COMPARATIVE EVALUATION OF MEAT QUALITY PARAMETERS OF DOMESTIC PIGEONS AND SELECTED CONVENTIONAL POULTRY SPECIES

[1]SULE, Kayode, [2]ADEGBENRO, Muyiwa, [2]AKINTOMIDE, Aanuoluwapo Adeyemi, [1]FOLORUNSO, Olayode Rasheed and [2]ONIBI, Gbenga Emmanuel

[1]Department of Animal Health and Production, Federal College of Agriculture, Akure, Nigeria.
[2]Department of Animal Production and Health, Federal University of Technology, Akure, Nigeria.

Corresponding Author: Sule, K. Department of Animal Health and Production, Federal College of Agriculture, Akure, Nigeria. **Email:** olukayodesule@gmail.com **Phone:** +234 703 345 3866

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ABSTRACT

The rising demand for poultry meat due to global population growth has emphasised the necessity of finding alternative protein sources to reduce pressure on conventional species like chickens and turkeys. This study examines the meat quality characteristics of the domestic pigeon compared to traditional poultry species which are consumed in Nigeria (laying birds, broilers and turkey), to meet consumer expectations and encourage sustainable dietary habits. Proximate analysis and meat quality assessments were conducted on both sexes, including laying birds, turkeys, broiler chickens, and pigeons. There were significant differences (p<0.05) in moisture, protein and fat content among species, with pigeons demonstrating higher protein and lower fat contents. Furthermore, significant variations (p<0.05) in thawing loss, cooking loss, cold shortening and thermal shortening were observed across species and sexes. Organoleptic evaluations highlighted species-specific variations in colour, tenderness and overall acceptability, with pigeon meat scoring lower in colour and tenderness. These findings underscore the potential of pigeon meat as a sustainable protein source and emphasised the importance of its inclusion in global diets. The study contributes to understanding poultry meat quality dynamics, providing valuable insights for stakeholders, policymakers and consumers to support sustainable feeding practices in an evolving global landscape.

Keywords: Domestic pigeon, Traditional poultry species, Cooking loss, Drip loss, Thawing loss, Proximate analysis, Sex, Species

INTRODUCTION

The steady increase in the production and consumption of poultry meat over recent years underscores its important role in meeting the evolving needs of global consumers. This surge in poultry consumption requires stakeholders in the industry to address two key priorities: meeting the increasing demand for quantity while ensuring high-quality standards, and factors such as increasing global population, affordability, accessibility and the nutritional value of poultry meat, as emphasized by Stoś *et al.* (2022). Additionally, consumers worldwide prioritize an array of meat quality criteria, including nutritional value and sensory attributes like flavour, aroma, texture and colour, alongside crucial technological factors such as pH and water-holding capacity (Meat-US, 2010; Pellattiero *et al.*, 2020). Kortz (2003) stated that meat quality consists of two pivotal components: technological or processing quality, which is pertinent to processing methods and consumption quality, which is indicative of its suitability for consumption or commercial value. Meat tenderness, juiciness and flavour stand as fundamental palatability attributes, while appearance, influenced by visual indicators like colour and marbling, holds a significant influence on consumers and consumption (Geletu *et al.*, 2012). Bertram *et al.* (2003) and Huff-Lonergan (2009) also observed that technological quality indicators such as Napole yield and water-holding capacity play crucial roles in raw meat processing efficiency.

However, both objective assessments by producers and subjective perceptions of consumers worldwide highlight meat quality as a paramount consideration (Adamski *et al.*, 2017; Skunca *et al.*, 2017). According to Aduku and Olukosi (2000), edible meat encompasses not only the anatomically distinct muscle tissue of farm animals but also the associated connective tissue and intramuscular fats. The composition of poultry meat varies based on species, breed and other factors, comprising muscle, connective tissue, fat and bone, with water content typically around 75% (Ismail and Joo, 2017). Marangoni *et al.* (2015) emphasized that poultry meat serves as a reservoir of essential nutrients, including high-quality proteins, iron, phosphorus and B vitamins, contributing significantly to human nutrition.

This study undertakes a thorough comparative assessment of meat quality parameters, examining not only conventional poultry species but also the often-overlooked pigeon (*Columba livia domestica*). Chickens and turkeys have traditionally dominated the poultry industry in terms of production, consumption, preponderance of research and awareness campaigns, they have struggled to substantially meet the demands for poultry meat in many parts of the developing world due to factors such as cost of production, limited technological advancement, low production levels and affordability among others (FAO, 2013). Pigeons, on the other hand, present a promising alternative because of their low production cost, rapid growth rates, efficient breeding cycles and adaptability to various environmental conditions (Ahamed *et al.,* 2021). Despite these advantages, pigeon meat remains underutilized in Nigeria and many parts of Sub-Saharan Africa, primarily due to cultural biases and misconceptions (Sule *et al.*, 2024a, b). Despite the historical reverence for pigeon meat, its underutilization compared to chicken poses challenges in meeting global protein demands (Apata *et al.*, 2015). Research on pigeon meat quality in Nigeria remains sparse, yet initial studies suggest notable differences influenced by factors such as sex, as explored by Apata *et al.* (2015). In essence, the exploration of poultry meat quality unveils a complex interplay of factors, underscoring the importance of a detailed understanding to meet the evolving needs of both producers and consumers in our dynamic global landscape.

This study conducts a thorough analysis of key quality parameters, including nutritional composition, water-holding capacity and sensory attributes, for pigeons, chickens and turkeys. Through a methodical examination of these factors, the study aims to reveal the complex differences that characterize quality attributes, thus shedding light on the distinctive characteristics and potential benefits of consuming pigeon meat. Furthermore, the study aims to emphasize the advantages of promoting pigeon meat as a sustainable protein source, capable of diversifying animal protein supplies and reducing reliance on resource-intensive poultry species like chickens and turkeys. These insights can inform policymakers, food industry stakeholders and consumers, on the need to integrate pigeon meat into the national diets and contribute to sustainable feeding practices for our growing population while ensuring the resilience of the poultry industry in the face of evolving demands and challenges.

