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## Research Article

# Comparative Analysis of Broiler Meat Quality Under Fresh and Chilled Conditions

**Jannatul Fardous Juthi, Most. Mustary Mahbub, Siam-ul- Bari, Md. Mushfiquer Rahaman Raihan, Shraboni Jhora Badhan and Md. Abul Kalam Azad**✉

Department of Animal Science, Faculty of Animal Husbandry, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh

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**Correspondence**
Md. Abul Kalam Azad
✉: azad_animalscience@bau.edu.bd



**ABSTRACT**

The experiment was conducted to compare meat quality parameters between fresh and chilled broiler meat. For this purpose, 30 broilers were chosen from the Meat Research Unit of Animal Science farm of Bangladesh Agricultural University, Mymensingh. The birds were slaughtered and meat characteristics were compared against fresh carcasses and chilled carcasses. The breast of birds was collected to evaluate different physicochemical attributes (color, pH, temperature, shear force value, cooking loss, drip loss, water holding capacity). Significant differences in pH and cooking loss were found in broiler breast meat of fresh carcasses compared to broiler breast meat of chilled carcasses ($p>0.05$). No significant differences were found in water holding capacity of breast meat between chilled and fresh broiler carcasses (0.05). For color, Lightness (L*) no significant differences were found in breast meat from chilled and fresh carcasses ($P> 0.05$). Breast meat from chilled and fresh carcasses did not differ significantly in terms of redness (a*). No significant variations ($P> 0.05$) were identified in the yellowness (b*) of the breast meat from chilled and fresh carcasses. Based on the results obtained from the current study, it may be concluded that chilled broiler meat is better than fresh broiler meat.



## Introduction

The need for practically priced, high-quality protein sources is growing in Bangladesh, one of the world's most densely populated nations. Because of its rich nutritional profile, affordability, and cultural acceptability, poultry meat, especially quality chicken meat, is essential to meet this requirement. Poultry continues to be the cheapest animal protein both domestically and internationally, making a substantial contribution to food security and human nutrition (Simon, 2009).

Chicken is a white meat that has gained a lot of admiration because of its high protein content and low cholesterol (Akter et al., 2022; Azad et al., 2021; Das et al., 2022). Poultry products, including meat and eggs, have been associated with decreasing risks of cardiovascular disease, hypertension, and some types of cancer due to their easy digestion. In addition to its nutritional benefits, Bangladesh's poultry business makes employment opportunity over six million people, promoting gender equality and sustaining rural communities (Ansarey, 2012).

Commercial chicken production in Bangladesh has grown rapidly since the 1990s because of advancements in genetics, scientific feeding, and contemporary management techniques. In fiscal year (2023-24), the poultry subsector made up 1.83% of the national GDP (DLS, 2023-24). Approximately, 396.03 million poultry were raised during this time, with 327.77 million of those being chickens. Notwithstanding these developments, Bangladesh's meat consumption (137.90 g/day/head) is still below worldwide norms, highlighting the industry's room for growth.

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In Bangladesh, commercial poultry farming has developed from backyard systems to complex operations that involving this with urban entrepreneurs, women, and young people. Since the 1980s, investment in the sector has grown seventeen times, to a total of BDT 25,000 crore taka. At present, the yearly per capita consumption of chicken is only 3.63 kg, although the daily demand for chicken meat is over 1,700 metric tonnes, in contrast to the global average of 18–20 kg. Concomitantly growing hatcheries, breeding farms, and the poultry feed sector have all contributed to the industry's expansion.

Consumer tastes are greatly influenced by factors including looks, textures, juiciness, tenderness, and flavor. Meat quality and processing suitability are evaluated using quantifiable characteristics such as shear force value, cooking loss, drip loss, pH, and water holding capacity. These qualities are determined by a number of factors, including postmortem management (particularly temperature), diet, genetics, and slaughter settings (Offer & Knight, 1988).

One of the most important measures for ensuring meat safety and increasing shelf life is chilling after slaughter. According to USDA (2009), carcass temperatures must be lowered to less than 4.4°C in 4–8 hours. Despite its usefulness, immersion cooling can cause nutritional leaching. According to studies, chilled carcasses preserve their tenderness longer than hot, deboned meat, and with careful handling, freezing can maintain nutritional integrity (James et al., 2006; Soyer et al., 2010).

Because of their beneficial size, tenderness, and short cooking time, lightweight broiler chickens (around 800 ± 5 g) have become increasingly popular, especially for use in soups and grilled fast-food products. Scientific information on the quality of these birds' meat is still lacking, despite their increasing commercial significance. Important qualitative characteristics like softness, juiciness, and water-holding capacity are determined in large part by the postmortem muscle-to-meat conversion, which is controlled by temperature, pH fall, and the progress of rigor mortis. By assessing and contrasting the physicochemical characteristics of fresh and 24-hour chilled grill meat, with an emphasis on carcasses intended to provide insightful information about how to maximize meat quality in this little-studied but popular grill market.

