

Original Research Article

Quality attributes and antioxidant activities of meat of broiler chickens administered aqueous *Lagenaria breviflora*

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Abstract

The ban on antibiotics across the globe necessitated the need for an alternative in the production and management of animal health, and this made herbal medicines like *Lagenaria breviflora* validated to be an alternative. Two hundred and eight (208) day-old Cobb 500 chickens were randomly assigned to four (4) treatment groups of *Lagenaria breviflora*: control (0g), 50, 100, and 150 grams per litre, with fifty-two (52) birds each, having thirteen (13) birds per four (4) replicates. The meat was excised from the breast region of slaughtered birds on the 49th day of the experiment and evaluated for meat technological quality, oxidative stability, and sensorial profile. The data generated were evaluated using the One-way analysis of variance (ANOVA). The highest water absorption capacity (WAC) (61.50%) and water holding capacity (WHC) (51.09%) were observed in groups 150 g Lb and 100 g Lb, respectively. Administration of 50 g and 150 g aqueous extract of *Lagenaria breviflora* affected ($p < 0.05$) the intrinsic a^* (redness) meat colour but had no significant effect ($p > 0.05$) on its L^* (lightness) and b^* (yellowness). The data showed that administration of *Lagenaria breviflora* had no effect ($p > 0.05$) on the sensory profile of the breast meat. Glutathione peroxidase (1.85U/L) ($p < 0.05$) was highest and similar in the control and 150 g Lb group. In conclusion, to ensure improved meat quality and oxidative stability of meat from broiler chickens, the administration of aqueous *Lagenaria breviflora* at 150 g per litre of water is recommended.

Keywords: *Lagenaria breviflora*; oxidative stability; phytobiotics; meat quality attributes

INTRODUCTION

The abundance of natural flora and the closeness of life to grasses, herbs, shrubs, and other important tree species in Africa has contributed to the importance of ethno-medicinal options in both human and animal health systems (Ekunseitan et al., 2016b; Kuralkar and Kuralkar, 2021). This continuous access necessitated their usage in the health management system of animals by rural livestock farmers, and until recently has found its relevance in small-scale and commercial

poultry industry in Nigeria (Ekunseitan et al., 2016b). The use of herbs in animal production has helped the treatment in the management of health and overall performance as elicited by various researchers (Mirzaei-Aghsaghali, 2012; Kumar et al., 2014). Apart from the positives listed, a direct influence on the quality of meat has also been reported. The use of phytobiotic strategies to improve the quality of meat is being favoured over conventional options since the latter has resulted in an increase in the occurrence of

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residues in products and food hazards, and this caused a recent ban on antibiotics and growth promoters by National Agency for Food and Drug Administration and Control (NAFDAC, 2018). This necessitated the current trend to bridge the interface between animal products and food industries.

The use of plant extracts is gaining more recognition as a result of numerous efforts in phasing out the use of antibiotics, due to public reservations regarding the development of antibiotic resistant bacteria and residual effects in food (Ekunseitan et al., 2016a). However, one of the greatest challenges in the meat industry is not just about antibiotics usage but obtaining reliable information about post-mortem meat quality, along the production process, ultimately providing guaranteed quality meat products for the consumers (Liu et al., 2003). These quality factors perceived by consumers are linked to sensory characteristics, nutritional properties, and the appearance of meat and its products (Toldrá, 2006). Plants and herbs contain numerous compounds, mostly especially antioxidants, which are proficient in inhibiting oxidative changes in meat (Najafi and Toriki, 2010) leading to better shelf-life quality. Phytobiotics such as *Moringa oleifera* leaf powder contain a significant amount of natural anti-oxidants (vitamin E and selenium), minerals (calcium, phosphorus, and magnesium) and phytochemicals such as caffeic acid (Moyo et al., 2012). These bioactive components aid in the improvement of meat quality; inhibiting the development of osteoclasts, and natural anti-oxidants thereby decreasing lipid oxidation in meat (Rehman et al., 2018).

