and width of the villi were measured according to the procedure described by Hampson (1986) using an optical microscope and a camera.

2.6. Statistical analysis

Data obtained were subjected to one way Analysis of Variance and were analysed using the general linear model procedure of (Statistical Package for Social Sciences 2011) version 20. Treatment means were separated for significant difference at p < 0.05 using the Duncan Multiple Range Test (DMRT) of the same package.

2.6.1. Experimental model

Where:

\[ Y_{ij} = \mu + T_i + E_{ij} \]

\( Y_{ij} \) = Observed value of the dependant variable
\( \mu \) = Population mean
\( T_i \) = Effects of graded levels of supplemented Yohimbe (0, Larvacide, 60, 120 and 180 mg/Kg)
\( E_{ij} \) = Random residual error

3. Results

3.1. Growth performance of broiler chickens fed supplemented diets at the starter (3–4 weeks) and finisher phases (5–8 weeks)

Tables 2 and 3 show the effect of dietary inclusion of Larvacide and Yohimbe on the growth performance and feed cost ratio of broiler chickens fed starter (3–4 weeks) and finisher (5–8 weeks) diets respectively. At the starter phase, there were no significant differences (p > 0.05) in the final weight; total weight gain, total feed intake, feed conversion ratio (FCR) and mortality of chickens fed the supplemented diets. However, at the finisher phase, there was significant reduction (p < 0.05) in the total feed intake of chickens fed diet supplemented with 180 mg Yohimbe compared to chickens fed basal diet and Larvacide supplemented diets.

3.2. Effect of supplemented diet on overall growth performance of broiler chicken

Table 4 shows the effect of supplemented diet on the overall performance of broiler chicken. There were no significant differences (p > 0.05) in the Initial, final, total weight gain, Feed conversion ratio (FCR), mortality of chicken fed control diet and chicken fed supplemented Larvacide, 60 mg, 120 mg, and 180 mg Yohimbe. However, the
total feed intake of chicken fed 180 mg Yohimbe at 4617.55 g was significantly reduced ($p<0.05$) compared to chickens fed Larvacide at 5363.44 g. However, there were no significant differences ($p>0.05$) between the control, 60 mg and 120 mg Yohimbe respectively.

### 3.3. Serum biochemistry of broiler chickens fed dietary supplementation of Larvacide and Yohimbe

Table 5 and 6 show the effect of feeding dietary treatments on the serum indices of broiler chickens at the starter and finisher phases respectively. At the starter phase, significant differences ($p<0.05$) were observed in the total serum protein, albumin, globulin, Alanine aminotransferase (ALT), creatinine, and High density Lipoprotein (HDL) values. Chickens fed basal diet without supplement and chickens fed 180 mg Yohimbe + basal diet had the highest ($p < 0.05$) total serum protein compared to other treatment groups. Also, chickens fed Control diet and chickens fed Basal diet + 60 mg Yohimbe had significantly higher ($p<0.05$) blood albumin levels compared to chickens fed other supplemented diets. However, chickens fed basal diet + 180 mg Yohimbe recorded the highest globulin values followed by those fed the basal diet only while the chickens fed basal + 180 mg Yohimbe had lower ($p<0.05$) globulin levels compared with the chickens fed control diet.

In addition, chickens fed basal diet + 0.12 and basal diet + 180 mg Yohimbe had the lowest ($p<0.05$) ALT levels ($p<0.05$) followed by those fed basal diet + 60 mg Yohimbe while chickens fed basal diet + Larvacide had the highest ($p<0.05$) ALT levels. There were no significant differences ($p>0.05$) in the Pack Cell Volume (PCV), haemoglobin, and Mean corpuscular haemoglobin concentration (MCHC). RBC was increased in chickens groups fed experimental diets. However, there were significant differences ($p<0.05$) in the Red Blood Cell (RBC) count, White Blood Cell (WBC) count, heterophils, lymphocytes, eosinophils, basophils, monocytes, mean corpuscular haemoglobin (MCH), mean corpuscular volume (MCV), and mean corpuscular haemoglobin concentration (MCHC). RBC was increased in chickens groups fed basal diet only and basal diet + 180 mg Yohimbe while WBC was increased ($p<0.05$) in the group of chickens fed basal diet + 180 mg Yohimbe.

