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Effect of sex on meat quality attributes of pigeon birds (*Columbia livia*) in Abeokuta metropolis

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Abstract
A study was carried out to investigate the effect of sex on meat quality attributes of pigeon (Columbia livia) found in Abeokuta metropolis. Twenty four (12 males and 12 females) adult pigeons of weight between 200 and 220g were used. They were purchased from different markets in Abeokuta metropolis and transported to Department of Animal Production Meat Science Laboratory of Olabisi Onabanjo University, Yewa Campus, Ayetoro, Ogun State where they were rested for 2 weeks and slaughtered, dressed and fabricated. Meat-to-bone ratio, physical, chemical and sensory evaluation of the pigeons meat were determined. The results showed that meat-to-bone ratio was higher ($p<0.05$) in male pigeons meat while breast cut had highest ($p<0.05$) meat-to-bone ratio followed by thigh and least ($p<0.05$) in fore back of female pigeons. Physical characteristics were better ($p<0.05$) in male pigeons' meat than in females meat. Crude fat was higher ($p<0.05$) in male pigeons meat, while Nitrogen Free Extract was higher ($p<0.05$) in female pigeons meat. There was no significant ($p>0.05$) difference in the pH values of meat from both sexes of pigeon. Male pigeons' meat elicited higher ($p<0.05$) organoleptic properties over the female pigeons' meat in this study. It was concluded that pigeon meat needed be introduced into market in both developed and developing economies in order to encourage pigeon production and consumption in order to complement protein supply in these countries, most especially in developing economies.

1. Introduction

Pigeon meat has been consumed by rural populations of the world since time immemorial and recognized as delicious and nutritious poultry food. Bhuyan *et al* (1999) reported that pigeon meat is a rich source of protein and other nutrients comparable to that of chicken. However, pigeon meat has not been fully utilized as food to meet the protein requirements of the populace as the birds are mostly used for ceremonial purposes (Parkhurst and Mountuey, 2004) in developed countries and for ritual occasions in most developing countries (Abulude *et al*., 2006). Pigeons are very easy to raise, hardy and less prone to many of the common poultry diseases, being descendant of the semi-wild blue rockdove of Europe, Asia and Africa belonging to the order columbiformes and family of columbidae (Sainbury, 2000; Oluyemi and Robert, 2000). They are usually found roving about in pairs; male in company of female, thus a group might be a whole family. The continued neglect of pigeon production and processing of its meat primarily for food in poultry industry for growing populations of the world to improve animal protein supply is of great concern (Apata *et al.,* 2009).

A lot of research had been carried out that compared meat yield between breeds and sex of broiler chicken as well as duck (Omojola *et al.,* 2004; Omojola, 2007), but a thorough review of literature available revealed that adequate work has not been done to access the meat quality attributes of sexes of pigeon found in Nigerian market. This could be partly due to the size of pigeon bird which most researchers could be regarded as too small to reckon with. The aim of this study is therefore, to investigate the physicochemical and sensory characteristics of pigeon birds meat found in Abeokuta metropolis as affected by their sexes.

2. Materials and Methods

2.1. Birds and their Management

Mature pigeon birds numbering twenty four of weight between 200-220g (12 males and 12 females) were used for this study. They were purchased from markets within Abeokuta metropolis and were transported to the Meat Science Laboratory of the Department of Animal Production, Olabisi Onabanjo University, Yewa Campus, located at Ayetoro Ogun State Nigeria where this study was carried out. They were rested for 2 weeks during which period they were fed ground maize, guinea corn, clean water ad-libitum and all necessary medications were given.

2.2. Slaughtering, Dressing and Fabrication of Birds

At the end of 2 weeks resting period the birds were fasted for 8 hours, but were supplied clean and enough water after which they were sticked and bled for 30mins. The carcasses were scalded, defeathered, singed, eviscerated and chilled at 4^0C for 24hrs before they were dissected into wholesale cuts (Omojola, 2007).

2.3. Meat Quality Attributes

2.3.1. Meat-to-Bone Ratio

This was carried out on each primal cut. Each of the cut was boiled for 20mins and flesh including the skin was separated from bones and weighed.