## Materials and Methods

### *Experimental Site*

This experiment was conducted at Meat Research Unit, Bangladesh Agricultural University and Animal Science Laboratory, Department of Animal Science, Bangladesh Agricultural University, Mymensingh.

### *Sample Collection and Preparation*

A total of 30 broilers of 800±5.0 g live weight was taken from Meat Research unit of Meat Research Unit farm. After taking the live weight of the birds, the birds were slaughtered, bled, and defeathered. Then, after evisceration of the carcasses; head, and shank were removed. Then in the first part, the carcass's pH and color were measured in fresh condition and in chilled condition (24 hours) at different time intervals (control, 20 min, 40min, 60 min, 120min, 180 min). And in the second part of the experiment, all the meat quality parameters were again compared between fresh and chilled (24 hours) conditions of carcasses.

### *Measurement of quality parameters*

#### *pH*

For measuring pH, 2 g of sample was added with 18 ml of distilled water and homogenated and filtered through a filter paper. The pH value of the meat filtrate was determined with a pH meter.

#### *Determination of Color*

Instrumental color (CIE L* a* b*) was taken from breast muscles samples at different time intervals after postmortem. Then the meat samples were refrigerated for 24 hours at 4°C temperature and the color of breast meat was individually measured using Konica Chroma Meters CR- 22 410 (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 meat color were expressed in the CIE LAB dimensions of lightness (L*), redness (a*), and yellowness (b*).

#### *Water Holding Capacity*

WHC was measured by centrifuging each 1 g sample at 10,000 rpm for 10 minutes at 4℃. WHC was expressed as the ratio of the sample's weight after centrifugation to its initial weight (Szmańko et al., 2021).

WHC =

$$\frac{sample\, weight\, after\, centifugation(\%)}{sample\, weight\, before\, centifugation(\%)} \times 100$$

#### *Cooking loss*

Cooking loss was determined by collecting 50-60 g sample from the upper breast muscle (W1) and sealed in a polythene bag, then tagged and double-sealed in another bag. The water bath was filled two-thirds and heat the meat until the internal temperature reached to

72°C. Cooking loss was calculated as a percentage of weight loss during cooking (Vujadinović et al., 2014).
Cooking loss (%) =

$$\frac{wt\ before cooking - wt.after cooking}{wt.before cooking} \times 100$$

*Drip loss*

After 24 hours post-mortem, approx. 10 g of breast and thigh muscle was weighed. Then the meat was hung in an airtight box, and stored at 4°C.
Drip loss (%) =

$$\frac{Initial\ wt.of\ the\ sample - final\ wt.of\ the\ sample}{initial\ wt.of\ the\ sample} \times 100$$

*Statistical model and analysis*

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

## Results and Discussion

The study assessed the effect of storage conditions (fresh vs. chilled) on the meat quality attributes of broiler breast meat weighing approximately 800 ± 5g. Parameters measured include pH, cooking loss, drip loss, water holding capacity (WHC), and meat color attributes (L*, a*, b*).

Table 1 shows data on the meat quality characteristics of broiler breast meat from fresh carcasses. The results indicate that there were observable variations in pH and color over different time points. While the differences in pH were not statistically significant (p>0.05), a declining trend over time was noted, reflecting the typical postmortem acidification process. These findings align with those of Le Bihan-Duval et al. (1999), who reported that meat quality traits in broiler carcasses change progressively after slaughter. Regarding color attributes (L*, a*, b*), the table shows noticeable differences across time intervals, though not statistically significant. This observation is consistent with Augustynska-Prejsnar et al. (2019), who reported that different thawing methods did not significantly affect the pH values or color stability of broiler meat. Overall, the data suggest that fresh broiler meat maintains relatively stable physicochemical properties within a short postmortem window, although subtle changes may occur due to ongoing biochemical processes.

