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# Growth Performance, Nutrient Digestibility and Cost-Efficiency of Broiler Chickens Administered Higher Doses of Yohimbe (*Pausinystalia yohimbe*) and Larvacide

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ABSTRACT

The use of plant-based additives has helped in the improvement of feed utilization, performance, and poultry welfare. Yohimbe is a botanical additive that could be used to achieve these objectives. A total of 225 broiler chickens were randomly into five (5) treatment groups. The group includes: T1 = Control, T2 = 5mg/kg Larvicide, T3 = 240 mg/kg Yohimbe, T4 = 300mg/kg Yohimbe, T5 = 360mg/kg Yohimbe was further divided into 3 replicates. All replicate groups had 15 chickens each with relatively similar live weights. Feed was served to chickens ad libitum at the starter and finisher phases, while data were collected on intake, growth, and later, feed digestibility. Results showed that chickens served 300mg/kg Yohimbe diet had better digestion of carbohydrates, energy, crude fiber, and livability, while other performance parameters were unaffected. It is therefore concluded that Yohimbe can be included up to 300 mg/kg, above which there was a decline in the growth performance and nutrient digestibility of broiler chickens.

## Introduction

Botanical feed additives have emerged as a promising alternative to traditional growth promoters. These additives are generally considered safe and effective in enhancing animal performance and welfare. One of their primary mechanisms of action involves the stimulation of digestive enzymes, facilitating the breakdown of feed components and improving nutrient digestibility (Biswas *et al.*, 2024). Some bioactive compounds present in botanical additives, include: polyphenols, flavonoids, terpenoids, tannins, and saponins (Alem, 2024). These compounds possess diverse biological properties that can positively impact animal health and productivity.

Yohimbe (*Pausynistalia yohimbe*) is a tree plant found in southwest Nigeria and could be found in neighboring countries such as Gabon and Cameroon. The primary bioactive compound in yohimbe is yohimbine, an indole alkaloid found in all parts of the plant. Yohimbine has garnered attention for its potential therapeutic applications in humans, which include: anti-inflammation, anti-cancer, treatment of polycystic ovarian syndrome (PCOS), antidote in the management of clinical cases associated with acute pesticide ingestion and myocardial dysfunction (Jabir *et al.*, 2022). The therapeutic dose of yohimbine ranges from 50 to 300 ng/mL in the blood, above which is reported to be toxic (Drevin *et al.*, 2020).

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In livestock, Yohimbe was reported to have a stimulatory influence on the salivary glands, thereby facilitating the production of saliva for the digestion of carbohydrates in feed (Jabir *et al.*, 2022). Previous study conducted by Obajuluwa *et al.* (2020) reported improved growth in chickens fed diets supplemented with 180 mg/kg Yohimbe, while Metin *et al.* (2016) observed improvement in final weights of chickens served yohimbine in drinking water at 120 ppm as well as an increase in protein accretion and a significant decrease of lipid content in the carcass. However, both studies recommended an increase in the intake of Yohimbe to ascertain the optimum level of inclusion in chicken diets. Therefore, this study investigated the optimum levels of Yohimbe inclusion in starter and finisher diets of broiler chickens for effective performance, cost benefit, and nutrient utilization.

## Materials and Methods

### Experimental site, diet, and management

The experiment was carried out at a station in DUFARMS (Directorate of University Farms), Federal University of Agriculture Abeokuta, Ogun State, Nigeria. The area lies within the rainforest vegetation zone of South-Western Nigeria on latitude 7°13'29.01"N and longitude 3°25'26.40"E, elevation 126.187m above the sea level, and high altitude 379.476m (Google Earth, 2025). Test ingredient (*Pausinystalia yohimbe* bark) was purchased from a commercial market in Abeokuta, Nigeria after which it was cleaned and air-dried until a constant weight was achieved. The dried bark was pulverized using wooden mortar and pestle until it was reduced into small particles. The particles were sieved using metal sieve of size 0.3 cm. The siftings were added to the compounded diet at appropriate levels of inclusion while the shaft was discarded. Prior to the arrival of the birds, all management practices such as washing and disinfecting of the pen, drinkers and feeders were ensured. Also, spreading of wood shaving on the floor, pre-warming of pens with the use of electric bulb to raise room temperature to the thermo-neutral temperature of day old poultry chicks were achieved. Furthermore, weighing scale (kitchen scale) was provided, heat source (coal pot), compounded chick mash, and portable water were made available**.** The birds were brooded together for the first two weeks in a deep litter pen.