Heterophils was increased ($p<0.05$) in chickens fed basal diet + 60 mg Yohimbe while Lymphocytes was reduced ($p<0.05$) in chickens fed Basal diet + 60 mg Yohimbe than the chickens on Basal diet only and Basal diet + Larvacide supplement. Eosinophils was increased ($p<0.05$) in the group of chickens fed Basal diet + 60 mg Yohimbe and Basal diet + 180 mg Yohimbe. Monocytes was reduced ($p<0.05$) in chickens groups fed Basal diet + 60 mg Yohimbe and Basal diet + 180 mg Yohimbe. Mean corpuscular volume was increased ($p<0.05$) in the group of chickens fed Basal diet + Larvacide and Basal diet + 60 mg Yohimbe while Mean corpuscular haemoglobin was

### 3.4. Haematological indices of broiler chickens fed diets supplemented with Larvacide and Yohimbe

Table 7 shows the effect of supplemented starter diet on the haematological indices of broiler chickens. There were no significant differences ($p>0.05$) in the Pack Cell Volume (PCV), haemoglobin, and basophils of chickens groups fed the experimental diets. However, there were significant differences ($p<0.05$) in the Red Blood Cell (RBC) count, White Blood Cell (WBC) count, heterophils, lymphocyte, eosinophils, basophils, monocytes, mean corpuscular haemoglobin (MCH), mean corpuscular volume (MCV), and mean corpuscular haemoglobin concentration (MCHC). RBC was increased in chickens groups fed basal diet only and basal diet + 180 mg Yohimbe while WBC was increased ($p<0.05$) in the group of chickens fed basal diet + 180 mg Yohimbe.

Heterophils was increased ($p<0.05$) in chickens fed basal diet + 60 mg Yohimbe while Lymphocytes was reduced ($p<0.05$) in chickens fed Basal diet + 60 mg Yohimbe than the chickens on Basal diet only and Basal diet + Larvacide supplement. Eosinophils was increased ($p<0.05$) in the group of chickens fed Basal diet + 60 mg Yohimbe and Basal diet + 180 mg Yohimbe. Monocytes was reduced ($p<0.05$) in chickens groups fed Basal diet + 60 mg Yohimbe and Basal diet + 180 mg Yohimbe. Mean corpuscular volume was increased ($p<0.05$) in the group of chickens fed Basal diet + Larvacide and Basal diet + 60 mg Yohimbe while Mean corpuscular haemoglobin was

### Table 2
Effect of supplemented diet on performance of broiler chickens at starter phase.

| Parameters                  | Basal          | Basal + 5 mg Larvacide | Basal + 60 mg Yohimbe | Basal + 120 mg Yohimbe | Basal + 180 mg Yohimbe | SEM  |
|-----------------------------|----------------|------------------------|-----------------------|------------------------|------------------------|------|
| Initial weight (g)          | 195.55         | 192.22                 | 194.44                | 195.55                 | 190.00                 | 1.507|
| Final weight (g)            | 655.95         | 690.00                 | 660.00                | 682.30                 | 693.33                 | 14.869|
| Total weight gain (g)       | 460.39         | 497.77                 | 465.55                | 486.74                 | 503.33                 | 14.894|
| Total Feed intake (g)       | 895.96         | 946.66                 | 948.00                | 978.98                 | 963.33                 | 17.418|
| FCR                         | 1.94           | 1.90                   | 2.06                  | 2.01                   | 1.93                   | 0.037|
| Mortality (%)               | 2.22           | 0.00                   | 0.00                  | 2.22                   | 0.00                   | 0.605|

FCR = Feed Conversion Ratio.
SEM = Standard Error of Mean.

