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Physico-chemical, Microbiological and Sensory Quality of Chicken and Beef Stored in Home Refrigerator

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ABSTRACT

The purpose of this study was to ascertain how long raw chicken meat and beef meat kept at 4°C in a typical home refrigerator would last. Researchers from Chattogram Veterinary and Animal Sciences University performed an extensive examination over five days, assessing 10 meat samples (five chicken meat and five beef meat) obtained from local markets in Chattogram (Jhawtola, Bahaddar Hat, and Chawk Bazar). The quality assessment encompassed physico-chemical, microbiological, and sensory criteria, including pH, water-holding capacity (WHC), extract release volume (ERV), protein degradation (tyrosine value), fat oxidation (TBARS), total viable microbial count (TVC), and aroma. Significant data indicated a gradual deterioration in quality for both types of meat. Sensory evaluation indicated a significant escalation in off-odours, becoming especially evident by the fifth day. Physicochemical research revealed a steady decrease in pH for chicken, whereas beef pH exhibited greater variability. The water-holding capacity was minimal for both meats on the penultimate day. Moreover, elevated tyrosine and TBARS levels indicated continuous breakdown of proteins and lipids, respectively. Microbiologically, beef had a greater overall viable count compared to chicken. The study revealed that whereas beef demonstrated a more rapid decomposition rate, both meats underwent considerable quality degradation by the fifth day of refrigerated storage. These findings point out the importance of appropriate raw meat handling and timely storage techniques for preserving domestic food safety and quality.

Keywords: Physicochemical properties, microbiological analysis, sensory evaluation, chicken meat, beef meat, home refrigeration

INTRODUCTION

Meat is a vital and often expensive source of high-quality protein in the human diet. In Bangladesh, meat plays a significant cultural, nutritional, and economic role. Among the various types of meat, chicken and beef are widely consumed due to their high protein content and nutritional value. Globally, these meats are popular for their versatility in cooking and ability to supply essential nutrients such as iron, zinc, iodine, vitamins—particularly B12—and essential fatty acids, making them a critical part of daily nutrition (Smith et al. 2022).

In Bangladesh, meat is one of the most commonly consumed food items; however, its supply is often inconsistent. This irregular availability has led to the common practice of freezing meat for preservation. Although freezing is useful, it can negatively impact meat quality through drip loss during thawing, resulting in reduced protein content, color, tenderness, and juiciness (Alam et al. 2017).

Maintaining meat hygiene is essential, especially since the slaughtering process in many regions of Bangladesh lacks modern facilities. Contamination during slaughter increases the risk of microbial growth, lowering meat quality and reducing shelf life. While some hygienic practices are maintained by industries like Bangladesh Meat Integrated Technology (BMIT) and retail outlets such as Shwapno, Basket, and Mina Bazar, chilled meat remains unaffordable for many middle-income consumers due to its high cost.

Postmortem glycolysis plays a crucial role in meat preservation. After slaughter, glycogen in muscle tissue is converted into lactic acid, which helps regulate pH, inhibit microbial growth, tenderize meat, and enhance flavor (Samelis et al. 2000). Red meat, particularly beef, is rich in myoglobin, making it appear red when raw. It contains 20–24 g of protein per 100 g and provides vital micronutrients such as iron, zinc, phosphorus, magnesium, and vitamins A, B1, B2, B3, B6, and B12 (Wyness, 2016).

Consumer evaluation of meat is often based on appearance, texture, juiciness, tenderness, flavor, and odor, both before and after purchase (Gagaoua et al. 2016) From a processing perspective, measurable parameters such as pH, water-holding capacity (WHC), drip loss, cooking loss, and fat-binding capacity are essential for determining meat quality and profitability (Mir et al. 2017). With increasing awareness of health and nutrition, consumers are showing a growing preference for meat products labeled "light," "lean," "low-fat," and "reduced-calorie" (John et al. 2016). Poultry products, in particular, meet these demands due to their lower fat and calorie content (Northcutt, 2009).

The pH of meat is a vital quality determinant. It reflects the concentration of hydrogen ions, usually influenced by lactic acid formed during postmortem glycolysis. The typical final pH of meat ranges from 5.4 to 7.2. A low pH leads to lighter meat with lower water retention, while a higher pH results in darker meat with reduced drip loss. pH also affects texture, flavor, and juiciness (Watanabe et al. 1996).

Water in meat exists in three forms: bound, immobilized, and free water. Bound water is tightly associated with proteins, while immobilized water is trapped within muscle structures. Changes in muscle fiber structure and pH levels can cause this water to be lost, affecting meat quality. Several pre- and post-mortem factors—including breed, genetics, feed, slaughter method, and post-slaughter treatments like freezing or aging—impact the water-holding capacity (Huff-Lonergan and Lonergan, 2005; Cheng and Sun, 2008).