2.3.2. Cooking Loss

This was determined using freshly cut breast meat sliced to about 3cm thick, of 10g and 6cm long. Three steaks were made from the breast muscle and each steak was broiled in a preheated oven at 175^0C. The steaks were broiled for 5mins on each side to 72^0C doneness and cooled to room temperature to determine cooking loss. (Malgorzata *et al*., 2005).

$$\text{Cooking loss} = \frac{\text{Wt of raw meat sample} - \text{Wt of cooked meat sample}}{\text{Wt of raw meat sample}} \times 100$$

2.4. Cooking Yield = (100% – Cooking Loss %)

2.5. Thermal Shortening

The same meat samples used for measuring cooking loss which were 6cm long were used for determining thermal shortening. The final lengths of the meat samples were taken after cooling to room temperature and the difference in length was expressed as thermal shortening (Malgorzata *et al*., 2005).

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

2.6. Drip Loss

This was determined gravimetrically. Meat samples from the breast (10g) were wrapped in polythene bags and hung in a refrigerator at 2^0C for 48hrs. The meat samples were removed and the excess fluids on the surface were blotted and weight loss was expressed as g/100g of original weight of meat samples. (Honikel, 1998).

$$\text{Drip loss} = \frac{\text{Initial wt of meat} - \text{Final wt of meat}}{\text{Initial wt of meat}} \times 100$$

2.7. Cold Shortening

This was carried out by measuring 10g with 6m meat samples from the breast. The meat samples were wrapped in polythene bags and refrigerated at 2^0C for 48hrs. The lengths of meat samples were remeasured and reduction in length was expressed as a percentage reduction in length of original length of meat samples (Hedrick *et al;* 1994). Thus:

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

2.8. Water Holding Capacity

This was determined using press method as described by Mallikarjuman and Mittal (1994). Approximately 1.0g of meat sample from the breast was placed between two previously weighed 9cm Whatman No 1 filter papers (Model C, Caver Inc. Wabash, USA). The meat sample was pressed between two 10.2 x $10.2cm^2$ plexi-glasses at about $35.5kg/cm^3$ absolute pressure for 1 minute using a vice. The weight of wet filter paper was taken and water holding capacity of meat samples was calculated as:

$$1 - \frac{(\text{wt of wet paper} - \text{wt of dry paper})}{\text{Wt of meat sample}} \times 100$$

2.9. Shear Force

Meat samples were removed from the breast and boiled for

20mins cooled and chilled at 4^0C for 18hrs. They were removed and allowed to equilibrate to room temperature. Cores of 1.25cm in diameter were removed from the meat samples manually with a cork borer device (Qiaofen and Da-Wan, 2005) parallel to the orientation of muscle fibre. Each core was sheared perpendicular to the muscle fibre orientation at three locations using a Warner – Bratzler V-notch blade shearing machine at a cross head speed of 50mm/min (Honikel 1998).

2.10. Proximate Composition and pH

Proximate composition of meat samples was carried out following the procedures of AOAC (2000). Moisture content, was determined by weighing out 2g of meat sample from breast into a silica dish and oven dried for 24hrs at 100 – 105^0C to a constraint weight. Each meat sample was cooled for 10mins in a desiccator before reweighing and the percentage moisture obtained.

$$\%\text{moisture} = \frac{\text{Initial wt of meat} - \text{Final wt of meat}}{\text{Initial wt of meat}} \times 100$$

2.10.1. Crude Protein

This was determined by digesting 2g of each ground meat sample in a Khjedahl flask and distilled over Markham apparatus and titrating the distillate with 0.01N HCL. Crude Protein value was derived by converting nitrogen (N%) content of meat samples obtained through titration with a constant (6.25) and thus obtained as (6.25 x N%).

2.10.2. Ether Extract (Crude Fat)

This was determined with soxhlet extractor connected with a reflux condenser. 2g of each meat sample (ground) was transferred into a thimble and placed in an extractor using petroleum ether as solvent in a flask. The apparatus was heated over a bursen burner and the solvent was allowed to siphon into the flask for at least 8 – 10 times. The flask with the oil was weighed and dried in a preheated oven to a constant weight and crude fat calculated thus

$$\%\text{ crude fat} = \frac{\text{Weight of Oil}}{\text{Weight of meat sample}} \times 100$$

2.10.3. Ash Content

2g of each ground meat samples were placed in crucibles and transferred into a muffle furnace set between 550 – 600^0C for 4hrs. The crucibles and their contents were cooled in a desiccators to about (27^0C) and reweighed.

$$\%\text{ Ash} = \frac{\text{Weight of Ash}}{\text{Weight of meat sample}} \times 100$$

2.11. Sensory Evaluation

Meat samples for sensory evaluation was taken from the breast muscle and boiled for 20mins to an internal temperature of 70^0C. A total of 10 semi-trained taste panelists aged between 21 and 32 years of mixed sexes were employed to assess the coded meat samples of equal bite size from each treatment, replicated thrice and served in clean plates. Each meat sample was evaluated independently on a 9-point hedonic scale on which I corresponds to dislike extremely and 9 to like extremely for colour, flavour, tenderness, juiciness, texture and overall acceptability (AMSA 1995).

