ISSN 1682-8356
ansinet.org/ijps

INTERNATIONAL JOURNAL OF

POULTRY SCIENCE

ANSInet
308 Lasani Town, Sargodha Road, Faisalabad - Pakistan
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OPEN ACCESS International Journal of Poultry Science

ISSN 1682-8356
DOI: 10.3923/ijps.2019.144.150

Research Article
A Comparative Study of Carcass Characteristics and Meat Quality Traits of Breast Muscle Between Broiler and Cockerel Chicken

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Abstract

Background and Objective: Poultry meat, especially broiler and cockerel, consumption is increasing gradually in the country. As income of common people has been upgrading, they are now choosing quality food for consumption considering nutrient contents, meat quality and so on. The current study aimed to compare the meat quality of broiler and cockerel chicken in terms of proximate composition, physico-chemical properties, meat color, microbial load and carcass characteristics. **Materials and Methods:** To achieve this, apparently healthy twenty (20) broilers of 42 days old weigh between 1320-1380 g and similar number of same aged cockerels weigh between 740-790 g were selected from the experimental house and related jobs were performed carefully. **Results:** Results showed that the crude protein content of cockerel breast meat was significantly higher ($p<0.05$) when compared to broiler. The drip loss, cooking loss and free fatty acid content of broiler breast meat were significantly ($p<0.01$) higher than the cockerel meat. Lightness (L*) and yellowness (b*) values were also significantly higher in broiler meat although redness (a*) was higher ($p<0.01$) in cockerel meat. In respect to microbial load, *E. coli*, *S. aureus* and TBARS value of broiler breast meat samples were found significantly higher ($p<0.01$) than the cockerel meat. The dressing percentage was found significantly higher ($p<0.01$) in broiler chickens. The results from this experiment showed that the broiler breast meat quality is comparatively lower than that of cockerel in terms of nutrient contents, pH, TBARS, free fatty acid, meat color and microbial load. **Conclusion:** Thus, it could be stated that meat quality of cockerel is better than broiler in terms of the above mentioned criteria.

Key words: Broiler vs cockerel, microbial analysis, meat quality, carcass characteristics, proximate composition

Received: November 12, 2018 Accepted: January 03, 2019 Published: February 15, 2019

Citation: Md. Nazmul Hasan, Md. Ataul Goni Rabbani, Tahera Yeasmin, Moinul Hasan and Md. Harun Or Rashid, 2019. A comparative study of carcass characteristics and meat quality traits of breast muscle between broiler and cockerel chicken. Int. J. Poult. Sci., 18: 144-150.

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Competing Interest: The authors have declared that no competing interest exists.

Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

Although annual growth of poultry industries has gained momentum in Bangladesh, per capita chicken meat consumption is nearly 3.63 kg here against the minimum requirement for maintaining global health standard around 18-20 kg per year[1]. Recently, predominantly in the developing countries, the consumption of poultry meat has increased rapidly and consumers have started to pay more attention to meat quality[2,3]. There are several factors affecting the quality of poultry meat, such as age, breed, sex, genotype of the birds as well as diet[4,5]. Day by day the demand of poultry meat is being increased, so farmers have been trying to improve the growth rate, feed efficiency and breast-meat yield of their birds.

Appearance and texture are the two most important attributes for poultry meat. Appearance is not only critical for the consumers' initial selection of any product but also final satisfaction from product consumption. That is why, farmers have given priority to produce products with the appropriate color targeting a particular market and to avoid appearance defects, which will negatively affect product selection or price[6]. There are some nutritional values related to poultry meat quality, such as high-value protein, unsaturated fatty acid, vitamins, cholesterol and other biologically active compounds. The important sensory traits are color, aroma and flavor. It can be stated that if poultry meat fully accomplish the consumer expectations then poultry meat is of good quality than other meats. Modern consumers seek some essential traits exists in meat that are low in fat, tender, juicy with good flavor and aroma[7].

