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Carcass and Organoleptic Characteristics of Duck Meat as Influenced by Breed and Sex

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Abstract: Carcass and meat quality traits of three breeds of duck which include Rouen, Pekins and Muscovy were investigated. A total of thirty-six matured ducks with twelve ducks from each breed were used for the study in a 3×2 (breed×sex) factorial arrangement in a completely randomized design. The ducks were slaughtered in batches of six, properly bled, defeathered and dressed. The ducks were chilled at 2°C for 24 h immediately after dressing, prior to cutting up into primal cuts. Samples for cooking loss, shear force and taste panel evaluations were taken from the breast portion. The dressing percentage was highest in the Muscovy duck with values of 71.18 and 69.75% for male and female respectively while the least value of 65.28% was obtained from the female Rouen duck. The male Muscovy ducks gave the highest absolute values ($p<0.05$) in all the primal cuts while the female Rouen gave the least values for wing, breast, hind and for back respectively however, the female Muscovy duck gave the least value for thigh. The external offals were higher in the male Pekin and Muscovy ducks than their female counterparts while there was no noticeable ($p>0.05$) sex effect in the Rouen breed. The moisture content of duck meat evaluated ranged from 72.69 (female Muscovy) to 76.72% for female Rouen ducks. Apart from the male Pekin duck that gave the highest ($p<0.05$) water holding capacity (WHC) the others gave values that were statistically similar ($p>0.05$). Shear force values of 2.15 and 2.30 kg/cm^3 were obtained from the male and female Rouen ducks respectively while higher values of 2.64 and 3.41 kg/cm^3 were given by both male and female Pekin ducks. The highest shear force value (3.91 kg/cm^3) was obtained from the female Muscovy duck. In terms of flavour, tenderness and juiciness, the taste panelist has higher preference for meat from the male Rouen duck. The result also revealed that sex and breed had no significant ($p>0.05$) effect on the texture and overall acceptability of duck meat.

Key words: Breed, carcass, meat, organoleptic, sex

Introduction

Ducks are raised primarily for meat. They are easy to raise, hardy and less susceptible to many of the common poultry diseases. Despite all these attributes, the local duck in Nigeria which constitute about ten percent of the local chicken (Oluyemi and Ologbobo, 1997) has been greatly neglected.

The continued decline in duck industry and duck meat consumption in Nigeria is a matter of great concern. Interest is therefore aroused in the type and strain of duck to be used for obtaining maximum yield of eviscerated and edible meat. Quite a lot of researchers have reported works dealing with comparison of meat yield between breeds (Wahid *et al*., 1974), sex and slaughter weights of broiler chicken (Omojola *et al*., 2004) but a thorough review of literature available revealed that practically no work has been done to access the yield of meat from different breeds of duck commonly available in Nigerian market. In contrast to the indigenous fowls, the local duck has hardly received any systematic scientific attention. This is partly because of the suspicion that duck meat cause ailments (Oluyemi and Ologbobo, 1997).

The focus of this study is therefore to investigate the yield, the eating qualities and carcass characteristics of the three breeds of duck commonly found in Nigerian market.

Materials and Methods

The three breeds of duck used in this study are Rouen, Pekin and Muscovy. These breeds were identified based on visual appearance of the plumage colour, shape and colour of shank. A total of thirty-six matured ducks with twelve ducks from each breed were used for the study in a 3×2 (bread×sex) factorial arrangement. Completely randomized design was employed.

The ducks were purchased from a specialized duck market at Ibadan, Oyo State, Nigeria. The ducks were kept in individual cages for a period of four weeks prior to slaughtering where they had unlimited access to feed and fresh, cool water.

Prior to slaughtering the birds were weighed and deprived of feed for eight h. Slaughtering was carried out in batches of six, representing two (a male and a female) from each breed. The slaughtered birds were thoroughly bled and the bled weight recorded. The birds were subsequently defeathered, discected and all the internal organs were carefully removed. After slaughtering and dressing, the warm carcass weight was obtained and the dressing percentage calculated (Price, 1967). The dressed carcasses were chilled before they were cut up into primal cuts and the weight of the primal cuts recorded.

