

## Original Research Article

### MEAT AND SENSORY QUALITIES OF BROILER CHICKENS FED DIETS WITH GRADED LEVELS OF BITTER (*VERNONIA AMYGDALINA*) LEAF MEAL

#### ABSTRACT

Feed constitutes the greatest cost input in livestock production. Feed costs continue to increase due to high inflation rates which impact negatively on livestock production in developing countries. Researchers continue to work toward reducing cost by sourcing for low-cost, unconventional feed ingredients to boost livestock production. Therefore, this experiment was designed to evaluate the effects of feeding diets containing graded levels of the commonly available Bitter Leaf Meal (BLM) meat and sensory characteristics of broiler chickens. Four dietary treatments were formulated thus: Treatment 1/Control (0% BLM), Treatment 2 (5% BLM), Treatment 3 (7.5% BLM), Treatment 4 (10% BLM). Two hundred and forty, 2 week old broiler chicks were obtained and randomly allotted to each treatment in a completely randomised design making 60 birds per treatment with 3 replicates of 20 birds each. Feed and water were given *ad libitum* for 8 weeks after which four birds from each replicate were randomly selected, fasted overnight and slaughtered. The prime cuts, meat and sensory qualities were evaluated and data obtained were statistically analysed. There was no significant difference between the cooking loss of drumstick of treatment 1 (Control) and other treatments fed graded levels of BLM. However cooking loss for breast was significantly higher in treatment 4 (10% BLM) at 24.7, and treatments 1 to 3 recording 21.29, 18.72, and 18.97 respectively. For thigh, cooking loss was significantly lower in treatment 4 at 22.14 while values for other treatments were similar. There was no significant difference among all the treatments for oxidative rancidity and pH. Water Holding Capacity was significantly lower in treatments 3 (7.5% BLM) and 4 (10%) BLM with values of 61.11 and 66.44 while treatments 1 and 2 had significantly higher values of 75.00. There were no significant differences among treatments for Colour, Aroma, Tenderness, Texture and Overall Acceptability. Only treatment 4 (10% BLM) had significantly lower value for Juiciness. Flavour was significantly higher in treatments 1 (0% BLM) and 3 (7.5% BLM) with values of 5.6 and 5.7 while the other treatments were similar. Results obtained showed that dietary inclusion of BLM between 5-7.5% generally had no deleterious effects on meat and sensory characteristics of broiler chickens and can therefore be adopted to reduce feed costs.

**Keywords:** Bitter leaf meal, Broiler Chicken, Meat quality, Sensory evaluation

#### INTRODUCTION

Broiler production is currently oriented for parts marketing, and no longer to whole carcasses, which led to the development of birds with higher lean tissue yield and lower fat content [1]. Carcass fat content is one of the main concerns of poultry companies as the increasing awareness of consumers on health problems has generated rejection of fat carcasses. In addition to genetics, lean tissue accretion and fat deposition are influenced by nutrition, feeding program, age, sex, and environmental conditions [2].

In the past, Nigeria government in an attempt to alleviate this problem of protein deficiency has always resorted to mass importation of protein product - poultry meat. The present government is emphasizing on self-sustainability in poultry production and a ban has been placed on the importation of all poultry products. The challenge cause by the ban, is that of harmonizing or balancing the shortages in supply caused by the ban on importation of frozen chicken and increasing local poultry production. Poultry industry in Nigeria is controlled and managed by private individuals and farmers. [3] opined that broiler production is a very popular livestock business in Nigeria. He added that many farmers who are into poultry business in Nigeria ranging from layers, turkeys, most times preferred to venture into broiler poultry farming first, because it is a fast and reliable way of raising poultry meat for human consumption and at the same time an income generating venture.

The poultry business is costsensitive. Feed cost, for instance, account for between 65% and 70% of the total cost of raising poultry. Even with increasing feed cost, the poultry industry is contending with relative constant and sometimes decreasing prices of poultry products occasioned by low prices of imported broilers and declining income levels of consumers [4]. Thus, there is the perception that poultry farmers are being squeezed by the declining output prices and the increasing input (feed) cost. Given the critical role of poultry industry especially broiler production in addressing the countries nutritional needs and the negative impact of economic recession,

it becomes imperative to evaluate the profitability of broiler business in a recession period. One unconventional feed source that could be used to reduce the high cost of conventional protein sources in livestock diet with particular reference to poultry is the bitter leaf (*Vernonia amygdalina*) meal.