To completely describe the characteristics of breast meats, study related to sensory analysis, chemical analysis, physicochemical analysis, color and microbial load are necessary. The important information of each analysis contributes specific character on breast meat quality. Changes in muscle color and water holding capacity of breast meat is directly affected by changes in muscle pH. Besides, the changes in muscle pH ultimately affect protein structure and subsequent hydration properties of the meat proteins. In consideration of the above facts, this study was aimed to compare the meat quality traits by chemical composition, physico-chemical properties (pH, FFA, color, per-oxide value and lipid), color band and microbial load of the breast meat between broiler and cockerel.

MATERIALS AND METHODS

Experimental birds and their management: For this experiment, 150 day old cockerel chicks (ISA Brown) and 150 broiler chicks (Cobb 500) were purchased from a reputed hatchery of the country. The experiment was conducted at local farm in Boiler village under Trishal upazila of Mymensingh district of Bangladesh during later part of 2017 (October 20 to November 30, 2017). The chicks were reared without any antibiotic or probiotic except vaccination under open sided poultry house. During the experimental period, Broiler starter (CP 21.5%, Fat 3.5%, CF 5%, Moisture 12%, ME 2900 kcal kg^{-1}) feed was provided 0-16 days and Broiler Grower (CP 20%, Fat 3%, CF 5%, Moisture 12%, ME 3000 kcal kg^{-1}) was maintained rest period (17-42 days). Identical management (brooding, lighting, biosecurity) and care were ensured throughout the experimental period to get optimum results.

Sample collection and preparation: For this experiment, apparently healthy twenty broilers (42 days old and 1320-1380 g body weight) and twenty cockerels (42 days old and 740-790 g body weight) were collected from the experimental house. As far as possible, all connective tissues and visible fat were trimmed off. The muscles were rinsed and washed with clean water to remove blood and cut into small pieces. All of the meat pieces were mixed properly by hand.

Lab location: Laboratory analyses of the experimental samples were carried out in the relevant laboratories of the Departments of Animal Science, Department of Food Technology and Rural Industries at Bangladesh Agricultural University, Mymensingh.

Meat chemical analyses: Meat proximate chemical analysis was done according to AOAC[8].

Dry matter: Five gram meat sample was taken in pre-weighed porcelain crucibles. The crucible was kept at 105°C in an oven for a period of 24 h. After that the crucible was cooled in desiccators. The meat dry matter was calculated as a difference between the meat sample weights before and after drying.

Ether extract: Five gram ground meat sample was taken in a thimble and added 200 mL diethyl ether in a Soxhlet. At about 7-8 h extraction was done at 40-45°C. After extraction, the flask was dried at 100°C. Then the flask was cooled in desiccators and weighed.

Ash: Five gram sample was taken in porcelain crucibles and pre-ashed at 105°C for 24 h. The crucible was then placed in a muffle furnace and heated at 550°C for 6 h. The crucible was then cooled in desiccators and weighed.

pH: The meat pH was measured using a pH meter in meat homogenate, prepared by blending 10 g of meat with 50 mL distilled water. The laboratory pH meter was adjusted at room temperature (adjusted with buffer pH 7.0).

Drip loss: From each sample, a standardized muscle cylinder (30 g) was suspended in an inflated plastic box (4°C) for 24 h. This work was done within 48 hours of postmortem. The drip loss was calculated by the following formula:

$$\text{Drip loss}(\%)=\frac{\text{Final weight}-\text{initial weight}}{\text{Sample weight}}\times 100$$

Cooking loss: The meat sample was boiled to an internal temperature of hot water bath at 90°C for 30 min. Cooking loss was determined by the following calculation:

$$\text{CL}(\%)=\frac{\text{Initial weight of fresh meat-weight of meat after cooking}}{\text{Initial weight of fresh meat}}\times 100$$

Color estimation: Samples were taken from the experimental longissimus dorsi (LD) muscles and Hunter color components lightness (L), redness (a) and yellowness (b) were recorded using Hunter Lab Tristimulus colorimeter model D25 m-2. Subsequently these samples were frozen and stored for cooking loss and shear force determinations.