**Table 1. Pectoralis superficialis muscle of broiler breast meat at fresh condition**

| Variables | | Time (min) | | | | | |
|---|---|---|---|---|---|---|---|
| | | 0 | 20 | 40 | 60 | 120 | 180 |
| pH | | 6.2±.04[a] | 6.1±.04[ab] | 6.0±0.04[b] | 6±.06[b] | 5.7±.05[c] | 5.7±.5[c] |
| Temp (°C) | | 39.3±.19[a] | 25.2±.23[b] | 24.3±.17[c] | 24.3±.17[c] | 24.3±.17[c] | 22.2±.15[d] |
| Color | L* | 46.1±1.20[b] | 50.3±2.61[ab] | 50±2.23[ab] | 53.3±.51[a] | 48±.67[b] | 46.03±.6[b] |
| | a* | 12.9±.1.5[a] | 10.64±1.9[c] | 11.5±1.7[b] | 9.4±..61[d] | 11.61±1[b] | 12.5±1.18[a] |
| | b* | 14±.7[a] | 14.09±.69[a] | 14.12±.67[a] | 15.89±.4[a] | 15.8±1.8[a] | 15.8±.68[a] |

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

Table 2 represents the meat quality characteristics of broiler breast meat after chilling. As expected, the pH value decreased slightly following 24 hours of chilling, consistent with postmortem biochemical changes and lactic acid accumulation. However, the reduction was not statistically significant (p>0.05), indicating stable pH under chilled conditions. This observation corroborates the findings of Augustynska-Prejsnar et al. (2019), who reported no significant effect of chilling or thawing methods on the pH of broiler meat. In terms of *color parameters (L, a*, b*)**, chilled breast meat exhibited minimal variation compared to the fresh samples.

Lightness (L*) remained within the expected range, and no significant differences were found in redness (a*) or yellowness (b*), suggesting that chilling did not cause pigment degradation or visual discoloration. These findings are in agreement with Devatkal et al. (2019), who observed consistent color attributes between fresh and chilled broiler meat over short-term storage.

**Table 2. Pectoralis superficialis muscle of broiler breast meat at chilled condition**

| Variables | | Time (min) | | | | | |
|---|---|---|---|---|---|---|---|
| | | 0 | 20 | 40 | 60 | 120 | 180 |
| pH | | 6.35±.06$^{b}$ | 6.2±.04$^{b}$ | 6.15±0.06$^{bc}$ | 6.05±.03$^{c}$ | 5.58±.03$^{d}$ | 5.6±.04$^{d}$ |
| Temp (°C) | | 37.25±2.03 | 25.15±.23$^{b}$ | 24.25±.17$^{bc}$ | 24.25±.17$^{bc}$ | 24.3±.17$^{bc}$ | 22.15±.15$^{c}$ |
| Color | L* | 48.01±1.2$^{b}$ | 50.48±2.6$^{c}$ | 49.25±.17$^{c}$ | 53.34±.51$^{a}$ | 47.98±.67$^{b}$ | 46.15±.15$^{b}$ |
| | a* | 8.49±.1.2$^{a}$ | 8.06±.5$^{a}$ | 7.12±.37$^{b}$ | 7.71±..23$^{b}$ | 7.43±.13$^{b}$ | 8.36±.32$^{a}$ |
| | b* | 9.82±.35$^{c}$ | 25.15±.23$^{a}$ | 24.12±.67$^{a}$ | 25.89±.4$^{a}$ | 25.8±1.8$^{a}$ | 22.8±.68$^{b}$ |

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

### *pH*

Table 3 shows the pH values of fresh and chilled broiler breast meat (24 h postmortem). The mean pH ranged from 6.15 in pre-rigor to 5.80 in post-rigor samples. Notably, the pH of fresh carcasses was recorded at 6.15 ± 0.06, significantly higher than the pH of chilled carcasses (5.80 ± 0.04). This drop is a typical post-mortem phenomenon resulting from anaerobic glycolysis, wherein glycogen reserves are metabolized into lactic acid following slaughter. As glycolysis proceeds, accumulation of lactic acid leads to acidification of the muscle tissue. A low ultimate pH in meat is closely associated with protein denaturation, discoloration, and decreased water retention (Zhang et al., 2021; Honikel, 1998). Moreover, the extent and rate of pH decline significantly affect meat tenderness, juiciness, and shelf life.

**Table 3. Pectorals superficial muscle of broiler breast meat at fresh vs chilled condition**

| Variables | Fresh | Chilled Carcass (after 24 hours) |
|---|---|---|
| pH | 6.15±.06$^{a}$ | 5.8±.04$^{b}$ |
| Temperature (°C) | 39.18±.14$^{a}$ | 19.18±1.24$^{b}$ |
| CIE L* | 46.32±1.04$^{b}$ | 50.82±.82$^{a}$ |
| CIE a* | 12.32±1$^{a}$ | 8.5±.12$^{b}$ |
| CIE b* | 14.27±.48$^{a}$ | 13.41±.23$^{a}$ |
| DL (%) | 2.28±.08$^{a}$ | 1.72±.06$^{b}$ |
| CL (%) | 8.78±.06$^{b}$ | 11.34±.09$^{a}$ |
| WHC (%) | 88.13± .43$^{a}$ | 85.13± .4$^{b}$ |

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

### *Muscle Temperature*

Freshly slaughtered meat maintained a high internal muscle temperature (39.18 ± 0.14°C), which dropped significantly to 19.18 ± 1.24°C in chilled carcasses after 24 hours. Rapid chilling is a crucial component in post-mortem meat handling, aiming to inhibit microbial growth and reduce enzymatic activity (Zhou et al., 2010). However, if not managed properly, the interaction between chilling rate and pH decline may lead to cold shortening or pale, soft, exudative (PSE) meat, depending on species and muscle type.

