Quality assessment of meat in relation to colour and muscle fiber types

Mubashera Anwer, Muhammad Issa Khan, Imran Pasha, Muhammad Rizwan Tariq and Muhammad Sohaib

National Institute of Food Science and Technology, University of Agriculture, Faisalabad

Corresponding author: drkhan@uaf.edu.pk

ABSTRACT

The current study was premeditated to evaluate meat quality based on its colour and fiber types. The meat samples were analyzed for its chemical constituents (ash, crude protein, crude fat, moisture) and quality parameters like pH, colour, and water holding capacity, cooking loss, drip loss and tenderness. The moisture content of meat cuts was found between 74.46-76.78%. The crude protein content was observed from 22.78-24.20%. The crude fat content was ranged from 5.70-9.76%. The ash content was 1.77-1.98%. The pH content was observed 5.80-5.90%. The color content was varied 39-42 for L*(lightness), 20-23 for a*(redness) and 5-7 for b*(yellowness). The cooking loss was found between 33-37%. The muscle fiber types are varied between three cuts, Type I was high in rib cut 62%, types II A was high in round cut 24% and type II B was high in sirloin cut 55%. Finally, Data obtained was subjected to statistical analysis.

Keywords: Meat, Meat quality, Muscle fiber, Meat color, Texture

INTRODUCTION

Meat is an important edible postmortem constituent originating from the live animals that are used as food by the humans. All muscle tissues of meat contain high amount of protein, and are considered as adequate source of vitamin B6, vitamin B12, phosphorus, niacin, zinc, choline, riboflavin, selenium and iron. However they do not contain dietary fiber and are very low in carbohydrates. The meat fat content varies depending on the breed, species and the way of growth (1). Pakistan’s total production of meat up to the year of 2011 was estimated 3095,000 tons, from which mutton and beef were 616,000 tons and 1,711,000 tons respectively (2).

Increased consumer awareness and demand about quality products in the recent past have urged the food manufacturers to produce homogeneous and high quality products. Similarly the meat quality has become an area of great importance and concern in the recent years (3). Chemical composition, sensory and technological attributes of meat affected by weight, sex, breed, environment and post-mortem factors, storage time and temperature (4, 5). Consequently, the main concern of user is inconsistency in quality characteristics of meat (6, 7).

Quality of meat is most important for meat retailer and producer in order to meet the consumer’s demand and applicable standard requirements for a consistent satisfactory product (8). As a result of multifaceted combination of visual appeal and eating satisfaction, consumer agrees to take the product. Particularly, flavor, juiciness and tenderness satisfy the eating properties due to influence on replicate purchases, these showing overall meat quality (9). Meat should appear good to consumers when they decide to buy it before satisfying their taste. Once the meat is bought, it must meet the expectations of juiciness, aroma, tenderness and flavor (10).

Meat colour is the first condition that consumer use to judge meat quality and acceptability (11). (12) Stated that colour is an important factor in selection of meat products. Meat colour is one of the most important for consumers are indication of an originality and uprightness. Consumers will often refuse products in which the colour varies from the predictable appearance. Therefore, colour is frequently used to determine economic value of food. A comprehensive understanding of the variation in quality properties associated to colour is important for further processing to decrease the potential
negative impact of meat color variation on further processed products (13). It is declared that the color is the main quality characteristic that responsible for shelf life of meat products. Retail sale enhanced as color of the product will be adequate.

The oxidation condition of the muscle pigment myoglobin tells the color of fresh meat (14). Three forms of myoglobin stays. In the reduced formed myoglobin is of purple color in the absence of oxygen. In the presence of oxygen, oxymyoglobin is formed, that has bright red color. The iron has in ferrous state in both these forms (15). The reduced-myoglobin and oxymyoglobin is convertible that depends on the concentration of oxygen (16). The color of meat is affected by chemical changes like oxidation, changes in pH, enzyme action, hydrolysis and protein denaturation.

Muscle fibers are polynucleated, elongated cells classified on their contractile and metabolic properties. Fibers are classified on the basis of stain reactions, as type I (slow-twitch oxidative) or β- red fibers, IIA (fast-twitch oxidative) or α-red fibers, and IIB (fast-twitch glycolytic) or α-white fibers. Muscles have more than 40% β-red fibers are red, more than 40% α-white fibers are white, and others are intermediate. Muscle fiber type composition is extremely variable and can be subjective by many extrinsic and intrinsic factors such as animal breed, class, selection intensity and post-slaughter processing (17).