Peroxide value determination: The peroxide value was determined according to Sallam *et al.*[9].

$$\text{Per}-\text{oxide value}(\text{meq kg}^{-1})=\frac{S\times N}{W\times 100}$$

Where
S = Volume of titration (mL)
N = Normality of sodium thiosulfate solution (n = 0.01)
W = Sample weight (g)

Free fatty acid value: Free Fatty acid value was determined by Rukunudin *et al.*[10].

FFA (%) = mL titration×Normality of KOH×28.2/g of sample

Crude protein: Determination of total protein was done by establishing the total nitrogen with the Kjeldahl method[11], which consists in extracting the total nitrogen from a mineralized sample [as ammonium sulphate-$SO_4(NH_4)_2$], then expressing it as ammonia (through distillation and caption on acid) and converting the total ammonia into protein with a correction factor. AOAC[8] method was followed to determine CP using following formula:

N% = [(mL standard acid×normality acid)-
(mL standard NaOH×normality NaOH)]×1.4007/g sample

Crude protein% (CP) = N%×6.25

TBARS determination: The TBARS value was measured according to Vyncke[12]. TBARS, expressed as micromole of malondialdehyde per kilogram of meat, was calculated using TEP/malonic aldehyde as standard.

Enumeration of *Staphylococcus aureus*: Baird Parker agar (Oxoid, England), a selective medium for the isolation and counting of coagulase positive staphylococci was used for the enumeration of *Staphylococcus aureus* as described by Bhandare *et al.*[13].

Enumeration of *Escherichia coli*: *Escherichia coli* were counted as colonies with distinct metallic sheen[13]. *Escherichia coli* were enumerated on Eosin methylene blue agar (Oxoid, England) by plating an appropriate dilution on plates followed by aerobic incubation at 37°C for 24 h.

Dressing percentage and other organs weight: Dressing percentage (DP) = (carcass weight/live weight)×100. Weight of heart, liver, pancreas, gizzard, abdominal fat and spleen were taken with an electronic balance and the percentage of these organs to the carcass weight, were measured.

Statistical analysis: Data were analyzed using the SPSS version 20[14] for windows. Results were presented as mean±standard deviation and significance level was set at 5%.

RESULTS AND DISCUSSION

Proximate composition: A significant ($p<0.05$) variation was seen while estimating CP in between broiler breast meat and cockerel breast meat (Table 1). The CP content of cockerel breast meat is significantly higher ($p<0.05$) when compared to broiler breast meat while no significant ($p>0.05$) differences were found in dry matter, ether extract and ash percentage. Barteczko and Lasek[15] observed that broilers chicken was fed with mixtures of lower protein content (20 and 19%) showed lower body weight and protein percent in muscle tissue compared to broilers fed with higher protein content (23%). Wattanachant *et al.*[16] observed the level of

Table 1: Proximate chemical composition of broiler and cockerel breast meat

	Mean±SD			
Parameters	Broiler	Cockerel	p-value	Level of significance
DM (%)	26.76±0.21	26.17±0.34	0.062	NS
CP%	22.47±0.54	23.59±0.07	0.024	*
EE (%)	1.19±0.13	2.05±0.07	0.195	NS
Ash (%)	1.21±0.07	1.29±0.06	0.183	NS

DM: Dry mater, CP: Crude protein, EE: Ether extract, NS: Non-significant, *p<0.05, SD: Standard deviations

Table 2: Comparison on different physicochemical parameters of broiler and cockerel breast meat

	Mean±SD			
Parameters	Broiler	Cockerel	p-value	Level of significance
Drip Loss (%)	2.54±0.08	2.12±0.05	0.001	**
Cooking Loss (%)	26.60±0.63	21.48±0.26	0.001	**
Moisture (%)	75.26±0.93	74.30±0.51	0.194	NS
pH	5.86±0.08	6.09±0.04	0.010	**
Fat (%)	1.85±0.06	1.61±0.03	0.003	**
FFA (%)	1.00±0.01	0.93±0.02	0.004	**
PV (meq kg^{-1})	0.91±0.03	0.83±0.03	0.023	*

FFA: Free fatty acid, PV: Peroxide value, NS: Non-significant, *p<0.05; **p<0.01, SD: Standard deviations

crude protein in the breast muscles of young broilers was lower than native chicken breeds (over 24%). The results of our experiment are similar to these findings. The dry matter and ash contents in breast meat of broilers and native bird were found almost similar by De Marchi *et al.*[17] and Wattanchant *et al.*[16]. The present study results were also in agreement with these findings. Moreover, breast meat from the broiler tended to have higher moisture and significantly lower protein content.

