Organoleptic Characteristics of Bali Beef Meatballs Based on Collagen Concentration in UKKMB and Time of Maturation

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Abstract. This study aims to look at the organoleptic quality of meatballs derived from Balinese beef which is fed by the Multinutrient Block Urea Water Coconut Collagen (UKKMB) for 45 days. UKKMB is a modification of UMMB where coconut water replaces molasses and collagen is added. Collagen is derived from the scapula bone extraction of Bali cattle. Before making meatballs, beef muscle Longissimus dorsi (LD) was matured (aging) at a temperature of 2-5\(^\circ\)C for 16 days. The design of the study was a complete design of factorial pattern 3 x 3 where factors one percentage of collagen (25, 50, and 100%) and factors two maturation time (0, 8, and 16 days). The parameters observed were a score of tenderness, elasticity, chewing residues and flavor intensity by 20 taste panelists. The results showed the percentage of collagen decreases tenderness, elasticity, and residual mastication scores, while the flavor intensity is more or less the same. The maturation time decreases tenderness scores, while elasticity, chewing residues and flavor intensity are more or less the same. This research concluded that the percentage of collagen in the UKKMB block feed improves the organoleptic quality of Balinese beef meatballs.

Keywords: meatballs, organoleptic quality, UKKMB, maturation, Bali cattle

1. Introduction
Meatballs are one of the processed red or white meat products that are very popular in Asia, especially in Indonesia. The importance of meatballs for public consumption is indicated by about 60% of cattle slaughtered in slaughterhouses for meatballs (personal communication). In 2017 cattle slaughter in Indonesia reached 1,114,748 heads [1], with an estimated 50 kg beef cattle weight, then beef meatball production reached 33,442.4 tons/year or 91.62 tons/day in Indonesia.

The assessment of the quality of meatballs by consumers based on soft, chewy, dense, not easily broken, and the taste of meat stands out. These qualities are solely determined by the amount of meat inside the dough and its quality in which tender meat will produce a better quality of meatballs than tough meat. Thus, meat pre-rigor, signified by its high capacity to hold water (water holding capacity), will produce meatballs with higher quality and yields compared to those of post-rigor meat. As [2] uses the pre-rigor meat to increase the level of yields and sausage meat texture.

The rigor-mortis process that takes place after livestock has died results in a decrease in the functional properties of muscles characterized by the formation of stiffness in which the meat's ability to bind water decreases. Efforts to maintain water holding capacity in meat can be done by adding phosphate [3] - [5], salt [5], liquid smoke [6] and recently with the addition of collagen [7], [8]. The use of liquid smoke or smoked flour in previous studies showed that the quality of fresh meat and meatballs increased [6], [9], as well as the addition of collagen to buffalo meatballs [8] and beef dough [7]. The use of gelatin through the ability to protect food ingredients from oxidation is stated by [10]
The cooking loss of meat decreases and the level of redness of the meat (a*) increases with the increase in the percentage of collagen in the supplement feed block [12].

Addition of liquid smoke and collagen in block supplement feed as feed for cattle during fattening before slaughtered cattle produce high-quality meat is characterized by one of the increasing water holding capacity during the rigor-mortis process [6], [13].

This study presents the results of researches that had been conducted on Balinese beef meatballs which were added with collagen at the level of 2% of the weight of UKKMB with a maturation time of 16 days, thus aiming to examine the sensory quality of the meatballs.

2. Materials and Method
The materials used were Bali beef from pre-rigor muscle *Longissimus dorsi* (LD) of 6 cattle aged 2 to 3 years, collagen from *Os scapula*, ice, tapioca flour, salt, and distilled water. The animals before slaughtering were fed by urea coconut water collagen multi-nutrient block (UKKMB). The composition of feed materials in UKKMB showed in Table 1.

**Collagen Preparation**
Collagen extraction was carried out using Bali scapula bone (*Os scapula*) which was cut to 1-2 cm in size and then washed. Fat on the bone is removed by the 60% ethanol (v/v) was used for 2x2 hours with a bone ratio: 60% ethanol (1:1.5). Demineralization was carried out using a 0.5 M H2SO4 solution for 48 hours with a bone ratio: 0.5 M H2SO4 (1:1.5). Then ossein was neutralized using 10% Ca (OH) 2 for 24 hours with a bone ratio: 10% Ca (OH) (1:1.5). A total of 300 g of bone is extracted with an extraction solution with a bone ratio: extraction solution (1:1.5) (v/v). Extraction was carried out in 2 stages each for 24 hours with different temperatures: 55-60°C stage 1 and 65-70°C stage 2. Extraction results of stages 1 and 2 were mixed and then filtered using a flannel cloth to produce filtrate. The filtrate is then dried using an oven at a temperature of 55-60°C for 48 hours to produce a dense collagen extract. The collagen extract is then blended to produce gelatin [14], [15].