MATERIALS AND METHODS

Study Sites: Management of poultry species took place at the Poultry Demonstration Unit of the Poultry Section of the Training and Research Farm, Federal College of Agriculture, Akure, Nigeria. Analyses of meat quality parameters, including drip loss, thawing loss, cooking loss, cold shortening, thermal shortening and organoleptic assessment were conducted at the General Laboratory of the Department of Animal Health and Production, Federal College of Agriculture, Akure, Nigeria. Analysis of the proximate composition of meat samples was conducted at the Nutrition Laboratory of the

Department of Animal Production and Health, Federal University of Technology, Akure, Nigeria.

Source of Poultry Species, Management Procedures and Experimental Arrangement: Twenty-four (24) pigeons (12 males and 12 females) were selected from a flock kept in the Poultry Demonstration Unit of the Poultry Section of the Training and Research Farm, Federal College of Agriculture, Akure, Nigeria, three (3) layer cocks and three (3) hens, six (6) broiler chickens (3 males and 3 females) and four (4) turkeys (2 gobblers and 2 hens) were purchased from a local poultry farm in Ilara-Mokin, Ondo State, Nigeria for the study. Mature birds commonly consumed as meat in Nigeria were used for the experiment.

The poultry species were stabilised for two (2) weeks. During this time, they were housed in well-ventilated poultry experimental pens. They provided commercial growers' mash (Hybrid Growers Mash having 18% crude protein and 2800 Kcal/Kg metabolizable energy) and cool, clean water *ad libitum.* After the period of stabilization, the birds were slaughtered by severing their jugular veins, bled, de-feathered after scalding in hot water and dressed. Meat samples were collected from the breast muscle of each slaughtered bird, pooled together according to their species and sexes, packaged in well-labelled Ziploc polythene bags and refrigerated at 3 – 7°C for twelve (12) hours before analysis. The meat samples were thereafter arranged according to poultry species and sex in a 4 × 2 factorial arrangement. Proximate composition, thawing loss, cooking loss, thermal shortening, cold shortening and organoleptic qualities of the meat samples were determined.

Proximate Analysis: Whole meat samples weighing 100 g each, obtained from the breast muscle of poultry species (male and female separate), were minced using a 5 mm plate of the Japanese Moulinex meat-grinding machine (Model HV8). The minced meat samples were packed into Ziploc bags and frozen for laboratory analysis. After three days, the frozen meat samples were allowed to thaw for one hour at room temperature (23°C) in separate bowls according to species and sex. Subsequently, the samples were thoroughly mixed and analyzed to determine moisture content, ash, crude protein and fat content using the standard procedures outlined by AOAC (2019).

Meat Quality Analysis: The following meat quality attributes were evaluated; drip loss, thawing loss, cooking loss, thermal shortening and cold shortening.

Drip loss: Drip loss was determined using 50 g of intact fresh breast muscle samples in quadruplicate and placed inside a Ziploc polythene bag. The bags were placed in a refrigerator (3 – 7°C) for 12 hours and weight loss was measured. The weight of meat samples taken after 12 hours was expressed as a percentage of the initial weight thus: Drip loss (%) = Initial Weight of Meat – Final Weight of Meat x 100 ÷ Initial Weight of Meat (Apata *et al.*, 2023).

Thawing loss: 50 g of meat samples were collected in quadruplicate and subjected to deep freezing. After 48 hours of freezing, the samples were recovered from the freezer and weighed (W1) to determine the weight before thawing. They were then thawed in a refrigerator at around 3 - 7°C for 12 hours. Subsequently, the samples were weighed again to obtain the weight after thawing (W2) and the thawing loss was calculated as a percentage (%) using the following formula: W1 – W2 x 100 ÷ W1 (Apata *et al.*, 2023).

Cooking loss: 50 g of fresh meat samples (W1) taken from the breast muscle were packed into a watertight Ziploc bag and cooked thermostatically in a laboratory water bath at 60°C for 20 minutes. After cooking, the samples were cooled for 30 minutes under room temperature (27 ± 3°C), blotted dry with tissue paper and weighed (W2) for determination of cooking loss (%) using the formula: Cooking loss (%) = W1 – W2 x 100 ÷ W1 as described by Apata *et al.* (2023).

Thermal shortening: The meat samples utilized to assess cooking loss were employed for evaluating thermal shortening. The initial length of the meat samples was measured before cooking and the final length was measured after the meat had cooled to room temperature. The disparity in length was quantified as thermal shortening thus: Thermal shortening = Initial Length of Meat – Final Length of Meat x 100 ÷ Initial Length of Meat (Sobczak *et al.*, 2005).

Cold shortening: 50 g of 6 cm meat segments, cut along the muscle fibres, in quadruplicate from the breast muscle were used to determine the percentage of cold shortening of the meat samples. These meat segments were enveloped in Ziploc polyethene bags and placed in a refrigerator at 3 – 7°C for 48 hours. The length of the meat segments was measured and the reduction in length was expressed as a percentage of the original length of the meat segments thus: Cold shortening = Initial Length of Meat – Final Length of Meat x 100 ÷ Initial Length of Meat (Fakolade *et al.,* 2016).

Organoleptic Assessment: An organoleptic assessment was performed on both raw and cooked breast meat samples from male and female specimens of the four different poultry species. The raw meat samples were placed on clean, white flat trays and presented to a panel of ten (10) trained panellists, drawn from the Higher National Diploma students and staff of the Federal College of Agriculture, Akure, Nigeria. These participants were given a brief overview of the assessment expectations and how to go about it.

The panellists evaluated the raw meat samples for colour, texture and overall acceptability. Following this, the meat samples were cut into bite-sized pieces, wrapped in Ziploc polyethene bags and cooked thermostatically in a laboratory water bath at 60°C for 15 minutes. After cooling, the cooked samples were assessed by the panellists for colour, tenderness, flavour, juiciness and overall acceptability.

In both evaluations (raw and cooked), the panellists rated the meat samples using questionnaires featuring a 5-point Hedonic scale to determine the consumer's appeal for each sensory attribute. The scale ranged from 1 (low appeal) to 5 (excellent appeal) as outlined by Berdos *et al.* (2020). Each panellist was provided with a bottle of clean water to rinse their mouth between tasting each cooked sample, to minimize carry-over effects.