2.12. Experimental Design and Statistical Analysis

Completely randomized design was employed for this study with four replicates. Data collected were subjected to analysis of variance (ANOVA) using (SAS 2002) and significant means were separated with Duncan multiple range test of the same software.

3. Results

Table 1 shows that breast yielded the highest ($p<0.05$) proportion of meat per unit bone (male 7.96±1.66; female 6.61±2.33) followed by thigh (male 5.27±1.14; female 3.48±1.39) while the least ($p<0.05$) values were observed for the fore back in female (0.87±0.48). there were significant ($p<0.05$) differences in meat-to-bone ratio of the primal cuts, with male pigeon meat having higher values than those of female pigeon meat.

Table 1. *Meat-to-bone ratio of primal cuts of pigeon birds carcasses as affected by sex*

Variable	Male	Female
Breast	7.96 ± 1.66^a	6.67 ± 2.33^b
Thigh	5.27 ± 1.14^a	3.48 ± 1.39^b
Drumstick	4.21 ± 0.24^a	2.70 ± 0.45^b
Wing	3.00 ± 0.53^a	1.87 ± 0.61^b
Hindback	2.67 ± 0.21^a	1.33 ± 0.30^b
Foreback	1.95 ± 0.33^a	0.87 ± 0.48^b
Neck	1.54±0.70	1.96±0.39

ab: Means on the same row with different superscripts are statistically significant ($p<0.05$).

All the physical characteristics of pigeon meat measured in this study Table 2 were higher ($p<0.05$) in female meat samples except water holding capacity value (21.45±2.12%) that was higher ($p<0.05$) in meat sample from male pigeons, as against (15.77±2.75%) obtained for meat sample from female pigeons. Shear force value (0.36±0.06kg/cm^3) was higher ($p<0.05$) in female pigeons meat probably due to higher cooking and drip losses as well as cold and thermal shortenings which were hitherto lower in male pigeons meat.

Table 2. *Physical Characteristics of Pigeon bird's meat as affected by sex*

Variable	Male	Female
Cooking loss (%)	22.13 ± 7.80^b	30.29 ± 435^a
Cooking yield (%)	77.87 ± 1.10^a	69.71 ± 1.21^b
Thermal shortening (%)	15.23 ± 9.58^b	19.12 ± 5.41^a
Cold shortening (%)	4.80 ± 0.60^b	6.28±0.40a
Drip loss (%)	4.65 ± 0.76^b	10.25 ± 0.53^a
Water Holding Capacity (%)	21.42 ± 2.12^a	15.77 ± 2.75^b
Shear force (kg/cm^3)	0.24 ± 0.06^b	0.36 ± 0.01^a

ab: Means on the same row with different superscripts are statistically significant ($p<0.05$).

Table 3 shows that Crude fat was higher ($p<0.05$) in meat from male pigeons while Nitrogen Free Extract (NFE) was higher ($p<0.05$) in meat from female pigeons (Table 3). However, there were no significant ($p>0.05$) differences in moisture, protein, ash content and pH of meat from both sexes of pigeon birds in this study.

Table 3. *Proximate Composition and pH of Pigeon bird's meat as affected by sex*

Variable	Male	Female
Moisture (%)	67.20±0.05	67.72±0.03
Crude Protein (%)	20.40±0.32	19.82±0.40
Crude fat (%)	9.31±0.20[a]	8.20±0.24[b]
Ash (%)	2.05±0.07	2.21±0.02
Nitrogen Free Extract (%)	1.04±0.57[b]	2.05±0.49[a]
pH	6.86±0.02	6.80±0.04

ab: Means on the same row with different superscripts are statistically significant ($p<0.05$).

