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Research Article

Comparison of meat yield and physicochemical characteristics of indigenous, cockerel and sonali chicken

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Abstract

The experiment was conducted to compare the meat yield and quality characteristics of indigenous, cockerel and sonali male (Backcrossed; RIR♂ × Sonali♀) chicken weighing around 750g. The birds were slaughtered and meat yield characteristics such asbreast, thigh, drumstick, wing, liver, heart, head, gizzard, neck etc. were compared against their live weight. After that the breast, thigh and drumstick of all birds were stored at 4˚C to evaluate different quality characteristics at 24hour postmortem. No significant differences ($p>0.05$) were found in meat yield characteristics among indigenous, cockerel and sonali chicken except dressing percentage. Highly significant ($p<0.001$) differences were observed in dressing percentage among three types of chicken. Dressing percentage was significantly higher ($p<0.001$) in indigenous chicken compared to cockerel and sonali chicken. In proximate composition, no significant differences ($P>0.05$) were found in dry matter, ash, moisture and crude protein content among the breast meat of three types of chicken but the ether extract content was significantly higher in indigenous chicken breast meat compare to cockerel and sonali chicken ($P<0.05$). The pH of breast and thigh meat at 24-hour postmortem and the instrumental color (CIE L^* a^* b^*) of breast, thigh and drumstick meat at 2-hour (on-rigor) and 24-hour (post-rigor) postmortem did not differ among the three types of chicken. Highly significant differences ($p<0.01$) in water holding capacity of breast, thigh and drumstick meat were found, although no significant differences ($P>0.05$) were found in cooking loss and drip loss among the three types of chicken. Water holding capacity was significantly lower in breast meat, but higher in thigh and drumstick meat in case of cockerel compare to other two types of chickens.

Introduction

Poultry are one of the most commonly kept livestock species and have been reared as an integral part of rural household in the least developing countries around the world (Akter et al., 2022; Ali et al., 2022; Hashem et al., 2022). Chicken meat and eggs are well accepted by all religious, economic, social, and demographic groups (Bithi et al., 2020; Boby et al., 2021; Disha et al., 2020). Indigenous, cockerel and sonali chicken generally have a slower growth rate than that of commercial broilers, which may contribute to differences in the properties of their meats. Due to higher protein content, better taste and pigmentation, comparatively smaller to medium in size, wider availability and highly accepted by people these chickens are widely used to prepare special dishes and delicious roast (Rahman et al., 2022; Islam and Nishibori, 2009).The advantage of native chickens is that they have traits of fighting cocks including strong, tough muscles, its hardiness and ability to thrive under adverse climatic conditions (Jaturasitha et al., 2008).Cockerels constitute nearly 50% of the layer chicks produced from commercial hatcheries. These are not killed in hatcheries; rather, they are sold at a lower price to interested farmers. Many consumers prefer cockerel to native chickens, although the former is not as fleshy but because of the cost, they are often utilized in festivals such as wedding ceremonies to prepare special dishes (Chowdhury, 2013). The sonali is a cross-bred chicken from Rhode Island Red cocks and Fayoumi hens (RIR♂×Fayoumi♀) that has a similar phenotypic appearance and characteristics to that of indigenous chicken. It was introduced to increase meat and egg production considering in the village level due to their higher adaptability and productivity under the semi-scavenging or scavenging condition. Nowadays, sonali has gained so much popularity as replacement of slow growing indigenous chickens in our country. Recently, poultry farmers in Bangladesh have attempted to practice backcrossing between Sonali female and RIR male in attempt to put a greater emphasis on meat production with the advantages of plumage color and better weight gain.In recent years people become very aware about what they are eating. In recent years, interest has increased in the quality attributes of food (Farmer et al., 1997). Generally, consumers prefer to have high quality, convenient and safe meat products that contain natural flavor and taste (Saba et al., 2018; Khatun et al., 2022; Hossain et al., 2021; Islam et al., 2021; Sarker et al., 2021).The present study was carried out to compare the meat yield and quality characteristics of meat from indigenous, cockerel and sonali chicken of about similar body weight.