### Table 3
Effect of supplemented diet on performance of broiler chickens at finisher phase.

| Parameters                  | Basal          | Basal + 5 mg Larvacide | Basal + 60 mg Yohimbe | Basal + 120 mg Yohimbe | Basal + 180 mg Yohimbe | SEM  |
|-----------------------------|----------------|------------------------|-----------------------|------------------------|------------------------|------|
| Initial weight (g)          | 655.95         | 690.00                 | 660.00                | 682.30                 | 693.33                 | 14.869|
| Final weight (g)            | 2141.39        | 2145.95                | 1996.03               | 2088.25                | 2027.77                | 46.715|
| Total weight gain (g)       | 1485.43        | 1455.95                | 1336.03               | 1405.95                | 1334.44                | 51.597|
| Total Feed intake (g)       | 4224.98*       | 4416.77*               | 4097.38*              | 3934.04*               | 3654.22*               | 86.507|
| FCR                         | 2.84           | 3.10                   | 3.17                  | 2.83                   | 2.75                   | 0.110|
| Mortality (%)               | 6.66           | 8.88                   | 2.22                  | 0.00                   | 0.00                   | 1.575|

SEM = Standard Error of Mean.
FCR = Feed Conversion Ratio.

* Means on the same row with different superscripts differ significantly ($p<0.05$).
increased ($p < 0.05$) in chickens group fed Basal diet + 60 mg Yohimbe. Mean corpuscular haemoglobin concentration was reduced ($p < 0.05$) in the group of chickens fed Basal diet + 60 mg Yohimbe.

Table 8 shows the effect of supplemented finisher diet on the haematological indices of broiler chickens. There were no significant difference ($p > 0.05$) in the RBC, mean corpuscular volume, and mean corpuscular haemoglobin concentration of chickens fed the experimental diets. However, PCV and haemoglobin count were increased ($p < 0.05$) in chickens group fed basal diet + 180 mg Yohimbe. WBC increased ($p < 0.05$) in chickens group fed basal diet + 60 mg Yohimbe. Heterophils was reduced ($p < 0.05$) in chickens groups fed basal diet + 60 mg Yohimbe and basal diet + 120 mg Yohimbe. Lymphocyte was increased ($p < 0.05$) in the group of chickens fed basal diet + 120 mg Yohimbe than chickens on basal diet only. Also, the eosinophils increased in chickens on basal diet + Larvacide. Also, the group of chickens fed basal diet + 60 mg Yohimbe and basal diet + 180 mg Yohimbe had increased ($p < 0.05$) basophils counts. Furthermore, chickens group fed basal diet + 120 mg Yohimbe had increased ($p < 0.05$) monocyte count, followed by chickens group fed basal diet + 60 mg Yohimbe and basal diet + 180 mg Yohimbe. Chickens on Basal diet + 120 mg Yohimbe had increased ($p < 0.05$) mean corpuscular haemoglobin count than chickens fed basal diet only.

Table 9 shows the effect of supplemented diet on the gut morphology of broiler chicken. Duodenal villi height was significantly higher ($p < 0.05$) in Larvacide supplemented diet (975.87 μm) compared with the control diet (67.07 μm). However, Larvacide (874.56 μm), 120 mg Yohimbe (124.94 μm), and Larvacide supplemented diets (133.93 μm) were progressively and significantly lesser ($p < 0.05$) villi height compared with the broiler chicken fed control diet.

Table 5 shows the effect of supplemented starter diets on Blood Serum and Lipid profile of broiler chickens.

| Parameters                  | Basal       | Basal + 5 mg Larvacide | Basal + 60 mg Yohimbe | Basal + 120 mg Yohimbe | Basal + 180 mg Yohimbe | SEM  |
|-----------------------------|-------------|------------------------|-----------------------|------------------------|------------------------|------|
| Total Protein (g/dl)        | 3.975a      | 3.350a                 | 3.600a                | 2.950a                 | 3.950a                 | 0.112|
| Albumin (g/dl)              | 1.925b      | 1.775b                 | 1.925b                | 1.575b                 | 1.550b                 | 0.058|
| Globulin (g/dl)             | 2.075b      | 1.575b                 | 1.650b                | 1.350b                 | 2.425b                 | 0.110|
| ALT (U/L)                   | 33.300b     | 34.925b                | 30.700b               | 28.075b                | 28.450b                | 0.736|
| AST (U/L)                   | 53.775      | 54.000                 | 55.525                | 59.375                 | 53.550                 | 0.872|
| Creatinine (mg/dl)          | 0.750b      | 0.732b                 | 0.617b                | 0.662b                 | 0.585b                 | 0.019|
| Total Cholesterol (mg/dl)   | 126.000     | 118.000                | 119.000               | 127.250                | 123.750                | 2.402|
| HDL (mg/dl)                 | 67.900b     | 63.250b                | 64.875b               | 80.200b                | 72.425b                | 2.387|
| LDL (mg/dl)                 | 34.700      | 27.300                 | 30.475                | 30.250                 | 30.875                 | 1.644|

