Physical Quality of Chevon Meatballs with Different Levels of Taro Flour Substitution as a Filler

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Abstract. Taro tubers potentially serve as functional foods with significant health benefits, due to their abundant oligosaccharides. The substance is a potential raw material in flour production, as a result of their high starch composition of approximately 70%. The purpose of this research, therefore, was to determine the physical properties of chevon meatballs, comprising of various levels of taro substitutes as fillers. The materials involved were the thighs of the meat sample and taro flour. Additional ingredients consisted of ice, tapioca flour, pepper, salt, MSG, egg white, and garlic. Meatballs were produced from chevon with 10% flour as filler, in the form of tapioca and taro, with successive composition ratio of 10:0 (P0), 7.5:2.5 (P1), 5:5 (P2), 2.5:7.5 (P3), and 0:10 (P4). Data assessments were subsequently conducted, using analysis of variance (ANOVA). The results showed that the use of taro flour filler up to a level 10% did not affect the cooking loss of chevon meatballs, with exception in pH, water holding capacity (WHC) and tenderness. Consequently, the addition of filler ratio of 0:10 (tapioca:taro) tended to boost the pH, while reducing the WHC and tenderness. Moreover, the WHC increased by using tapioca and taro flours with a ratio of 5:5 (P2), compared to 7.5:2.5 (P1), 2.5:7.5 (P3), and 0:10 (P4). Furthermore, a considerable improvement in meatball tenderness was observed by the inclusion of P2 filler ratio, compared to utilizing tapioca and taro flours at 2.5:7.5 (P3) and 0:10 (P4). In summary, taro flour was feasibly applied in chevon meatball preparation up to a level of 5%, while retaining the physical properties.

Keywords: Meatballs, chevon, taro flour, physical quality, filler

1. Introduction
Chevon meat is a high-quality food source compared to other red meat, and is attributed to good protein, total fat, saturated fatty acids, and low cholesterol. Although the aroma of chevon presents a challenge for consumer acceptance, certain consumers show high preference for chevon [1], as the aroma and taste are similar to lamb [2] which differs from other red meats [3]. In Southeast Asia particularly Indonesia, satay is very popular, including chevon satay, and is prepared by grilling meat over coals with seasoning. This cooking method tends to produce heterocyclic amines, otherwise referred as carcinogenic [4]. Grilled red meat is a potential source of cancer, due to the presence of carcinogenic compounds [5].
addition, the roasting process is known to diminish nutrient quality, including proteins, fat, vitamins, and minerals [6]. Therefore, there is a considerable need to provide alternative cooking methods for chevon meat.

Meatball, a common food product in Asia, is derived from ground meat using filler, in addition to certain spices. Fillers play an important role in determining the physical quality of meatballs, e.g. textures. These materials are applied in the form of flour, e.g. corn, rice, sago and cassava. Meatballs sold in the market are usually from beef, fish or chicken [7]. Furthermore, taro has been cultivated in Indonesia with several varieties, and are used as carbohydrate sources [8]. The substance is rich in nutritional value including carbohydrates, protein, vitamins A and C, calcium, phosphorus and potassium, while also serving as medicine, due to the presence of bioactive compounds [9]. Essentially, taro flour contains amylopectin and amylose, suitable for fillers in chicken [10], pork [11], beef [12] and buffalo [13] meatballs. However, substituting taro with tapioca flour up to a level of 50% possibly decreases the pH of chicken meatballs [14], while a level up to 75% showed an improvement in tenderness and pH for pork [11].

Chevon meat demonstrates sufficient nutritional value in comparison to red meats, but it is problematic to consumer flavor preferences. The meat is usually consumed by roasting, resulting in carcinogenic compounds, with the capacity to decrease the nutritional content. Therefore, it is necessary to produce alternate food products from chevon, including meatballs, where the production requires fillers and employs preferably ingredients containing healthy bioactive compounds. Taro is a good filler choice, but it is not applied in preparing the meatball products. Furthermore, the physical quality of meatballs is an important aspect to evaluate consumer acceptance. Based on these problems, the study was conducted to determine the effect of using taro flour as a substitute for tapioca flour on the physical quality of chevon meatballs.