Materials and Methods

A total of 9 male birds of indigenous, cockerel and sonali chicken of approximately 750±50g standard weight were purchased from local market, Mymensingh. The live birds were immediately transferred to Bangladesh Agricultural University Poultry Farm. Then all of the birds were weighed before slaughter and were slaughtered, bled, plucked, weighed to determine blood and feather losses. The carcasses were eviscerated and dissected manually. Each eviscerated carcass was dissected without skin into: neck, wings, breast, thigh, drumstick and the remainder of the carcass. The dissected carcass components were weighed accurately using digital weighing balance to determine the meat yield. Then the meat samples were stored for 24 hours at 4°C temperature in the refrigerator. After refrigerating for 24 hours the breast, thigh and drumstick meat samples were analyzed for proximate composition, pH, color, water holding capacity, cooking loss and drip loss.

Proximate compositions

After being refrigerated for 24 hours, the breast meat samples were analyzed for proximate composition (dry matter, ether extract, crude protein, and ash) according to the methods (AOAC, 2005).

pH determination

The samples were refrigerated for 24 hours, and the pH of breast and thigh meat was individually measured using a HI 99163 pH meter (HANNA instruments. Inc. Highland Industrial Park, USA). For each reading 2 measurements were performed, and the final value for each sample is the average of those readings. The pH meter was calibrated with pH 4.01 and pH 7.0 prior to measurement. Following calibration, the sensor probe was inserted into the breast and thigh meat samples, and the pH value for each sample was recorded.

Determination of Color

At 2 hours of postmortem, instrumental color *(CIE L* a* b*)* was taken from breast, thigh, and drumstick meat samples. The meat samples were then refrigerated for 24 hours at 4°C temperature, and after 24 hours of refrigeration the color of the breast, thigh, and drumstick meat was again measured individually using Konica Chroma Meters CR-410 (Konica Minolta Inc., Tokyo, Japan). For each reading 3 measurements were performed, and the final value for each sample was the average of those readings. Breast, thigh and drumstick meat color were expressed in the *CIE LAB* dimensions of lightness *(L*)*, redness *(a*)*, and yellowness *(b*)*.

Determination of Water Holding Capacity

The Water Holding Capacity (WHC) of breast, thigh and drumstick muscle was measured by centrifugation assay. From each replication, approximately 1g of sample was cut into cubes and placed in a centrifuge tube for being centrifuged at 1000 RCF at 4°C for 10 minutes. The WHC was determined by the amount of exudate water via the following formula:

$$\text{WHC (\%)} = \frac{\text{Sample weight after centrifugation}}{\text{Sample weight before centrifugation}} \times 100$$

Determination of Drip loss

At 24 hours after post-mortem, the drip losses of the breast and thigh muscles were measured. Approximately 15g (wet weight) of regular-shaped muscle was cut from the breast and thigh muscle at the same position for each sample and then weighed (initial weight). The sample was then placed in an airtight box by hanging on a string and stored in a 4°C refrigerator. After 24 hours, samples were taken from the freezer and reweighed (final weight) by using a digital balance. The difference in weight expressed to the drip loss and showed as the percentage of the initial weight. The drip loss was calculated by using the following formula:

$$\text{Drip loss(\%)} = \frac{\text{Initial weight of the sample} - \text{final weight of the sample}}{\text{Initial weight of the sample}} \times 100$$

Determination of Cooking Loss

Weight of cooking loss samples was taken. Weighing samples were taken in the double-layer polythene bag and were placed in a water bath at 80°C for 30 minutes. After 30 minutes, the samples were removed from the water bath and spread for 10 minutes to dry on the surface. After 10 minutes, samples were weighed again. Cooking loss was calculated as the percentage of the loss weight of the cooked sample (Symeon et al., 2010). Then cooking loss was measured by using the following formula:

$$\text{Cooking loss(\%)} = \frac{\text{Sample wt before cooking} - \text{Sample wt after cooking}}{\text{sample wt before cooking}} \times 100$$

Statistical model and analysis

The data in this experiment were analyzed using the analysis of variance procedure of Statistical Analysis Systems Institute (SAS), and a Duncan's procedure was used to measure significant differences among means at a 5% level of significance (SAS, 2002).