In addition, vaccinations and medications such as: Newcastle Disease Vaccine (NDV), Infectious Bursal Disease Vaccine (IBDV), antibiotics and vitamins supplements were administered at appropriate time within the first two weeks of brooding. On the third week (after brooding), the birds were randomly assigned to five treatments groups of 45 birds per treatment. Treatments were further divided into three replicates with 15 birds per replicate. The experiment lasted for six weeks. Treatment groups include:

T1 = Feed without additives (control)
T2 = Feed with 5 mg/kg larvacide
T3 = Feed with 240 mg/kg of *P. yohimbe* bark
T4 = Feed with 300 mg/kg of *P. yohimbe* bark
T5 = Feed with 360 mg/kg of *P. yohimbe* bark.

**Table 1.** Gross composition of the experimental diets at starter phase (day 15 – 28)

| Ingredients (kg) | Control | 5mg/kg Larvacide | 240mg/kg Yohimbe | 300mg/kg Yohimbe | 360mg/kg Yohimbe |
|---|---|---|---|---|---|
| Maize | 52.50 | 52.50 | 52.50 | 52.50 | 52.50 |
| Wheat bran | 4.10 | 4.10 | 4.10 | 4.10 | 4.10 |
| Soybean meal | 18.50 | 18.50 | 18.50 | 18.50 | 18.50 |
| Groundnut cake | 16.50 | 16.50 | 16.50 | 16.50 | 16.50 |
| Fish meal | 2.50 | 2.50 | 2.50 | 2.50 | 2.50 |
| Bone meal | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 |
| Limestone | 2.00 | 2.00 | 2.00 | 2.00 | 2.00 |
| Salt (NaCl) | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 |
| Vit/Mineral Premix | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 |
| Methionine | 0.20 | 0.20 | 0.20 | 0.20 | 0.20 |
| Lysine | 0.20 | 0.20 | 0.20 | 0.20 | 0.20 |
| Total | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| Larvacide (g/kg) | - | 0.005 | - | - | - |
| Yohimbe (g/kg) | - | - | 0.24 | 0.30 | 0.36 |
| Determined Analysis (%) | | | | | |
| Crude Protein | 20.81 | 22.36 | 26.92 | 24.56 | 26.92 |
| Ether Extract | 8.26 | 10.01 | 5.72 | 5.85 | 5.93 |
| Crude Fiber | 3.25 | 3.92 | 5.68 | 5.39 | 2.91 |

| | | | | | |
|---|---|---|---|---|---|
| Ash | 1.25 | 1.92 | 3.47 | 3.25 | 3.47 |
| Nitrogen Free Extract | 45.21 | 46.08 | 47.04 | 49.3 | 50.06 |
| Metabolizable energy (kcal/kg) | 3282.343 | 3644.848 | 2957.651 | 3315.551 | 2973.772 |

*Premix composition per kg diet: Vit A: 400,000.00 IU, Vit D3: 800,000.00 IU, Vit E: 9,200.00mg, Vit k: 800.00mg, Vit B1: 1000.00mg, Vit B6: 500.00mg, Vit B12: 25.00mg, Niacin: 6000.00mg, Pantothenic acid: 2000.00mg, Folic acid: 200.00mg, Biotin: 8mg, Mn: 300,000.00g, Zn: 20,000.00g, Cobalt: 80.00mg, I: 40.00mg, Choline: 80,000.00g, Antioxidants: 800.00mg

**Table 2.** Gross composition of the experimental diets at finisher phase (day 29 -56)

| Ingredients (kg) | Control | 5mg/kg Larvacide | 240mg/kg Yohimbe | 300mg/kg Yohimbe | 360mg/kg Yohimbe |
|---|---|---|---|---|---|
| Maize | 55.00 | 55.00 | 55.00 | 55.00 | 55.00 |
| Wheat bran | 9.10 | 9.10 | 9.10 | 9.10 | 9.10 |
| Soybean meal | 14.00 | 14.00 | 14.00 | 14.00 | 14.00 |
| Groundnut cake | 15.00 | 15.00 | 15.00 | 15.00 | 15.00 |
| Fish meal | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Bone meal | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 |
| Limestone | 2.00 | 2.00 | 2.00 | 2.00 | 2.00 |
| Salt (NaCl) | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 |
| Vit/Mineral Premix | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 |
| Methionine | 0.20 | 0.20 | 0.20 | 0.20 | 0.20 |
| Lysine | 0.20 | 0.20 | 0.20 | 0.20 | 0.20 |
| Total | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| Larvacide(g/kg) | - | 0.005 | - | - | - |
| Yohimbe g/kg | - | - | 0.24 | 0.30 | 0.36 |
| Determined analysis (%) | | | | | |
| Crude Protein | 18.64 | 19.32 | 16.72 | 16.98 | 18.84 |
| Ether Extract | 6.81 | 7.11 | 4.68 | 4.82 | 5.12 |
| Crude Fibre | 4.67 | 5.11 | 4.45 | 5.31 | 5.97 |
| Ash | 2.84 | 3.86 | 3.16 | 3.21 | 3.45 |
| Nitrogen Free Extract | 51.61 | 50.91 | 55.67 | 54.65 | 53.24 |
| Metabolizable Energy (kcal/kg) | 3082.085 | 3093.409 | 3005.050 | 2684.042 | 2518.431 |