The diversity of skeletal muscle can be attributed to the heterogeneous characteristics of the individual muscle fibers and the mosaic composition of the numerous fiber types (18, 19). Fiber type composition can vary significantly in different species and muscle types, depending on function (20). Moreover, there are many factors that contribute to fiber type variation, such as sex, age (21), breed (22), hormones (23), and physical activity (24). These fiber type variations differ according to their molecular, metabolic, structural, and contractile properties (25). Therefore, having an understanding of such muscle fiber characteristics is important for the study of overall muscle characteristics and subsequent meat quality. The present study was planned to assess the meat quality on the basis of muscle fiber types and color of meat with following objective; to assess chemical composition and quality of meat cuts in relation to meat color and muscle fiber types.

**MATERIALS AND METHODS**

Meat samples were obtained from local market and stored at 4°C. Following chilling, all trimable fat and connective tissues were removed. Collected samples were subjected to various analyses with respect to their quality attributes.

**Chemical composition:**

Crude protein content was determined by kjeldahl method and moisture, ash and crude lipid according to (26).

**Physicochemical analysis**

The quality of meat samples was assessed by carrying out different physicochemical analyses: The pH of meat samples were measured by using pH meter following the method described by (27) with some modifications. The color of meat samples were determined by the L*(lightness), a* (redness), and b* (yellowness) using colorimeter by using method as describe by (28). The Water holding capacity of meat samples was determined by mixing meat with 0.6 M Nacl solution, place mixture in water bath. It was further centrifuged (4°C) at 10,000 rpm for 15 min in refrigerated centrifugation machine. The supernatant was decanded and measured (29). The Cooking loss of meat samples were measured by placing meat in polythene bag and heated in water bath. Cookout was drained and cook mass was cooled and weighed (30). The Drip loss of meat samples was determined by method describe by (31). Meat sample were placed in refrigerator under polyethylene sealed cover. After 24 hour sample were wiped and dried. Weight of sample was drip loss of meat sample. The Tenderness of meat samples were determined by the method described by (28). Sample were packed in plastic bag and cooked in a water bath in 95°C until core temperature reached 80°C. Sample was cooled and weighed for thermal loss determination. Then Shear force of meat samples were determined by the method described by (28). It was determined as maximum force perpendicular to the fibers.

**Histochemical analysis**

The histochemical analyses were carried out for different meat samples to assess the fiber types. The ATPase activity was determined by the method described by (32) with slight modifications. After acid incubation slices were incubated in ATP solution. The muscle fiber diameter was determined as described by (33) with some modifications. A core of muscle tissue was fixed in formal saline for 24 h.
and was blended at low speed for 30 sec. A drop of the homogenate was placed over a glass slide and observed under a microscope with calibrated micrometer. The diameter of fiber was measured.

Statistical analysis

The results obtained from different parameter were exposed to statistical analysis by following the respective methods described by (34).

RESULTS AND DISCUSSION

The results regarding mean values for chemical composition of meat cuts are given in Table 4.1. The moisture content varied non-significantly between 74.46-76.78% in different cuts of meat. The higher moisture content was found in round cut. The protein content varied significantly between 22.78-24.20%. Rib cut have higher content of protein. The fat content varied greatly significant between three cuts from 5.70 to 9.76%. Higher fat content were observed in round cut. The ash content varied significantly between 1.77-1.98%.

