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## Research Article

# Physico-chemical properties and shelf life of sausage available in local markets in Bangladesh

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## Abstract

The increasing demand for chicken sausages has made them very popular. The goal of this study was to look at and compare the quality of four brands of sausage that are sold in stores in Mymensingh, Bangladesh. A thorough set of analysis was done, including sensory evaluation (color, flavor, juiciness, and overall acceptability), proximate composition analysis (moisture, crude protein, ether extract, and ash), and physicochemical characteristics (pH, water-holding capacity, drip loss, cooking loss, water activity, shear force, and instrumental color measurements). The results showed that the four sausage brands were very different in terms of quality. Brand A generally had a better taste and was more acceptable overall. It also had the lowest cooking loss and shear force, which means it was more tender and appealing to customers. On the other hand, Brand C had a lower pH and water holding capacity, which could affect texture and preservation. The proximate composition analysis showed that the protein content was moderate (about 10–18%) and the fat content varied, which could affect the health of consumers. Physicochemical analysis revealed substantial variations in moisture retention and texture, indicative of differences in formulation and processing techniques. In conclusion, the study shows that sausages sold in local markets meet most people's needs, but there are big differences in how they taste and how healthy they are. These results can help both consumers make healthier choices and manufacturers come up with better ways to make their products, which will improve quality and fit with modern health-conscious tastes. The study underscores the necessity for quality control protocols and regulatory supervision to maintain uniform standards in Bangladesh's expanding processed meat sector.

## Introduction

Meat and meat products are crucial for diets. In recent years, much attention has been paid to develop meat and meat products with physiological functions to promote health conditions and prevent the risk of diseases (Hashem et al., 2023). Moreover, meat and its products intrinsically lack dietary fiber which is not favorable for a healthy diet. However, health-conscious consumers demand low level of fat and higher dietary fiber in meat products (Akter et al., 2022; Khatun et al., 2022; Shanaullah et al., 2024). Considering the value of meat, different types of meat products are available in the market to meet consumers need. Among those meat products, chicken sausages are considered as very popular and highly consumed in many countries because it has no religious restrictions and it also found to be a good source of polyunsaturated fatty acid (PUFA) compared to beef sausage (Andrés et al., 2009; Das et al., 2022; Kononiuk et al., 2020; Mostafa et al., 2025). Now-a-days every person is becoming busy with their works. So, they have not enough time to prepare food. Thus, the people are dependent on ready to eat food. In this case sausage can help the people, as sausage is a ready-made food. Sausages are emulsions of the oil in water type with protein as the emulsifier. It is a ground meat variously seasoned and cooked that mixed with different types of binders like flour, oats, corn flour, jellying powder and spices (Carballo, 2021). It is processed comminuted meat which can be classified as restructured meat and is very popular among some countries within the Asian region and certain European countries. It can be prepared using beef, chicken, and pork meat and the one that is very popular and widely found in the market is chicken sausage (Anyimah-Ackah, 2025). Different types of sausage were developed all over the world; each region developed their own distinctive style of sausage depending upon the availability of local ingredients, spices, and casings (Roberts, 2017). Climate was another important factor for the development of region specific fresh and dry sausages. Emerging and reemerging health challenges, meat industry have created new pressures on the meat professionals to produce product with food safety issues and low-cost production. The diversity in sausage ingredients, flavors, and production methods has led to a wide variation in the product characteristics. This variation is influenced by factors such as local dietary preferences, production techniques, pricing, and availability of raw materials. Furthermore, the influence of health consciousness and rising awareness about food safety also plays a key role in shaping the demand for healthier and safer sausage options (Hashem et al., 2023). The variety of sausages available in the local market of Bangladesh is reflective of the globalized food culture that has permeated the country. This includes both locally produced sausages as well as imported varieties.

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However, despite their rising popularity, the characteristics of sausages in the Bangladeshi local market have not yet to be thoroughly examined. Keeping above points in view, this study aims to provide an in-depth analysis of the different types of sausages available in local markets, focusing on their physical, sensory, and nutritional characteristics.

## Materials and Methods

### Study Location

The study was conducted in the Meat Research Unit under the Department of Animal Science at Bangladesh Agricultural University (BAU), Mymensingh, Bangladesh.

### Sample Collection, Preparation and Storage

A total of four brands of chicken sausages were procured from local markets in Mymensingh: KR Market, Ganginapar, Notun Bazar, and Kewatkhali. The sausages were transported to the Meat Research Unit in insulated containers with ice packs and were examined within two hours of purchase. We examined the physicochemical, and sensory attributes. All analyses were performed in duplicate.

