Meat Research
Vol 3, Issue 6: 1-6, Article 78
ISSN: 2790-1971
https://doi.org/10.55002/mr.3.6.78 http://www.bmsa.info/meatresearch

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Keywords:

Indigenous chicken
Indigenous duck
Meat yield
Meat quality

Article Info:

Received: 03 December 2023
Accepted: 21 December 2023
Published online: 31 December 2023

Research Article

Comparison of meat yield and physicochemical characteristics of indigenous chicken and duck

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Abstract

Three indigenous male chicken and 3 indigenous male duck were slaughtered to compare the meat yield and quality characteristics. After slaughter meat yield characteristics of breast, thigh, drumstick, wing, liver, heart, head, gizzard, neck etc. were compared against their live weight. After comparing the yield characteristics the breast, thigh and drumstick of all birds were stored at 4˚C to evaluated different quality characteristics at 24-hour postmortem. The following parameters were compared; proximate composition, pH, cooking loss, drip loss, water holding capacity and instrumental color (CIE *L* a* b**). Findings revealed that dressing, thigh, drumstick, breast, gizzard, heart and shank weight percentage were significantly higher in indigenous chicken ($p<0.05$), while blood weight, feather weight and head weight were significantly higher in indigenous duck ($p<0.05$). Significantly higher crude protein was observed in indigenous chicken breast and thigh meat ($p <0.05$), while ash and ether extract were significantly higher in indigenous duck breast and thigh meat. Significantly higher pH was observed in chicken breast and thigh meat compare to duck breast and thigh ($p<0.05$). Cooking loss was higher in duck breast but lower in thigh meat compare to chicken breast and thigh meat. Significantly higher ($p <0.05$) water holding capacity was found in duck breast compare to chicken breast meat ($p <0.05$). At 2 hour of post mortem, lightness (L*) of breast and thigh meat did not show significant differences ($p> 0.05$), but highly significant difference was found in drumstick meat of chicken and duck ($p< 0.01$). Redness (a*) was significantly higher in duck breast and drumstick meat and yellowness was higher in duck breast at 2 hour of post mortem compare to chicken. At 24 hour of post mortem no significant differences were found between chicken and duck breast, thigh and drumstick meat. The present study reveals that the dressing, breast, thigh and drumstick weight percentage, crude protein and pH were significantly higher in the indigenous chicken compare to duck, while ether extract, ash and redness (a*) values were significantly higher in duck compare to chicken.

Introduction

Indigenous chicken and duck is considered as an economic livelihood option in Bangladesh especially for smallholders and women. Indigenous chicken and duck play a vital role for income generation, nutritional fulfillment and employment generation in the rural areas of Bangladesh (Islam et al., 2003; Sayeed et al. 2023). There are about 311.80 million chickens and 63.85 million ducks in Bangladesh (DLS 2021-22). About 89% of rural households keep chicken with an average flock size of 5.33 per holding under backyard scavenging system which reflects the significance of indigenous chicken for Bangladesh perspective (Bhuiyan et al., 2013). Despite tremendous growth of the broiler industry, indigenous scavenging chicken meat constitutes nearly 40% of the total chicken meat production (Bhuiyan, 2011; Parvin et al. 2017). Duck meat is one of the most commonly consumed meats in the world as well as in Bangladesh. Ducks have several advantages over other poultry species, particularly in disease tolerance. Indigenous ducks are preferred by the farmers under traditional scavenging system due to their high adaptability to farming conditions, better foraging ability, long productive life and less affected by diseases (Pervin et al., 2013; Moraduzzaman et al., 2015).

In recent days some consumers are confused regarding the quality of broiler meat, claiming that the procedures may corporate objectionable items in the process of broiler production and marketing for faster growth (Murshed et al. 2023; Islam et al. 2019). Indigenous chicken and duck possess fewer toxins from free foraging. Consumers perceive these birds as naturally produced in extensive farming system. Generally, meat from those species possesses a firm texture and flavor, particularly after cooking than the meat from broilers. The preferences of indigenous chicken are also for pigmentation, taste, leanness, firmness, flavor and suitability for special dishes (Akter et al., 2009 and 2022; Hashem et al., 2022 & 2023; Islam et al., 2002). Duck breast muscles are characterized by a favorable amino acid profile with a higher content of leucine, lysine, tryptophan, phenylalanine, and tyrosine and by a higher proportion of polyunsaturated fatty acids, including linoleic and linoleic fatty acids, when compared with the breast meat of broiler chickens (Ali et al., 2007; Rahman et al., 2022; Woloszyn et al., 2006). The objectives of this study were to compare meat yield and quality characteristics of indigenous chicken and duck at their marketing weight.