Bitter leaf is a shrub or small tree that grows throughout tropical Africa. It is popularly called bitter leaf because of its abundant bitter principles [5]. The findings by [6] reported that the young leaves, often preferred for human consumption contain high cyanide (60.1 mg 100<sup>-1</sup> g DM) and tannin content (40.6 mg 100<sup>-1</sup> g DM). Research has shown that bitter leaf has some beneficial effects in disease management of poultry [7]; such as anti-coccidiosis, anti-bacterial and anti-parasitic [8; 9]; as an anti-oxidant [10] and as a growth promoter by enhancing the gastro intestinal enzymes thus increasing feed conversions efficiency [11; 12].

Therefore, the aim of this study was to evaluate the beneficial effects of bitter leaf meal (*Vernonia amygdalina*) on meat quality and sensory evaluation of broiler chicken.

## MATERIALS AND METHODS

### Experimental site

The experiment was carried out at the poultry section of the National Veterinary Research Institute (NVRI) Vom, Nigeria. Vom environment is characterized by the dry harmattan winds which are cold and dry. From the middle or towards the end of January, as the harmattan winds begin to recede [13], Vom is located in Jos Southlocal government area of Plateau state. It is situated on the south east of Jos, the Plateau State capital which is located at 8<sup>o</sup>45 East and 9<sup>o</sup>43 North with a height of about 1,285 meters above sea level. Vom has a remarkable cool climate, in December and January; the night may be extremely cold, the wet season is from late April to middle October [13].

Source of test material: Bitter leaf was harvested from the tree in the same community, air dried at room temperature and crushed into a meal.

**Experimental diet:** Four diets containing 0 (control), 5, 7.5 and 10% of bitter leaf meal (BLM) were formulated. The diets were represented by treatments 1, 2, 3 and 4 respectively and contain 23% crude protein.

Experimental birds: Two hundred and forty day-old arbo acre broiler chicks of mixed sexes were purchased from a reputable hatchery and brooded for two weeks, they were uniform in sizes and at 2-week old they were randomly allotted to the four dietary treatments.

### Experimental animals and management

A total of 240 unsexed two weeks old broiler chicks were randomly distributed to four (4) dietary treatments in a completely randomised design at three (3) replicates of twenty (20) birds each. The feed was presented in mash form and water was provided *ad libitum*. The birds were raised on deep litter and were subjected to standard management practices and the recommended vaccines for broilers was administered.

**Table 1: Composition of experimental diet**

Ingredient	Control T1	T2 (5%BLM)	T3 (7.5%BLM)	T4 (10%BLM)
Maize	50.00	48.00	45.00	47.30
Wheat offal	6.30	6.30	6.80	4.00
Soya beans meal	20.00	18.00	18.00	17.00
Groundnut cake	19.00	18.00	18.00	17.00
Vegetable oil	2.00	2.00	2.00	2.00
BLM	—	5.00	7.50	10.00
Bone meal	2.00	2.00	2.00	2.00
Premix (broiler ST)	0.15	0.15	0.15	0.15
Methionine	0.20	0.20	0.20	0.20
Lysine	0.10	0.10	0.10	0.10
Salt	0.25	0.25	0.25	0.25
Total	100.00	100.00	100.00	100.00

BLM=Bitter Leaf Meal, ST= Starter

Carcass evaluation: At the end of the eight weeks feeding trial, four birds from each replicate were randomly selected, fasted for (16) hours and slaughtered by severing the throat with the aid of sharp knife, The birds were

Comment [k1]: of Akwaowo et al (6)

Comment [k2]: Where is the ethical approval statement?

Comment [k3]: Make the title Bold

Comment [k4]: Make the title Bold

Comment [k5]: Should cite the table 1 here?

Comment [k6]: Make the title Bold

Comment [k7]: Delete

Comment [k8]: were

allowed to bleed for five minutes and defeathered manually by immersing in warm water. Determination of carcass characteristics was done according the method described by [14], carcasses were eviscerated to determine the dressed weight and weight of the carcass components (thighs, drumstick, breast, back, wings, and neck, internal organs were; heart, lung, spleen, liver were measured. Carcass, organs, and gut were weighed with the aid of laboratory electronic scale (ACCULAB).