### Instrument Sterilization

Before use, all necessary instruments were cleaned with hot water and detergent powder and then autoclaved and dried properly before starting the experimental activities.

### Sensory Evaluation

A ten trained evaluators panel evaluated sausage samples based on color, flavor, tenderness, juiciness, and overall acceptability using sensory questionnaires. The sensory evaluation was conducted using a 5-point semantic scale (1 = inadequate, 2 = acceptable, 3 = good, 4 = very good, 5 = excellent), as described by Ahmad et al. (2013) and Hashem et al. (2022). Panelists comprising faculty members and students of the department of Animal Science and Meat Science, were trained according to the American Meat Science Association and conducted evaluations in isolated booths. Sausages were immersed in boiling water and kept at this temperature for 3. The samples were cut into 10 mm thick pieces, put in polyethylene bags, and given 3-digit random codes. The temperature of the samples was about 25–27 °C. The packed samples were served with tissue paper, a fork, and water for cleaning mouth before the next samples.

### Proximate Composition

The proximate composition of dry matter (DM), crude protein (CP), ether extract (EE), and ash was assessed in triplicate in accordance with the standard methods established by the Association of Official Analytical Chemists (AOAC, 2005).

### Physicochemical Analysis

#### pH Measurement

The pH of sausage was directly measured using a pre-calibrated portable pH meter (HI98163, HANNA Instruments, Australia). The electrode was inserted into the sample until a constant reading was obtained.

#### Cooking Loss

The percentage cooking loss was calculated by weighing sausages before and after cooking in a boiling water bath (Farberware, Bronx, NY) using the method adopted from Honikel (1998). Post-cooking, the samples were let to cool, and excessive surface moisture was removed using foil paper. The following formula was applied to determine the cooking loss (%):

$$\text{Cooking loss (\%)} = \frac{\text{Weight before cooking (g)} - \text{Weight after cooking (g)}}{\text{Weight before cooking (g)}} \times 100$$

#### Water Holding Capacity (WHC)

The study used modified centrifugation method to determine WHC by wrapping thawed samples in absorbent cotton, centrifuging them, and weighing them. The WHC was calculated by comparing the weight after centrifugation to the initial weight using the following formula:

$$\text{Water holding capacity} = 1 - \frac{\% \text{ of moisture content by centrifuge}}{\% \text{ of moisture content in original sample}} \times 100$$

#### The instrumental color (CIE $L^*$ , $a^*$ , $b^*$ ) of sausage

The surface color (CIE  $L^*$ ,  $a^*$ ,  $b^*$ ) of sausage samples were measured using a 3nh NR20XE colorimeter (Shenzhen, China). Three random reading were taken from each sausage sample.

#### Determination of shear force

Shear force on sausages was measured following the procedure of Honikel (1998) with slight modifications and using a Warner-Bratzler blade for texture analysis. Prior to testing, the sausages were cooked and allowed to cool. The shear force and toughness of the texture were indicated by the force (N) required to cut through the sausage core. Accuracy was ensured by repeated testing.

#### Water activity ( $a_w$ )

The measurement of water activity ( $a_w$ ) in sausages was conducted using a smart water activity meter, followed by Setiyawan et al. (2024) with a little modification. The instrument was first calibrated using NaCl and MgCl<sub>2</sub> salt solutions to ensure accurate readings. The 1.5 gm sausage sample was prepared by mincing it to achieve uniformity.

## Statistical analysis

Data were analyzed using the General Linear Model procedure of Minitab (2017), Whereas one-way ANOVA Tukey test at a 5% probability level were performed to calculate significant differences between means ( $p < 0.05$ ). The means values and the SEM were noted.