*Premix composition per kg diet: Vit A: 400,000.00 IU, Vit D3: 800,000.00 IU, Vit E: 9,200.00mg, Vit k: 800.00mg, Vit B1: 1000.00mg, Vit B6: 500.00mg, Vit B12: 25.00mg, Niacin: 6000.00mg, Pantothenic acid: 2000.00mg, Folic acid: 200.00mg, Biotin: 8mg, Mn: 300,000.00g, Zn: 20,000.00g, Cobalt: 80.00mg, I: 40.00mg, Choline: 80,000.00g, Antioxidants: 800.00mg

## Growth performance characteristics

Daily feed intake and body weight were meticulously recorded. Livability rates were tracked daily by taking note of all live chickens in each treatment replicates. Also, body weight gain and feed conversion ratio (FCR) were calculated based on these measurements.

## Feed intake

Feed intake was measured daily for each experimental group. To determine the actual feed consumed, leftover feed was weighed and subtracted from the total feed provided. The average daily feed consumption per bird was calculated by dividing the total feed consumed by the number of birds in each group.

$$Feed\ intake\ (g) = Weight\ of\ Total\ Feed\ given\ (g) - Weight\ of\ left\ over\ Feed\ (g)$$

$$Average\ daily\ feed\ intake\ per\ bird (g) = \frac{Daily\ feed\ intake\ (g)}{Number\ of\ birds\ in\ the\ replicate}$$

## Body weight gain

The initial body weight of the birds was measured for each replicate at the commencement of the experiment. Weight gain was calculated by subtracting the initial body weight from the final body weight on weekly basis.

$$Average\ body\ weight\ gain\ per\ bird\ (g) = \frac{Final\ body\ weight\ (g) - Initial\ body\ weight\ (g)}{Number\ of\ birds\ in\ the\ replicate}$$

## Feed conversion ratio (FCR)

This was calculated as feed intake (g) per body weight gain

$$Feed\ conversion\ ratio = \frac{Total\ feed\ consumed\ (g)}{Body\ weight\ gain\ (g)}$$

## Livability

Livability rates were determined by dividing the number of alive birds by the total number of birds at the experiment's outset, expressed as apercentage.

$$\% \, Livability = \frac{Number\ of\ alive\ birds\ per\ replicate}{Total\ Number\ of\ birds\ in\ the\ replicate} \ X \ 100$$

## Cost Analysis

To determine the cost of feed consumed per kilogram of weight gain, the market prices of Yohimbe bark and other feed ingredients were obtained at the time of the study. These prices were then used to calculate the feed cost per kilogram of weight gain, using the methodology outlined by Basit *et al.* (2025).

$$\text{Cost of Feed Consumed (₦)} = \text{Total weight of feed consumed} \times \text{Cost per kilogramme of feed}$$

$$\text{Cost of feed per Kilogramme diet (₦/kg)} = \frac{\text{Total Cost of feed consumed (₦)}}{\text{Total weight of feed consumed (kg)}}$$

$$\text{Cost of feed per Kilogramme weight gain} \left(\frac{₦}{\text{kg}}\right) = \text{Cost of Feed per Kg} \times \text{FCR}$$