Physicochemical properties: Table 2 shows the drip loss, cooking loss, moisture, pH, fat, free fatty acid and per-oxide value percentage of breast meat of broiler and cockerel. The fat percentage, drip loss, cooking loss and free fatty acid percentage of broiler breast meat were significantly ($p<0.01$) higher than that of cockerel. In this study, the peroxide value of broiler breast meat was significantly ($p<0.05$) higher. Breast meat from the cockerel had a significantly ($p<0.05$) higher pH when compared to the broiler breast meat group of chicken, whereas no differences were found in moisture percentage.

Fanatico *et al.*[18] in their experiment found that the drip loss of slow growing birds were significantly lower than the fast-growing ones which supported the present study results. The results of our findings indicated that broiler meat had a lower pH and higher drip loss. According to El Rammouz *et al.*[19], the pH (5.66) value of broiler chicken was less than the pH (5.73) of slow growing local birds. Le Bihan-Duval *et al.*[20] also stated the same. These finding has similarities with the present results. Jakubowska *et al.*[21] indicated that initial muscle pH determines some physicochemical traits such as water holding capacity, color, cooking loss or tenderness of heat-treated meat. Valsta *et al.*[22] stated that broiler chicken fed with appropriate manipulation of diet could modify fatty acid profile and increase the nutritional value of meat. De Marchi *et al.*[17] reported as the fat content of cockerel breast meat was higher than that of broilers breast meat but the present study results showed higher fat percentage in broiler. This may be due to fast growing nature of broiler compared to cockerel birds. Low peroxide values may also be acquired for any extremely rancid products, besides initially the peroxides formed have all undergone further oxidation reactions[23]. High peroxide values are a definite hint of a rancid fat.

Meat color: In the present study, differences in meat color parameters were found while comparing broiler and cockerel breast meat as shown in Table 3. The lightness (L*) and yellowness (b*) values of broiler breast meat were significantly ($p<0.01$, $p<0.05$ respectively) higher than that of the cockerel meat although redness (a*) was higher ($p<0.01$) in cockerel. Woelfel *et al.*[24] found relatively higher L* value (60) which disagreed the current findings. Color may be the vital factor for measurement of good quality meat, besides it influences the appearance, attractiveness of breast meat to consumers. Consumer's preferred different colors, depending on their place of residence, observed by Bianchi *et al.*[25]. For consumers' decision, the breast meat color is a critical criterion. Mehaffey *et al.*[26] suggested that the breast meat should have a pink color when raw. Qiao *et al.*[27] suggested L* value of examined deboned breast meat as 48 <L*<51(normal), L*<46 (darker than normal); L*>53 (lighter

Table 3: Comparison on meat color of broiler and cockerel breast meat

	Mean±SD			
Parameters	Broiler	Cockerel	p-value	Level of significance
L*	53.92±0.18	50.61±0.45	0.001	**
a*	1.37±0.003	1.69±0.10	0.005	**
b*	17.34±0.79	15.61±0.14	0.020	*

L*: Lightness, a*: Redness and b*: Yellowness of meat, *p<0.05; **p<0.01, SD: Standard deviations

Table 4: *Escherichia coli* (CFU/cm^2), *Staphylococcus aureus* (CFU/cm^2) and TBARS (μmol kg^{-1}) of broiler and cockerel breast meat

	Mean±SD			
Parameters	Broiler	Cockerel	p-value	Level of significance
Escherichia coli	2.60±0.04	2.28±0.08	0.003	**
Staphylococcus aureus	3.48±0.10	3.18±0.07	0.013	*
TBARS	0.08±0.01	0.06±0.003	0.009	**