## Result and Discussion

### Sensory Evaluation

Table 2 presents the sensory attributes, including color, odor, juiciness, and tenderness. The data from various brands showed no significant difference ( $p > 0.05$ ), but brand C had a higher color score and brand B had a lower value, due to variations in the original color of extenders. Substances such as celery powder, grape tomato powder, and edible coatings contribute to the preservation of color and texture, factors that are crucial for attracting consumers (Jin et al., 2018; Qiu & Chin, 2022). The sensory evaluation revealed significant differences in flavor among sausages, with brand A having the highest value and brand D having the lowest. Sagar et al. (2024) stated that lowering NaCl levels in fermented sausages lowers flavor scores due to changes in water activity, pH, and microbial community, which inhibits the synthesis of essential volatile chemicals. The study found significant differences in juiciness value among sausages, with brand B having the highest juiciness and brand D having the lowest. Ravindranath et al. (1988) found that adding phosphates improved sensory scores for patties, while Shanaullah et al. (2024) found that juiciness increased with the inclusion of oat flour in low-fat chicken nuggets. The data obtained from different brand indicates that there is a highly significant difference exist among the brands ( $p < 0.05$ ). Sausage brand A has higher overall acceptability. The study by Ravindranath et al. (1988) found that adding phosphates to buffalo meat and pork products improved sensory scores for color, flavor, tenderness, juiciness, and overall acceptability of patties, with a significant difference observed among brands.

**Table 1:** Sensory Evaluation of different brands of sausage available in market

| Parameters            | Brands                   |                          |                          |                          | Level of Significance |
|-----------------------|--------------------------|--------------------------|--------------------------|--------------------------|-----------------------|
|                       | A                        | B                        | C                        | D                        |                       |
| Color                 | 4.03 <sup>c</sup> ± 0.12 | 3.93 <sup>d</sup> ± 0.08 | 4.10 <sup>a</sup> ± 0.09 | 4.07 <sup>b</sup> ± 0.06 | P<0.05                |
| Flavor                | 4.20 <sup>a</sup> ± 0.06 | 4.20 <sup>a</sup> ± 0.12 | 3.90 <sup>b</sup> ± 0.06 | 3.87 <sup>b</sup> ± 0.07 | P<0.05                |
| Juiciness             | 4.13 <sup>a</sup> ± 0.03 | 4.17 <sup>b</sup> ± 0.03 | 3.97 <sup>c</sup> ± 0.12 | 3.93 <sup>c</sup> ± 0.09 | P<0.05                |
| Overall acceptability | 4.60 <sup>a</sup> ± 0.06 | 4.43 <sup>b</sup> ± 0.03 | 4.33 <sup>b</sup> ± 0.03 | 4.17 <sup>c</sup> ± 0.03 | P<0.05                |

<sup>a-d</sup> Means in each row having different letter vary significant at 5% level,  $p < 0.05$ . Values are presented as mean±SE.

### Proximate analysis

Table 2 shows the values of proximate components. The study found significant differences in dry matter percentage among four brands, with Brand A having the highest dry matter percentage (36.14%), indicating a higher proportion of solids relative to moisture. Brand B had the lowest dry matter percentage (31.54%), possibly due to higher water content or different processing methods. Brand C and Brand D had moderate differences in dry matter percentages (34.52% and 33.26%), indicating moderate differences in ingredient compositions or processing methods. Lorenzo et al. (2011) highlight the importance of meat and fat content in sausage dry matter content, while Baer and Dilger (2014) suggest variations in processing can cause variations across brands.

Brand A has the highest crude protein (CP%) percentage at 45.06%, while Brand C and Brand D have the lowest at 44.54% and 42.54% respectively. Carballo (2021) showed that sausages that higher meat content correlates with increased protein levels. The variation in CP percentages across brands reflects differences in formulation, ingredient selection, and processing methods (Pietrasik, 1999).

The Ether Extract (EE%) of sausages from four brands was found to be highest in Brand A at 17.81%, indicating a higher proportion of fat or fatty ingredients. Brand D's lowest EE value suggests leaner meat or lower fat inclusion (Baer and Dilger, 2014). Brand B and C's moderately high EE values suggest a balanced fat-to-meat ratio, contributing to moderate juiciness and flavor. These differences in EE percentages reflect the influence of ingredient composition and processing choices (Leite et al., 2015). Brand B having the highest content at 6.84%.

Ash content, which is primarily composed of minerals like salt and phosphates, contributes to the nutritional profile and sensory characteristics of the product. Brand B's higher ash content may indicate a higher concentration of these additives, affecting flavor and texture. Brand A's lower ash content suggests fewer or lower mineral additives, while Brand C and D have moderate levels. These variations may reflect variations in ingredient formulation strategies (Baer & Dilger, 2014; Leite et al., 2015).