Data Analysis: Data generated from the meat samples of the poultry species were analyzed using analysis of variance (ANOVA) in a factorial arrangement, using the general linear model (GLM) of SAS (1988), with species and sex as the main factors. Data generated for males and females of each species and grouped data for all species were analyzed using the student's t-test. Significant means were separated using the New Duncan Multiple Range Test, a feature of the same statistical software package.

RESULTS AND DISCUSSION

Proximate Composition of Meat Samples: Mean values of the proximate composition of the meat of pigeons and selected poultry species are presented in Table 1. The moisture content, crude protein and fat content of meat samples from laying birds, turkeys, broilers and pigeons were significantly affected ($p<0.05$) by species differences. Broiler chickens exhibited the highest moisture content at 72.45 ± 2.64%, significantly differing from chicken, turkey and pigeon values, which were 69.47 ± 0.24, 67.85 ± 1.73 and 62.34 ± 0.19% respectively. The higher moisture content in broilers may be attributed to their intensive breeding for meat production, which enhances the water-holding capacity of their muscles (Mir *et al.*, 2017). In contrast, the muscle fibre structure and lower intramuscular fat of pigeons affect water retention (Shao *et al.*, 2024) and may be responsible for the lower moisture content in pigeons' meat observed in this study. Laying birds and turkeys showed moderate moisture content, reflecting their balanced muscle composition and specific breeding purposes. The moisture content obtained for poultry species in this study falls within ranges reported in similar earlier studies (Abulude *et al.*, 2006; Pomianowski *et al.*, 2009; Apata *et al.*, 2015).

Pigeon meat displayed the highest crude protein content among the sampled birds at 21.63 ± 1.20%, while domestic fowl had the lowest at 19.93 ± 2.71%.

Table 1: Comparative evaluation of proximate composition of meat of pigeon and selected poultry species

Interactions Species	Sex	Moisture Content (%)	Protein Content (%)	Fat Content (%)	Ash Content (%)
Layers	Male	71.10 ± 0.98[cd*]	21.23 ± 1.20[c*]	5.57 ± 0.59[a]	2.90 ± 1.22[a]
	Female	67.83 ± 0.70[c]	18.60 ± 1.06[a]	6.67 ± 0.25[b*]	3.53 ± 0.77[b*]
Turkey	Male	60.73 ± 0.76[b*]	20.97 ± 0.50[c]	9.38 ± 0.71[c*]	2.87 ± 1.24[a]
	Female	59.97 ± 2.48[b]	21.30 ± 1.50[c]	7.26 ± 0.46[b]	3.33 ± 1.05[b*]
Broiler	Male	72.43 ± 2.01[d]	20.97 ± 0.90[c*]	9.67 ± 0.78[c]	2.97 ± 0.31[a]
	Female	72.47 ± 1.23[d]	20.10 ± 0.30[b]	9.33 ± 0.55[c]	2.70 ± 0.46[a]
Pigeon	Male	53.27 ± 0.60[a*]	22.30 ± 0.45[d*]	4.50 ± 0.78[a]	4.37 ± 0.15[c*]
	Female	51.40 ± 1.76[a]	20.97 ± 0.83[c]	5.60 ± 0.26[a*]	3.57 ± 0.92[b]
Species					
Layers		69.47 ± 0.24[c]	19.93 ± 2.71[a]	6.12 ± 0.22[b]	3.22 ± 0.04[ab]
Turkey		67.85 ± 1.73[b]	21.13 ± 1.62[b]	8.32 ± 2.02[c]	3.10 ± 0.10[ab]
Broiler		72.45 ± 2.64[d]	20.53 ± 0.21[ab]	9.50 ± 0.24[d]	2.83 ± 0.11[a]
Pigeon		62.34 ± 0.19[a]	21.63 ± 1.20[b]	5.05 ± 0.01[a]	3.98 ± 1.01[b]
Sex					
Male		64.38 ± 0.28[*]	21.38 ± 0.47[*]	7.84 ± 3.24	3.28 ± 0.04
Female		62.91 ± 0.34	20.24 ± 0.56	7.78 ± 2.89	3.28 ± 0.01

*abcd = Means along the same column and for the same parameter with different letter superscripts are significantly different ($p<0.05$), * = Significantly different means between males and females using student's t-test pairwise comparison, tabulated data = mean ± SD*

Pigeons possess fast-twitch muscle fibres which are crucial for rapid, forceful contractions in birds and contain elevated levels of contractile proteins like myosin and actin (Velten and Welch, 2014), which may have enhanced the overall protein content of pigeon meat in the present study. Their lower intramuscular fat content also contributes to this protein richness, making muscles with a prevalence of fast-twitch fibres, like pigeon breast muscles which are used for flight, notably protein-dense (Listrat *et al.*, 2016).

The fat content was highest in broiler chickens (9.50 ± 2.26%) and lowest in pigeons (5.05 ± 0.01%). This finding can be attributed to broilers' selective breeding for meat production, which results in enhanced fat content from their energy-rich diets (Choi *et al.*, 2023). In contrast, pigeons have a lean muscle composition suited for flight, which may account for the minimal fat content observed in this study. The arrangement of protein and fat within meat directly impacts its moisture content, while the amount of free water retained relies on the space between the myofilaments (Listrat *et al.*, 2016). These findings are consistent with those of Abulude *et al.* (2006) who reported lean muscle in pigeons.

Species' effect on birds' ash content was not significantly different ($p>0.05$). However, sex had a highly significant effect ($p<0.05$) on moisture content and crude protein, with males exhibiting higher levels (64.38 ± 0.26% moisture content and 21.38 ± 0.47% crude protein) compared to females (62.91 ± 0.34% moisture content and 20.24 ± 0.56% crude protein). This can be attributed to male birds typically developing more muscle mass and lower fat deposition than female birds (Swanson *et al.,* 2022). This finding is consistent with previous studies suggesting that male birds tend to possess leaner and more protein-rich muscle tissue than female birds (Abulude *et al.,* 2006; Apata *et al.,* 2015). Damaziak *et al.* (2014) also reported slightly higher values for males over females in moisture content, protein, fat and ash in both local and exotic turkey breeds. The interaction between species and sex had no significant effect ($p>0.05$) on all proximate parameters measured except fat content.