Microbial contamination remains a critical concern in meat safety. In developing countries, infections caused by E. coli, Salmonella, and Staphylococcus aureus pose significant public health risks (Edris et al. 2022). Therefore, ensuring microbiological safety through proper handling and storage is essential.

This study employed various measures to assess the quality of raw beef and chicken stored in the home refrigerator, including pH, water holding capacity (WHC), extract release volume (ERV), tyrosine value (TV), thiobarbituric acid reactive substances (TBARS), and total viable count (TVC). These indicators facilitate the evaluation of deterioration rates and establish the safe shelf life of chicken and beef held in household environments.

MATERIALS AND METHODS

Study area and period

The study was carried out at the Post-Graduate Lab of the Department of Animal Science and Nutrition, Faculty of Veterinary Medicine, Chattogram Veterinary and Animal Sciences University (CVASU), Bangladesh during February to March 2024.

Collection of samples

A total of 10 meat samples – five chicken and five beef samples – each weighing 1 kg were collected from different local markets in Chattogram (Jhawtola, Bahaddar Hat, and Chawk Bazar). The samples were collected such that 1 chicken and 1 beef samples were sourced from each market. After collection, meat samples were taken into sterile plastic zipper bags, transferred to ice box and transported to the laboratory within 1 hour of collection.

Storage in refrigerator

The collected samples were separated into different fractions with respect to test and day of analysis (Day 1, 2, 3 and 5). The analysis for day 1 was done without storage and the samples for analysis in different days were taken into sterile plastic zipper bags and stored in a home refrigerator with a temperature of 4 °C.

Determination of pH

The meat pH Meter (HANNA Instruments HI98163 model, manufactured in Romania) was used to estimate the pH. The probe of pH meter was insert around 3 cm into the muscle to read the pH.

Determination of WHC

Exactly 0.3 mg meat sample was taken on a Whattman No. 41 filter paper. Then, 2 slides were placed, so that filter paper was sandwiched between two glass slides. A one hundred-gram weight was placed on top of the topmost glass slide. This arrangement was kept on a hard-top plate for period of 3 minutes. The meat sample's released water was taken up by the filter paper and left behind as impression. The impression's edge was carefully marked with a sharp pencil. The area covered on the filter paper by the released water was measured. An increased area indicates lower WHC and vice-versa.

Determination of ERV

Fifteen gm of meat was blended with 60 ml of extraction reagent (50 ml, 0.2 M KH2PO4 and 3.72 ml, 0.2 M NaOH mix up to 200 ml distilled water) in a food blender and mixture instrument. The content was then filtrate through a Whatman No. 1 filter paper having a diameter of 18 cm using a funnel of 10 cm diameter. The amount of filtrate in 15 minutes were considered as ERV. A decrease in ERV volume of meat samples indicates higher microbial load and spoilage.

Determination of TV

To estimate TV, first of all trichloroacetic acid extract (TCA) of meat samples were prepared. To do that, 1 gm of meat sample, 5 mL 10% TCA and 5 mL distilled water was taken into a 100 mL measuring cylinder. The content was then homogenized using a tissue homogenizer. The obtained homogenate was then centrifuge at 500×g for 10 minutes, and supernatant was collected as TCA extract. Then, 500 µL of TCA extract was mixed with 900 µL of distilled water, and 2 mL of 0.5 N NaOH and 200 µL of Folin-Ciocalteu's phenol reagent. The content was kept at room temperature for 15 minutes to develop a blue color. The absorbance was then measured by a spectrophotometer at a wave length of 660 nm. The TV was determined by comparing the absorbance with a pre-prepared standard curve using pure tyrosine amino acid.

Determination of TBARS

For TBARS, the TCA extract prepared in the section "Determination of TV" were used. 2 mL of TCA extract was mixed with 2 mL of Thiobarbituric acid (TBA) reagent in a test tube. The content was then heated in a hot water bath for 30 minutes at 80 °C. The content was then kept at room temperature for cool down. The absorbance of the content was then taken by spectrophotometer at 532 nm weave length. The data was presented as cooperative absorbance.