One of the prominent ethno-veterinary options in Nigeria is *Lagenaria breviflora* (Spotted pumpkin). The use of *Lagenaria breviflora* in ethno-medicine cannot be overemphasised in both humans and livestock. *Lagenaria breviflora* has been used extensively by rural rearers as prophylactic and curative options for several disease conditions in livestock and likewise by rural dwellers in human ethno-medicine. Not until recently, in 2016, a participatory rural appraisal (Ekunseitan et al., 2016b) was carried out in selected villages to detail these plants and subsequently on-field *in vivo* study to ascertain its health efficacy and give credence to the folkloric claims put forward by rural dwellers. The fruit contains moderate amounts of vitamins (notably C, B, and E), proteins and bioactive molecules which confer its antioxidant properties observed when administered to Wistar rats. The screening of the fruit extract revealed important phytochemicals such as phenols, alkaloids, carotenoids, and flavonoids (Ekunseitan et al., 2016a) capable of scavenging free radicals thereby preventing

oxidative cell damage. *Lagenaria breviflora* fruits have also been documented via gas chromatography to contain higher compounds reported to have the capacity to increase the fruit's potent antioxidant and antimicrobial activity (Adeyemi et al., 2017). The presence of 1,2-benzenedicarboxylic acid, mono[2-ethylhexyl], its presence in the tested fruit is suggestive of its anti-oxidant and anti-inflammatory properties as this compound has been reported to act as an anti-oxidant and anti-inflammatory substance (Adeyemi et al., 2017). However, there is no information on the fruit's activity on meat quality characteristics. The objective of the present study was to assess the effectiveness of the administration of *Lagenaria breviflora* on meat quality parameters, oxidative stability, and sensorial properties of meat of broiler chickens.

MATERIALS AND METHODS

The experiment was conducted at the Poultry Unit of the Directorate of University Farms, Federal University of Agriculture, Abeokuta, Ogun State, Nigeria located on latitude 7°15'N, longitude 3°26'E. The experiment was conducted in April – May (temperature: 31.4–33.14 °C; humidity: 61 – 67%).

Lagenaria breviflora fruits were washed with clean water, cut into smaller parts, then soaked for 72 hours and extracted according to Ekunseitan et al. (2017) to give concentrations of 50, 100, and 150 grams per litre of water (weight/volume). The aqueous extract was administered on three consecutive days per week all throughout the duration of the experiment.

Two hundred and eight (208) male day-old Cobb500 chicks were used for the experiment. The birds were raised under an intensive system of management using deep litter. Birds were randomly allotted to four (4) treatment groups: 0, 50, 100, and 150 grams per litre, containing fifty-two (52) birds each and further divided into four replicates of thirteen (13) birds each. All procedures performed were in agreement with the ethical standards of the Institutional and/or National Research Committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards. This experiment conformed to the ethical standards of the College of Animal Science and Livestock Production Committee on Animal Experimentation.

Commercial feed was given to the birds using a starter diet from day-old to four weeks and a finisher diet from five weeks of age to seven weeks of age (Table 1). The birds were provided with feed and clean water *ad-libitum* throughout the duration of the study.

Table 1. Gross nutritional composition of the diet

Determined Analysis	Starter	Finisher
Metabolisable energy (kcal/kg)	2800	2900
Crude protein (%)	21	18
Ether extract (%)	6	6
Crude fibre (%)	5	5
Calcium (%)	1	1
Available phosphorus (%)	0.45	0.4
Lysine (%)	1	0.85
Methionine (%)	0.5	0.34
Salt (min)	0.3	0.3

Meat sample collection

At the 49th day of the experiment, two birds per replicate were selected and slaughtered for meat quality evaluation. Before slaughtering, birds were starved for 12 hours and slaughtered via the neck slit, and then allowed to bleed. The meat was excised from the breast region, placed in a polythene bag, and labelled accordingly for laboratory analysis at the Animal Product and Processing Laboratory, Department of Animal Production and Health, College of Animal Science and Livestock Production, Federal University of Agriculture, Abeokuta, Ogun state.

Water Holding Capacity: Water-holding capacity was determined using a centrifugation technique by Hamm (1986). The amount of added solution retained by the meat was reported as the water holding capacity in ml per 100 g meat.

$$\text{Water Holding Capacity (WHC)}(\%) = \frac{\text{Before centrifuge} - \text{After centrifuge}}{\text{Before centrifuge}} \times 100$$

Water Absorption Capacity: A modified centrifugation method (Arganosa et al., 1991) was used to determine the water absorption capacity of the samples.

$$\text{Water Absorption Capacity (WAC)}(\%) = \frac{\text{gram of water absorbed}}{\text{gram of meat}} \times 100$$

Meat colour: The muscle colour was determined by taking a sample of sliced meat from the posterior part of the breast muscle obtained from broilers after slaughter to determine the colour of muscle (Intrinsic and Extrinsic section) set-up using a Colorimeter (Chroma Meter CR- 410, Japan). The meat samples were placed in a Petri dish and the colorimeter was placed on top of the meat and the values displayed were recorded. The values of L*, a* and b* colorimetric coordinates were determined on scale (Riegel et al., 2003): L* = corresponds to Lightness, a* = corresponds to Redness, b* = corresponds to yellowness.