Comment [k9]: Barton-Gade (14)

The cut parts were expressed as percentage of live weight. The dressing percentage was calculated as a ratio of dress weight to live weight multiplied by hundred

$$\text{Dressing percentage} = \frac{\text{dressed weight}}{\text{live weight}} \times 100$$

#### Cooking yield

The weight of meat was recorded before and after cooking and the yield was expressed as percentage

Comment [k10]: Make the title Bold

$$\text{Cooking yield} = \frac{\text{Weight of cooked meat}}{\text{Weight of raw meat}} \times 100$$

#### Drip loss

This was measured by the method of [15] with some modifications. Each breast was weighed immediately after ageing, hung in a laminate bag, closed loosely with string and allowed to thaw. After thawing for 24 h at 4°C, the meat samples were taken out, mopped and re-weighed and the drip loss calculated.

Comment [k11]: Make the title Bold

Comment [k12]: Mahendrakar et al (15)

#### Sensory evaluation

A total of 20 trained individuals aged between 20 and 40 years were used to assess two replicate of the prepared sausage. The samples were evaluated using a 9-point hedonic scale for flavor, colour, juiciness, tenderness, and overall acceptability. The scale had a maximum score of 9 while the lowest score of 1 was assigned to the poorest condition [16]

Comment [k13]: Make the title Bold

#### Water holding capacity

Water Holding Capacity (WHC) was determined according [17]. Minced meat (20 g) was placed in a centrifuge tube containing 30 ml of 0.6 M NaCl and was stirred with glass rod for 1 min. The tube was then kept at 4 ± 1 °C for 15 min, stirred again and centrifuged at 3000g (R-24, Remi Instruments, India) for 25 min. The supernatant was measured and WHC was expressed in percentage.

Comment [k14]: Make the title Bold

Comment [k15]: AOAC (17)

#### pH

The pH value of raw and cooked meat samples was determined by weighing 10 grams of sample into a blender with 90ml of distilled water and homogenised until smooth slurry was formed. The digital pH meter was placed in a buffer solution in order to allow equilibrium for two minute before placing it into prepared slurry. An average of three readings taken gave the pH value according to method described by [18].

Comment [k16]: Make the title bold

Comment [k17]: Oshibanjo (18)

Comment [k18]: Make the title bold

#### Determination of Extract Release volume (ERV)

The technique showed a value in determining incipient spoilage in meat as well as in predicting refrigerator shelf life.

Principle: The technique is based on the volume of aqueous extract released by homogenate of meat when allowed to pass through the filter paper for a given period of time, by this meat of good organoleptic and microbial quality release large volume of extract, whereas meat of poor quality releases smaller volume or none. Requirements: Beaker, distilled water, Whatman No. 1 filter paper, pestle and mortar, graduated cylinder.

#### Procedure

- Take 25 g meat sample in 100 ml distilled water
- Bend it with in pestle and mortar
- Filter through Whatman No. 1 filter paper, folded thrice so as to make eight sections.
- Allow the homogenate to seep between the folds
- Collect the extract in 100 ml graduated cylinder for 15 min.
- Record extract release volume and interpret results

#### Interpretation:

ERV (ml) Meat quality  
> 25 ml Good quality  
> 20 ml Incipient spoilage  
< 20 ml Spoiled meat

Comment [k19]: Make the title Bold

#### Determination of meat swelling Capacity

Comment [k20]: Make the title Bold

**Principle:** This test determines the freshness of meat. Swelling capacity of meat increases during spoilage due to protein degradation and penetration of more amounts of water in protein matrix. A method of measuring the water binding capacity of muscle proteins with low water holding forces known as meat swelling (SW).

Requirements: distilled water, centrifuge, blender, graduated cylinder

**Procedure**

- I. Take 25 g of meat in 100 ml of distilled water
- II. Blend it for 2 min
- III. Centrifuge 35 ml of homogenate at 2000 rpm for 15 min
- IV. Measure the volume of supernatant (S)
- V. Record the volume and denote it as "S".