*p<0.05; **p<0.01, SD: Standard deviations

Table 5: Carcass characteristics of Broiler and Cockerel chicken

	Mean±SD			
Parameters (g/100 g of body weight)	Broiler	Cockerel	p-value	Level of significance
Dressing parentage (%)	67.17±2.41	54.24±0.79	0.001	**
Liver	2.39±0.42	2.17±0.04	0.003	**
Heart	0.49±0.02	0.45±0.04	0.073	NS
Gizzard	1.59±0.03	1.49±0.01	0.002	**
Pancrease	0.25±0.03	0.23±0.01	0.330	NS
Spleen	0.13±0.006	0.11±0.01	0.025	*
Abdominal fat	1.83±0.02	1.58±0.01	0.000	**
Intestine	2.91±0.03	2.82±0.05	0.073	NS

wt: Weight, NS: Non-significant, *p<0.05, **p<0.01, SD: Standard deviations

than normal). The present findings were consistent with previous observations[27]. Color and pH value is correlative to measure the meat quality. The L* value of broiler breast meat was higher than cockerel breast meat and this may be interrelated to the lower pH values of the broiler breast meat.

Microbial load: In respect to microbial load, the *E. coli* and TBARS value of broiler breast meat samples in the present experiment were significantly (p<0.01) higher than the cockerel meat (Table 4). Similar response were found in case of *S. aureus* (p<0.05). Voidarou *et al.*[28] reported that the higher level of microbial contamination present in meat including *S. aureus.* Many researchers[29,30] have been found the presence of *E. coli* strains in meat and meat products. Pointon *et al.*[31] investigated the similar results for retail chicken (>90% incidence of *E. coli*) in Australia. Pikul *et al.*[32] reported TBARS value as to be a good indicator of fat oxidation. Buckley and Connolly [33] found a TBARS value of 1.0 to be a good cut-off point, of a rancid taste for raw pork. In this experiment, this cut-off point was considered as a guideline. In our findings, a positive correlation between microbial load and TBARS values was observed in broiler breast meat.

Carcass characteristics: The effect of mean values regarding various carcass characteristics and relative organ weight of the broiler and cockerel has been shown in Table 5. The dressing percentage was significantly (p<0.01) higher in broiler chickens than that of in cockerel. The proportion of liver, gizzard and abdominal fat showed significant (p<0.01) difference between broiler and cockerel chicken. Statistical analysis of the data regarding relative weights (g organ weight/100 g body weight) of heart, pancreas and intestine did not show any difference in the mean values among the treatment groups. Several studies[17,34] have confirmed that low live weight has been associated with low carcass yield. Similar results were also reported by Mahmood *et al.*[35] and Kamruzzaman *et al.*[36]. The present study results were in agreement with most of the previous findings might be due to type of birds used in the experiment.

CONCLUSION

In the present study, the CP content of cockerel breast meat was found significantly higher than that of broiler while drip loss, cooking loss and free fatty acid and fat percentage

of broiler breast meat were significantly higher. Lightness (L*) and yellowness (b*) were also significantly higher in broiler meat but redness (a*) was found higher in cockerel. While considering microbial load (*E. coli*, *S. aureus* and TBAFRS value), cockerel meat was found better but dressing percentage was higher in broiler. From the above results, it can be concluded that there exists wide range of differences in proximate and chemical composition, meat color, microbial loads and carcass characteristics of broiler and cockerel meat. Further study is required in this regard.

SIGNIFICANCE STATEMENT

The current study was undertaken to guide common people about the most consumed broiler and cockerel meat as these are very much popular to them. With the passage of time, people are becoming careful about the quality food products. This study results will definitely help people to choose quality meat between broiler and cockerel meat.

ACKNOWLEDGMENT

The authors would like to thanks to the Department of Animal Science, Department Poultry Science and Department of Food Technology and Rural Industries of Bangladesh Agricultural University and Poultry Production Research Division of Bangladesh Livestock Research Institute for providing technical cooperation to carry out research work successfully. Authors also like to acknowledge all out efforts of Mr Karim Mia, the farm owner from Boiler village under Trishal upazila of Mymensingh district where the trial took place.

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