## Apparent nutrient digestibility

A digestibility trial was initiated when the chickens reached 56 days of age to assess the apparent nutrient digestibility and energy metabolizability of the experimental diets. Nine (9) chickens, divided into three replicates of three birds each, were randomly selected and housed in individual metabolic cages equipped with separate feeding and watering troughs, as well as facilities for collecting droppings. A three-day acclimatization period preceded the four-day metabolic trial. Known quantities of feed, slightly exceeding daily requirements, were provided to each bird in their respective cages. Droppings were collected daily for four days, then oven-dried at 60°C until a constant weight was achieved. The dried samples, along with the original feed, were analyzed for proximate composition using the methods outlined by the Association of Official Analytical Chemists (AOAC, 2005). Nutrient digestibility was calculated as stated below.

$$\text{Apparent nutrient digestibility} = \frac{\text{Nutrient in feed intake} - \text{Nutrient in excreta output}}{\text{Nutrient in feed intake}} \times 100$$

## Apparent and true metabolizable energy

To assess energy metabolic efficiency, three birds were randomly chosen from each replicate at the conclusion of the finisher phases and relocated to metabolic cages. These birds underwent a 24-hour fasting period to ensure empty digestive tracts prior to receiving a measured quantity of feed. A control group of birds, also randomly selected, was transferred to metabolic cages and subjected to a 24-hour fast, but received only water to determine endogenous losses.

Following the 24-hour fasting period, excreta were quantitatively collected from both groups of birds, then dried in an oven at 60°C until a constant weight was achieved. The dried excreta samples were pooled for each bird, ground into a fine powder, and analysed for gross energy content as described by Tavenari *et al.*, (2018). The apparent and true metabolizable energy were calculated as follows:

$$AME = \frac{(Fi * GEFi) - (Ee * GEe)}{Fi}$$

$$TME = \frac{(Fi * GEFi) - (Yf - Ye)}{Fi}$$

$$AMEn = \frac{(Fi*GEFi) - (Ee*GEe) - (NR*K)}{Fi}$$

$$TMEn = \frac{(Fi*GEFi) - (Yf-Ye) - (NR*K)}{Fi}$$

Where:
AME = Apparent metabolizable energy
AMEn = Apparent metabolizable energy corrected for nitrogen
TME = Total metabolizable energy
TMEn = Total metabolizable energy corrected for nitrogen
Fi = Feed intake (g/DM)
GEFi = Gross energy of feed (MJ/kg)
Ee = Excreta output (g/DM)
Gee = Gross energy of excreta (MJ/kg)
Yf = Energy and gross energy of fed bird
Ye = Energy and gross energy of fasted bird
NR = Nitrogen retained (g)
K = 34.4 (constant)

## Statistical Analysis

Data collected were subjected to Analysis of Variance (ANOVA) using Completely Randomized Design. The significant means were separated using Duncan's Multiple Range Test (DMRT) at 5% probability level as contained in SAS (2010).

# Results

## Effect of increased inclusion of *P. yohimbe* on performance and cost analysis of starter broiler chickens

Table 3 presents the outcomes of the study examining the influence of elevated *P. yohimbe* supplementation on the performance and economic aspects of broiler chickens during their starter phase. The results indicate that there were no significant differences ($p>0.05$) in performance metrics such as: final weight, weight gain, feed intake, feed conversion ratio, livability rate. Also, cost of feed per kilogram of diet and cost of feed per weight gain were not significantly different ($p>0.05$) among broiler chickens fed diets containing varying levels of *P. yohimbe*, including the control group at the starter phase.

### Effect of increased inclusion of *P. yohimbe* on the performance and cost analysis of finisher broiler chickens

Table 4 presents the results of an investigation into the impact of varying levels of *P. yohimbe* supplementation on the performance and economic aspects of broiler chickens during the finisher phase. While no significant differences (p>0.05) were observed in performance metrics such as: final weight, weight gain, feed intake, feed conversion ratio, and feed cost per unit of diet and weight gain, the inclusion of 300mg of *P. yohimbe* in the finisher diet resulted in a notable improvement (p<0.05) in livability rate (98.572%) compared to the control and larvacide (91.905 and 90.587%) group.

### Effect of increased inclusion of *P. yohimbe* on the overall performance and cost analysis of broiler chickens

Table 5 reports the outcomes of the study examining the influence of elevated *P. yohimbe* supplementation on the performance and economic aspects of broiler chickens during their starter phase. The results indicate that there were no significant disparities (p>0.05) in key performance metrics such as final weight, weight gain, feed intake, feed conversion efficiency, and feed cost per unit of diet and weight gain among broilers fed diets containing varying levels of *P. yohimbe*, including the control group. However, a notable exception was observed in livability rates, with broilers fed the Larvacide diet exhibiting a significantly lower livability rate (81.698 %) compared to those receiving other experimental diets.