Meat Quality Parameters: The percentages of drip loss, thawing loss, cooking loss, cold shortening and thermal shortening in both male and female chickens, turkeys, broilers and pigeons are presented in Table 2. Species differences did not show significant variation (p>0.05) in drip loss across all the poultry species assayed. Numerically, pigeon meat exhibited the lowest drip loss at 3.11 ± 0.45%, while turkey had the highest at 4.25 ± 1.04%. The lower drip loss in pigeon meat compared to broiler, layers and turkey may be attributed to its unique muscle fibre structure optimized for flight and characterized by a higher proportion of slow-twitch muscle fibres with a tighter arrangement and reduced myofibres leakage, as well as the typically lower intramuscular fat content, which minimizes the release of water and other fluids during processing, thus contributing to reduced drip loss (Weng *et al.*, 2022). According to Ponsuksili *et al.* (2008), drip loss occurs due to the leakage of myofibres and the loss of water, iron and proteins during the transition from muscle to meat. Excessive drip loss from fresh meat signifies not only financial losses but also the loss of valuable nutrients such as vitamins, minerals, flavour compounds and water (Devi *et al.*, 2019). This study indicated that pigeon meat had lower drip loss compared to broilers, laying birds and turkeys; this suggests that pigeons had a superior ability to retain their water than all the other poultry species evaluated. Both species and sex differences had a significant effect (p<0.05) on thawing loss, cooking loss, cold shortening and thermal shortening in all examined birds. The effect of sex on drip loss was highly significant (p<0.05), with females exhibiting higher percentages than males. This contradicts the findings of Chodová *et al.* (2021) who reported slightly higher drip loss in male chickens (2.33%) compared to females (2.23%). Drip loss varies across species and between sexes due to differences in interlocked connective tissues (Chen *et al.*, 2007; Sarsenbek *et al.*, 2013).

Muraduzzaman *et al.* (2023) reported a drip loss of 3.02% for pigeon breast meat, which was slightly lower than the 3.11 ± 0.45% obtained in the present study. However, Apata *et al.* (2015) reported a higher drip loss of 4.65% for pigeon meat, exceeding the values obtained in the present study. These slight discrepancies may have arisen from differences in bird sources and variations in management procedures. The thawing loss value observed in turkey meat (8.96 ± 1.03%), was the highest in this study and significantly surpassed (p<0.05) the values recorded for laying birds, broilers and pigeons, which were 2.23 ± 0.18, 6.46 ± 1.09 and 4.00 ± 0.09% respectively.

Freezing, storage and subsequent thawing induce various changes in frozen meat, including fat oxidation, protein denaturation and an increase in the total number of bacteria, thereby diminishing the processing performance and commercial value of the frozen meat (Hanenian and Mittal, 2004). Xia *et al.* (2009) referred to this phenomenon as the freeze-thaw cycle, which impacts drip loss and elevates thawing loss due to the formation of ice crystals leading to protein denaturation, thereby exacerbating fluid losses. Additionally, according to Devi *et al.* (2019), thawed meat not only loses moisture but also experiences a decline in functional properties such as water retention ability and protein content, potentially affecting the quality of final meat products. Domestic layers exhibited the lowest thawing loss value of 2.23 ± 0.18% in this study, indicating superior performance in this regard.

The values obtained for cooking loss differed significantly (p<0.05) among domestic layer, turkey, broiler and pigeon, with percentages of 34.65 ± 3.42, 29.45 ± 1.29, 27.42 ± 2.27 and 21.81 ± 3.14% respectively. Pigeon meat generally has lower intramuscular fat content compared to broiler, layers and turkey. Intramuscular fat can contribute to cooking loss by melting and draining away during cooking. The lower fat content in pigeon meat may therefore have contributed to the reduced cooking loss recorded for pigeons. Omojola *et al.* (2012) reported a cooking loss of 28.74% for pigeon breast meat, which is higher than the 21.81 ± 3.14% observed in this study. Similarly, Kucukozet and Uslu (2018) documented a cooking loss of 35.27% for chicken, which compares with the 34.65 ± 3.42% recorded in this study. Broilers exhibited significantly higher (p<0.05) cold shortening (8.27 ± 2.04%) and thermal shortening (17.30 ± 2.04%) compared to all other birds examined. Broilers are typically bred for rapid growth, have a higher proportion of fast-twitch muscle fibres and are more susceptible to cold shortening and thermal.

Table 2: Comparative evaluation of meat quality parameters in meat of pigeon and selected poultry species

Interactions		Drip Loss (%)	Thawing Loss (%)	Cooking Loss (%)	Cold Shortening (%)	Thermal Shortening (%)
Species	**Sex**					
Layers	Male	3.52 ± 0.02[bc]	2.56 ± 1.27[b*]	28.56 ± 0.17[bc]	2.29 ± 0.01[a]	2.67 ± 0.04[a]
	Female	4.41 ± 1.73[c]	1.90 ± 0.02[a]	40.74 ± 0.08[d*]	2.76 ± 0.02[ab]	8.49 ± 2.40[b*]
Turkey	Male	2.35 ± 0.93[a]	7.04 ± 1.54[e]	25.89 ± 0.02[b]	2.26 ± 0.64[a]	9.50 ± 2.26[c]
	Female	6.14 ± 0.04[d*]	10.88 ± 0.67[f*]	33.00 ± 0.43[c*]	4.28 ± 1.97[c*]	11.04 ± 2.68[d*]
Broiler	Male	4.00 ± 0.02[c]	5.69 ± 0.79[d]	26.41 ± 0.07[b]	7.38 ± 0.05[d]	26.24 ± 3.30[f*]
	Female	3.53 ± 0.99[bc]	7.23 ± 0.64[e*]	28.42 ± 2.01[bc]	9.15 ± 0.03[e*]	8.37 ± 0.70[b]
Pigeon	Male	3.19 ± 1.04[b]	4.00 ± 0.09[c]	25.14 ± 0.24[b*]	3.57 ± 1.17[b]	14.39 ± 2.09[e*]
	Female	3.03 ± 0.05[b]	4.00 ± 0.49[c]	18.48 ± 0.26[a]	9.69 ± 0.31[e*]	10.45 ± 0.95[d]
<u>Species</u>						
Layers		3.97 ± 0.02[ab]	2.23 ± 0.18[a]	34.65 ± 3.42[d]	2.53 ± 0.01[a]	5.58 ± 0.01[a]
Turkey		4.25 ± 1.04[b]	8.96 ± 1.03[d]	29.45 ± 1.29[c]	3.27 ± 0.27[b]	10.27 ± 2.01[b]
Broiler		3.77 ± 1.01[ab]	6.46 ± 1.09[c]	27.42 ± 2.27[b]	8.27 ± 2.04[d]	17.30 ± 2.04[d]
Pigeon		3.11 ± 0.45[a]	4.00 ± 1.21[b]	21.81 ± 3.14[a]	6.63 ± 1.0[c]	12.42 ± 1.09[c]
<u>Sex</u>						
Male		3.26 ± 0.01	4.82 ± 1.14	24.50 ± 3.14	3.88 ± 1.04	13.20 ± 2.21[*]
Female		4.28 ± 1.04[*]	6.00 ± 2.21[*]	30.16 ± 2.07[*]	6.47 ± 1.42[*]	9.57 ± 0.79