Oxidative stability of meat: Samples were excised from the breast muscle region of each bird for analysis. The degree of lipid oxidation and stability of meat samples were monitored by measuring the MDA concentration (Rael et al., 2004), superoxide dismutase (SOD) (Oberley et al., 1987) and glutathione peroxidase (GSH-Px) activity (Baker et al., 1990).

Sensorial profile: The untrained panel consisted of seven people. Samples of excised meat were cut into cubes and tagged for identification. The samples were labelled and placed in a polythene bag and cooked in a water bath at 70 °C for 20 minutes. The meat was allowed to cool down to room temperature. Sensory evaluation was conducted in a room where disturbance to sensory stimuli was minimised, away from distracting noise, odours and with neutral lighting. Each member evaluated some of the sensory characteristics such as juiciness, meaty flavour, tenderness, saltiness, overall flavour, and overall acceptability using a nine-point hedonic scale. Water was served to the panelists to rinse the mouth after scoring each treatment sample of meat to minimise carry-over effect.

Statistical analysis

The data generated were arranged in One-way analysis of variance (ANOVA) in a completely randomised design. Significant differences between means were separated using Tukey’s test at 5% level of significance. Mean values for WAC and WHC are presented in a custom combined chart.

RESULTS

The effect of aqueous *Lagenaria breviflora* (spotted pumpkin) extract on water holding capacity (WHC) and water absorption capacity (WAC) of breast meat of broiler chicken is presented in Figure 1. The highest (61.50%) value of WAC of breast meat was recorded in birds administered 150 g of the aqueous *Lagenaria*

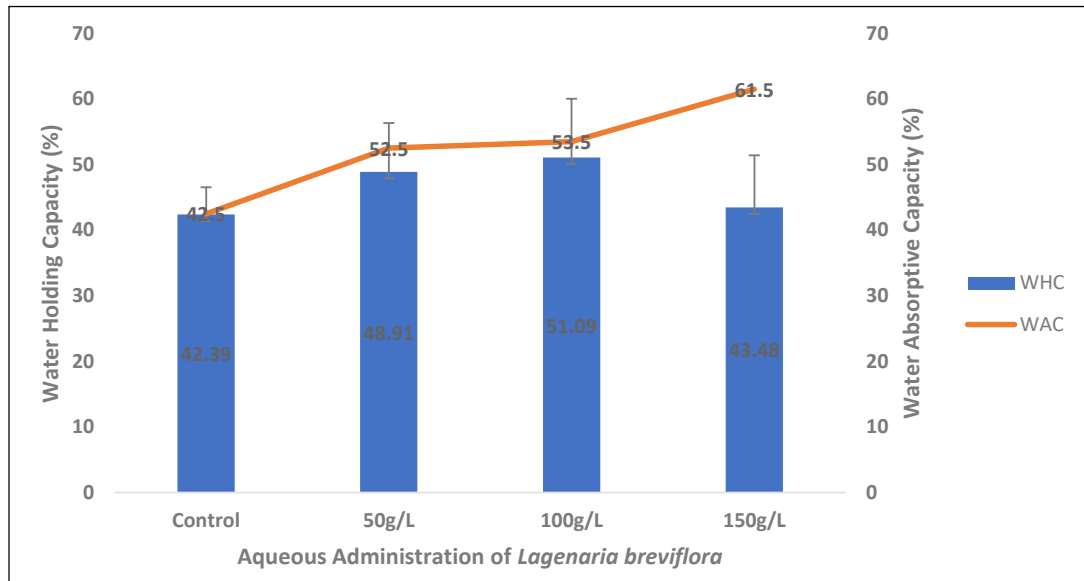


Figure 1. Effect of aqueous *Lagenaria breviviflora* (spotted pumpkin) extract on water holding capacity (WHC) and water absorption capacity (WAC) of breast meat of broiler chickens

breviflora extract while the least value (42.50%) was recorded in the control group. WHC value was highest in the 100 g/Lb (51.09%) with the least observed in the control group.