Percent meat swelling can be determined as

$$\% \text{ swelling} = \frac{(35 - S - 7)}{7} \times 100$$

**Cold shortening**

This was measured by the method of [19] with some modifications. Each breast meat was cut into 10cm long (initial length) then placed on a tray and immediately kept in the freezer for 24 hours. After frozen for 24 h at -10°C, the meat samples length was taken before thawing (final length). Cold shortening in percentage was calculated using the formula below:

$$\text{Cold shortening} = \frac{\text{Initial length} - \text{Final length}}{\text{Initial length}} \times 100$$

**Thermal shortening**

This was measured by the method of [18] with some modifications. Each breast meat was cut into 10cm long (initial length) then placed on a tray and immediately put into the oven which have been preheated to 100°C for 20 min. The final length was measured and recorded. Thermal shortening in percentage was calculated using the formula below:

$$\text{Thermal shortening} = \frac{\text{Initial length} - \text{Final length}}{\text{Initial length}} \times 100$$

**Analysis of Oxidative Rancidity/Lipid per oxidation**

Thiobarbituric acid value (TBA) was estimated by modified methods of [19]. Three mls each of glacial acid and 1% TBA solution were added to test tubes appropriately labelled blank and tests. 0.6ml of distilled water was added to the blank, while 0.6ml of the homogenised sample was added to each of the tests tubes. These were thoroughly mixed, incubated in a boiling water bath for 15 minutes, then allowed to cool, after which they were centrifuged and their supernatants collected. The supernatant from the blank was used to zero the spectrophotometer (preset at 532nm) before reading the absorbance of the supernatant from the test solutions. The amount of TBARS was expressed as milligrams of malondialdehyde per gram of sample.

$$\text{TBA} = \frac{\text{O.D} \times \text{V} \times 1000}{\text{A} \times \text{v} \times \text{I} \times \text{Y}}$$

Where:

O.D = Absorbance of test at 532nm.

V = Total volume of the reaction mixture = 6.6mL

A = Molar extinction coefficient of the product, and according [19] is equal to  $1.56 \times 10^5$

I = Length of light path = 1cm.

Y = mg of tissue in the volume of the sample used.

v = volume of tissue extract used = 0.6ml

Data analysis

The data obtained were subjected to analysis of variance of S.A.S package and means was separated using New Duncan multiple range test of the same software.

Comment [k21]: Make the title Bold

Comment [k22]: swelling

Comment [k23]: Make the title Bold

Comment [k24]: Make the title Bold

Comment [k25]: Buege and Aust (19)

Comment [k26]: Make the title Bold

Comment [k27]: Oshibanjo (18)

Comment [k28]: Make the title Bold

Comment [k29]: Buege and Aust (19)

## RESULTS

Table 2: Cooking loss of meat from broiler chickens fed graded levels of Bitter leaf meal

Parameter (%)	Control	5%Bitter leaf	7.5%Bitter leaf	10%Bitter leaf	SEM
Breast	21.29 <sup>b</sup>	18.72 <sup>c</sup>	18.97 <sup>c</sup>	24.07 <sup>a</sup>	0.66
Drumstick	25.93	26.17	21.58	25.44	0.94
Thigh	27.62 <sup>a</sup>	29.39 <sup>a</sup>	28.92 <sup>a</sup>	22.14 <sup>b</sup>	0.92

Note: Means with different superscript on the same row are significantly different (P<0.05).

Table 2 illustrated the cooking loss of meat from broiler chicken fed graded levels of Bitter leaf meal. As shown in the Table, the cooking loss for the breast were 21.29, 18.72, 18.7 and 24.07 for 0.00% , 5.00%, 7.50% and 10.00% level of bitter leaf meal inclusion. The drumstick cooking loss were 25.93, 26.17, 21.58 and 25.44 for the respective level of inclusion while the thigh cooking loss were 27.62, 29.39, 28.92 and 22.17 for the various level of inclusion mentioned above.

Comment [k30]: Table (2)

Table 3: Oxidative rancidity and pH of meat from broiler chicken fed graded levels of Bitter leaf meal

Parameter	Control	5%Bitter leaf	7.5%Bitter leaf	10%Bitter leaf	SEM
Oxidative Rancidity (mg/g)	1.45	1.45	1.39	1.21	0.05
pH	6.45 <sup>b</sup>	6.65 <sup>a</sup>	6.65 <sup>a</sup>	6.65 <sup>a</sup>	0.03

Note: Means with different superscript on the same row are significantly different (P<0.05).

Table 3 showed the oxidative rancidity and pH of meat from broiler chicken fed graded levels of bitter leaf meal. The oxidative rancidity value were 1.45, 1.45, 1.39 and 1.21 for 0.00%, 5.00%, 7.50% and 10.00% respectively. The PH values were 6.45, 6.65, 6.65 and 6.65 for the respective levels of inclusion.