**Block Feed Preparation**
The block supplement feed (UKKMB) is made by mixing feed ingredients consisting of urea, coconut water, fine rice bran, finely ground corn, milled coconut meal, salt, cow minerals, hydration collagen and building cement. All feed ingredients are finely mixed evenly [16]. Coconut water will make the mixture of feed ingredients easy to form into dough and then pressed using special press tools to form a feed block weighing 500 g per block. A total of 500 g of block feed and 6 kg of probiotic rice straw were given to cows for each head during fattening (45 days).

**Table 1. The composition of feed materials in UKKMB**

| Feed materials  | Composition (g/kg) at different percentage of collagen |
|-----------------|-------------------------------------------------------|
|                 | 25% | 50% | 100% |
| 1. Coconut water| 28  | 28  | 28   |
| 2. Urea         | 5   | 5   | 5    |
| 3. Rice Bran    | 30  | 30  | 30   |
| 4. Cornmeal     | 10  | 10  | 10   |
| 5. Copra meal   | 10  | 10  | 10   |
| 6. Cement       | 10  | 10  | 10   |
| 7. Cow Mineral  | 2   | 2   | 2    |
| 8. Table salt   | 3   | 3   | 3    |
| 9. Collagen     | 2   | 2   | 2    |
**Meatballs Preparation**

The making of the dough begins with grinding the meat with salt and ice cubes to extract as much of myosin as possible so that the meatballs are springy, compact and solid. After that, the addition of tapioca flour and collagen hydration while ground using a food processor until the mixture is evenly mixed. Meatball dough that has been made then made meatball spheres then boiled at a temperature of 80 °C until the meatballs expand to the surface of the boiling water [6].

The study was conducted by using the completely randomized design of factorial pattern 3 x 3 where factor one was a percentage of collagen (25, 50 and 100%) and factor two was the time of maturation (0, 8, and 16 days) with three replications.

The parameters measured in the sensory test included tenderness, elasticity, mastication residue and flavor intensity.

The sensory test involved 20 panelists who had previously undergone training and assessed the sensory quality of meatballs based on the scale -converted into an assessment score, ranging from 1 – 6, indicating that 1 is very tough, very un chewy, very much residue mastication, very low flavor intensity and 6 is very soft, very chewy, very little residue mastication and very high flavor intensity [6]-[17].

**Data Analysis**

Data were calculated using analysis of variance of factorial pattern to find out the effects of treatment to both factors on the organoleptic quality of meatballs with the help of SPSS program (SPSS 16, SPSS Ltd., West Street Woking, Surrey, UK). If the significant effect was found, then it was continued with the least significant difference test [18].

3. **Results and Discussion**

**Tenderness**

Meatball tenderness score based on a the percentage of collagen in feed and maturation time is shown in Table 2.

Analysis of variance showed the percentage level of collagen in UKKMB feed and maturation time had a very significant effect (P <0.01) on tenderness scores.

The higher the level of collagen percentage in UKKMB feed the lower meatball tenderness score reached 10.93% at 100% collagen level compared to 25%, even though there was no significant difference between collagen 50% and 100%. An indication that a percentage of collagen in the feed has not been able to increase the tenderness score. Addition of collagen in feed increases the toughness meatball of beef *Longissimus dorsi* muscle. The nature of collagen which is a binding network in the muscle structure and provides muscle strength resulting in an increase in the percentage of collagen in the diet increased the toughness muscle [19]. The score of Balinese beef meatballs tenderness which was given smoked flour 3.37, was lower than the current study [9].