The effect of aqueous *Lagenaria breviviflora* extract on the intrinsic breast meat colour of broiler chickens is presented in Table 2. The result showed that it had a significant effect ($p < 0.05$) on the intrinsic L (lightness), a (redness), and a^* (redness). The intrinsic L was highest

in the control group. The redness (a^*) value was highest ($p < 0.05$) in meat samples from birds administered 50 and 150 g aqueous *Lagenaria breviviflora* extract.

The effect of aqueous *Lagenaria breviviflora* extract on the extrinsic breast meat colour of broiler chicken is shown in Table 3. The result showed that it had no significant ($p > 0.05$) effect on any colour parameters measured.

Table 2. Effect of *Lagenaria breviviflora* extract on colour of intrinsic breast meat of broiler chicken

Parameter	Level of administration of <i>Lagenaria breviviflora</i>				P-Value
	Control	50g/L	100g/L	150g/L	
L	49.54 ^a ±3.24	46.92 ^{ab} ±2.45	47.89 ^{ab} ±1.94	46.05 ^b ±2.35	0.0500
a	10.08 ^b ±1.79	10.61 ^{ab} ±2.14	10.11 ^b ±0.34	12.19 ^a ±0.79	0.0230
b	3.96±0.96	3.96±1.69	3.89±0.67	3.75±0.78	0.9790
L*	56.34±3.08	54.03±2.45	54.98±1.91	53.15±2.35	0.0874
a*	11.69 ^b ±1.94	12.52 ^a ±2.38	11.84 ^b ±0.45	14.25 ^a ±0.79	0.0130
b*	11.69±1.15	5.10±2.31	4.93±0.89	4.81±0.98	0.4280

^{a, b, c}: Means not followed by the same superscript are significantly different ($p < 0.05$) along the row

SEM: Standard Error of the mean L*, lightness; a*, redness; b*, yellowness

Table 3. Effect of *L. breviviflora* extract on colour of extrinsic breast meat of broiler chickens

Parameter	Level of administration of <i>Lagenaria breviviflora</i>				P-Value
	Control	50g/L	100g/L	150g/L	
L	46.2±2.89	44.4±1.27	43.5±2.80	43.7±1.67	0.0860
a	12.2±2.45	12.5±1.14	13.0±0.92	12.4±1.21	0.7820
b	5.88±1.70	5.05±1.37	5.94±0.92	4.55±1.12	0.1220
L*	53.39±2.84	51.59±1.30	50.61±2.85	50.81±1.72	0.0870
a*	14.42±2.82	14.86±1.20	15.19±2.01	14.85±1.37	0.8890
b*	7.77±2.34	6.72±1.98	8.02±1.32	6.03±1.51	0.1340

SEM: Standard Error of the mean L*, lightness; a*, redness; b*, yellowness

Table 4. Effect of *L. breviflora* on antioxidant profile of breast meat from broiler chicken

Parameters	Control	50g	100g	150g	P-value
SOD (U/L) (x10 ⁻³)	1.17±0.06	0.91±0.22	0.94±0.32	0.97±0.06	0.8840
TBARs ((U/L))	1.35±0.33	1.46±0.10	1.53±0.16	1.31±0.04	0.8330
GSH-Px ((U/L))	1.85±0.05 ^a	0.55±0.15 ^c	1.15±0.05 ^b	1.35±0.15 ^a	0.0160

^{a, b, c}: Means not followed by the same superscript are significantly different ($p < 0.05$) along the row.

Table 5. Effect of *Lagenaria breviflora* extract on sensory evaluation of breast meat of broiler chicken

Parameter	Level of administration of <i>Lagenaria breviflora</i>				P-Value
	Control	50g/L	100g/L	150g/L	
Juiciness	4.61±0.48	4.63±0.41	4.80±0.39	5.31±0.38	0.6301
Meaty flavour	4.47±0.48	4.83±0.37	5.44±4.00	4.56±0.52	0.4194
Tenderness	5.07±0.38	5.39±0.27	5.18±0.34	5.65±0.44	0.6853
Saltiness	5.50±0.39	4.94±0.35	5.78±0.38	5.00±0.41	0.3399
Overall flavour	4.78±0.34	4.59±0.33	4.88±0.49	4.87±0.58	0.9635
Overall acceptability	4.31±0.34	4.50±0.36	4.17±0.43	4.53±0.39	0.8949

SEM: Standard Error of the Mean

The effect of the aqueous extract of *Lagenaria breviflora* on the antioxidant profile of breast meat from broiler chickens is presented in Table 4. It had no significant ($p > 0.05$) effect on the antioxidant profile of broiler meat except glutathione peroxidase (GSH-Px).