SEM = Standard Error of Mean.
ALT = Alanine aminotransferase.
AST = Aspartate aminotransferase.
HDL = High Density Lipoprotein.
LDL = Low Density Lipoprotein.
g/dl = gram/decilitre.
mg/dl = milligram/decilitre.
* Means on the same row with different superscripts differ significantly ($p < 0.05$).
180 mg Yohimbe (162.48 μm) was significantly increased \((p < 0.05)\) compared to chicken fed control diet (145.50 μm). However, chicken fed Larvacide (134.53 μm) and 120 mg Yohimbe supplement (9.46 μm) had significantly reduced \((p < 0.05)\) apical width compared with the control diet.

Jejunal basal width was significantly reduced \((p < 0.05)\) in broiler chicken fed 120 mg Yohimbe supplemented diet (3.47 μm) compared with the control diet (61.50 μm). However, chicken fed 60 mg (158.48 μm), 180 mg Yohimbe (74.89 μm) and Larvacide supplemented diets (72.48 μm) had significantly reduced \((p < 0.05)\) basal width compared to control diets.

Ileal villi height was significantly highest \((p < 0.05)\) in broiler chicken fed 120 mg Yohimbe supplemented diet (1045.05 μm) compared with the control (561.07 μm), followed by Larvacide (828.55 μm), 60 mg Yohimbe (820.94 μm), and lastly 180 mg Yohimbe supplemented diet (735.08 μm).

Ileal crypt depth was significantly highest in broiler chicken fed 60 mg Yohimbe supplemented diet (213.94 μm) compared with the control diet (83.57 μm), followed by 120 mg Yohimbe (179.14 μm), Larvacide (119.94 μm), and 180 mg Yohimbe supplemented diet (112.05 μm).

Ileal apical width and ileal basal width was significantly highest in broiler chicken fed 120 mg Yohimbe (213.12 μm and 113.46 μm) compared to the control diet. However, broiler chicken fed 60 mg (179.95 μm and 109.95 μm), 180 mg Yohimbe (115.91 μm and 93.54 μm) and Larvacide supplemented diets (136.92 μm and 81.08 μm) had significantly declining ileal apical compared with 180 mg Yohimbe supplemented diet (155.91 μm and 93.54 μm).

### Table 6
Effect of supplemented finisher diets on Blood Serum and Lipid profile of broiler chickens.

| Parameters               | Basal | Basal + 5 mg Larvacide | Basal + 60 mg Yohimbe | Basal + 120 mg Yohimbe | Basal + 180 mg Yohimbe | SEM  |
|--------------------------|-------|------------------------|-----------------------|------------------------|------------------------|------|
| Total Protein (g/dl)     | 3.800₀ | 3.175⁰                 | 4.450⁰                | 4.100⁰                 | 4.575⁰                 | 0.157|
| Albumin (g/dl)           | 2.225₀ | 1.850⁰                 | 2.850⁰                | 2.200⁰                 | 2.575⁰                 | 0.117|
| Globulin (g/dl)          | 1.575⁰ | 1.325⁰                 | 1.600⁰                | 1.900⁰                 | 2.090⁰                 | 0.068|
| ALT (U/L)                | 25.000₀| 26.500⁰                | 30.500⁰               | 24.250⁰                | 27.750⁰                | 0.792|
| AST (U/L)                | 63.500₀| 59.000                 | 71.000                | 64.500                 | 59.000                 | 1.990|
| Creatinine (mg/dl)       | 1.100  | 0.900                  | 1.175                 | 1.125                  | 1.175                  | 0.085|
| Total Cholesterol (mg/dl)| 132.850₀| 89.675⁰               | 119.575⁰             | 95.375⁰                | 119.400⁰               | 5.088|
| HDL (mg/dl)              | 81.800₀| 42.725⁰                | 72.025⁰               | 49.875⁰                | 74.350⁰                | 4.378|
| LDL (mg/dl)              | 29.300₀| 28.975                 | 27.150                | 24.300                 | 26.475                 | 1.228|

SEM = Standard Error of Mean.
ALT = Alanine aminotransferase.
AST = Aspartate aminotransferase.
HDL = High Density Lipoprotein.
LDL = Low Density Lipoprotein.
g/dl = gram/decilitre.
U/L = Unit/Litre.
mg/dl = milligram/decilitre.
* Means on the same row with different superscripts differ significantly \((p < 0.05)\).