The results of current study are in near to the finding of (35), according to it the mean and standard deviation for moisture, fat and ash of beef round and chunk cuts were 72.28 ± 2.83, 6.86 ± 3.45, and 1.26 ± 0.28 mg/g, respectively. According to (36), Moisture, fat, protein and ash of Gluteus medius (GLM) muscle of sirloin were 73.86±0.40, 3.80±0.50, 20.86 ± 0.26 and 1.40± 0.02 respectively. Moisture, fat, ash and protein of Longissimus dorsi (LOD) muscle of rib were 72.47± 0.40; 5.45± 0.50; 1.17± 0.02; 20.87± 0.26. The results regarding mean values for physicochemical traits of meat cuts are given in Table 4.2. The pH values of three cuts varied non-significantly between 5.74-5.90. The highest pH (5.90) was observed in Round. (37), Mean pH values for the longissimus dorsi were decrease from 6.47 ± 0.21 to 5.46 ± 0.05 from 1st hour to 24th hour and for triceps brachii muscles decreases from 6.66 ± 0.20 to 5.54 ± 0.14. A significantly higher pH is recorded in comparison with heifers and young bulls of the longissimus dorsi (LL) and semitendinosus (ST) muscle. Similarly, pH have significant impact on ageing time in the muscles. As conditioning time was increased up to 48 hours pH decreased and then constant up to 48 hours. In LL muscle pH drop from 6.68 to 5.66 and in ST muscle from 6.65 to 5.60 during aging time 45 minutes to 14 days (38) The color L* varied highly significant among different cuts of meat animals from 39.12 to 42.44. The highest L*(42.44) content was observed in Round cut. The a* value varied highly significant among different cuts of meat animals from 20.66 to 23.44. The value of b* varied highly significant among different cuts of meat animals from 6.89 to 7.64. The highest b*(7.64) content was observed in Round. The results of current study are in line with the finding of (39) reported that color values of different muscles of round and rib cut. Longissimus dorsi, Psoas major and Semimembranosus muscles have 42.16±1.29, 19.40±1.04, 8.44±0.77; 40.15±1.61, 19.22±1.58, 7.91±1.32, and 37.51±1.06, 19.56±2.04, 7.65±1.38 values for L*, a* and b* respectively. The round and chunk cuts had color values (L*, a*, and b*) means and standard deviations as 41.06 ± 4.55, 29.57 ± 4.05, and 22.78 ± 4.32, respectively. Yield grade or quality grade has no effect the color values lightness, redness and yellowness as weight of carcass. For each of these properties (L*, a*, and b*) the value increased as weight of the carcass increased (35). (40) observed color values of rib muscle cut LT longissimus thoracis of beef based on L* (33.7), less red a* (18.4) and b* (6.6), which is near to current study. The cooking loss varied significantly among different cuts of meat animals from 33.88 to 35.77. The highest cooking loss (35.77) content was observed in Round. (41) reported that different muscles show significant differences in cooking loss. Triceps brachii and ongissimus thoracis show the lowest values, representing a better water holding capacity while semitendinosus muscle showed the highest losses. Related results were also found by (42) from Chianina cattle on the same muscles.

The results indicate that drip loss varied significantly among different cuts of meat animals from 4.55 to 5.38. The highest drip loss (5.38) content was observed in Sirloin. (39) observed drip loss (%) in different muscles of round and sirloin cut Longissimus dorsi 3.51±0.15, Psoas major 3.28±0.28 and Semimembranosus 3.25±0.54. According to (38) drip loss increases as the aging time increases, in LL muscle drip loss increases from 1.54 to 2.87 after 14 days and in ST muscle increase from 2.26 to 3.53%.

The water holding capacity varied non-significantly among different cuts of meat animals from 43.77 to 45.22. The highest (45.22) water holding capacity was observed in Round. Our results match with (35) findings weight loss due to centrifugation, the mean and standard deviation for expressible moisture of round and chunk muscle was 37.50± 5.15%. According to (36) mean values for water holding
capacity for GLM and LOD are 41.29 and 37.67 respectively.

Table 1: Mean Values Of chemical composition of meat cuts

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Moisture</th>
<th>Protein</th>
<th>Fat</th>
<th>Ash</th>
</tr>
</thead>
<tbody>
<tr>
<td>T₁</td>
<td>76.78±1.54</td>
<td>22.78b±0.46</td>
<td>9.76a±0.15</td>
<td>1.86b±0.06</td>
</tr>
<tr>
<td>T₂</td>
<td>75.92±1.49</td>
<td>23.34b±0.47</td>
<td>6.40b±0.1</td>
<td>1.77c±0.12</td>
</tr>
<tr>
<td>T₃</td>
<td>74.46±1.52</td>
<td>24.20a±0.28</td>
<td>5.70c±0.1</td>
<td>1.98a±0.04</td>
</tr>
</tbody>
</table>