Comment [k31]: values

Table 4: Physical properties of meat from broiler chickens fed graded levels of Bitter leaf meal

Parameter (%)	Control	5% Bitter leaf	7.5% Bitter leaf	10% Bitter leaf	SEM
Water Holding Capacity	75.00 <sup>a</sup>	75.00 <sup>a</sup>	61.11 <sup>c</sup>	66.44 <sup>b</sup>	1.8
Extract Release Volume	47.50 <sup>a</sup>	33.33 <sup>b</sup>	46.67 <sup>a</sup>	48.67 <sup>a</sup>	2.27
Cold shortening	3.19 <sup>ab</sup>	3.48 <sup>ab</sup>	2.59 <sup>b</sup>	3.95 <sup>a</sup>	0.19
Drip loss	18.19 <sup>b</sup>	34.38 <sup>a</sup>	14.29 <sup>d</sup>	20.02 <sup>b</sup>	2.29

Note: Means with different superscript on the same row are significantly different (P<0.05).

Table 4 showed the physical properties of broiler chicken fed graded levels of bitter leaf meal. This include the water holding capacity, extracts release volume, cold shortening and drip loss of meat from broiler chicken fed graded levels of bitter leaf meal. The values of water holding capacity include 75.00, 75.00, 61.11 and 66.44 for 0.00%, 5.00%, 7.50% and 10.00% levels of bitter leaf inclusion. The extract release volume are 47.50, 33.33, 46.67 and 48.67 for the various levels of inclusion. The value of the cold shorting recorded include 3.19, 3.48, 2.59 and 3.95 for the respective treatments. While the drip loss are 18.19, 34.38, 14.29 and 20.02 for 0.00%, 5.00%, 7.50% and 10.00% levels of bitter leaf inclusion respectively.

Comment [k32]: included

Comment [k33]: volumes

Comment [k34]: were

Comment [k35]: values

Comment [k36]: included

Comment [k37]: were

Table 5: Sensory evaluation of meat from broiler chicken fed graded levels of Bitter leaf meal

Parameter	Control	5%Bitter leaf	7.5%Bitter leaf	10%Bitter leaf	SEM
Colour	7.2	6.4	6.6	6.5	0.26
Aroma	5.4	4.6	6.3	4.8	0.32
Flavour	5.6 <sup>a</sup>	5.0 <sup>b</sup>	5.7 <sup>a</sup>	4.7 <sup>b</sup>	0.28
Juiciness	5.6 <sup>a</sup>	5.9 <sup>a</sup>	5.5 <sup>ab</sup>	4.2 <sup>b</sup>	0.31
Tenderness	5.7	6.3	6.7	5.4	0.29
Texture	5.6	6.1	5.7	5.3	0.26
Overall acceptability	6.6	7.7	7.0	6.2	0.29

Note: Means with different superscript on the same row are significantly different (P<0.05).

Table 5 shows the colour, aroma, flavor, juiciness, tenderness, texture and overall acceptability of meat from broiler chickens fed graded levels of bitter leaf meal. The color values obtained were 7.2, 6.4, 6.6 and 6.5 for 0.00%, 5.00%, 7.50% and 10.00% levels of inclusions of bitter leaf meal respectively. The aroma values were 5.4, 4.6, 6.3 and 4.8 for the respective treatment. As for the flavor the value recorded were 5.6, 5, 5.7 and 4.7 for various level of inclusion of bitter leaf meal respectively. Tenderness values observed were 5.7, 6.3, 6.7 and 5.4 for 0.00%, 5.00%, 7.50% and 10.00% levels of inclusion of bitter leaf meal respectively. The texture values were 5.6, 6.1, 5.7 and 5.3 for the respective levels of inclusion. The overall acceptability values are 6.6, 7.7, 7 and 6.2 for the various treatment respectively.

Comment [k38]: showed

Comment [k39]: values

## DISCUSSION

In Table 2, the results obtained showed significant difference in the values of breast and thigh cooking loss. It was observed that there were significant differences in the breast and thigh muscles cooking loss. The cooking loss for breast was significantly ( $P < 0.05$ ) higher in T4 (24.07) while T1, T3 and T2 were 21.29, 18.97 and 18.72 respectively. The cooking loss for thigh were significantly higher in T2 (29.30) and T3 (28.92), while T4 (27.62) and T1 (22.14) had the least values. The drumstick was not significantly different across the treatment with T2 (26.17) having the highest value, followed by T1 (25.93), T4 (25.44) and T3 (21.58). 5% and 7.5% of Bitter leaf meal inclusion were particularly effective in reducing cooking loss compared to the control, which has significant implications for product yields. Leaf meals containing high content of protein have been incorporated in broiler diets. Besides being rich in protein, leaf meals also contain a wide variety of biological active components that may serve as growth-promoting and health-promoting agents for broiler chickens.