### Table 7
Effect of supplemented starter diets on Haematological Indices of broiler chickens.

| Parameters               | Basal | Basal + 5 mg Larvacide | Basal + 60 mg Yohimbe | Basal + 120 mg Yohimbe | Basal + 180 mg Yohimbe | SEM  |
|--------------------------|-------|------------------------|-----------------------|------------------------|------------------------|------|
| Pack Cell Volume (%)     | 33.000 | 32.500                 | 33.000                | 32.000                 | 33.750                 | 0.363|
| Haemoglobin(g/dl)        | 11.000 | 10.725                 | 10.850                | 10.675                 | 11.250                 | 0.133|
| RBC (× 10⁶/L)            | 11.125₀ | 13.025                 | 11.225⁰               | 13.500⁰                | 14.325⁰                | 0.444|
| WBC (× 10³/L)            | 3.025₁ | 2.700₁                 | 2.675₁                | 2.675₁                 | 3.025₁                 | 0.053|
| Heterophils (%)          | 31.500₀ | 33.500                 | 39.250⁰               | 34.750⁰                | 35.500⁰                | 0.881|
| Lymphocyte (%)           | 67.250₁ | 65.250                 | 59.750⁰               | 64.750⁰                | 63.000⁰                | 0.900|
| Eosinophils (%)          | 0.250₀ | 0.500₀                 | 0.750₀                | 0.000₀                 | 0.750₀                 | 0.101|
| Basophiles (%)           | 0.500₀ | 0.500                  | 0.250                 | 0.250                  | 0.750                  | 0.095|
| Monocytes (%)            | 0.500₀ | 0.250                  | 0.000                 | 0.250                  | 0.000                  | 0.060|
| Mean corpuscular volume (Fl) | 112.125₀ | 120.700₀               | 123.650⁰              | 119.600⁰               | 112.625⁰               | 1.531|
| Mean corpuscular haemoglobin concentration (g/dl) | 37.375₀ | 39.875⁰ | 40.625⁰ | 39.900⁰ | 37.525⁰ | 0.496|

SEM = Standard Error of Mean.
g/dl = gram/decilitre.
L = Litre.
fl = femtolitre.
pg = picograms.
* Means on the same row with different superscripts differ significantly \((p < 0.05)\).

### 4. Discussion
At the starter phase, there were no increase in the final weights, total weight gained per chickens, total feed intake, and FCR. The non-response of chicken at the starter phase may be because the digestive organs were not fully developed to process hard feed stuff. This is similar to the finding of Metin and Ahmet (2016) who supplied Yohimbin in the drinking water of broiler chickens at the starter phase but recorded no significant changes in the performance parameters. However, at the finisher phase, Yohimbe reduces feed intake which consequentially reduced the feed conversion ratio (FCR) of the broiler chickens. The reduction in feed intake is a phenomenon once reported by Currie and Wilson (1992) who supplied dietary Yohimbe to rats and observed suppressed appetite and decreased energy level intake in same. The reduction in feed intake can be due to the presence of tannin.
Effect of supplemented diet on the gut morphometry of broiler chickens.