Materials and Methods

Three indigenous male chicken and 3 indigenous male duck were stunned and killed by conventional neck cut. The carcasses were eviscerated and dissected manually. Each eviscerated carcass was dissected with skin. The dissected carcass components were weighed accurately using digital weighing balance. Meat samples (breast, thigh and drumstick) were collected from the slaughtered birds. After that instrumental color (CIE L^* a^* b^*) was taken from breast, thigh and drumstick meat samples at 2 hours of postmortem. 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 Composition

Two samples (breast and thigh) from each bird were analyzed for dry matter, moisture, ether extract, crude protein and ash by the standard procedures of (AOAC, 2007).

pH

The pHs of breast, thigh and drumstick meat were individually measured using a HI 99163 pH meter (HANNA instruments. Inc. Highland Industrial Park, USA). Before measurement, the pH meter was calibrated with standard buffers of 4.0 and 7.0 at 25°C.

Color analysis

Instrumental color (CIE L^* a^* b^*) was taken from breast, thigh and drumstick meat samples at 2 hours of postmortem. Then the meat samples were refrigerated for 24 hours at 4°C temperature and further measured color using Konica Chroma Meters CR-410 (Konica Minolta Inc., Tokyo, Japan). Three random readings were taken from each meat sample.

Water Holding Capacity

The Water Holding Capacity of breast, thigh and drumstick muscle was measured by centrifugation assay. About 1g breast sample was cut into cubes from each replication and kept in a centrifuge tube and then centrifuged at 10000 RCF at 4°C for 10 minutes according to Azad et al. 2022.

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

Drip loss

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 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.

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

Cooking loss

To determine cooking loss weighted 5 ± 1g samples and taken in a foil paper and kept in a water bath at 80°C for 30 minutes. Samples surface were died and weighed. Cooking loss was calculated as the percentage of the loss weight of the cooked sample (Symeon et al., 2010 and Afroz et al. 2020).

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

Statistical model and analysis

The data were analyzed by t test using Statistical Analysis Systems (SAS, 2002).

Results and Discussion

Meat yield characteristics

The data obtained from Table 1 indicate that significantly higher variation was found in almost all parameters between the two species where significantly higher differences were found in thigh, drumstick, breast, and shank weight percentage of indigenous chicken compare to duck ($P<0.001$). But blood and head weight percentage were showed highly Significant ($p<0.01$) in indigenous duck. In case of dressing, gizzard and heart weight percentage were significantly higher ($P<0.05$) in indigenous chicken, but the feather weight percentage was showed highly significant in indigenous duck ($P<0.05$). While no significance differences were found in wing, liver and neck weight percentage between the two species ($P>0.05$). Hossain et al. (2012) reported that the meat yield characteristics were found in head 4.74%, breast 13.11%, thigh 9.89%, drumstick 9.16%, neck 3.77% and heart 0.46% of indigenous chicken with respect of live weight. In this study head, neck and breast are similar with that report but other parameters were found higher in amount. Nielsen et al. (2003) reported that slow-growing chickens were characterized by a significantly lower breast yield, but higher yield of thigh and drumstick muscles than fast-growing chickens.

Table 1. Meat yield characteristics of indigenous chicken and duck

Parameters	Indigenous Chicken	Indigenous Duck	P-Value
Dressing (%)	62.28±1.40	56.69±.87	0.028
Blood (%)	5.08±0.26	6.46±0.04	0.007
Feather (%)	10.43±0.28	11.76±0.26	0.027
Thigh (%)	14.18±0.65	7.21±0.06	0.000
Drumstick (%)	12.91±0.23	6.05±0.41	0.000
Breast (%)	14.85±0.55	9.20±0.20	0.001
Wing (%)	9.38±0.30	9.05±0.26	0.454
Head (%)	4.83±0.17	5.90±0.46	0.004
Liver (%)	3.25±0.32	2.98±0.20	0.515
Gizzard (%)	4.07±0.20	3.06±0.11	0.012
Heart (%)	1.31±0.02	0.84±0.12	0.021
Neck (%)	4.16±0.33	4.56±0.16	0.345
Shank (%)	4.744±0.02	2.83±0.08	0.000

Dry Matter

No significant differences were found of moisture content in breast and thigh meat between the two species (P>0.05). The observed moisture content in chicken breast and thigh meat were 73.08% and 75.73% respectively, while in indigenous duck these values were 74.99% and 75.89% respectively. Ali et al. (2007) showed that the moisture content in breast meat of chicken and duck were 75.47%and 76.41% respectively.