The effect of aqueous *L. breviflora* extract on sensory evaluation of breast meat of broiler chickens is presented in Table 5. The result showed that its administration had no significant effect ($p > 0.05$) on the sensory value of breast meat of broiler chickens.

DISCUSSION

Water-holding capacity is one of the most vital quality attributes of meat in its processing suitability. An increased WHC is an indication of lower protein denaturation thereby subsequent upturn in the volume of water conserved within the cells of muscle (Honikel, 1998). This could be due to the antioxidant property of *Lagenaria breviflora* extract (Onasanwo et al., 2011), thus stabilising the meat muscular membrane and the volume of myofibrils via reduced denaturation of protein. The observed result aligns with the result of Rehman et al. (2018) who observed increased water-holding capacity of meat in broilers fed a diet containing *Moringa oleifera* Leaf Powder (MOLP). The improved or higher WAC value observed in the 100 g Lb administered group according to Wang et al. (2006) is vital in maintaining moisture content in products.

Colour is an important trait of meat quality which appeals to consumers during the selection of fresh meat. Meat colour is known to be associated with the degree of meat oxidation (Sohaib et al., 2015) and measured by various parameters: (lightness (L*), redness (a*), and yellowness (b*)). Administration of *Lagenaria breviflora*

extract had an impact on the redness of broiler meat. This may be due to the carotenoid present in *Lagenaria breviflora* (Ekunseitan et al., 2016a). *Lagenaria* fruits which is a Cucurbitaceae family have been established to be rich in a carotenoid known as β -carotene (Rahman, 2003) and capable of enhancing the red pigmentation of meat according to Meléndez-Martínez et al. (2007). The phenolic components of the fruit may be responsible for the significant reduction in intrinsic lightness of the meat observed in the present study as extracts rich in phenolic compounds has been reported to inhibit colour change in meat and its products (Jia et al., 2012). This observation aligns with Yu-yue et al. (2013) who depicted those other rich phenolic extracts such as pomegranate juice exhibited a reduced lightness of pork. A variety of secondary compounds from plants can improve oxidative stability and prevent the discoloration of meat of small ruminants. In addition, the improved water absorption capacity (WAC) and water holding capacity (WHC) in the study had a direct bearing on the colour.

There was a rapid increase of GSH-Px level as administration of *Lagenaria breviflora* increased from 50 to 150 g Lb. This observation may be attributed to the fact that *Lagenaria* exerts appreciable antioxidant activity (Erasto and Mbwambo, 2009) which enhanced and stabilised the muscular membrane by activating antioxidants and preventing excess free radicals in the system. Studies have established that natural herbal options contain various phytochemicals and possess powerful antioxidant activity (Liu et al., 2008; Orłowski et al., 2018). Likewise, Lb extracts have been established to be dose-dependent in their activities in inhibition of free radical and superoxide anion

(Onasanwo et al., 2011) which was also observed in this study. The mechanisms of the activity of Lb have been attributed to a metal-chelating ability, strong hydrogen-donating ability, and efficiency in scavenging peroxides, superoxide anions and nitric oxide free radicals. The overall effect of activity reduction of lipid peroxidation and improved quality of a product as antioxidant-rich herbs have the potential to protect against oxidative damage.

Saba et al. (2018) observed that fortification of beef meatballs with *Lagenaria siceraria* leaf extract had no effect on the sensory parameters, and this may explain why *Lagenaria breviflora* did not have any significant effect on the sensory evaluation of broiler chicken meat.

CONCLUSION

Breast meat excised from the control had the highest intrinsic L while 50 and 150 g had the highest intrinsic redness (a and a*) with the latter having the highest GSH-Px activity. The results of this study indicated that it is possible to improve the quality attributes and oxidative stability of meat of broiler chickens through oral administration of *Lagenaria breviflora* whole fruit up to 150 g/L.

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CONFLICT OF INTEREST

The authors declared no conflicts of interest with respect to the research, authorship, and publication of this article.

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