Results and Discussion

Meat yield characteristics

The data on meat yield parameters of indigenous, cockerel and sonali chicken obtained from this experiment are presented in Table 1. The data obtained from this experiment indicate that no significant differences were found in meat yield characteristics among indigenous, cockerel and sonali chicken except dressing percentage. Highly significant ($P<0.01$) differences were observed in dressing percentage among the three types of chicken. Significantly higher dressing percentage was found in indigenous chicken (61.03%) while no significant differences were found between cockerel (57.43%) and sonali chicken (56.97%) in dressing percentage. Ali et al.(2022)found the dressing percentage of backcrossed sonali (RIR♂ × Sonali♀) chicken

55.49% which was also slightly lower than our findings. Akhter et al. (2018) found the dressing percentage of non-descriptive native chicken 61.52% that agrees with our findings.

Table 1. Meat Yield Characteristics of indigenous, cockerel and sonali chicken.

Parameter	Indigenous	Cockerel	Sonali	p-value
Live weight (g)	771.00±7.37	771.33±11.62	746.00±30.55	0.59
Dressing (%)	61.03^{a}±0.31	57.43^{b}±0.12	56.97^{b}±0.09	<0.01
Blood (%)	4.02±0.17	4.58±0.16	4.38±.06	0.07
Feather + Skin (%)	16.29±0.27	16.48±0.47	16.73±0.79	0.86
Thigh (%)	12.62±0.33	12.12±0.79	13.03±0.28	0.51
Drumstick (%)	11.58±0.34	11.07±0.22	11.98±0.07	0.09
Breast (%)	14.05±0.05	13.92±0.14	13.94±0.05	0.59
Wing (%)	8.29±0.22	8.14±0.53	8.58±0.11	0.65
Head (%)	5.53±0.18	5.19±0.21	4.81±0.14	0.07
Liver (%)	5.53±0.16	3.11±0.10	3.53±0.09	0.12
Gizzard (%)	2.38±0.09	2.55±0.06	2.30±0.22	0.50
Heart (%)	1.29±0.14	1.25±0.14	1.42±0.14	0.69
Neck (%)	4.06±0.19	3.38±0.17	3.51±0.24	0.12
Shank (%)	6.04±0.47	6.49±0.24	6.12±0.11	0.58

Data are Mean ± SEM. Mean ± SEM in each row having different superscript varies significantly at values P<0.05. Again Mean ±SEM values having same superscript in each row did not differ significantly P>0.05.

Proximate Analysis

After refrigerating 24 hours after the postmortem, the breast meat of the indigenous, cockerel and sonali chicken were analyzed to estimate the proximate composition. The proximate compositions of three types of chicken breast meat like; dry matter, crude protein, ether extract and ash are presented in Table 2. No significant differences were found in proximate composition among indigenous, cockerel and sonali chicken except the ether extract. Significant differences (P<0.05) in EE content were found among the three types of chicken. Significantly higher EE content were found in indigenous chicken meat compared to the cockerel and sonali chicken. Jaturasitha et al. (2008) and Wattanachant et al. (2004) reported that genotype of chickens plays an important role in carcass fatness and meat quality.No significant differences (P>0.05) were found in dry matter content among the three types chicken breast meat. Hasan et al. (2020) found that the DM of cockerel breast meat was 26.17% which was higher than our findings. From the data of proximate composition analysis, we did not find any significant differences (P>0.05) in ash content among the three types of chicken. Pambuwaand Tanganyika (2017) found 20, 24 and 28 weeks aged indigenous chicken's ash content were 1.288, 1.296 and 1.394% respectively. They also found the ash content in indigenous chicken cocks was 1.320%. From the data of proximate composition analysis, we did not find any significant differences (P>0.05) in CP content among the three types of chicken. Although no significant differences were found in CP content among the three types of chicken breast meat, indigenous chicken showed higher (25.69%) CP content than the cockerel (23.05%) and sonali (21.83%) chicken. Jaturasitha et al. (2008) found that the CP values in Thai indigenous chickens were 22.6% to 24.8% which was lower than this finding. Sirri et al. (2010) reported that the protein content of slow-growing chicken genotypes was 24.6% that agree with the present research work.