Meat quality attributes

Water holding capacity: This was determined using the press method as modified by Tsai and Oeckerman (1981). Approximately 0.5g sample was taken from the breast portion and weighed into a 9cm diameter Whatman No 1 filter paper (Model C, Carver, Inc Wabash IN, USA) and pressed between two 10.2×10.2 cm plexi glass at approximately 35.2 kg/cm^3 for 1 min. The area of the free water was measured using a compensatory planimeter (Planix 5000, Tamaya Technics Inc, Tokyo, Japan) and percent free water was calculated based on sample weight and moisture content (Tsai and Oeckerman, 1981). Percent bound water (WHC) was calculated as 100% minus free water percent.

Cooking loss: Samples for cooking loss were taken from the breast meat and cut into steaks of approximately 3cm thick. Three steaks were selected in sequence from the breast muscle and each steak was weighed before broiling. Broiling was done at an oven temperature of 177°C with temperature stabilization for 5 min prior to the start of broiling (Okubanjo *et al.*, 2003). The steaks were broiled for 5 min on each side to medium doneness and then cooled to room temperature to determine cooking loss.

Cooking loss = [weight of raw sample-weight of cooked sample] / [Weight of raw sample] x 100

Shear force: The objective evaluation of tenderness was performed using the modified Warner Bratzler shear force procedure (Bouton and Haris, 1978). Three cores of 0.5cm in diameter were removed from sample used for cooking loss using an electric coring machine. The coring were done parallel to the orientation of muscle fibre and each core was sheared perpendicular to the muscle fibre orientation at three locations using a Warner Bratzler instron blade attached to an Instron universal testing machine (Model 5543, Instron, UK Ltd) at a cross head speed of 50 mm/min.

Chilling loss: The carcasses were chilled at 2°C for 24 h immediately after dressing prior to cutting up into primal cuts. The chilling loss was determined as the difference between the warm carcass weight and the chilled weight.

Moisture: The percent moisture was determined according to the method described by A.O.A.C. (1990).

Taste panel evaluation: Samples for sensory evaluations were taken from the breast muscle and cooked to an internal temperature of 72°C. A total of twelve trained individuals aged between 22 and 35 years (33.33% male and 66.67% female) were employed to assess the coded meat samples. Equal bite size from each treatment was coded, replicated thrice and served in an odourless plastic plates. Each sample was evaluated independent of the other. The samples were evaluated on a 9-point hedonic scale for colour, flavour, tenderness, juiciness, texture and overall, acceptability.

Statistical analysis: All data obtained were subjected to analysis of variance and where statistical significance was observed, the means were compared using the Duncais Multiple Range (DMR) test. The SAS computer soft ware package (1998) was used for all statistical analysis.

Results and Discussion

The mean live weight as reported in this study revealed that the male Pekins and Muscovy ducks has higher weight than their female counter parts while the reverse was the case for Rouen breed. The live weight ranged from 1.47 to 2.00 kg in all the breeds considered in this study. Many factors could be responsible for the low live weight, apart from the age of the ducks that were put at an average of 10 weeks, the nutritional status prior to purchase and other managerial practices could account for the observed low weight.

The percent blood loss was highest ($p<0.05$) in the male Pekin duck where a value of 9.52% was recorded. The amount of blood loss was however not sex or breed dependent. It was observed that the female ducks irrespective of their breed tends to have higher feather cover per unit body size than the males however the percent feather weights were not significantly ($p>0.05$) different from each other. The losses due to blood and feather loss are higher than the 14% reported by Leclercq and Carville (1985) for muscovy ducks.

The dressing percentage is a trait of economic importance. The dressing percentage of the male and female duck within each breed were not significantly ($p>0.05$) different from each other (Table 1) although, the males of Rouen and Muscovy tended to have higher numerical values than the females of the same breed. The Muscovy ducks gave the highest dressing percent of 71.18 and 69.75 for male and female respectively. The high dressing percent recorded is Muscovy might be due to the fact that this breed is an heavy breed which has been highly regarded for meat production. The high dressing percentage obtained from the male ducks of Rouen and Muscovy ducks contradicts the findings of Moran (1995) for sex influence on dressing percent of broiler chicken. The range of dressing percentage obtained in this study compared with the range value of 66.56-68.40 reported for 2.0-2.5kg broiler chicken (Omojola *et al.*, 2004). The result also showed that the higher the percent blood and feather loss, the lower the dressing out percentage.