### *Color Attributes (L*, a*, b*)*

Color is one of the most critical quality traits influencing consumer perception of freshness and acceptability. In this study, the lightness (*L**) increased significantly in chilled meat (50.82 ± 0.82) compared to fresh meat

(46.32 ± 1.04). This increase can be attributed to moisture loss and structural changes in muscle fibers, which affect light scattering on the meat surface. The redness ($a^*$) value decreased significantly from 12.32 ± 1.00 in fresh meat to 8.50 ± 0.12 in chilled meat, likely due to the oxidation of oxymyoglobin to metmyoglobin during storage. However, yellowness ($b^*$) did not differ significantly between treatments.

These changes reflect the denaturation of sarcoplasmic proteins and heme pigment instability due to declining pH and exposure to oxygen (Mancini & Hunt, 2005; Faustman et al., 2010).

### *Drip Loss (DL%)*

Drip loss was significantly higher in fresh samples (2.28 ± 0.08%) compared to chilled ones (1.72 ± 0.06%). This may be due to the muscle being in a pre-rigor state immediately after slaughter, where sarcomere structure is intact, allowing higher moisture release. As chilling sets in, rigor mortis and protein denaturation increase, resulting in less free water movement. The formation of tighter actomyosin cross-bridges and reduced intracellular space also contribute to reduced drip loss (Huff-Lonergan & Lonergan, 2005).

### *Cooking Loss*

Table 3 represents the cooking loss of fresh and chilled broiler breast meat at 0 h and 24 h. The mean cooking loss extended from 8.78% in fresh meat to 11.34% in chilled samples. Although the alteration was not statistically significant ($p > 0.05$), fresh meat consistently showed lower cooking loss, indicating better water retention. Particularly, aging tended to reduce cooking loss slightly, suggesting enhanced meat functionality over time without significant deprivation. These results highlight the superior cooking yield of fresh broiler meat related to chilled counterparts under short-term storage.

### *Water Holding Capacity*

Table 3 shows that Water holding capacity was significantly higher in fresh meat (88.13 ± 0.43%) than in chilled meat (85.43 ± 0.40%). The reduction in WHC during chilling is closely linked to post-mortem acidification, which brings the muscle pH closer to the isoelectric point of myofibrillar proteins. At this point, net protein charges are neutralized, reducing water binding sites and allowing more moisture to escape (Purslow et al., 2016; Lawrie & Ledward, 2006).

### *Drip loss*

Table 3 represents the drip loss notches of fresh and chilled broiler breast meat at 0 h and 24 h. Fresh samples showed provocatively lower mean drip loss (2.28) compared to chilled ones (1.72), indicating superior water retention. Although drip loss increased over storage time, the change was statistically insignificant ($p > 0.05$). Fresh broiler breast meat preserved the most desirable drip loss profile, reinforcing its quality advantage during early post-slaughter management.

## Conclusion

This study intended to compare the physicochemical properties of broiler breast meat consequent from fresh and chilled carcasses. Thirty broilers (800 ± 500 g) were sourced from the Meat Research Unit, Department of Animal Science, and slaughtered under controlled conditions. Breast meat samples were collected post-slaughter to evaluate key quality parameters including pH, internal temperature, color attributes (L*, a*, b*), shear force, cooking loss, drip loss, and water holding capacity. The results uncovered a significant difference in pH between fresh and chilled breast meat ($p < 0.05$), indicating postmortem biochemical changes during chilling. A significant increase in cooking loss was observed in chilled samples compared to fresh ones ($p < 0.05$), while no significant differences were found in water holding capacity, shear force, or color parameters (L*, a*, b*) between the two groups ($p > 0.05$). These findings suggest that chilling does not adversely affect the visual quality or tenderness of broiler breast meat, but does alter certain functional properties like pH and cooking loss.

Inclusive, chilled broiler breast meat demonstrated superior acceptability after 24 hours postmortem, likely due to better consistency, microbiological stability, and desirable textural properties. Therefore, from a meat quality perspective, chilling appears to be a favorable post-slaughter handling method compared to marketing fresh meat straight after slaughter. These insights may be useful for enhancing meat processing protocols and attractive product quality in the poultry industry.

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