Table 2. Proximate composition of breast meat of indigenous, cockerel and sonali chicken

Parameter (%)	Indigenous	Cockerel	Sonali	p-value
DM	25.89±0.43	27.24±0.62	26.79±0.14	0.18
Moisture	74.10±0.44	72.76±0.62	73.20±0.14	0.18
Ash	1.30±0.03	1.27±0.02	1.25±0.03	0.61
CP	25.69±1.06	23.05±1.04	21.83±1.41	0.14
EE	1.92^{a}±0.05	1.73^{b}±0.04	1.53^{b}±0.08	0.012

Data are Mean ± SEM. Mean ± SEM in each row having different superscript varies significantly at values P<0.05. Again Mean ±SEM values having same superscript in each row did not differ significantly P>0.05.

pH

The pH of meat is a measurement of acidity. The pH of meat can range from 5.2 to 7.0. In this study, the pH was taken from the breast and thigh meat of indigenous, cockerel and sonali chicken after 24 hours of post mortem. Before taking pH, the breast and thigh meat sample were refrigerated overnight at 4˚C. The observed pH among the three types of chicken is presented in Table 3. No significant differences (P>0.05) were found in pH content of breast and thigh meat among the three types of chicken. The pH value has been associated with numerous other meat quality attributes including tenderness, WHC, cooking loss, juiciness, and shelf life (Allen et al., 1998). The mean pH for chicken breast meat is between 5.7 and 5.9 (Mendes, 2001) which is lower than this experiment. The pH being within the ranges considered good for chicken meat indicates a good meat quality, may have a shelf life longer than a chicken muscle (Das et al., 2022; Fletcher et al., 2000).

Table 3. pH (after 24 hours of postmortem) of breast and thigh meat from indigenous, cockerel and sonali chicken

Meat type	Chicken type			p-value
	Indigenous	Cockerel	Sonali	
Breast	6.38±0.06	6.34±0.02	6.80±0.01	0.42
Thigh	6.41±0.03	6.38±0.01	6.35±0.01	0.17

Data are Mean ± SEM.

Color

Color value **(CIE L*, a*, b*)**of different treatments among the three types of chicken including 2 hours and 24 hours after the post mortem was shown in Table 4. From the data analysis from breast, thigh and drumstick meat of three types of chicken, we did not find any significant (p>0.05) differences in instrumental color (CIE L*, a*, b*) at 2 and 24 hours after postmortem.

Table 4. The color (CIE L*, a*, b*) values of breast, thigh and drumstick (without skin) meat of indigenous, cockerel and sonali chicken

Time	Body parts	Color value (CIE)	Indigenous	Cockerel	Sonali	p-value
2-hour of post-mortem	**Breast**	***L****	41.06±3.01	44.23±3.57	30.87±7.59	0.24
		a*	6.45±2.48	6.42±1.55	3.65±0.76	0.48
		b*	5.73±0.81	7.98±1.18	4.57±1.42	0.19
	Thigh	***L****	33.73±6.76	42.72±6.68	24.12±10.3	0.33
		a*	7.04±1.85	9.24±0.36	10.94±0.26	0.11
		b*	7.88±1.59	8.55±2.52	7.89±1.58	0.96
	Drumstick	***L****	37.88±7.06	28.74±7.09	40.41±6.79	0.50
		a*	6.42±1.97	6.71±0.95	9.44±1.20	0.33
		b*	4.60±0.32	7.12±0.66	3.88±2.18	0.27
24-hourof post-mortem	**Breast**	***L****	50.50±3.69	42.63±3.32	41.39±1.66	0.15
		a*	4.38±1.73	6.26±1.58	4.70±0.69	0.62
		b*	3.94±1.04	5.04±1.28	4.47±0.42	0.74
	Thigh	***L****	34.44±12.67	42.99±7.91	39.38±7.27	0.82
		a*	5.99±1.47	7.47±2.04	10.66±1.33	0.20
		b*	2.18±1.64	5.33±1.08	4.18±1.82	0.40
	Drumstick	***L****	39.59±6.46	53.50±5.76	31.74±2.87	0.06
		a*	6.00±1.12	10.79±1.97	9.49±1.10	0.13
		b*	3.37±1.36	9.25±2.89	4.61±1.17	0.16

Data are Mean ± SEM.