*abcdef = Means along the same column and for the same parameter with different letter superscripts are significantly different (p<0.05), * = Significantly different means between males and females using student's t-test pairwise comparison, tabulated data = mean ± SD* shortening due to their rapid contraction and relaxation properties compared to other poultry species (Huo *et al.*, 2022). Cold shortening occurs due to rapid carcass chilling immediately after slaughter, before muscle glycogen conversion to lactic acid. It results in meat toughness up to five times higher than normal (Kuddus, 2018). Extreme chilling conditions inducing cold shortening may reduce protein degradation beyond the shortening effect.

Sex effects on all measured parameters were statistically significant ($p<0.05$), with females consistently exhibiting higher values than males, except in thermal shortening, where males (13.20 ± 2.21%) showed higher percentages than females (9.57 ± 0.79%). This observation is consistent with the findings of Apata *et al.* (2015) who reported higher values for female pigeon meat compared to males in cooking loss, thermal shortening, cold shortening and drip loss. Interaction between species and sex had significant effects ($p<0.05$) on drip loss, cooking loss and cold shortening, but no significant difference ($p>0.05$) was observed in thawing loss and thermal shortening.

Organoleptic Parameters: The comparative assessment of organoleptic parameters in the meat of pigeons and selected poultry species is presented in Table 3. The effect of species differences on the colour, tenderness and overall acceptability of raw meat samples from domestic fowl, turkey, broiler and pigeon was highly significant ($p<0.05$). It also had a significant effect ($p<0.05$) on the juiciness of cooked meat samples from these birds. Raw meat samples from turkey scored highest for colour (4.40 ± 1.20%), tenderness (4.15 ± 1.21%) and overall acceptability (4.40 ± 1.02%), while raw meat samples from pigeons had the lowest scores for these three parameters (colour, texture and overall acceptability) with 1.95 ± 0.25, 3.20 ± 1.01 and 2.15 ± 0.01% respectively. Pigeons are entirely dark meat birds with a high concentration of myoglobin, giving the meat its distinctive colour and taste (Cummins, 2018). While myoglobin is concentrated in the legs of other poultry species such as turkey and chicken, it spreads throughout the entire body of pigeons, resulting in the characteristic dark colouration (Saikia, 2013). This unique dark colour of pigeon raw meat accounted for its low score in terms of colour, unlike the meat from turkey, broiler and chicken, which are generally classified as white poultry meat. Pigeon was rated as the least tender of all poultry species evaluated. Pigeon meat tends to be less tender compared to other poultry species due to a higher proportion of endurance-oriented muscle fibres, more connective tissues, a diet rich in grains and seeds, higher activity levels and genetic differences affecting muscle structure and composition, all of which can contribute to tougher meat (Ismail and Joo, 2017).

Broiler chicken meat was rated as the juiciest (3.85 ± 1.04%), while pigeon meat was rated as the least juicy (3.05 ± 0.11%), this may be attributed to the hot and dry nature of the meat of matured pigeons, as indicated by Canova (2005). Lower fat content recorded for pigeons is also a major factor contributing to its poor rating in juiciness, higher fat content is known to improve the juiciness and mouth feel of meat, contributing to a more enjoyable eating experience (Kokoszyński *et al.*, 2020). However, cooked pigeon meat received the highest score in terms of flavour (3.85 ± 0.01%), while domestic chicken had the lowest score (3.15 ± 0.74%). Pigeon meat is typically lean with a distinctive gamy flavour due to its lack of fat reserves (Baxter, 2024).

The influence of sex on organoleptic characteristics is notable, particularly in terms of the colour and overall acceptability of raw meat samples, where female birds received higher scores than males. Conversely, males outperformed females in colour, tenderness, flavour, juiciness and overall acceptability of cooked meat samples. This outcome aligns with the findings of Apata *et al.* (2015) who observed similar higher scores for cooked meat from male pigeons compared to females across all evaluated organoleptic qualities.

Table 3: Comparative evaluation of organoleptic parameters in meat of pigeon and selected poultry species