Table 8

| Parameters                        | Basal     | Basal + 5 mg Larvacide | Basal + 60 mg Yohimbe | Basal + 120 mg Yohimbe | Basal + 180 mg Yohimbe | SEM  |
|----------------------------------|-----------|------------------------|-----------------------|------------------------|------------------------|------|
| PCV (%)                          | 34.000a   | 34.000a                | 34.000a               | 34.000a                | 34.000a                | 0.941|
| Haemoglobin (g/dl)               | 11.450    | 11.400                 | 11.400                | 11.400                 | 11.400                 | 0.316|
| RBC (× 10⁶/L)                    | 3.150     | 2.950                  | 2.650                 | 2.900                  | 2.900                  | 0.093|
| WBC (× 10⁹/L)                    | 10.275    | 11.650                 | 11.850                | 9.975                  | 10.790                 | 0.236|
| Heterophil (%)                   | 39.250    | 36.500                 | 30.250                | 29.500                 | 33.500                 | 1.201|
| Lymphocyte (%)                   | 60.250    | 62.500                 | 68.250                | 69.500                 | 65.000                 | 1.135|
| Eosinophil (%)                   | 0.000a    | 0.750b                 | 0.250b                | 0.250b                 | 0.250b                 | 0.081|
| Basophil (%)                     | 0.250a    | 0.250b                 | 0.750b                | 0.000c                 | 0.750b                 | 0.093|
| Monocytes (%)                    | 0.250a    | 0.000c                 | 0.500c                | 1.000d                 | 0.500e                 | 0.104|
| Mean corpuscular volume (fl)     | 109.650   | 115.775                | 113.175               | 117.425                | 118.775                | 1.605|
| Mean corpuscular haemoglobin (pg) | 36.922    | 38.947b                | 37.887b               | 40.892b                | 39.022b                | 0.537|
| Mean corpuscular haemoglobin concentration (g/dl) | 33.720 | 33.625 | 33.452 | 34.327 | 32.912 | 0.264 |

SEM = Standard Error of Mean.

Table 9

Effect of supplemented diet on the gut morphometry of broiler chicken.

| Parameters                        | Basal     | Basal + 5 mg Larvacide | Basal + 60 mg Yohimbe | Basal + 120 mg Yohimbe | Basal + 180 mg Yohimbe | SEM  |
|----------------------------------|-----------|------------------------|-----------------------|------------------------|------------------------|------|
| Duodenum Villi Height (µm)       | 969.10    | 975.87                  | 584.08                 | 705.11                  | 617.54                 | 45.362|
| Crypt depth (µm)                 | 67.07     | 128.55                  | 167.48                 | 187.92                  | 115.10                 | 11.271|
| Apical width (µm)                | 319.51    | 229.50                  | 183.10                 | 143.49                  | 238.53                 | 15.815|
| Basal width (µm)                 | 128.50    | 109.52                  | 91.53                  | 94.04                   | 68.10                  | 7.364 |
| Jejunum Villi Height (µm)        | 1001.46   | 874.56                  | 564.45                 | 50.90                   | 1333.93                | 115.989|
| Crypt depth (µm)                 | 113.04    | 166.96                  | 156.50                 | 8.49                    | 124.96                 | 15.054|
| Apical width (µm)                | 145.50    | 134.53                  | 203.46                 | 9.46                    | 162.48                 | 17.418|
| Basal width (µm)                 | 61.50     | 72.48                   | 158.48                 | 3.47                    | 74.89                  | 13.239|
| Ileum Villi Height (µm)          | 561.07    | 828.55                  | 820.94                 | 1045.05                 | 735.08                 | 41.848|
| Crypt depth (µm)                 | 83.57     | 119.92                  | 213.94                 | 179.14                  | 112.05                 | 12.735|
| Apical width (µm)                | 97.89     | 136.92                  | 179.95                 | 213.12                  | 155.91                 | 10.402|
| Basal width (µm)                 | 75.11     | 81.08                   | 109.95                 | 113.46                  | 93.54                  | 4.063 |

SEM = Standard Error of Mean.

µm = micrometre.

* Means on the same row with different superscripts differ significantly (p<0.05).
phase were within range compared with the values reported by Talebi, Asri-Rezaei, Rozeh-Chai and Sahraei (2005). There was improvement in the haematological indices of chicken fed diets containing Yohimbe supplements. RBC, MCV, MCH, and MCHC were increased with Yohimbe supplementation. The PCV, Haemoglobin, MCH, MCHC are indicators for assessing the circulatory electrolytes (Peters, Gunn, Imomunor, Agaviezor & Ikoebi, 2011). It is suggested by Chineke, Ologun and Ikoebi (2006) that high PCV implies increase in RBC production and the values of MCH and MCHC are preferred to be high as low level implies anaemia (Aster, 2004). The improvement in the haematological indices of chickens fed Yohimbe supplemented diets is traceable to its’ ability to stimulate the production of Red Blood Cells as it is reportedly used as blood tonic in Western African medicine (Clark & Sunderland, 2004). In addition, there were increase in the White Blood Cell (WBC) counts and their differentials with the supplementation of Yohimbe in chickens diets. The White Blood Cells (WBC) and its differentials are responsible for the combat of disease infections. They transport antibodies during immune response. Animals with low WBC are susceptible to disease infections which makes them less adaptable to some environments (Soetan, Akinrinde & Ajibade, 2013).