### Effect of increased *P. yohimbe* inclusion on the nutrient and energy digestibility of broiler starter diet

Table 6 presents a comparative analysis of nutrient and energy digestibility in broiler starter diets supplemented with various concentrations of *P. yohimbe*. The results indicate that the inclusion of *P. yohimbe* significantly influenced the digestibility of ash, fat, crude protein, carbohydrate, crude fibre and energy. Diets containing 240 mg and 360 mg of *P. yohimbe* demonstrated a notable reduction in dry matter (74.933%, 74.159%) digestibility compared to the control group and the 300 mg *P. yohimbe* treatment (76.766%). Additionally, ash digestibility was consistently lower in diets supplemented with *P. yohimbe*. Regarding individual nutrients, the Larvacide-treated diet exhibited superior fat and protein digestibility (92.402%, 83.989% respectively) compared to the *P. yohimbe* groups. However, the inclusion of *P. yohimbe*, particularly at higher concentrations (300 and 360mg), negatively impacted crude protein digestibility (73.611%, 73.208% respectively).

The impact on fiber and carbohydrate digestibility exhibited subtle variations. Diets containing 240 mg and 300 mg of *P. yohimbe* significantly improved fiber digestibility (48.776%, 51.497% respectively), whereas diet with 360 mg of *P. yohimbe* resulted in the lowest carbohydrate digestibility (16.809%). In terms of overall energy digestibility, as measured by TME and TMEn, the Larvacide-supplemented group (3644.848 kcal/kg, 3640.119 kcal/kg respectively) significantly outperformed the control and 300 mg *P. yohimbe* groups. Conversely, the 240 mg and 360 mg *P. yohimbe* diets resulted in notably lower energy digestibility.

**Table 3.** Effect of increased inclusion of *P. yohimbe* on growth performance and cost analysis of starter broiler chickens (day 15-28)

| Parameter | Control | 5mg/kg Larvacide | Dosage of Yohimbe (mg/kg) 240 | 300 | 360 | SEM |
|---|---|---|---|---|---|---|
| Initial weight (g) | 220.000 | 214.444 | 228.888 | 215.555 | 220.000 | 3.372 |
| Final weight (g) | 559.523 | 518.589 | 535.317 | 629.444 | 573.290 | 19.029 |
| Total weight gain (g) | 339.523 | 304.145 | 306.428 | 413.888 | 353.290 | 19.701 |
| Average daily weight gain (g/bird) | 24.251 | 21.724 | 21.887 | 29.563 | 25.235 | 1.407 |
| Total Feed intake (g/bird) | 615.133 | 668.311 | 703.555 | 708.688 | 684.844 | 17.415 |
| Average daily feed intake (g/bird) | 43.938 | 47.736 | 50.253 | 50.620 | 48.917 | 1.243 |
| Feed Conversion Ratio (FCR) | 2.001 | 2.213 | 2.310 | 1.772 | 1.951 | 0.112 |
| Livability (%) | 97.778 | 91.112 | 91.112 | 95.556 | 91.112 | 0.126 |
| Cost of feed/kg diet (₦/kg) | 159.080 | 159.087 | 161.480 | 162.080 | 162.680 | 0.405 |
| Cost of feed/kg weight gain (₦/kg) | 318.349 | 352.083 | 373.138 | 287.286 | 317.407 | 17.973 |

SEM = Standard Error of Mean

**Table 4**. Effect of increased inclusion of *P. yohimbe* on the growth performance and cost analysis of finisher broiler chickens (day 29-56)

| Parameter | Control | 5mg/kg Larvacide | Dosage of Yohimbe (mg/kg) 240 | 300 | 360 | SEM |
|---|---|---|---|---|---|---|
| Initial weight (g) | 559.523 | 518.589 | 535.317 | 629.444 | 573.290 | 19.029 |
| Final weight (g) | 2049.67 | 2127.33 | 2025.33 | 2253.67 | 1976.00 | 44.726 |
| Total weight gain (g) | 1490.142 | 1608.743 | 1490.015 | 1624.222 | 1402.709 | 42.522 |
| Average daily weight gain (g/bird) | 53.219 | 57.455 | 53.214 | 58.007 | 50.096 | 1.518 |
| Total Feed intake (g/bird) | 3386.008 | 3417.398 | 3723.743 | 3283.077 | 3617.662 | 126.385 |
| Average daily feed intake (g/bird) | 120.928 | 122.049 | 132.990 | 117.252 | 129.202 | 4.513 |
| Feed Conversion Ratio (FCR) | 2.276 | 2.148 | 2.582 | 2.014 | 2.589 | 0.123 |
| Livability (%) | 91.905 [b] | 90.587[b] | 97.913 [ab] | 98.572 [a] | 96.974 [ab] | 0.655 |
| Cost of feed/kg diet (₦/kg) | 141.420 | 141.427 | 143.820 | 144.420 | 145.020 | 0.405 |
| Cost of feed/kg weight gain (₦/kg) | 321.897 | 303.925 | 371.365 | 290.969 | 375.589 | 17.915 |