Meat yield: The males irrespective of the breed tended to have higher wing weight than the females. The male

Table 1: Live, Fasted, blood feather and the dressing percentage of duck as affect by sex and breeds

	Rouen		Perkins		Muscovy		
Parameters	Male	Female	Male	Female	Male	Female	SEM
Live Weight (g)	1466.70^{c}	1516.70^{b}	2000.00^{a}	1466.70^{c}	2000.0^{a}	1583.30^{b}	169.69
Fasted Weight (g)	1366.70^{b}	1283.30^{b}	1750.00^{a}	1366.70^{b}	1966.70^{a}	1333.30^{b}	103.86
%	93.18^{a}	84.61^{b}	87.50^{b}	93.18^{a}	98.34^{a}	84.21^{b}	3.52
Bled Weight (g)	1286.70^{bc}	1191.70^{c}	1583.30^{ab}	1300.0^{bc}	1816.70^{a}	1250.00^{bc}	101.01
(%)	94.15	92.86	90.47	95.17	92.27	93.75	2.12
Blood Weight (g)	83.33	91.67	166.67	66.67	150.00	83.33	21.78
Blood (%)	6.10	7.12^{b}	9.52^{a}	4.88^{d}	7.63^{b}	6.25^{c}	1.22
Feather Weight (g)	150.00	159.00	183.33	165.33	183.33	163.33	35.20
(%)	10.98	12.39	10.48	12.10	9.32	12.25	2.81
Dressing (%)	68.90^{ab}	65.28^{b}	66.67^{b}	68.78^{ab}	71.18^{a}	69.75^{a}	3.21

•Expressed as percentage fasted weight, Means along the same row with similar superscripts are not significantly (p>0.05) different

Table 2: Means of Primal cuts and their proportions as a influenced by breed and sex

	Rouen		Perkins		Muscovy		
	Male	Female	Male	Female	Male	Female	SEM
Wings (g)	166.60^{b}	135.70^{b}	275.00^{a}	186.83^{b}	300.33^{a}	175.50^{b}	7.09
(%)	12.19^{b}	10.57^{c}	15.71^{a}	13.67^{b}	15.27^{a}	13.16^{b}	1.02
Thigh (g)	141.67^{b}	140.00^{b}	161.77^{ab}	142.23^{b}	204.17^{a}	132.59^{b}	12.72
(%)	10.37	10.91	9.24	10.41	10.38	9.95	0.94
Breast (g)	212.37^{bc}	158.07^{c}	256.37^{b}	256.10^{b}	393.83^{a}	250.43^{a}	27.66
(%)	15.54	12.32^{c}	14.65^{b}	18.74^{a}	20.03^{a}	18.78^{a}	1.30
Hind Back (g)	145.30	113.93	133.57	117.47	165.70	122.13	15.71
(%)	10.62^{a}	8.88^{ab}	7.63^{b}	8.60^{ab}	8.43^{ab}	9.16^{a}	1.21
Fore back	85.07^{bc}	81.53^{c}	100.67^{bc}	135.40^{b}	194.90^{a}	122.00^{b}	15.81
(%)	6.23^{b}	6.35^{b}	5.75^{c}	9.91^{a}	9.91^{a}	9.15^{a}	0.88

[1]Expressed on percent of fasted weight

^{abc}Means along the same row with similar superscripts are not significantly (p>0.05) different from each other

Pekin and the male Muscovy duck had the highest percent wing with values of 15.71 and 15.27% respectively. The percent wing was observed to be higher than the thigh most probably because of the flighty nature of the bird which favours wing development than the thigh.

The Rouen and the Pekin females has higher percent thigh than the males while the Muscovy drake had higher percent thigh than their female counterparts however, the observed sex differences in the percent thigh were not significant (p>0.05).

The breast is one of the primal cut of high economic value (Omojola *et al*., 2004). The result of this study indicated that the males of the Rouen and Pekins ducks has higher values (15.54) and 20.03%) than the females with values of 12.32 and 18.78% respectively while the female Pekin duck has higher value (18.74%) than the males (14.65%). The result obtained in this study for Pekin was similar to that of Kosba *et al*. (1981) and Powell (1985), who reported that at comparable age, females tended to have higher proportion of breast meat than males. The range of values obtained for breast meat in this study compared with 15.9 percent reported by Stadelman and Meinert (1977). Breast meat is a highly desirable portion of the duck carcass from consumer viewpoint. Deposition of meat in the breast occurs relatively late in the development of duck (Jung *et al*., 1975).