The high values of WBC, Heterophils, Eosinophils of chickens fed Yohimbe supplement contradicts the findings of Musa (2007), who reported reduction in the WBC in rat with the inclusion of Yohimbe. The contradiction could be due to the species of animal used in the two studies. The increase in the WBC with Yohimbe supplementation shows its immune stimulatory properties (Vidanarachchi, Mikkelsen, Sims, Iji & Choct, 2006). However, the Lymphocytes and monocytes were reduced in chickens fed Yohimbe supplemented diet. The decline in Lymphocytes and monocytes were also reported by Musa (2007) who supplemented Yohimbe in rat. However, dietary Larvacide supplementation reduced the heteropils of broiler chickens when administered in the starter diet.

The increase in PCV, Haemoglobin and MCH, with the supplementation of Yohimbe in the finisher diet shows that the supplement enhances the production of circulatory electrolyte. This agrees with the findings of Kuhlmann (1999) who reported Yohimbe bark extract was traditionally used in Africa tropics as stimulant and a tonic for men. Also, the WBC differentials Lymphocyte, Basophils, Monocytes, increased with the supplementation of Yohimbe. This is traceable to the immunostimulatory properties of the herb (Vidanarachchi et al., 2006) while the Heterophils, Eosinophils reduced with the supplementation of Yohimbe. However, WBC increased at low inclusion rate of Yohimbe but declined as the inclusion rate increased.

The supplementation of chickens feed with Yohimbe affected the intestinal morphometric measurement at the duodenum, ileum, and jejunum. The villi height and crypt dept indicates intestinal proliferative and absorptive capacity (Lenhardt and Mozel, 2003) and it shows how developed are the intestinal components (Franco, Murakami, Natali, Garcia & Furlan, 2006). The improvement of the crypt dept of chicken fed supplemented Yohimbe at the duodenum and jejunum shows the supplement encourages fast intestinal cell renewal and maintains the natural proximodistal decline of the morphometric indices from the duodenum to the ileum (Biasato et al., 2017). This also shows improved secretion of digestive enzymes as most digestive enzymes are secreted in the jejunum (Iji, Saki & Tivey, 2001). However, the improvement of the villi height, apical and basal width at the jejunum and ileum but not at the duodenum in chicken fed Yohimbe shows nutrient absorption occurs most at the jejunum and ileum.

5. Conclusion

This study concluded that chickens fed Basal diet + 180 mg Yohimbe performs better than chickens fed diets with Larvacide and lower levels of Yohimbe inclusion. Also, chickens fed Basal diet + 180 mg Yohimbe had better blood profile and highest villi height compared to chickens fed with other diets. Consequently, this study recommends that the increased inclusion of Yohimbe in chickens diet positively influence its’ growth performance and health status, and gut morphometry of chickens over larvacide.

Ethics statement

The following conditions were met by the investigators:

1. All phytophagous must be processed in Animal nutrition laboratory.
2. Be sure you ensure proper bio-safety and biosecurity in Animal Production and Health laboratory
3. Be sure you ensure proper bio-safety and biosecurity in Animal Production and Health laboratory
4. Chief investigator must confirm that the samples of the phytophagous will not be used in any form or way or associated with biological weapon and transferred to another institution
5. All animal experimentation must be conducted with adequate space and use of appropriate methodology that will avoid pain to the animal will strictly be adhered to.
6. Your experimental station shall be open to committee’s inspection whenever it is required

Declarations of Competing Interest

Author declares there is no conflict of interest of any form on the journal paper.

Acknowledgement

The research assistance and financial support provided by the world bank through the Centre of Excellence in Agricultural Development and Sustainable Environment (CEADESE) of the Federal University of Agriculture, Abeokuta is duly acknowledged.

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