[a,b,] Means on the same row with different superscripts differ significantly (p <0.05)
SEM = Standard Error of Mean

**Table 5.** Effect of increased inclusion of *P. yohimbe* on the overall growth performance cost analysis of broiler chickens (day 15-56)

| Parameter | Control | 5mg/kg Larvacide | Dosage of Yohimbe (mg/kg) 240 | 300 | 360 | SEM |
|---|---|---|---|---|---|---|
| Initial weight (g) | 220.000 | 214.444 | 228.888 | 215.555 | 220.000 | 3.372 |
| Final weight (g) | 2049.67 | 2127.33 | 2025.33 | 2253.67 | 1976.00 | 44.726 |
| Total weight gain (g) | 1829.666 | 1912.888 | 1796.444 | 2038.111 | 1756.000 | 45.013 |
| Average daily weight gain (g/bird) | 43.563 | 45.544 | 42.772 | 48.526 | 41.809 | 1.071 |
| Total Feed intake (g/bird) | 4001.141 | 4085.709 | 4427.299 | 3991.766 | 4302.506 | 129.853 |
| Average daily feed intake (g/bird) | 95.265 | 97.278 | 105.411 | 95.042 | 102.440 | 3.091 |
| Feed Conversion Ratio (FCR) | 2.195 | 2.159 | 2.517 | 1.952 | 2.454 | 0.105 |
| Livability (%) | 89.683 [b] | 81.698[b] | 89.024 [b] | 94.127 [a] | 88.086 [b] | 0.467 |
| Cost of feed/kg diet (₦/kg) | 150.250 | 150.257 | 152.650 | 153.250 | 153.850 | 0.405 |
| Cost of Feed/kg weight gain (₦/kg) | 329.912 | 324.446 | 384.246 | 299.183 | 377.647 | 16.171 |

[a,b,] Means on the same row with different superscripts differ significantly (p <0.05)
SEM = Standard Error of Mean

**Table 6.** Effect of increased *P. yohimbe* inclusion on the nutrients and energy digestibility of broiler starter diet

| Parameter | Control | 5mg/kg Larvacide | Dosage of Yohimbe (mg/kg) 240 | 300 | 360 | SEM |
|---|---|---|---|---|---|---|
| Dry matter (%) | 79.641 [a] | 80.285[a] | 74.933 [c] | 76.766 [b] | 74.159 [c] | 0.678 |
| Ash (%) | 55.975 [a] | 37.023 [b] | 3.762 [d] | 4.879 [d] | 10.840 [c] | 5.555 |
| Fat (%) | 74.773 [d] | 92.402 [a] | 84.093 [c] | 85.387 [b] | 83.399 [c] | 1.506 |
| Crude protein (%) | 81.931 [b] | 83.989 [a] | 74.335 [c] | 73.611 [c] | 73.208 [c] | 1.239 |
| Crude fibre (%) | 22.782 [c] | 32.097 [b] | 48.776 [a] | 51.497 [a] | 16.809 [d] | 3.724 |
| Carbohydrate (%) | 82.971 [b] | 83.300 [b] | 82.570 [b] | 84.817 [a] | 81.298 [c] | 0.333 |
| TME (kcal/kg) | 3282.343 [b] | 3644.848 [a] | 2957.651 [c] | 3315.551 [b] | 2973.772 [c] | 76.756 |
| TMEn (kcal/kg) | 3278.305 [b] | 3640.119 [a] | 2956.811 [c] | 3314.788 [b] | 2972.421 [c] | 76.458 |
| AME (kcal/kg) | 3100.842 [a] | 3267.505 [a] | 2709.135 [b] | 3077.291 [a] | 2615.659 [b] | 75.987 |
| AMEn (kcal/kg) | 3096.805 [a] | 3262.777[a] | 2708.295 [b] | 3076.528 [a] | 2614.308 [b] | 75.727 |

[a,b,c,d] Means on the same row with different superscripts differ significantly (p<0.05)
SEM = Standard Error of Mean
TME = True Metabolizable Energy
TMEn = True Metabolizable Energy corrected for Nitrogen
AME = Apparent Metabolizagle Energy
AMEn = Apparent Metabolizable Energy corrected for Nitrogen

**Table 7.** Effect of increased *P. yohimbe* inclusion on the nutrients and energy digestibility of broiler finisher diet

| Parameter | Control | 5mg/kg Larvacide | Dosage of Yohimbe (mg/kg) 240 | 300 | 360 | SEM |
|---|---|---|---|---|---|---|

| | | | | | | |
|---|---|---|---|---|---|---|
| Dry matter (%) | 79.709[a] | 77.990[b] | 75.877[c] | 76.170[c] | 72.319[d] | 0.688 |
| Ash (%) | 5.960[b] | 20.891[a] | 4.446[b] | 5.552[b] | 7.994[b] | 1.782 |
| Fat (%) | 87.958[b] | 89.298[a] | 82.481[d] | 84.326[c] | 79.792[e] | 0.942 |
| Crude protein (%) | 82.349[a] | 75.051[b] | 61.848[c] | 63.646[c] | 59.212[d] | 2.371 |
| Crude fibre (%) | 46.252[bc] | 47.883[ab] | 43.605[c] | 50.205[a] | 48.513[ab] | 0.736 |
| Carbohydrate (%) | 85.080[ab] | 84.877[b] | 86.170[a] | 86.012[ab] | 83.076[c] | 0.323 |
| TME(kcal/kg) | 3082.085 | 3093.409 | 3005.050 | 2684.042 | 2518.431 | 129.584 |
| TMEn (kcal/kg) | 3078.752 | 3090.192 | 3002.940 | 2681.819 | 2515.074 | 129.581 |
| AME (kcal/kg) | 2915.896 | 2760.579 | 2811.660 | 2498.062 | 2266.813 | 129.514 |
| AMEn (kcal/kg) | 2912.563 | 2757.362 | 2809.550 | 2495.840 | 2263.456 | 129.521 |

[a,b,c,d,e] Means on the same row with different superscripts differ significantly (p <0.05)
SEM = Standard Error of Mean
TME = True Metabolizable Energy
TMEn = True Metabolizable Energy corrected for Nitrogen
AME = Apparent Metabolizagle Energy
AMEn = Apparent Metabolizable Energy corrected for Nitrogen

### Effect of increased *P. yohimbe* inclusion on the nutrient and energy digestibility of broiler finisher diet

Table 7 shows the effect of increased *P. yohimbe* inclusion on the nutrient and energy digestibility of broiler finisher diets. There were no significant differences ($p>0.05$) in the TME, AME, TMEn, and AMEn of broiler chickens fed diets containing *P. yohimbe*. However, the dry matter and crude protein digestibility were significantly and progressively reduced ($p<0.05$) in broiler chickens fed Larvacide, 240 mg, 300 mg, and 360 mg *P. yohimbe*-included diets, respectively, compared with the control diet. There was a significant increase ($p<0.05$) in the percentage ash digestibility in chickens fed Larvacide (20.891%) compared with chickens fed other experimental diets. Additionally, chickens fed Larvacide based diet exhibited higher fat digestibility (89.298%) compared with the control diet. Conversely, chickens fed *P. yohimbe* had significantly lower ($p<0.05$) percentage fat digestibility compared with the control diet, with 360 mg/kg having the least digestibility (79.792%).

Chickens fed the 300 mg *P. yohimbe* included diet had higher ($p<0.05$) percentage crude fiber digestibility (50.205%) compared to chickens fed the control and 240 mg *P. yohimbe* diets. Additionally, there was a reduction ($p<0.05$) in carbohydrate digestibility in chickens fed the 360 mg *P. yohimbe* diet (83.076%) compared to chickens fed other experimental diets. However, chickens fed the 240 mg *P. yohimbe* diet had significantly higher ($p<0.05$) carbohydrate digestibility (86.170%) compared to chickens fed the Larvacide-included diet.