The male Rouen duck has higher proportion of hind back (10.63%) than the male of Pekin (7.63%) and Muscovy (8.43%) while the females has similar (p>0.05) hind back values. The fore back were however highest in both sexes of the Muscovy duck while the least value of 5.75% was obtained in the male Pekin duck. The summation of the hind and fore back showed that the duck has comparable back proportion to broiler chicken slaughtered at 2.0 to 2.5kg body weight (Omojola *et al*., 2004).

External and internal offals: The parts of the body of the birds fall into three groups in respect of their stages of growth this are early maturing organ, intermediate and the late maturing parts (Oluyemi and Roberts, 2000). Liver, gizzard and intestine have very early growth (Leclercq and Carville, 1985). The results obtained in this study showed that the female Rouen has the highest percent liver (2.81%) followed by the male Pekin (2.60%) while the least value was obtained in the female Muscovy (1.11%) (Table 3). There was no clear-cut sex difference in the weight of the liver but generally the Muscory duck tended to have the least value (p<0.05). Like in the case of the liver, there was also no clear-cut distinction in the absolute weight of the gizzard as a result of breed. The kidney, the bile and the lungs followed a similar trend as observed for the liver and the gizzard.

Table 3: Means of external and internal organs of duck and their proportions by sex and breed

	Rouen		Perkins		Muscovy		
	Male	Female	Male	Female	Male	Female	SEM
External Offal							
Head (g)	69.00^{b}	60.60^{b}	85.78^{a}	58.93^{b}	91.63^{a}	59.66^{b}	7.43
%	5.05	4.72	4.90	4.31	4.66	4.48	1.85
Feet (g)	21.26^{b}	19.20^{b}	42.06^{b}	22.93^{b}	42.03^{a}	22.20^{b}	2.27
%	1.56^{b}	1.50^{b}	2.40^{a}	1.68^{b}	2.14^{a}	1.67^{b}	0.48
Shank (g)	12.37^{b}	12.77^{b}	23.65^{a}	13.16^{b}	24.13^{a}	12.13^{b}	0.89
	0.91^{b}	1.00^{b}	1.35^{a}	0.96^{b}	1.23^{a}	0.91^{b}	0.35
Neck (g)	138.93^{ab}	112.63^{bc}	125.30^{b}	87.10^{c}	158.23^{a}	80.97^{c}	11.55
(%)	10.17^{a}	8.78^{a}	7.16^{ab}	637^{b}	8.07^{a}	6.07^{b}	2.12
Internal Offals							
Heart (g)	10.41^{bc}	9.97^{c}	15.92^{a}	13.03^{b}	16.00^{a}	12.20^{b}	2.11
%	0.74	0.78	0.91	0.95	0.81	0.92	0.24
Liver (g)	27.37^{bc}	36.03^{ab}	45.43^{a}	20.20^{ab}	33.37^{ab}	14.80^{c}	5.20
(%)	2.00^{b}	2.81^{a}	2.60^{a}	1.48^{bc}	1.70^{bc}	1.11^{c}	0.31
Gizzard (g)	52.01^{a}	36.76^{c}	38.97^{c}	40.53^{b}	50.24^{a}	36.33^{c}	3.17
(%)	3.81	2.87	2.23	2.97	2.56	2.73	0.27
Kidney (g)	1.20	1.63	2.73	1.86	2.66	2.36	0.67
(%)	0.09	0.13	0.16	0.14	0.14	0.18	6.03
Bile (g)	1.27^{bc}	0.90^{c}	3.45^{ab}	1.46^{bc}	3.24^{ab}	4.51^{a}	6.32
%	0.09	0.07	0.20	0.11	0.17	0.34	0.06
Lungs (g)	11.70^{b}	10.80^{b}	17.63^{a}	9.73^{b}	17.90^{a}	9.56^{b}	3.43
%	0.86	0.84	1.01	0.71	0.91	0.72	0.21
Intestine (g)	171.83^{ab}	178.23^{ab}	169.23^{ab}	135.40^{b}	194.90^{a}	137.00^{b}	13.45