Interactions		Raw Meat			Cooked Meat				
Species	**Sex**	**Colour**	**Texture**	**OA**	**Colour**	**Tenderness**	**Flavour**	**Juiciness**	**OA**
Layers	Male	2.80 ± 0.92^{b}	3.40 ± 1.07^{a}	2.90 ± 0.88^{b}	2.90 ± 1.19^{a}	3.80 ± 1.03^{b}	3.30 ± 1.25^{ab}	3.20 ± 1.03^{b}	3.80 ± 1.03^{c}
	Female	3.50 ± 1.08^{c}	3.70 ± 1.06^{ab}	4.40 ± 0.52^{d}	3.50 ± 1.18^{ab}	3.90 ± 0.99^{b}	3.00 ± 1.05^{a}	3.60 ± 1.07^{bc}	3.60 ± 1.26^{bc}
Turkey	Male	4.10 ± 1.20^{d}	3.90 ± 0.88^{ab}	4.60 ± 0.52^{d}	3.60 ± 0.84^{ab}	3.80 ± 1.14^{b}	3.50 ± 0.97^{b}	3.70 ± 1.16^{bc}	4.00 ± 1.05^{c}
	Female	4.70 ± 0.48^{e}	4.40 ± 0.70^{b}	4.20 ± 1.14^{a}	4.00 ± 0.82^{b}	4.30 ± 0.82^{c}	2.90 ± 1.60^{a}	3.40 ± 0.82^{b}	3.40 ± 1.58^{b}
Broiler	Male	3.50 ± 0.97^{c}	3.90 ± 0.99^{ab}	3.60 ± 0.84^{c}	3.70 ± 0.95^{ab}	3.70 ± 1.16^{b}	3.70 ± 1.34^{b}	3.90 ± 0.82^{c}	3.40 ± 0.84^{b}
	Female	4.00 ± 1.15^{d}	3.50 ± 1.08^{ab}	4.20 ± 0.79^{d}	3.50 ± 0.85^{ab}	3.60 ± 0.84^{b}	3.40 ± 1.17^{ab}	3.80 ± 1.14^{c}	3.50 ± 0.71^{b}
Pigeon	Male	1.90 ± 1.18^{a}	3.30 ± 1.34	2.00 ± 0.67^{a}	3.90 ± 1.20^{b}	4.00 ± 0.82^{c}	3.70 ± 1.16^{b}	2.20 ± 0.63^{a}	2.80 ± 0.63^{a}
	Female	2.00 ± 1.05^{a}	3.10 ± 1.52	2.15 ± 0.82^{a}	2.90 ± 1.60^{a}	3.20 ± 1.62^{a}	4.00 ± 1.25^{c}	3.90 ± 1.45^{c}	4.10 ± 1.10^{c}
<u>Species</u>									
Layers		3.15 ± 0.52^{b}	3.55 ± 1.80^{b}	3.65 ± 0.07^{b}	3.20 ± 1.01^{a}	3.35 ± 1.01^{a}	3.15 ± 0.74^{a}	3.40 ± 0.^{75ab}	3.70 ± 0.19^{b}
Turkey		4.40 ± 1.20^{c}	4.15 ± 1.21^{c}	4.40 ± 1.02^{d}	3.80 ± 1.41^{b}	4.05 ± 1.23^{b}	3.20 ± 1.24^{a}	3.55 ± 1.02^{ab}	3.70 ± 0.91^{b}
Broiler		3.75 ± 0.19^{bc}	3.90 ± 1.07^{c}	3.90 ± 0.72^{c}	3.60 ± 017^{ab}	3.65 ± 0.24^{ab}	3.55 ± 0.24^{ab}	3.85 ± 1.04^{b}	3.45 ± 0.17^{a}
Pigeon		1.95 ± 0.25^{a}	3.20 ± 1.01^{a}	2.15 ± 0.01^{a}	3.40 ± 1.05^{ab}	3.60 ± 1.04^{ab}	3.85 ± 0.01^{b}	3.05 ± 1.01^{a}	3.45 ± 0.25^{a}
<u>Sex</u>									
Male		3.05 ± 0.11	3.63 ± 0.01	3.28 ± 0.24	3.53 ± 0.11	3.83 ± 0.19*	3.55 ± 0.01	3.83 ± 0.21*	3.65 ± 0.01
Female		3.55 ± 0.12*	3.63 ± 0.04	3.78 ± 0.14*	3.48 ± 0.19	3.50 ± 1.21	3.33 ± 0.72	3.10 ± 0.55	3.50 ± 0.07

*abcde = Means along the same column and for the same parameter with different letter superscripts are significantly different (p<0.05), * = Significantly different means between males and females using student's t-test pairwise comparison, tabulated data = mean ± SD*

Conclusion: This study compared meat quality parameters in pigeons and conventional poultry species, considering the influences of species and sex. The study aimed to increase the utilization of pigeon meat to partially fulfil human protein requirements amidst a growing global population. Pigeon meat exhibited distinct characteristics, including higher protein and lower fat content compared to other species, along with lower drip loss, indicating superior moisture retention ability. Variations in thawing loss, cooking loss, cold shortening and thermal shortening were notable across species and sexes. Generally, the meat of males displayed better tenderness, flavour and overall acceptability. It is recommended that further research into selective breeding programmes to enhance desired traits be conducted while exploring processing techniques to minimize losses. Additionally, conducting further studies to evaluate the impacts of age, diet and environmental factors on meat quality is suggested. Addressing these recommendations can bolster the poultry industry's competitiveness and sustainability by incorporating the use of highly versatile, productive and cost-effective pigeon meat to meet increasing demand and evolving consumer preferences for quality meat products.

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REFERENCES

ABULUDE, O., ADESANYA, W., AKINJAGUNLA, Y. and AKINBULI, P. (2006). Studies on pigeon bird (*Columba guinea* G): anatomical weight, proximate compositions, selected mineral contents and sensory evaluation. *Electronic Journal of Environmental, Agricultural and Food Chemistry,* 5(4): 1473 – 1478.

ADAMSKI, M., KUZNIACKA, J. and MILCZEWSKA, N. (2017). Preferences of consumers for choosing poultry meat. *Polish Journal of Natural Sciences*, 32(2): 261 – 271.

ADUKU, A. O. and OLUKOSI, J. O. (2000). *Animal Products Processing and Handling in the Tropics.* 2nd Edition, GU Publications, Abuja, Nigeria.

AHAMED, A. S., NUSRATHALI, N., MUFEETH, M., RANAWEERA, K. and MAJEED, U. A. (2021). Breed distribution and management practices of pigeon farming in Sri Lanka. *Journal of the Bangladesh Agricultural University*, 19(4): 477 – 485.

AOAC (2019). *Official Methods of Analysis of the Association of Official Analytical Chemists International*. 21st Edition, Association of Official Analytical Chemists (AOAC), Washington, D.C., USA.

APATA, E. S., KOLEOSO, I. M., TIJANI, L. A., OBI, O. O. and OKERE, I. A. (2015). Effect of sex on meat quality attributes of pigeon birds (*Columbia livia*) in Abeokuta metropolis. *International Journal of Agricultural Sciences and Natural Resources,* 2(2): 19 – 23.