Table 2. Proximate composition of breast and thigh meat of indigenous chicken and duck

Meat Types	Parameter	Indigenous Chicken	Indigenous Duck	P-Value
Breast	Moisture (%)	73.08±0.56	74.99±0.42	0.112
	Ash (%)	1.05±0.01	1.24±0.00	0.003
	CP (%)	23.99±0.21	18.96±0.60	0.016
	EE (%)	0.58±0.03	1.06±0.005	0.005
Thigh	Moisture (%)	75.73±0.32	75.89±0.27	0.186
	Ash (%)	1.04±0.00	1.08±0.00	0.000
	CP (%)	22.61±0.54	18.25±0.08	0.016
	EE (%)	0.83±0.03	1.03±0.03	0.052

Crude Protein

Highly significant differences were found in crude protein content of breast and thigh meat between the two species (P<0.05), while CP was significantly higher in indigenous chicken breast and thigh meat compare to duck (P<0.05). The observed CP content in chicken breast and thigh meat were 23.99% and 22.61% respectively, while these values in indigenous duck were 18.96% and 18.25% respectively. Ali et al. (2007) reported that crude protein content was significantly higher in chicken breast meat than duck breast meat (P<0.05). The protein content of duck breasts and legs are 20.8 and 19.6%, respectively (Cobos et al., 2000), which is lower than levels in chicken (Boby et al., 2021; Das et al., 2022; Disha et al., 2020; Jaturasitha et al., 2008) and turkey meat (Maruyama et al., 1996). Kokoszynski et al. (2020) compared ducks of different genotypes and found a higher content of CP in breast meat than leg meat. Smith et al. (1993) stated that duckling breast meat contained lower protein than chicken breast meat which was similar to my results.

Ether Extract (EE)

Highly significant differences were found in ether extract content of breast meat (P< 0.01), while significantly higher EE was found in indigenous duck breast meat compared to chicken (P<0.01). Although no significant difference (P>0.05) was found in thigh meat between the two species, but EE content was observed higher in duck thigh meat. The observed EE content in chicken breast and thigh meat were 0.58% and 0.83% respectively, in duck these values were 1.06% and 1.03% respectively. (Ali et al., 2007) described that fat content was significantly higher in duck breast than chicken breast meat (P<0.05). Mazanowski et al. (2003) reported that the fat content in duck breast meat was 1.7%. Ismoyowati and Sumarmono (2011) conduct research and reported that fat content in duck meat was higher than chicken meat.

Ash

Significantly higher differences were found the total ash content in indigenous duck breast and thigh meat compares to chicken (P<0.01). Ismoyowati and Sumarmono (2011) carried an experiment among broiler, duck, turkey and quail species to investigate different quality parameters. They reported that duck meat contained significantly higher in total ash content than broiler, turkey and quail species which was similar to my results.

Quality Properties

pH

Table 3 indicates significantly higher pH was observed in chicken breast meat compare to duck (P<0.05) while significantly higher in pH was found in thigh meat of indigenous chicken compare to duck (P<0.01). But no significant difference in pH was found of drumstick meat between the two species (P>0.05). The pH at 15 min, 1 h and 24 h varied significantly among breast meat of 4 broiler lines (Berri et al., 2001). Mazanowski et al. (2003) stated that the average pH at 24 h post-mortem was 6.0 and 6.4 in meat from A44 and A55 strains of ducks.

Table 3. pH of breast, thigh and drumstick meat from indigenous chicken and duck at 24 hours of postmortem

Meat Types	Indigenous Chicken	Indigenous Duck	P-Value
Breast	6.52±0.12	6.15±0.04	0.049
Thigh	6.45±0.05	6.16±0.003	0.005
Drumstick	6.32±0.08	6.22±0.026	0.333

Cooking Loss

Highly significant differences in cooking loss were found in breast and thigh meat between two species ($P<0.05$), but no significant difference was found in cooking loss of drumstick meat between the two species. Cooking loss was higher in duck breast but lower in thigh meat compare to chicken breast and thigh meat. The observed cooking loss at breast and thigh meat of chicken were 26.66% and 36% respectively, while cooking loss at breast and thigh meat of duck were 33.81% and 32.04% respectively. Ali et al. (2007) performed a study and observed that the cooking loss of breast meat of commercial meat-type ducks ranged from 34.5% to 35.6%, cooking loss (%) was higher in duck breast compared to chicken breast meat. Alvarado and Sams (2000) found higher cooking loss in duck breast compared to chicken breast at different post-mortem deboning times, which agreed with this study. Muraduzzaman et al. (2023) observed cooking loss of breast and thigh of pigeon meat were 32.46% and 23.74% and breast and thigh of quail meat were 21.53% and 19.53% respectively.