The increasing maturation time of *Longissimus dorsi* muscle, meatball tenderness score decreases to reach 10.09% in the eight and 16 days maturation. Previous studies using smoked flour, tenderness score of 3.88 at seven-day maturation [9] were lower than current studies. An indication that the panelists assessed that the addition of collagen in cattle feed is better if compared to the use of smoked flour in meatball dough. The increase in the percentage of collagen in UKKMB feed has not been able to increase the tenderness score during maturation, indicating that during maturation there is an increase in the toughness of meatball. The cathepsin enzyme [19] which digests the meat protein during maturation not working optimally in the presence of collagen in UKKMB feed can explain this.
Table 2. Effects of collagen percentage in UKKMB and aging time of Longissimus dorsi on the quality organoleptic scores of Bali cattle meatballs (means and SE)

| Treatments | Tenderness | Elasticity | Residual Mastication | Flavor intensity |
|------------|------------|------------|----------------------|-----------------|
| Col percentage: | | | | |
| 25% | Sig:0.001 | 4.21±0.31a | 4.32±0.37a | 4.25±0.29a | 3.90±0.15 |
| 50% | 4.23±0.41b | 4.03±0.39ab | 3.91±0.47ab | 3.76±0.20 |
| 100% | 3.75±0.37bc | 3.84±0.28b | 3.75±0.38b | 3.73±0.39 |
| Average | 4.06±0.41 | 4.06±0.39 | 3.97±0.42 | 3.80±0.27 |
| Aging: | Sig:0.001 | Sig:NS | Sig:NS | Sig:NS |
| 0 days | 4.36±0.22a | 4.22±0.22 | 3.98±0.22 | 3.93±0.20 |
| 8 days | 3.92±0.43b | 3.98±0.45 | 3.93±0.53 | 3.67±0.26 |
| 16 days | 3.92±0.43bc | 3.98±0.45 | 4.00±0.50 | 3.78±0.29 |
| Average | 4.06±0.41 | 4.06±0.39 | 3.97±0.42 | 3.80±0.27 |

Description: Numbers with different superscripts in the same column stated a significant difference (P <0.05) and a highly significant difference (P <0.001).

Assessment Scores: 1-6 (1, very tough, very not chewy, very much residual mastication, very low flavor intensity… 4, rather soft, slightly chewy, slightly little residual mastication, slightly high flavor intensity… 6, very soft, very chewy, very little residual mastication, very high flavor intensity).

Elasticity
Analysis of variance showed the percentage level of collagen in UKKMB feed had a significant effect (P <0.05) while the maturation time had no significant effect on the elasticity score of beef meatballs Longissimus dorsi muscle.

The higher the level of collagen in feed decreases the elasticity score reaches 11.11% lower at 100% collagen level compared to the 25% level, even though there is no real difference between collagen 50% and 100%. An indication that the addition of collagen in the feed has not been able to increase the elasticity score. Collagen as a connective tissue that gives strength to muscle structure and has elastic properties [19] does not increase meatball elasticity score with increasing percentage of collagen in the feed. Previous research [6] also shows that muscle types and rigor-mortis phases do not affect the elasticity of the meatballs.

The maturation time produces meatball elasticity score more or less the same even though there is a tendency to decrease the score with increasing maturation time. However, based on the panelist scoring, storage duration was significantly (p <0.01) affecting the elasticity of the liquid smoke meatballs 1% [6]. The elasticity score is roughly similar to the meatballs liquid smoke 1%.

Mastication Residue
Analysis of variance showed the percentage level of collagen in UKKMB feed had a significant effect (P <0.05) while the maturation time had no significant effect on the score of mastication residues.

The higher the level of collagen percentage in UKKMB feed decreased the mastication residue reached 11.76% at 100% collagen level compared to 25% collagen level, even though there was no significant difference between 50% collagen and 100%. An indication that the addition of collagen in UKKMB feed results in a lower score of mastication residues. The results of previous studies showed a lower mastication residue score of 3.11 from the results of the present study [9]. The lower the mastication residue, the more tender the meatball is. Adding collagen in UKKMB feed as much as 50% can be considered sufficient chewing residues and produce meatballs that are quite tender.

The maturation time results in a score of approximately the same mastication residue, even though there is a tendency for the residual score to increase.
Flavor Intensity
Analysis of variance showed the percentage of collagen in feed and maturation time did not significantly affect the score of flavor intensity.

The percentage of collagen in the UKKMB feed produces a flavor intensity score that is approximately the same even though there is a tendency for the score to decrease with increasing collagen. In line with the previous research which shows that the flavor intensity score is not influenced by both the muscle type and the rigor mortis phase [6].

The maturation time produces a score of flavor intensity that is approximately the same even though there is a tendency for the score to decrease with increasing maturation time.

4. Conclusion
The percentage of collagen decreases the scores of tenderness, elasticity and mastication residue, while flavor intensity is more or less the same. The maturation time decreases tenderness scores, while the elasticity score, mastication residue, and flavor intensity are more or less the same. It can be concluded that the percentage of collagen in the UKKMB block feed improves the organoleptic quality of Balinese beef meatballs.

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