Comment [k40]: obtained

Table 3 depicts the oxidative rancidity and pH of meat from broiler chickens fed graded levels of bitter leaf meal. There was no significant difference ( $P < 0.05$ ) in the oxidative rancidity levels across treatments however, T1 and T2 had same numerical value (1.45). The pH values were significantly higher in the meat from broiler chickens fed Bitter leaf meal. This could be due to the alkaline nature of the bitter leaf contents. The slightly higher pH of meat from birds fed with BLM diets is thought to be beneficial to meat quality, as it indicates there was no significant build up of lactic acid in the meat which may increase the rate of protein denaturation and other qualitative nutrient losses [20].

Comment [k41]: health

Comment [k42]: depicted

Comment [k43]: indicated

Table 3 shows the physical properties of meat from broiler chicken fed graded levels of bitter leaf meal. The parameters studied were water holding capacity, extract release volume, cold shortening and drip loss. Significant difference ( $P < 0.05$ ) exist in all the parameters studied. The water holding capacity (WHC) was significantly higher in T1 (75.00) and T2 (75.00) followed by T4 (66.44) and T3 (61.11). Water holding capacity, having direct bearing on the colour and tenderness of meat, is among the most important functional properties of raw meat. Increase in the water content of muscles, enhancing tenderness, juiciness, firmness, and appearance, improve the quality and economical value of meat. The WHC values observed in this experiment were not compromised in any significant manner by BLM as to negatively impact other important meat attributes, and are similar to observations by [21]. The extract release volume and the cold shortening were significantly higher in T4 (48.67 and 3.95 respectively). While the drip loss was higher in T2 (34.38), followed by T4 (20.02), T1 (18.19) and T3 (14.29). The results were mixed and followed no particular pattern.

Comment [k44]: showed

Comment [k45]: existed

Comment [k46]: illustrated

Table 4 illustrates the sensory in valuation of meat from broiler chicken fed graded levels of bitter leaf meal. No significant difference was observed in the colour, aroma, flavor, Juiciness, tenderness, texture and overall acceptability. The colour in T1 (7.3) was numerically higher, while T2 (6.4) had the least values. The aroma was numerically higher in T3 (6.3) followed T1 (5.4), T4 (4.8) and T2 (4.6). The juiciness, tenderness, texture and overall acceptability were numerically higher in T1 (5.9, 6.3, 6.1 and 7.7 respectively) and numerically least in T4 (4.2, 5.4, 5.3 and 6.2 respectively).

## CONCLUSION AND RECOMMENDATION

The inclusion of bitter leaf meal in broiler chicken diets had significant differences ( $P < 0.05$ ) on the cooking loss of the breast, and thigh but not on the drumstick. The pH of meat from broiler chickens fed graded levels of bitter leaf meal were significantly higher than the control. Significant differences were also observed in the physical properties of meat from broiler chickens fed graded levels of bitter leaf meal compared to the control, while no significant difference was observed in most of the sensory quality parameters observed; especially overall acceptability.

Comment [k47]: was

Therefore, it is suggested that Bitter leaf meal can be added in boiler chickens diet up to 7.5% without any deleterious effect on meat quality.