APATA, E. S., OLALEYE, O. O., APATA, O. C., OLUGBEMI, M. T. and OMOJOLA, A. B. (2023). Evaluation of physical characteristics of chevon as affected by post-mortem carcass dressing and freezing preservation. *Theory and Practice of Meat Processing,* 8(2): 144 – 151.

BAXTER, K. (2024). *What Does Pigeon Taste Like*? Eat Delights. www.eatdelights.com/pigeon-taste Assessed January 29, 2024.

BERDOS, J. I., AQUINO, A. A. A., GARCIA, L. B. and ANGELES, A. R. S. (2020). Fish entrails meal as feed for broilers (*Gallus gallus domesticus*): Its potential as dietary supplements on the carcass quality and meat organoleptic evaluation. *Journal of Animal Science and Veterinary Medicine,* 6(1): 14 – 19.

BERTRAM, H. C., ANDERSEN, H. J., KARLSSON, A. H., HORN, P., HEDEGAARD, J., NØRGAARD, L. and ENGELSEN, S. B. (2003). Prediction of technological quality (cooking loss and Napole Yield) of pork based on fresh meat characteristics. *Meat Science*, 65(2): 707 – 712.

CANOVA, J. (2005). Monuments to the birds: Dovecotes and pigeons eating in the land of fields. *Gastronomica*, 5(2): 50 – 59.

CHEN, X. D., MA, Q. G., TANG, M. Y. and JI, C. (2007). Development of breast muscle and meat quality in Arbor Acres broilers, Jingxing 100 crossbred chickens and Beijing fatty chickens. *Meat Science*, 77(2): 220 – 227.

CHODOVÁ, D., TŮMOVÁ, E., KETTA, M. and SKŘIVANOVÁ, V. (2021). Breast meat quality in males and females of fast-, medium- and slow-growing chickens fed diets of 2 protein levels. *Poultry Science*, 100(4): 100997. https://doi.org/10.1016/j.psj.2021.01.020

CHOI, J., KONG, B., BOWKER, B. C., ZHUANG, H. and KIM, W. K. (2023). Nutritional strategies to improve meat quality and composition in the challenging conditions of broiler production: A review. *Animals*, 13(8): 1386. https://doi.org/10.3390/ani13081386

CUMMINS, E. (2018). *Americans Used to Eat Pigeons All the Time—and it Could be Making a Comeback*. Popular Science. https://www.popsci.com/eat-pigeons-squab/#:~:text=First%2C/pigeons/are/an/ entirely,its/unique/color/and/taste.

DAMAZIAK, K., MICHALCZUK, M., SZARA, T., MARZEC, A., NIEMIEC, J. and TUREK, B. (2014). Effect of genotype on selected quality attributes of turkey bone. *European Poultry Science,* 78: 12. https://doi.org/10.1399/eps.2014.12

DEVI, R., RASANE, P., KAUR, S. and SINGH, J. (2019). Meat and meat losses: Influence on meat quality. *International Journal of Research and Analytical Reviews (IJRAR)*, 6(1): 762 – 786.

FAKOLADE, P. O., AKINDURO, V. O. and OGUNGBADE K. O. (2016). Proximate, physico-chemical and palatability analysis of grilled and boiled meat from broilers fed varying levels of honey in their diet during dry season. *Journal of Biology, Agriculture and Healthcare*, 6(9): 88 – 93.

FAO (2013). *Poultry Development Review*. Food and Agriculture Organization of the United Nations, Rome, Italy. https://www.fao.org/4/i3531e/i3531e.pdf

GELETU, U. S., USMAEL, M. A., MUMMED, Y. Y. and IBRAHIM, A. M. (2021). Quality of cattle meat and its compositional constituents. *Veterinary Medicine International*, 2021: 7340495. https://doi.org/10.1155/2021/7340495

HANENIAN, R. and MITTAL, G. S. (2004). Effect of freezing and thawing on meat quality. *Journal of Food, Agriculture and Environment,* 2(3/4): 74 – 80.

HUFF-LONERGAN, E. (2009). Fresh meat water-holding capacity. Pages 147 – 160. *In:* KERRY, J. (Ed.). *Improving the Sensory and Nutritional Quality of Fresh Meat*. Elsevier Science, Amsterdam, The Netherlands.

HUO, W., WENG, K., LI, Y., ZHANG, Y., ZHANG, Y., XU, Q. and CHEN, G. (2022). Comparison of muscle fiber characteristics and glycolytic potential between slow- and fast-growing broilers. *Poultry Science*, 101(3): 101649. https://doi.org/10.1016/j.psj.2021.101649

ISMAIL, I. and JOO, S. T. (2017). Poultry meat quality in relation to muscle growth and muscle fiber characteristics. *Korean Journal for Food Science of Animal Resources*, 37(6): 873 – 883.

KOKOSZYŃSKI, D., STĘCZNY, K., ŻOCHOWSKA-KUJAWSKA, J., SOBCZAK, M., KOTOWICZ, M., SALEH, M., FIK, M., ARPÁŠOVÁ, H., HRNČÁR, C. and WŁODARCZYK, K. (2020). Carcass characteristics, physicochemical properties, and texture and microstructure of the meat and internal organs of carrier and king pigeons. *Animals*, 10(8): 1315. https://doi.org/10.3390/ani10081315

KORTZ, J. (2003). The quality of pork - its characteristics and the requirements of the consumers and meat processing plants. *Animal Science Papers and Reports,* 21(Suppl. 1): 77 – 91.

KUCUKOZET, A. O. and USLU, M. K. (2018). Cooking loss, tenderness and sensory evaluation of chicken meat roasted after wrapping with edible films. *Food Science and Technology International,* 24(7): 576 – 584.

KUDDUS, M. (2018). *Enzymes in Food Biotechnology: Production, Applications, and Future Prospects.* 1st Edition, Academic Press, Cambridge, Massachusetts, United States.