Water holding capacity

Water holding capacity depends on factor like pH, sarcomere length, ionic strength, osmotic pressure and rigor mortis as these factors alters the intracellular and extracellular components. The data of water holding capacity of breast, thigh and drumstick meat from indigenous, cockerel and sonali chicken is presented in Table 5. Highly significant differences (p<0.01) were observed in water holding capacity (WHC) of breast, thigh and drumstick meat among the three types of chicken. Significantly higher (P<0.01) WHC were observed in thigh and drumstick meat in the cockerel chicken compared to the indigenous and sonali chicken but significantly lower (P<0.05) WHC was found in the cockerel chicken breast meat than the indigenous and sonali chicken breast meat. In breast meat significantly higher (P<0.01) WHC were observed in the indigenous and sonali chicken than the cockerel. Poor water holding capacity will lack of juiciness and tenderness in meat (Fanatico et al., 2007).

Table 5. Water holding capacity of breast and thigh meat of Indigenous, Cockerel and Sonali Chicken

Meat type (%)	Indigenous	Cockerel	Sonali	p-value
Breast	97.68^{a}±0.06	95.76^{b}±0.09	97.68^{a}±0.05	<0.01
Thigh	98.20^{b}±0.07	98.91^{a}±0.01	97.65^{c}±0.06	<.01
Drumstick	98.42^{b}±0.06	98.76^{a}±0.08	98.53^{b}±0.02	0.016

Data are Mean ± SEM. Mean ± SEM in each row having different superscript varies significantly at values P<0.05.

Cooking loss

The data of cooking loss obtained from the breast and thigh meat of three types of chicken is presented in Table 6. The data obtained from the table indicate that no significant differences (P>0.05) were found in cooking loss among the three types of chicken. Although no significant differences were observed in cooking loss of breast and thigh meat among the three types of chicken, the breast of sonali meat showed higher value compared to the indigenous and cockerel chicken but in case of thigh meat the value was higher in the indigenous chicken breast meat than the other two types of chicken. Wattachant et al. (2004) made an experiment on Thai indigenous chicken named Black Thai, Northern Thai, Naked neck and Kai Dang. They found the cooking loss percentages in breast muscle 22.08, 18.99, 20.78, 20.28 and 24.04% respectfully. In our experiment we observed the cooking loss in breast meat of three genotypes of chickens are about to similar with the above findings but in terms of thigh the value was higher than the Watachant's value.

Drip loss

The data of drip loss from breast and thigh meat from the indigenous, cockerel and sonali chicken meat are presented in Table 6. No significant differences (p>0.05) were found in the drip loss value in breast and thigh meat among the three types of chicken. Although no significant differences (p>0.05) in breast and thigh meat among the three types of chicken were found in this experiment, the drip loss value of breast and thigh meat was higher in the cockerel chicken compared to the indigenous and sonali chicken meat. Again, showing no significant differences in the drip loss of breast and thigh meat, the drip loss was lower in the indigenous chicken than the other two types of chicken. Tuoi et al. (2020) found the drip loss value in Vietnamese indigenous Noi chicken was 2.06% which in higher than our experiment but Funaro et al. (2014) found that drip loss of breast meat of free-range chicken was 1.12% that was lower than this experiment.

Table 6. Cooking and drip loss of breast and thigh meat from Indigenous, Cockerel and sonali chicken

Meat type (%)	Parameter	Indigenous	Cockerel	Sonali	P value
	Cooking loss	21.97±0.40	21.53±0.47	22.23±0.66	0.65
Breast	Drip loss	1.24±0.39	1.68±0.04	1.56±0.48	0.07
	Cooking loss	30.04±2.05	23.79±2.86	27.69±0.95	0.19
Thigh	Drip loss	1.45±0.22	1.90±0.09	1.88±0.69	0.29

Data are Mean ± SEM.

Conclusion

In this experiment no significant differences were found in meat yield characteristics among the three types of chicken except the dressing percentage. Dressing percentage was higher in indigenous chicken compared to the cockerel and sonali chicken. In proximate composition of breast meat did not differ except fat content. Fat content was higherin indigenous chicken compared to the cockerel and sonali chicken. Significant differences in water holding capacity of breast, thigh and drumstick meat were found, but no significant differences were found in cooking loss and drip loss among the three types of chicken.

Conflicts of interest

No potential conflict of interest was reported by the authors.

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