[1]Expressed as percent fasted weight, Means in the same row with different superscript are significantly different ($p<0.05$)

The maximum length of intestine (192cm) reported for 6 weeks old duckling (Leclercq and Carville, 1985) compared with the maximum length (190.67cm) obtained in the female Rouen duck in this study. The intestine could therefore be classified as early maturing.
The proportion of the head of duck ranged from 4.31% in the female Pekin ducks to 5.05% in the male Rouen ducks. The head as proportion of live weight was however not significantly different ($p>0.05$) from each other irrespective of sex and bread of the duck. The male has higher absolute head weight than the female ducks and the male Muscovy duck has pronounced absolute head weight ($p<0.05$) than all other breed and sexes of duck considered in this experiment.
The feet and the shank followed similar trend with the male having higher values than the female. The neck of the males were also observed to be higher in weight than the females ($p<0.05$) there was however no noticeable, ($p>0.05$) breed differences in the weight of the neck.

Meat quality attributes: The structural orientation of protein and fat content within muscle foods directly influence, the moisture content while the amount of free water maintained within meat depends on the amount of space between myofilaments. The percent moisture content obtained ranged from 72.69 to 76.72 (Table 4). The percent moisture content obtained in this study was not sex dependent nor was it influenced by breeds of the duck.
The water holding capacity which was defined as the ability of meat to retain its water upon application of external forces (Hedrick *et al.*, 1994) is a primary indicator of the degree of juiciness of meat.
The highest ($p<0.05$) WHC (71.06%) was obtained from the male of white Pekin duck. The male ducks of the three breeds used in this study has higher values ($p>0.05$) than the female ducks. The least WHC was obtained in the female Rouen duck. The observed differences in the WHC was not sex or breed dependent. The values of 62.46-71.06% obtained for WHC in this study compared with the range values of 63.64-76-71 reported for broiler chicken fed graded levels of supplemental enzyme (Adeshiyan, 2004).
The Pekin and Muscovy duck gave higher shear force values than the Rouen. In all the breeds studied, the female duck has higher ($p>0.05$) shear force values than the males. The Rouen breed produced more tender ($p<0.05$) meat than the other two breeds.
Cooking yield of meat is dependent on the cooking loss percent. Meat with less cooking loss will invariably give higher yield per unit cut. Attempts to reduce cooking losses by withdrawing feed and water for 60 h prior to slaughter or injecting the carcass with aqueous solution of various salts (Stadelman and Meinert, 1977 and Klinger and Stadelman, 1975) have had a small positive effect on cooking yield. The female birds across the breeds had higher cooking loss values. It was also observed that the higher the WHC the lower the cooking loss and vice versa. The higher cooking loss in the female could therefore be due to the low ability of meat from the female duck to hold on the water on application of external force.

Table 4: Meat quality attributes of duck meat as influenced by breed and sex

	Rouen		Perkins		Muscovy		
	Male	Female	Male	Female	Male	Female	SEM
Moisture (%)	73.33	76.72	75.62	74.71	73.55	72.69	2.75
WHC (%)	64.65^{b}	62.46^{b}	71.06^{a}	63.68^{b}	66.10^{b}	63.25^{b}	3.25
Shear force (kg/cm^{3})	2.15^{c}	2.30^{c}	2.64^{bc}	3.41^{ab}	3.28^{ab}	3.91^{a}	0.27
Cooking loss %	25.79^{b}	32.40^{a}	23.67^{b}	29.77^{ab}	25.50^{b}	32.22^{a}	2.25
*Chilling loss %	2.01	1.96	2.06	2.00	1.88	1.81	0.70

*Chilling loss of whole carcass, Means in the same row with different superscripts are significantly different. (p<0.05)

Table 5: Organoleptic characteristics of duck meat as influenced by breed and sex