Determination of TVC

Initially, 5 test tubes are taken, each holding 9 mL of diluent (Composition: 4 gm of NaCl, 0.1 gm of KCl, 0.72 gm of Na phosphate-dibasic, 0.12 gm of potassium phosphate monobasic and bacto-peptone 10 gm in 500 mL). A 45 mL diluent is used to homogenize a 5-gram sample of meat, which is then suspended in a beaker. One milliliter of the original sample is added to test tube number one and well mixed. Then, 1 mL of the mixed content from the 1st test tube was transferred to the 2nd test tube and proceed up to the last one. Next, 500 µL of the mixture from each test tube to the Petri dish. The samples were spread using a sterile glass spreader. The Petri dishes were then labeled with the sample number, date, and other pertinent information and are incubated for one to two days at 37 °C with the lid on. Colonies were detected from one day to three days following incubation. A count of 30–300 plate colonies were included for count. Three Petri dishes were used for each tube and numbers of colonies were expressed as average count.

Sensory evaluation

On Days 1, 2, 3, and 5, a trained sensory panel assessed the odor of meat. Panelists were instructed to identify off-odors using fresh and stored raw chicken and beef. The off-odor was measured in a scale of 1 to 5 (1 being no off-odor, 2 being noticeable, 3 being somewhat pronounced, 4 being pronounced, and 5 being extremely pronounced).

Statistical analysis

The number of data were entered into Microsoft Excel 2013. The data were than sorted and arranged for analysis. One-way ANOVA and Tukey's post-hoc test was performed in Graphpad prism (version 8) was used to make the graphs.

RESULT AND DISCUSSION

This study evaluated the physico-chemical, microbiological, and sensory quality of raw chicken and beef meat stored in a home refrigerator (4°C) over five days. The results for each parameter are discussed below:

pH

The pH values for both chicken and beef showed fluctuations over the five-day storage period. Chicken initially had a slightly higher pH (5.83–6.02), which then decreased slightly and stabilized after day 2. Beef showed a wider fluctuation in pH values (5.63–5.80), with a slight rise towards day 5. However, statistical analysis indicated no significant differences ($P > 0.05$) between the two meat types at any

timepoint. These findings are consistent with previous studies (Abril et al. 2001; Mach et al. 008), suggesting that pH remains relatively stable in refrigerated meat during early storage, though it may be influenced by microbial activity and lactic acid production.

Water holding capacity (WHC)

The WHC values remained relatively similar for both chicken and beef, ranging from 3.14–3.83 cm^2 for beef and 3.26–3.63 cm^2 for chicken. Minor fluctuations occurred, particularly by day 5, but these were not statistically significant ($P > 0.05$). A decrease in WHC over time may be attributed to muscle fiber breakdown and moisture loss, which aligns with prior research Abeyrathne et al. 2021.

Extract release volume (ERV)

ERV was a more sensitive indicator of spoilage and microbial activity. Chicken showed a significant drop in ERV after day 1, indicating reduced water retention due to spoilage. In beef, ERV initially remained stable but increased sharply by day 3 before declining again by day 5. The changes were statistically significant on days 1 (*P<0.05), 3 (**P<0.01), and 5 (*P<0.05). These patterns reflect microbial activity and degradation, consistent with findings by Kar et al. (2025).

Tyrosine value (TV)

TV increased progressively for both chicken and beef over the storage period, indicating ongoing protein degradation. Beef showed consistently higher TV than chicken, with significant differences observed at all timepoints (***P<0.001). This supports previous findings that enzymatic and microbial breakdown of proteins occurs during refrigerated storage (Devadason et al. 2014).

Thiobarbituric acid reactive substances (TBARS)

TBARS values, indicative of fat oxidation, showed a decreasing trend over time in both chicken and beef, contrary to expectations. This discrepancy may result from methodological limitations or environmental factors during testing. While some previous studies (Ali et al. 2007) showed TBARS increased with storage, variations in sample type or preparation may explain the differences in this study.

Total viable count (TVC)

Microbial counts increased over time in both meat types, with beef having higher counts than chicken. On day 2, TVC reached 275×10^3 CFU/g in chicken and 503×10^3 CFU/g in beef. Although statistical analysis showed no significant difference ($P > 0.05$), the trend suggests beef is more prone to microbial spoilage, aligning with findings from Peng et al. (2011).

Sensory evaluation (Odor)

Off-odor scores progressively increased for both meats. Beef showed a more pronounced odor by day 5, reaching a score of 5 (very pronounced), while chicken was slightly lower. Significant differences were observed on day 5 (*P<0.05), indicating accelerated spoilage in beef. This finding correlates with the sensory panel results and aligns with Bhawana et al. (2023).

CONCLUSIONS

When kept in a home refrigerator at 4°C, both beef and chicken experience significant quality decline, with microbiological and sensory spoiling being noticeable by the fifth day. Compared to chicken, beef spoils more quickly, exhibiting stronger off-odors and greater microbial development in the same amount of time. In order to guarantee domestic food safety, these findings point to a key window for consumption and stress the significance of appropriate handling and limited refrigerated storage.

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