The sensory evaluation results showed that meat from male pigeon birds had better ($p<0.05$) eating characteristics (Table 4). Colour is the first parameter that consumers use to judge meat quality and acceptability (Conforth, 1994). The taste panel ratings for colour in male pigeon meat was 6.83±1.32 against 5.12±1.68 score for female pigeon meat. These results indicated that consumers would prefer meat from male pigeon than that from female pigeon. Male pigeon meat had higher ($p<0.05$) flavour score of 6.81±0.35 while the female meat had ($p<0.05$) 5.60±0.63. The male pigeon birds produced the most tender ($p<0.05$) meat as adjudged by the taste panelist, while the toughest ($p<0.05$) meat was furnished by female pigeons.

Table 4. *Organoleptic Properties of Pigeon bird's meat as influence by sex*

Variable	Male	Female
Colour	6.83±1.32[a]	5.12±1.68[b]
Flavour	6.81±0.35[a]	5.60±0.63[b]
Tenderness	5.92±0.38[a]	4.61±0.34[b]
Juiciness	5.57±0.78[a]	4.20±0.80[b]
Texture	5.91±0.22[a]	4.36±0.45[b]
Overall Acceptability	5.72±0.30[a]	4.45±0.39[b]

ab: Means on the same row with different superscripts are statistically significant ($p<0.05$).

The scores were obtained based on a 9-point Hedonic scale on which 1 = dislike extremely and 9= like extremely

4. Discussion

These results could be due to the fact that males need to build high musculature for them to carry out efficient mounting during mating and for more flight during search for food especially when the females are incubating their eggs and nursing the young ones (Apata *et al*., 2009). Omojola (2007) reported higher weights for primal cuts of male duck than for females which agreed with the results of this study as higher weights translated to higher meat-to-bone ratios. The fact that these meat characteristics were lower in male pigeons' meat would have resulted in higher water holding capacity (WHC) of the meat as observed in this study. Similar findings were reported by Omojola (2007) for male duck meat which corroborated the results of water holding capacity observed in this study. Also cooking yield of meat is dependent on the percentage cooking loss. It therefore, means that meat with higher cooking loss would invariably furnish lower yield per unit cut. It was observed that the higher the WHC the lower the cooking loss and vice versa (Zhang *et al* 1993). The higher cooking loss in the female could be arrogated to low ability of meat from female pigeon to hold on to its internal water on application of external force such as cooking. (Apata and Okubanjo, 2010). The structural orientation of protein and fat within any given meat directly influence the moisture content, while the amount of free water held within the meat depends on amount of space between myofilament (Hedrick *et al;* 1994). The results obtained in this study were in agreement with the findings of Bhuyan *et al*. (1999) for pigeon birds aged 16 weeks and that of Abulude *et al* (2006) who reported higher protein content for male pigeons' meat. This could be due to higher fat content of meat from male pigeon. Duckett and Kuber, (2001) reported that the higher, the fat content of meat the more intense is the flavour hence the higher flavour score of male pigeon meat observed in this study. Tenderness is regarded as the most important sensory attribute affecting meat acceptability (Luciano *et al*., 2007). It has also been identified as the most critical eating quality which determines whether consumers would repurchase any particular meat type or not (Maltin *et al*, 2003). The result from the taste panel was similar to Warner-Batzler shear force result in this study in that both showed that female pigeons' meat was tougher. Meat juiciness is directly related to the intramuscular lipid and moisture content (Fernandez *et al*., 1999). When meat is chewed, fat is released which creates the impression perceived by the consumer, thereby increase acceptability and more of the meat is consumed. Meat from male pigeon elicited higher juiciness with 5.57±0.78 score than meat from female pigeons which in addition to high texture score (5.91±0.22) culminated in its high acceptability (5.72±0.30) as adjudged by the taste panelist.

5. Conclusion

Male pigeon birds gave higher meat-to-bone ratio as well as better meat physical characteristics, crude fat as well as higher organoleptic properties than their female counterparts in this study. Also, the meat of male pigeon birds was well accepted than that from female pigeon birds. The results of this study revealed that sex has significant effects on meat characteristics of pigeon birds with exceptions of meat-to-bone ratio of neck cut, crude protein and pH of the meat. In overall assessment, pigeon meat is favouraly comparable to those of other poultry species in terms of quality. It is needed therefore, to introduced pigeon birds meat to consumers in both developed and developing countries meat market so that pigeon birds production and consumption of its meat could be encouraged on a global bases to boost animal protein supply especially in developing countries of the world.

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