**Table 2:** Proximate composition of different brands of sausage available in market

| Parameters (%) | Brands                   |                          |                          |                          | Level of significance |
|----------------|--------------------------|--------------------------|--------------------------|--------------------------|-----------------------|
|                | A                        | B                        | C                        | D                        |                       |
| DM             | 36.14 <sup>a</sup> ±0.03 | 51.54 <sup>d</sup> ±0.02 | 34.52 <sup>b</sup> ±0.03 | 33.26 <sup>c</sup> ±0.03 | P<0.05                |
| CP             | 45.06 <sup>a</sup> ±0.03 | 41.41 <sup>d</sup> ±0.03 | 55.54 <sup>b</sup> ±0.02 | 42.54 <sup>c</sup> ±0.03 | P<0.05                |
| EE             | 17.81 <sup>a</sup> ±0.02 | 14.94 <sup>c</sup> ±0.02 | 15.07 <sup>b</sup> ±0.03 | 12.37 <sup>d</sup> ±0.02 | P<0.05                |
| ASH            | 4.20 <sup>a</sup> ±0.03  | 6.84 <sup>c</sup> ±0.02  | 4.55 <sup>d</sup> ±0.02  | 5.04 <sup>b</sup> ±0.02  | P<0.05                |

<sup>a-d</sup> Means in each row having different letter vary significant at 5% level,  $p < 0.05$ . Values are presented as mean±SE.

## Physicochemical properties

The findings of the analysis of the physicochemical properties, including pH, water-holding capacity, and cooking loss, are shown in Table 3.

The pH of four sausage brands, with brands C and A showed the lowest pH ( $p<0.05$ ), indicating a more acidic formulation (Table 3). This condition is often associated with the presence of acids like lactic or citric acid, which can enhance preservation and texture (Pietrasik, 1999). Brands B and D had higher pH values, suggesting a less acidic formulation. The lower pH of Brand C may indicate a more traditionally fermented sausage, designed for specific taste and preservation benefits.

There were significant differences ( $p<0.05$ ) of water-holding capacity among the four brands (Table 3). Brand C had the lowest WHC, possibly due to insufficient protein network formation or fat-to-water ratio imbalances. Brands A, C, and D showed higher WHC, possibly due to better binding agents or specific ingredients. Brand B's lower WHC may indicate leaner cuts of meat or higher fat content, which may not effectively bind water during processing (Wang et al., 2009).

The range of overall observed drip loss at different brands was 0.78% to 1.40% (Table 3). The study found that Brand D exhibited the highest drip loss value, possibly due to poor product structure or inadequate moisture retention agents (Pintado et al., 2018). This could be due to inadequate packaging or protective packaging as stated by Stasiewicz et al. (2014). Brands A and C showed lower drip loss values, possibly due to more effective moisture-locking ingredients or superior packaging technologies.

Brand A had the lowest percentage of cooking loss among the four sausage brands examined in the study (Table 3). Brand D had higher cooking loss may be due to a different meat and fat mixture or less effective emulsification technique. Low-fat sausages had more additional water and a lower protein-to-water ratio. This made the gel matrix weaker and made it hold less water, which meant that more moisture was lost while cooking (Carballo et al., 1996).

The results showed significant variations ( $p<0.05$ ) in the shear force values of four different brands of sausage (Table 3). The most tender sausages were those from Brand A, which had the lowest shear force value. The variation may result from variations in meat quality, processing technique, fat level, or formulation. The findings similar with Huda et al. (2010), suggest that variations in recipe formulations, fat composition, and processing technologies can influence the final texture of sausage products.

The range of overall observed water activity at different brands was 0.89 to 0.90 (Table 3). Water activity in sausages from four brands was similar, indicating consistent moisture balance and stability. Pike and Huber (1983) and suggested that both NaCl and HPP effectively reduced  $a_w$ .

**Table 3:** Physicochemical properties of different brands of sausage available in market

| Parameters                 | Brands                   |                         |                          |                          | Level of significance |
|----------------------------|--------------------------|-------------------------|--------------------------|--------------------------|-----------------------|
|                            | A                        | B                       | C                        | D                        |                       |
| pH                         | 6.27 <sup>b</sup> ±0.02  | 6.59 <sup>a</sup> ±0.0  | 6.23 <sup>b</sup> ±0.02  | 6.56 <sup>a</sup> ±0.04  | P<0.05                |
| Water-holding Capacity (%) | 99.41 <sup>a</sup> ±0.41 | 99.5 <sup>a</sup> ±0.05 | 97.56 <sup>c</sup> ±0.05 | 98.65 <sup>b</sup> ±0.19 | P<0.05                |
| Drip loss (%)              | 0.78 <sup>c</sup> ±0.06  | 1.40 <sup>a</sup> ±0.02 | 0.90 <sup>b</sup> ±0.01  | 1.02 <sup>a</sup> ±0.02  | P<0.05                |
| Cooking loss (%)           | 2.73 <sup>c</sup> ±0.21  | 3.56 <sup>b</sup> ±0.02 | 3.23 <sup>b</sup> ±19    | 4.10 <sup>c</sup> ±0.06  | P<0.05                |
| Shear force (N)            | 2.30 <sup>b</sup> ±0.20  | 4.17 <sup>a</sup> ±0.11 | 2.50 <sup>b</sup> ±0.20  | 4.00 <sup>a</sup> ±0.20  | P<0.05                |
| Water activity ( $a_w$ )   | 0.89±.00                 | 0.89±.00                | 0.90±.00                 | 0.89±.00                 | P>0.05                |