T₁= round, T₂=sirloin, T₃=rib

Table 2: Mean Values Of physicochemical traits of meat cuts

<table>
<thead>
<tr>
<th>Treatment</th>
<th>pH</th>
<th>L*</th>
<th>a*</th>
<th>b*</th>
<th>Water holding capacity</th>
<th>Cooking loss</th>
<th>Drip loss</th>
<th>tenderness</th>
</tr>
</thead>
<tbody>
<tr>
<td>T₁</td>
<td>5.90±0.115</td>
<td>42.44±0.8</td>
<td>23.44±0.4</td>
<td>7.64±0.1</td>
<td>45.22±0.9</td>
<td>35.77±0.7</td>
<td>4.96±0.1</td>
<td>5.26±0.15</td>
</tr>
<tr>
<td>T₂</td>
<td>5.85±0.115</td>
<td>39.12±0.7</td>
<td>21.21±0.4</td>
<td>6.89±0.1</td>
<td>43.77±0.8</td>
<td>34.64±0.1</td>
<td>5.38±0.1</td>
<td>5.46±0.15</td>
</tr>
<tr>
<td>T₃</td>
<td>5.74±0.115</td>
<td>40.55±0.8</td>
<td>20.66±0.4</td>
<td>5.75±0.1</td>
<td>44.55±0.9</td>
<td>33.88±0.6</td>
<td>4.55±0.1</td>
<td>4.80±0.1</td>
</tr>
</tbody>
</table>

T₁= round, T₂=sirloin, T₃=rib

tenderness varied significantly among different cuts

Table 3: Mean Values Of fiber types and fiber diameter of meat cuts

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Type 1</th>
<th>Type 11A</th>
<th>Type 11B</th>
<th>Fiber diameter</th>
</tr>
</thead>
<tbody>
<tr>
<td>T₁</td>
<td>25.29b±0.51</td>
<td>24.50a±0.49</td>
<td>49.89b±1.0</td>
<td>55.44±1.11</td>
</tr>
<tr>
<td>T₂</td>
<td>21.50c±0.43</td>
<td>22.50b±0.45</td>
<td>55.69a±1.12</td>
<td>53.77a±1.08</td>
</tr>
<tr>
<td>T₃</td>
<td>62.00a±1.24</td>
<td>19.69c±0.40</td>
<td>16.50c±0.33</td>
<td>50.58b±1.02</td>
</tr>
</tbody>
</table>

T₁= round, T₂=sirloin, T₃=rib
of meat animals from 4.80 to 5.46. The highest tenderness (5.46) was observed in Sirloin. (43) recommended the following categories for beef steaks on the basis of the W-B force: tender from 2.27 up to 3.58 kg, moderate 4.08–5.40 kg and tough 5.90–7.21 kg. According to this distribution, the ultimate LL and ST belongs to the tender category. (44) observed higher LD tenderness of meat obtained from the heifers and stored at 4°C. These authors declare that the aging time increased as shearing force W-B decreases. The force decreased as aging time increased, the force decreased from 7.21 to 3.80 kg in 2nd day and 14 days.

The results regarding mean values for fiber types and fiber diameter of meat cuts are given in Table 4.3. The results indicate that muscle fiber diameter varied significantly among different cuts of meat animals from 50.33 to 55.44. The highest tenderness (55.44) was observed in Round. (33) reported that fiber diameter and tenderness are negatively related. According to (39) In the PM (Psoas major) muscle longer sarcomere length with the lowest shear force WBSF, whereas shorter sarcomere length with highest WBSF was showed in SM (seminembranosus) muscle. Similar results were observed by (45). (46) also showed the relation of sarcomere length and shear force.

The results indicate that muscle fiber type 1 varied significantly among different cuts of meat animals from 21.50 to 62.0. The highest percentage of type1 (60.0) was observed in Rib cut. The results indicate that muscle fiber type 11A varied significantly among different cuts of meat animals from 19.69 to 24.50. The highest percentage of type1 (24.50) was observed in Round. The results indicate that muscle fiber type 11B varied significantly among different cuts of meat animals from 16.50 to 49.89. The highest percentage of type1 (49.89) was observed in Round. The results of current study are in line with the finding of (39) that the SM muscles contain higher percentage of fiber type 11A and type 11B as compared to other muscles, though type 1 fiber were high in PM muscle. SM muscle had lower percentage of fiber type 11A and LD muscle had lower percentage of muscle fiber type 11A. According to (39) composition of LD muscle were type 1, 33.1 type 11A. 14.9 and type11B 52.6%, and ST contain type1 12.0, type 11A 27.3 and type 11B 61.8%. (47) observed different muscles of round, sirloin and rib cut. GLM muscle of sirloin cut consist of type 1 19.5, type 11A 24.9 and type 11B 55.6%. SM contain type1 24.3, type 11A 26.0 and type 11B 49.7%. LD muscle contain type 1 35, type 11A 21.8 and type 11B 43.2%.

REFERENCES:


