

Organoleptic Analysis of Processed Beef Meatball Products Using the Analytic Hierarchy Process: A Case Study of “Bakso Roso”

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Abstract

Processed beef meatballs are widely consumed food products whose quality is largely determined by their sensory attributes. This study aims to analyze the organoleptic quality of beef meatball products at Bakso Roso Restaurant in Gorontalo Regency, focusing on appearance, aroma, taste, and texture. This research addresses a gap in previous studies, which typically rely on conventional sensory tests without applying a structured prioritization method. The study site was purposively selected based on branch availability, accessibility, modern facilities, and certified operations. Primary and secondary data were analyzed using the Analytic Hierarchy Process (AHP) to determine the relative weight of each criterion. The results show that taste is the most influential attribute (0.402), followed by aroma (0.294), texture (0.203), and appearance (0.100), with an inconsistency value of 0.02 indicating reliable judgments. Among product alternatives, Bakso Tennis ranks highest (40.2%), followed by Bakso Urat (29.4%). These findings highlight the dominant role of taste and aroma in shaping consumer preferences and provide a structured basis for product development through AHP-based organoleptic prioritization.

Keyword: Organoleptic, Processed Products, Meatballs, Analytic Hierarchy Process

INTRODUCTION

Beef meatballs are not merely a popular ready-to-eat food but also an integral component of Indonesian food culture and the broader livestock-based food industry (Amalia & Triyannanto, 2022; Meng et al., 2022; Suroyo et al., 2023). In Gorontalo Regency, beef meatballs

contribute to household protein intake while serving as an important source of income for small and medium-scale food enterprises (Yusuf et al., 2016). Within this context, Bakso Roso represents a relevant case for investigation, as it is one of the well-known local culinary businesses that reflects the competitive dynamics of the regional meatball market. Initial field observations, however, indicate a decline in customer visits following a previously high level of initial consumer interest. This condition suggests the need for a more systematic evaluation of factors influencing customer satisfaction and loyalty, particularly those related to product quality and overall dining experience.

In response to these challenges, growing attention has been directed toward organoleptic attributes. Sensory characteristics such as appearance, aroma, taste, and texture have been increasingly recognized as primary determinants of consumer acceptance of meatballs and other processed meat products (Cardona et al., 2023; Cangara et al., 2024). Variations in filler formulations, for example, have been shown to significantly alter taste and texture, while differences in color and shape are strongly influenced by the type of starch or flour incorporated during processing (Dauri et al., 2025). A balanced sensory profile, characterized by savory flavor, tender yet elastic texture, and appealing visual appearance, plays a decisive role in shaping consumer preferences (Godschalk-Broers et al., 2022; Cardona et al., 2023). These patterns align with broader purchasing behaviors in both traditional and modern beef markets, where sensory quality attributes such as color and firmness directly affect repeat-purchase decisions.

As the need for more accurate quality assessment continues to grow, quantitative approaches in sensory evaluation have gained increasing relevance. Multi-criteria decision-making methods, particularly the Analytic Hierarchy Process (AHP), have proven effective in structuring the relative weights of quality attributes and ranking product alternatives based on panelist or consumer judgments. Applications of AHP have been documented in various food commodities, including salted eggs, tea beverages, and other processed products requiring systematic attribute weighting (Muliawati et al., 2024). This approach is consistent with advancements in sensory evaluation methodologies that aim to reduce panelist subjectivity through structured decision frameworks (Rodrigues et al., 2024). Despite these developments, the use of AHP to assess organoleptic quality and prioritize beef meatball variants remains limited, particularly within local restaurant settings such as Bakso Roso. This gap highlights the need for empirical research capable of providing data-driven recommendations for product improvement.

Addressing this gap, beef meatball producers, especially Bakso Roso, currently lack



systematic and measurable information regarding the organoleptic quality of their products based on consumer perceptions, including the sensory attributes that most strongly influence preference. Appearance, aroma, taste, and texture have yet to be organized within a hierarchical decision framework that can guide quality enhancement and product development strategies. Therefore, this study aims to analyze the organoleptic quality of beef meatball products at Bakso Roso Restaurant using the Analytic Hierarchy Process (AHP) to determine the relative importance of each attribute and prioritize available product variants. Through this approach, the study seeks to develop a more structured organoleptic assessment model that can inform product innovation efforts and strengthen the competitive position of livestock-based culinary enterprises.

METHOD

Study Site

This study was conducted at Bakso Roso Restaurant, located in Gorontalo Regency. The site was selected purposively based on four considerations: (1) the area hosts the largest number of Bakso Roso outlets, (2) the restaurant is situated along a primary transportation corridor, (3) the establishment represents a modern meatball restaurant with adequate facilities, and (4) the business has obtained official certification.

Population and Sample

The population consisted of stakeholders from relevant institutions in Gorontalo Regency. Sampling was carried out using a purposive sampling technique. The organoleptic assessment employed expert panelists to evaluate the quality of beef meatball products. Expert panelists were individuals with experience in the food sector and specialized knowledge of the sensory characteristics of meatballs (Table 1).



Table 1. Expert Panelists by Institution

No.	Institution	Number of Experts
1	Livestock Division, Provincial Agriculture Office of Gorontalo	2
2	Provincial Food Office of Gorontalo	2
3	Livestock and Animal Health Office, Gorontalo Regency	2
4	Industry and Trade Office, Gorontalo Regency	2
5	Animal Science Study Program, Gorontalo State University	1
6	Food Technology Study Program, Gorontalo State University	1
Total		10

Source: Primary data (2025)

Data Collection

Primary data on the organoleptic quality of beef meatballs were collected from expert respondents using a structured questionnaire. The questionnaire consisted of closed-ended items developed based on Thomas Lorie Saaty's pairwise comparison scale. Secondary data were obtained from relevant institutions through documentation and review of available records. Additional supporting information was gathered from scientific literature.

Data Analysis

Organoleptic analysis was conducted to evaluate product quality based on human sensory perception. This analysis involved the assessment of appearance, aroma, taste, and texture. The Analytic Hierarchy Process (AHP) (Saaty, 2003) was used as the analytical method. The procedure began by defining the organoleptic criteria and decomposing them into elements until a hierarchical structure was formed. This decomposition process is illustrated in Figure 1. The analysis was performed using AHP software (Expert Choice), which applies four fundamental principles: decomposition, pairwise comparison, priority synthesis, and consistency ratio assessment.

Decomposition; the overall organoleptic quality of beef meatballs was broken down into hierarchical elements until no further subdivision was possible, forming several levels of assessment (Figure 1).



Figure 1. Decomposition Process

Source : Primary data (2025)

Pairwise Comparison; relative importance between elements at each hierarchical level was assessed using pairwise comparisons. Respondents evaluated criteria, subcriteria, and alternatives, generating weight values for each element. Assessments were based on Saaty's pairwise comparison scale (Table 2), which serves as the core of AHP and determines the priority of each element.

Table 2. Saaty's Pairwise Comparison Scale

Importance Level	Definition	Description
1	Equal importance	Both elements are equally important
3	Moderate importance	One element is slightly more important
5	Strong importance	One element is clearly more important
7	Very strong importance	One element is strongly favoured
9	Extreme importance	One element is overwhelmingly important
2,4,6,8	Intermediate values	Values between two adjacent judgments
Reciprocal	—	If element <i>i</i> is assigned a value over element <i>j</i> , then <i>j</i> receives the reciprocal value

Source: Saaty (2008)

Priority Synthesis; this stage involved ranking the elements according to their relative importance. Respondent judgments at all levels were aggregated to generate final priority weights. Consistency Ratio; the consistency of pairwise comparisons was examined using the Consistency Ratio (CR). A CR value of less than 0.1 indicates that the respondent's judgments are consistent and acceptable. If the CR exceeds 0.1, respondents may revise their assessments to reduce inconsistency (Sahara et al., 2019).

RESULTS AND DISCUSSION

Organoleptic Attribute Structure of Bakso Roso

Bakso Roso is a processed food product made from beef, and an organoleptic assessment is essential to address challenges related to product quality and consistency. The hierarchical structure of the organoleptic attributes of Bakso Roso in Gorontalo Regency is presented in Figure 2.

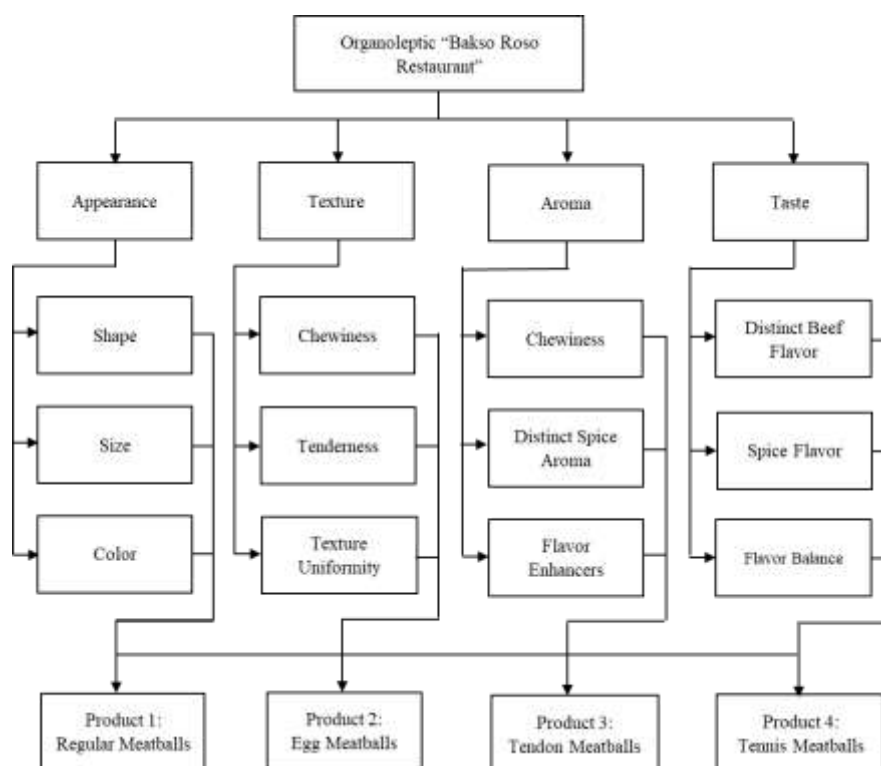


Figure 2. Hierarchical Structure of the Organoleptic Attributes of Bakso Roso

Source: Primary data (2025)

The hierarchical structure of the organoleptic attributes of Bakso Roso was evaluated across multiple levels. The assessment began with four primary attributes, namely appearance, texture, aroma, and taste, each of which was further decomposed into more specific sub attributes. The weight assigned to each element at every hierarchical level influences the overall priority within the structure. A detailed summary of the calculated weights for each organoleptic criterion and sub criterion is presented in Table 3.

Table 3. Weights of Organoleptic Criteria and Sub criteria of Bakso Roso

No.	Organoleptic Aspect	Criterion Weight	Sub criterion	Sub criterion Weight
1	Appearance	0.150	Shape	0.200
			Size	0.401
			Colour	0.398
2	Aroma	0.241	Distinct beef aroma	0.407
			Spice aroma	0.329
			Flavour enhancers	0.264
3	Taste	0.446	Distinct beef flavour	0.343
			Spice flavour	0.427
			Flavour balance	0.230
4	Texture	0.163	Chewiness	0.150
			Tenderness	0.200
			Texture uniformity	0.401

Source: Primary data (2025)

The highest weight among the organoleptic attributes of Bakso Roso is the taste criterion (0.446). This indicates that taste is the most prioritized aspect considered by the panelists in evaluating the product. Muhandri et al. (2023) explain that seasoning formulation plays a pivotal role in shaping the flavor and aroma profile of meatballs, thereby significantly influencing consumer preferences. For the appearance criterion, the highest priority is assigned to the size sub criterion (0.401). Physical product size greatly affects purchasing decisions (Kotler and Keller, 2016). The size of the meatball influences consumer comfort during consumption. An ideal meatball size not only facilitates chewing but also enhances visual appeal, contributing to consumer satisfaction and increasing product attractiveness.

Within the aroma criterion, the highest priority is attributed to the distinct beef aroma sub criterion (0.407). According to Muhandri et al. (2024), the characteristic aroma of beef is a key indicator of ingredient quality and freshness. The use of beef flavor in seasoning significantly improves the perception of beef aroma among panelists. For the taste criterion, the highest priority is given to the spice flavor sub criterion (0.427). Spices play a dominant role in developing a unique, rich, and appealing flavor profile that enhances palatability. Dauri et al. (2025) note that ingredients such as garlic, pepper, coriander, and nutmeg contribute strong savory notes and a characteristic aroma. The texture criterion shows that the highest priority is assigned to the texture uniformity sub criterion (0.391). Consistent and uniform texture provides a satisfying eating experience and strengthens perceptions of product quality. Meng et al. (2022) emphasize that texture uniformity in meatball products reflects stability in the production process, ensuring consistent sensory characteristics for consumers.

The synthesis of priorities identifies the ranking of product alternatives for Bakso Roso. The priority order is as follows: (1) Product 4, Tennis Meatballs (0.402), (2) Product 3, Tendon Meatballs (0.294), (3) Product 2, Egg Meatballs (0.203), and (4) Product 1, Regular Meatballs (0.100). The inconsistency value obtained from the respondents' pairwise comparisons is 0.02, indicating acceptable consistency in their judgments (Figure 3).

Combined Instance – Synthesis with respect to: Shape
(Goal: Meatball Organoleptic Quality > Appearance (Weight: 0.150) > Shape (Weight: 0.200))
Overall Inconsistency = 0.02



Figure 3. Priority Synthesis of the Organoleptic Attributes of Bakso Roso

Source: Primary data (2025)

The Tennis Meatball variant has the highest weight or priority compared with the other alternatives. Wahyuni and Prabowo (2021) state that organoleptic preferences among professional evaluators tend to be more critical toward technical attributes such as meat composition and processing techniques. The use of excessive fillers can reduce the intensity of the characteristic beef flavor and result in a softer texture that may easily break during chewing.

The Dynamic Sensitivity Chart (Figure 4) illustrates the degree of association between the criteria and product alternatives. The criteria with the highest weights are taste (44.6 percent) and aroma (24.1 percent). The product alternatives with the highest priority values are Product 4 (Tennis Meatballs) at 40.2 percent and Product 3 (Tendon Meatballs) at 29.4 percent. The combined weight of the taste and aroma criteria reaches 68.7 percent, while the combined priority of Tennis Meatballs and Tendon Meatballs is 69.6 percent. These values indicate that the two products are the most influential and attractive options for consumers.

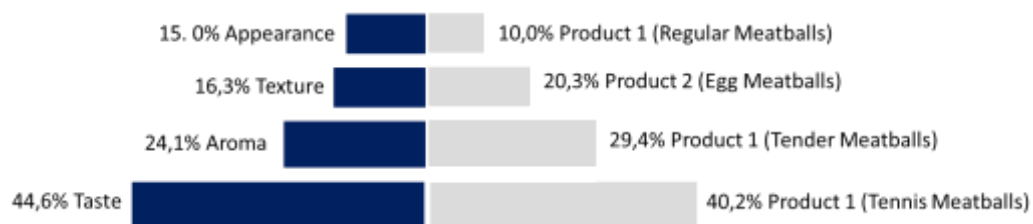


Figure 4. Sensitivity Analysis of the Organoleptic Attributes of Bakso Roso

The taste criterion, with a weight of 44.8 percent, indicates that taste is the primary aspect determining the quality of Bakso Roso. This attribute reflects not only the composition of ingredients but also the processing method, seasoning balance, and storage technique. According to Wahyuni and Prabowo (2021), taste is the strongest driver of consumer loyalty because it is the attribute most vividly remembered by consumers.

CONCLUSION

The findings of this study indicate that the taste attribute is the most influential criterion determining the organoleptic quality of Bakso Roso, followed by aroma, texture, and appearance. Each criterion is shaped by its dominant subcriterion, namely size for appearance, distinct beef aroma for aroma, spice flavor for taste, and texture uniformity for texture. These results demonstrate that the overall sensory experience is primarily driven by strong flavor characteristics, appealing aroma, and consistent texture. The synthesis of product alternatives further shows that Tennis Meatballs (Product 4) are the most preferred variant, followed by Tendon Meatballs (Product 3), Egg Meatballs (Product 2), and Regular Meatballs (Product 1). Overall, the application of AHP successfully identified the most critical organoleptic attributes and determined the product with the highest sensory quality, providing a data-driven foundation for quality improvement and product development for Bakso Roso.



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