	Rouen		Perkins		Muscovy		
	Male	Female	Male	Female	Male	Female	SEM
Colour	4.22^{b}	5.22^{a}	4.00^{b}	4.11^{b}	3.71^{bc}	3.50^{c}	0.63
Flavour	4.00^{a}	2.89^{c}	3.56^{b}	3.78^{a}	3.38^{b}	3.94^{a}	0.56
Tenderness	6.00^{a}	5.56^{ab}	3.67^{c}	5.56^{ab}	4.67^{ab}	4.50^{ab}	0.56
Juiciness	5.10^{a}	4.67^{ab}	4.78^{ab}	5.44^{a}	4.00^{b}	3.28^{b}	0.96
Texture	4.70	4.11	3.44	3.88	3.22	4.61	1.11
Overall Accep	6.20	5.78	5.67	6.22	5.11	5.94	0.88

Sensory attributes were measured on a 9-point hedonic scale 9 is extremely desirable and 1 extremely undesirable
Means in the same row with similar superscripts are not significantly different (P>0.05)

The percent chilling loss was not influenced by breed and sex of the duck. The female muscovy duck has the least value (1.81%) while the highest value of 2.00% was obtained in the male Pekin ducks, however, the percent chilling loss were not statistically (p>0.05) different from each other.

Sensory evaluation score: The taste panel evaluation score is shown is Table 5.

Colour: This is the first criterion consumers use to judge meat quality and acceptability (Conforth, 1994). Colour is mainly influenced by the myoglobin content and nature, the composition and physical state of muscle (Giddings, 1977 and Renerre, 1986) and the meat structure. The taste panel ratings for colour ranged from 3.50 in female Muscovy duck to 5.22 in the female Rouen. Apart from the females of Rouen and Muscovy which gave the highest (p<0.05) and the least (p<0.05) scores respectively, the colour rating for other ducks were statistically similar (p>0.00).

The female Pekin and Muscovy ducks has higher flavour score than their male counterparts however, the female Rouen has a lower flavour score than the male Rouen duck. The flavour perception is more dependent on sex than breed as revealed in this present study (Table 5).

Tenderness is regarded as the most important sensory in attribute affecting meat acceptability (Cross *et al*., 1986; Quali, 1990 and Warkup *et al*., 1995). Tenderness has also been identified as the most critical eating quality, which determines whether consumers are repeat buyer. Koohmarate *et al*. (1998) and Dransfield (1997) reported that consumers prefer to pay a premium for high quality product. The male Rouen duck produced the most tender meat as adjusted by the taste panelist while the toughest (p<0.05) meat was obtained from the male Pekin duck. The taste panel result in this study was similar to the WBSF result in that both judged the male Rouen duck meat as the most tender.

Juiciness of meat is directly related to the intramuscular lipid and moisture content of the meat (Cross *et al*., 1986). In combination with water, the melted lipid constitutes a broth which when retained in meat is released upon chewing. Juiciness is made up of two-effect viz, the impression of moisture released during chewing and also the salivation produced by flavour factors (Omojola *et al*., 2003). The highest juiciness rating (5.44) was given by the panelist to the meat from female Pekin ducks however, this value did not differ (p>0.05) from values of 5.10,4.67 and 4.78 obtained from male Rouen and female and male Pekin ducks respectively.

Meat from the female Muscovy duck was rated lowest for juiciness (Table 5). As stated earlier, juiciness is dependent upon the WHC and cooking loss Muscovy duck has one of the lowest WHC value and the highest cooking loss value.

The texture and the overall acceptability were not affected by breed and sex of the ducks. No matter the breed and sex, the overall acceptability of the duck meat was high and similar (p>0.05).

Conclusion: Muscovy ducks (both sexes) gave higher dressing percentage than the other two breeds considered in this study. Sex effect on dressing percentage was not significant (p>0.05) although, the male tends to have higher numerical value over the female in Rouen and Muscovy breeds. The Muscovy duck gave the highest primal cut value in all the parameter studied while the primal yield of the female Rouen duck was the least in virtually all the cut studied. The Rouen breed was adjusted the most tender by the taste panelist and the WBSF machine. In terms of flavour, tenderness and juiciness the taste panelist has

higher preference for meat from the male Rouen duck. The result of this study also revealed that sex and breed has no significant ($p>0.05$) effect on the texture and overall acceptability of duck meat.

In general, there is a need to introduce meat type ducks to many developing countries. Infact, the opportunity for expansion of the duck industry on a global basis is probably greatest in developing countries.

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