LISTRAT, A., LEBRET, B., LOUVEAU, I., ASTRUC, T., BONNET, M., LEFAUCHEUR, L., PICARD, B. and BUGEON, J. (2016). How muscle structure and composition influence meat and flesh quality. *The Scientific World Journal*, 2016: 3182746. https://doi.org/10.1155/2016/3182746

MARANGONI, F., CORSELLO, G., CRICELLI, C., FERRARA, N., GHISELLI, A., LUCCHIN, L. and POLI, A. (2015). Role of poultry meat in a balanced diet aimed at maintaining health and wellbeing: an Italian consensus document. *Food and Nutrition Research*, 59: 27606. https://doi.org/10.3402/fnr.v59.27606

MEAT-US (2010). *Information about Meat Quality and Meat Safety*. http://www.meat-us.com/quality.php Accessed January 07, 2024.

MIR, N. A., RAFIQ, A., KUMAR, F., SINGH, V. and 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.

MURADUZZAMAN, M., AHAMMED, M., HABIB, M., AZAD, M. A. K., HASHEM, M. A. and ALI, M. S. (2023). Comparison of meat yield and quality characteristics between pigeon and quail. *Meat Research*, 3(2): 52. https://doi.org/10.55002/mr.3.2.52

OMOJOLA, A. B., ISA, M. A., JIBIR, M., AJEWOLE, B. T., GARBA, S., KASSIM, O. R., OMOTOSO, A. B., ADEYEMO, O. A. and AKINLEYE, S. B. (2012). Carcass characteristics and meat attributes of pigeon (*Columbia livia*) as influenced by strain and sex. *Journal of Animal Science Advances*, 2(5): 475 – 480.

PELLATTIERO, E., TASONIERO, G., CULLERE, M., GLEESON, E., BALDAN, G., CONTIERO, B. and DALLE ZOTTE, A. (2020). Are meat quality traits and sensory attributes in favor of slow-growing chickens? *Animals*, 10(6): 960. https://doi.org/10.3390/ani10060960

POMIANOWSKI, J. F., MIKULSKI, D., PUDYSZAK, K., COOPER, R. G., ANGOWSKI, M., JÓŹWIK, A. and HORBAŃCZUK, J. O. (2009). Chemical composition, cholesterol content, and fatty acid profile of pigeon meat as influenced by meat-type breeds. *Poultry Science*, 88(6): 1306 – 1309.

PONSUKSILI, S., JONAS, E., MURANI, E., PHATSARA, C., SRIKANCHAI, T., WALZ, C., SCHWERIN, M., SCHELLANDER, K. and WIMMERS, K. (2008). Trait correlated expression combined with expression QTL analysis reveals biological pathways and candidate genes affecting water holding capacity of muscle. *BMC Genomics*, 9: 367. https://doi.org/10.1186/1471-2164-9-367

SAIKIA, A. (2013). Food habits in pre-colonial Assam. *International Journal of Humanities and Social Science Invention*, 2(6): 01 – 05.

SARSENBEK, A., WANG, T., ZHAO, J. K. and JIANG, W. (2013). Comparison of carcass yields and meat quality between Baicheng-You chickens and Arbor Acres broilers. *Poultry Science*, 92(10): 2776 – 2782.

SAS (1988). *SAS/STAT User's Guide: Release 6.03 Edition*. SAS Institute, Incorporated, Carry, North Carolina, United States.

SHAO, X., LU, X., SUN, X., JIANG, H. and CHEN, Y. (2024). Preliminary studies on the molecular mechanism of intramuscular fat deposition in the longest dorsal muscle of sheep. *BMC Genomics*, 25(1): 592. https://doi.org/10.1186/s12864024-10486-w

SKUNCA, D., TOMASEVIC, I., ZDOLEC, N., KOLAJ, R., ALEKSIEV, G. and DJEKIC, I. (2017). Consumer-perceived quality characteristics of chicken meat and chicken meat products in Southeast Europe. *British Food Journal*, 119(7): 1525 – 1535.

SOBCZAK, M., LACHOWICZ, K., KAMIENIECKI, H., WÓJCIK, J., GAJOWIECKI, L., ZOCHOWSKA, J., ZYCH, A., KOTOWICZ, M., SABLIK, P. and RZEWUCKA, E. (2005). The effect of cattle genotype on texture of selected muscles during post-mortem ageing. *Electronic Journal of Polish Agricultural Universities - Series Food Science and Technology*, 8(3): 1 – 9.

STOŚ, K., RYCHLIK, E., WOŹNIAK, A. and OŁTARZEWSKI, M. (2022). Red and processed meat consumption in Poland. *Foods*, 11(20): 3283. https://doi.org/10.3390/foods11203283

SULE, K., ADELEKE, M. A., ADEGBENRO, M., FOLORUNSO, O. R. and ONIBI, G. E. (2024a). Management and challenges of pigeon production in South-West Nigeria. *International Journal of Novel Research in Life Sciences*, 11(1): 14 – 24.

SULE, K., ADELEKE, M. L., ADEGBENRO, M., FOLORUNSO, O. R. and ONIBI, G. E. (2024b). People's perception of domestic pigeon (*Columba livia*) in South-West Nigeria. *Continental Journal of Applied Sciences,* 19(1): 64 – 75.

SWANSON, D. L., ZHANG, Y. and JIMENEZ, A. G. (2022). Skeletal muscle and metabolic flexibility in response to changing energy demands in wild birds. *Frontiers in Physiology*, 13: 961392. https://doi.org/10.3389/fphys.2022.961392

VELTEN, B. P. and WELCH, K. C. (2014). Myosin heavy-chain isoforms in the flight and leg muscles of hummingbirds and zebra finches. *American Journal of Physiology: Regulatory, Integrative and Comparative Physiology*, 306(11): R845 – R851.

WENG, K., HUO, W., LI, Y., ZHANG, Y., ZHANG, Y., CHEN, G. and XU, Q. (2022). Fiber characteristics and meat quality of different muscular tissues from slow- and fast-growing broilers. *Poultry Science*, 101(1): 101537. https://doi.org/10.1016/j.psj.2021.101537

XIA, X., KONG, B., LIU, Q. and LIU, J. (2009). Physicochemical change and protein oxidation in porcine *Longissimus dorsi* as influenced by different freeze-thaw cycles. *Meat Science*, 83(2): 239 – 245.