Table 4. Cooking and drip loss of breast, thigh and drumstick meat from indigenous chicken and duck

Meat Types	Parameter	Indigenous Chicken	Indigenous Duck	P-Value
Breast	Cooking loss (%)	26.66±1.22	33.81±1.71	0.028
	Drip loss (%)	4.13±0.34	3.68±0.65	0.575
Thigh	Cooking loss (%)	36.00±0.19	32.04±0.87	0.012
	Drip loss (%)	5.20±0.92	5.84±0.76	0.623
Drumstick	Cooking loss (%)	31.49±0.21	31.91±1.13	0.731

Drip Loss

The drip loss of two species is presented in Table 4. No significant differences were found in drip loss of breast and thigh meat between the two species ($P>0.05$). Although no significant differences were found but higher drip loss was observed in breast meat of chicken compare to duck, while higher drip loss was found in thigh meat of duck compare to chicken. Northcutt et al. (1994) stated that chicken meat expounded to high temperature (40 to 41°C) lost significant amounts of drip loss during the processing period. Sarker et al. (2022) observed that the drip loss value of breast and thigh meat among the three types of chicken did not show significant differences ($p>0.05$). Greater drip loss was observed for turkey breast muscle held at 30°C, whereas 0°C and 12°C minimized water losses (Lesiak et al., 1996).

Water Holding Capacity

Significantly higher Water holding capacity was found in duck breast compare to chicken breast (Table 5), however no significant difference was found in Water holding capacity between chicken and duck thigh meat ($P> 0.05$). Although no significant difference in WHC was found between chicken and duck thigh meat, WHC was higher in duck thigh meat. WHC of indigenous chicken breast and thigh meat were 96.05% and 96.14% respectively, while WHC of indigenous duck were 97.94% and 98.17% respectively. Joseph et al. (1992) stated that duck muscles have comparatively lower water holding capacity than chicken muscles, resulting in greater cooking loss and less emulsion stability.

Table 5. Water holding capacity of breast and thigh meat of indigenous chicken and duck

Body Parts	Indigenous Chicken	Indigenous Duck	P-Value
Breast (%)	96.05±0.13	97.94±0.42	0.013
Thigh (%)	96.14±0.59	98.17±1.13	0.056

Color

It is found from Table 6, at 2 hour of post mortem, lightness (L*) of breast and thigh meat did not show significant differences ($P> 0.05$), but highly significant difference was found in drumstick meat ($P< 0.01$). Significantly higher lightness (L*) was found in chicken drumstick meat compare to duck drumstick meat at 2 hours of postmortem. Redness (a*) was significantly higher in duck breast and drumstick meat ($P< 0.05$) and yellowness was higher in duck breast meat compare to chicken at 2 hour of post mortem ($P=0.050$). At 24 hour of post mortem no significant differences were found between indigenous chicken and duck breast, thigh and drumstick meat ($P> 0.05$). Ali et al. (2007) reported that duck breast meat contained significantly higher redness (a*), but lower lightness (L*) value compared to chicken breast. The higher a* value in duck breast meat compared to chicken breast should be related to higher red muscle fibers in duck breast compared to chicken (Smith et al., 1993) stated that duckling breast muscle contained approximately 16% white fibers and 84% red fibers compared with 100% white fibers in chicken breast.

Table 6. The instrumental color (CIE L*, a*, b*) values of breast, thigh and drumstick (with skin) meat of indigenous chicken and duck at 2 and 24 hours of post mortem

Time	Meat Types	Color value (CIE)	Indigenous Chicken	Indigenous Duck	P-Value
2 hours of post mortem	**Breast**	*L**	64.45±8.62	59.33±3.74	0.615
		*a**	6.86±1.04	11.29±1.04	0.040
		*b**	13.41±0.96	16.26±0.35	0.050
	Thigh	*L**	68.86±5.91	53.03±5.84	0.130
		*a**	8.70±3.34	8.86±1.21	0.965
		*b**	10.13±2.05	8.81±2.33	0.692
	Drumstick	*L**	78.21±2.50	40.89±0.72	0.000
		*a**	4.32±1.16	12.00±1.98	0.029
		*b**	8.70±1.65	6.40±2.02	0.429
24 hours of post mortem	**Breast**	*L**	52.00±5.43	58.46±5.77	0.461
		*a**	5.47±1.22	9.34±1.13	0.081
		*b**	10.33±1.04	18.44±6.54	0.288
	Thigh	*L**	53.74±9.63	50.26±2.47	0.744
		*a**	4.31±0.81	7.42±1.10	0.087
		*b**	11.90±3.85	10.97±2.05	0.843
	Drumstick	*L**	50.58±2.16	39.22±5.71	0.136
		*a**	4.53±0.60	8.65±1.72	0.088
		*b**	8.58±2.00	5.15±3.48	0.441

Conclusion

Based on the experimental results, it is therefore concluded that the dressing, breast, thigh and drumstick weight, crude protein percentage and pH were significantly higher in the indigenous chicken compare to duck, while ether extract, ash and redness (a*) values were higher in duck compare to chicken.

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