## Discussion

*Pausynistalia yohimbe* had no influence on the growth performance indexes and cost benefits of broiler chickens production at the starter phase even as the inclusion levels rises. This is similar to the findings of Obajuluwa *et al.* (2020) who supplied the supplement at a lower rate (60, 120 and 180 mg/kg) to broiler chickens as well as Metin *et al.* (2016) who supplied Yohimbine through drinkable water. The limited impact of yohimbe supplements at the earlier life of broiler chickens could be due to its less influence on protein digestion, as it is observed that yohimbe stimulatory influence is pronounced on the salivary gland which contains amylase that is needed for carbohydrate digestion (Jabir *et al.*, 2022). During the starter phase, the primary nutritional requirement for young broilers chickens is protein, which is crucial for cell division and growth. Carbohydrates primarily provide energy, which may be less critical during the starter phase as other ingredients supply it in the diet.

Though yohimbe supplementation in the diet did not significantly influence growth performance metrics during the starter phase, however, its effects on was more pronounced during the finisher phase. As evidenced by Anyanwu *et al.* (2023), yohimbe exhibits lipolytic properties, suggesting its potential to reduce body fat. Conversely, the stimulatory influence of yohimbe on salivary glands, as reported by Jabir *et al.* (2022), could promote carbohydrate utilization and potentially lead to increased fat accumulation. The observed positive effect of yohimbe on livability in broiler chickens fed 300 mg/kg diets highlights a potential benefit of this botanical additive during the finisher phase. Improved livability could be associated with the immunostimulatory properties of Yohimbine present in the additive. Asadu (2018) reported that yohimbine enhances humoral immunity in laboratory study of mice. Furthermore, the counteracting mechanisms of lipolysis and carbohydrate utilization may explain the similar performance indexes observed across different yohimbe inclusion levels, suggesting a balance between these opposing effects.

There were numerical differences in the cost of feed per kilogram diet and cost of feed per kilogram weight gain in chickens served the experimental diets. Although differences were not statistically significant, a unit reduction in the cost of feed could bring a large profit margin when production is at scale (Waithaka *et al*., 2023). The reduction in the cost of feed per kg weight gain at 300 mg/kg Yohimbe is due to improved FCR. This means more flesh is yielded in chickens served the supplemented diet at comparatively less feed cost.

There was a reduction in the True Metabolizable Energy (TME) of chickens on a starter diet with 360mg Yohimbe. This is due to the poor digestion of fat and protein in the diet as protein and fat has the highest energy content per kilogram amongst other nutrients in the diet and this affects the energy utilization of the supplied feed (Barzegar *et al*., 2020). Diets with improved protein and fat digestion also have a correlated improvement in the energy utilization efficiency. Furthermore, the decline in protein digestion could be related to the presence of anti-nutritional factors such as tannins and saponin which could interfere with digestion of proteins and amino acid in poultry species (Samtiya *et al*., 2020). However, compared with the basal diet, there was improvement in carbohydrate digestion with the inclusion of 300 mg/kg *P. yohimbe*. This could be associated with the saliva-stimulatory properties of *P. Yohimbe* as Jabir *et al.* (2022) reported that Yohimbine increased salivary secretion when consumed by both animals and human. The enzyme, amylase present in saliva could help with the digestion of starches in feed, and thereby improve the digestion of carbohydrates in supplemented diets. In addition, compared to the basal diet, there was improvement in the digestion of fats with the inclusion of *P. yohimbe* in the diets. This is traceable to its lipolytic properties as reported by Shi *et al.* (2025).

Contrastingly, due to the age of the chickens, the digestive system is not well developed to handle the digestion of the fibrous additives (Rybicka *et al*., 2024). This consequently reduced the digestion of fiber in the diet. Although the gastro-intestinal stimulatory properties of Yohimbe could have compensated, at 240 and 300 mg/kg *P. yohimbe* supplementation, as concentration increased, digestibility of fiber declined.

In the finisher diet, ash, fat and crude protein were poorly utilized by chickens on diets supplemented with Yohimbe, while there was improvement in carbohydrate digestion compared to control with *P. yohimbe*, till 300 mg/kg supplementation. However, carbohydrate digestion declined afterwards. This could be as a result of anti-nutritional factors such as oxalate and phytate which interferes with enzymatic digestion as reported to be present by Yılmaz *et al.* (2025).

## Conclusion

At the starter phase, Yohimbe supplementation improved fat, energy, carbohydrate and crude fiber digestion while at the finisher phase, Yohimbe inclusion promotes livability, digestion of carbohydrates and crude fiber. It is concluded that Yohimbe promote livability with carbohydrate and energy digestion in both starter and finisher diets till 300 mg/kg after which there is a decline in the digestibility of these nutrients.

## Competing Interests

There are no competing interest regarding the manuscript.

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