## REFERENCES

1. Buteri, C. B. (2003) Efeitos de diferentes planos nutricionais sobre a composição e o desempenho produtivo e econômico de frangos de corte. Tese de DSc em Zootecnia, UFV, Viçosa, Brasil, 151p.
2. Leeson, S. (1995) Nutrição e qualidade da carcaça de frangos de corte. In: conferência
3. Nworgu F.C., Ogungbenro, S.A. and Solesi, K.S. (2007). Performance and some Blood Chemistry indices of Broiler Chicken served fluted pumpkin (*Telferia occidentalis*) leaves Extract supplement. *American-Eurasian Journal of Agricultural and Environmental Science*, 2(1) 90-98.
4. Adelowo, O.V., Oshibanjo, D.O., Olaiya, O.D., Banjo, A.A. and Machen, M.J. (2019). Effects of Feeding Roasted *Canarium Schweifurthii* Seed Meal on Performance and Carcass Characteristics of Broiler Chicken. *Asian Journal of Research in Animal and Veterinary Sciences*. Volume 4(2): 1-6, 2019; Article no AJRAVS, 50561
5. Ekpo, A., Eseyin, O.A., Ikpeme, A.O., & Edoho, E.J. (2007). Studies on Some Biochemical Effects of Vernonia Amygdalina In Rats. *Asia Journal of Biochemistry*; 2(3): 193-197.
6. Akwaowo, E.U., Ndon, B.A., & Etuk. (2000). Minerals and antinutrients in fluted pumpkin (*Telferia occidentalis* Hook f.). *Food Chem*; 70: 235-240.
7. Dakpogan, H.B. (2006). Free range chick survivability in improved conditions and the effect of 3 medicinal plants on Eimeriatenella. M.Sc. Thesis, Department of Veterinary Pathobiology, The Royal Veterinary and Agricultural University, Denmark.
8. Gbolade, A.A. (2009). Inventory of antidiabetic plants in selected districts of Lagos State, *Nigeria. J. Ethnopharmacol*; 121:135-139.
9. Tadesse, A.A., Gebie-Hiwot, K., Asres, M., & Djote, F.D. (1993). The in vitro activity of Vernonia amygdalina on *Leishmania ethiopia*. *Ethiop. Med. J*; 31: 183-189.
10. Erasto, P., Grierson, D.S., & Afolayan, A.J. (2007). Evaluation of Antioxidant activity and the fatty acid profile of the leaves of Vernonia amygdalina growing in South Africa. *Food Chem*; 104:636-642.
11. Huffman, M.A., Koshimizu, K., & Ohigashi, H. (1996). Ethnobotany and Zoopharmacognosy of Vernonia amygdalina, A Medicinal Plant Used by Humans and Chimpanzees in the Wild. In: *Compositae: Biology and Utilization*, Caligari, P.D.S. and D.J.N. Hind (Eds.). The Royal Botanical Garden, Kew; 351-360.
12. Olobatoke, R.Y., & Oloniruha, J.A. (2009). Haematological assessment of bitter leaf (*Vernonia amygdalina*) efficiency in reducing infections in cockerels. Proceedings of the World Congress on Medicinal and Aromatic Plants, November 9-14, 2008, Cape Town, South Africa; 472-473.
13. Oluyemi, J.A., & Roberts, F.A. (2000). Poultry production in warm wet climate. Macmillan Press Ltd. 2nd Edition, Spectrum Books Ltd. Ibadan, Nigeria.
14. Barton-Gade PA, Demeyer D, Honikel KO, Joseph RL, Poulanne E, Severini M Smulders FJM, Tomberg E (1993). Reference method for water holding capacity in meat and meat products. Procedures recommended by an OECD working group. 39th International Congress of Meat Science and Technology. August 1-6 (1993), Calgary, Alberta. Canada
15. Mahendrakar, N.S., Khabade, U.S. and Dam, N.P (1988). Studies on the effect of fattening on carcass characteristics and quality of meat from Bannur lambs. *J. Food Sci. Tech.* 25: 225-231.
16. Wardlaw, F.B., Maccaskill, L.H and Acton, J.C. (1973) Effect of postmortal muscle changes in poultry meat loaf properties. *Journal of food science*, 38, 421-424
17. AOAC (2000). Association of Official Analytical Chemistry Official Methods of Analysis of AOAC international (17th ed.). MD, USA.
18. Oshibanjo D.O (2005) Chemical and organoleptic characteristics of three breeds of duck. Agric. project submitted to Department of Animal Science, Faculty of Agriculture and Forestry, University of Ibadan
19. Buege, J.A. and Aust, S.D., (1978). Microsomal lipid, Peroxidation. In: Flesicher, S., Packer, L. (Eds.), *Methods in Enzymology*. Vol. 52. Academic Press, New-York, pp. 302-310
20. Mir, N. A., Rafiq, A., Kumar, F., Singh, V., & Shukla, V. (2017). Determinants of broiler chicken meat quality and factors affecting them: a review. *Journal of food science and technology*, 54(10), 2997-3009. <https://doi.org/10.1007/s13197-017-2789-z>
21. Offer G, and Knight P (1988) The structural basis of water-holding in meat. General principles and water uptake in meat processing. In: *Developments in meat science*, Elsevier Applied Science Publishing Co., Inc, New York, pp 163-171

Comment [k48]: need to be aligned and follow the journal guidelines