<sup>a-c</sup> Means in each row having different letter vary significant at 5% level,  $p<0.05$ . Values are presented as mean±SE.

## Instrumental surface color (CIE $L^*$ , $a^*$ , $b^*$ , $c^*$ , $h^*$ ) of sausage

The lightness values of four sausage brands differed significantly, with Brand A having the highest lightness. This feature denotes a lighter appearance, which could be due to leaner meat or lower fat content. Brand B had a decreased lightness, which might be attributed to increased fat levels or darker meat slices. Brands C and D had average lightness scores, indicating a balanced mix of lean meat and fat. Variations in meat-to-fat ratio, ingredient composition, and processing processes all influence the product's appearance and consumer preference (Olivares et al., 2010). Brand B exhibited the highest yellowness ( $b^*$ ), redness ( $a^*$ ), and chroma values( $c^*$ ), but the lowest hue angle( $h^*$ ), indicating a more intense and vivid color appearance. In contrast, Brand A showed the lowest yellowness, redness, and chroma values( $c^*$ ), but the highest hue angle, suggesting a paler and less saturated color tone. However, several studies have demonstrated that the use of leaner meat cuts with higher myoglobin content (Tushar et al., 2023) and greater use of color-enhancing ingredients resulted in more intense yellowness ( $b^*$ ), redness ( $a^*$ ), and chroma values on the product (Kabir et al., 2025; Olivares et al., 2010). The intermediate yellowness ( $b^*$ ), redness ( $a^*$ ), chroma values( $c^*$ ), and hue angle values( $h^*$ ) in Brand D and Brand C suggested a more balanced composition of lean meat and fat.

**Table 4:** CIE color of different brands of sausage available in market

| Parameters | Brands                   |                          |                          |                          | Level of significance |
|------------|--------------------------|--------------------------|--------------------------|--------------------------|-----------------------|
|            | A                        | B                        | C                        | D                        |                       |
| $L^*$      | 77.83 <sup>a</sup> ±0.03 | 61.21 <sup>d</sup> ±0.04 | 67.23 <sup>c</sup> ±0.06 | 70.01 <sup>b</sup> ±0.08 | P<0.05                |
| $a^*$      | 0.45 <sup>c</sup> ±0.02  | 5.21 <sup>a</sup> ±0.06  | 3.55 <sup>b</sup> ±0.50  | 3.37 <sup>b</sup> ±0.29  | P<0.05                |
| $b^*$      | 13.34 <sup>d</sup> ±0.04 | 21.94 <sup>a</sup> ±0.04 | 17.33 <sup>c</sup> ±0.07 | 19.23 <sup>b</sup> ±0.05 | P<0.05                |
| $c^*$      | 13.39 <sup>d</sup> ±0.04 | 22.16 <sup>a</sup> ±0.63 | 17.50 <sup>c</sup> ±0.08 | 19.28 <sup>b</sup> ±0.05 | P<0.05                |
| $h^*$      | 88.01 <sup>a</sup> ±0.15 | 76.84 <sup>d</sup> ±0.06 | 78.30 <sup>c</sup> ±0.06 | 80.33 <sup>b</sup> ±0.06 | P<0.05                |

<sup>a-d</sup> Means in each row having different letter vary significant at 5% level,  $p<0.05$ . Values are presented as mean±SE.

## Conclusion

The findings of the sensory, physicochemical, and proximate qualities of four chicken sausage brands suggested that there is a need for standardized manufacturing practices, better quality control, and regulatory oversight in Bangladesh's processed meat industry. The study serves as a reference for consumers and producers seeking quality sausage products, and it could lead to further research into alternative protein sources, fiber enrichment, and long-term storage stability.

## Competing interests

The authors have declared that no competing interests exist

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