2. Material and method
The primary ingredients in meatball production were thigh meat from local goat (Capra aegagrus hircus) without fat, taro, tapioca, garlic powder, MSG, fine salt, egg white, ground pepper, and ice cubes.

The control (P0) was composed of chevon meat 75.18%, tapioca flour 10.00%, taro flour 0.00%, salt 1.65%, pepper 0.21%, garlic 1.65%, egg white 3.54%, ice water 7.07%, MSG 0.21%, and carrageenan 0.5%. This formulation replaced tapioca with taro, in a ratio of 7.5:2.5 (P1), 5:5 (P2), 2.5:7.5 (P3), and 0:10 (P4). Also, each treatment had six replications. Furthermore, the formula and steps for preparing these samples were in accordance with the outlined procedures by Kartikasari et al. [15], although certain modifications were required.

Physical quality assessments were conducted on the pH, water holding capacity (WHC), and cooking loss, using AOAC techniques [16] with a pH meter, Hamm method [17], and Priyanto et al. [18] approach respectively. In addition, tenderness was described in previous studies [19, 20], with the aid of a penetrometer (mm/minute) [15].

Data evaluations were conducted using analysis of variance (ANOVA) to determine significant differences at P<0.05. If there was a significant difference in the mean treatments, the analysis was followed by the Tukey’s test [21].

3. Result and Discussion
The results of the statistical analysis showed significant differences in pH, tenderness (P<0.01), and WHC (P<0.05), but no considerable change was observed for cooking loss (Table 1). However, the pH observed an increase when adding up to 7.5% taro flour (P3), while WHC improved by using tapioca and taro in a ratio of 5:5 (P2), compared to 7.5:2.5 (P1), 2.5:7.5 (P3), and 0:10 (P4). This taro inclusion in meatball dough, up to a level of 10% (P4), caused a relative decline in tenderness compared to other treatments (P1, P2, and P3) and non-taro flour (P0).

The addition of taro flour concentration at a level of 10% (P4) enhanced the pH value of the chevon meatballs due to the presence of amylopectin and amylose in the form of soluble-hydrophilic carbohydrates. This was in accordance with one study [11], where the sample was replaced with 75% tapioca flour, in an attempt to increase the pH value of pork meatballs. Based on [22], the manufacture of post layer chicken meatballs using 25% taro flour significantly influenced the pH. In the preparation
of beef meatballs, similar conditions significantly impacted cooking loss [23]. Furthermore, the starch content in taro is relatively higher, comprising of amylose and amylopectin [24]. Starch plays an important role in the formation of well-defined meatball structures and also absorbs water, particularly amylose [25]. Therefore, excess water content was enclosed within the product, and was responsible for the extensive pH. In this study, meatball pH ranged between 6.47-6.67, in accordance with chicken meatballs as well as the addition of taro, ranging from 5.82 - 6.76 [14].

Table 1. Evaluation of physical properties of chevon meatball with different levels of taro flour substitution as a filler

| Parameters          | Treatment (mean±SD) | p-value  |
|---------------------|---------------------|----------|
|                     | P0                  | P1       | P2       | P3       | P4       |
| pH                  | 6.47±0.82<sup>a</sup> | 6.53±0.06<sup>b</sup> | 6.40±0.09<sup>c</sup> | 6.53±0.08<sup>ab</sup> | 6.67±0.06<sup>a</sup> | 0.001   |
| WHC (%)             | 46.49±0.93<sup>a</sup> | 45.42±0.66<sup>b</sup> | 46.35±0.63<sup>c</sup> | 45.25±0.94<sup>b</sup> | 45.55±0.55<sup>b</sup> | 0.024   |
| Cooking Loss (%)    | 6.85±1.04           | 6.36±1.12 | 6.39±0.39 | 6.49±0.57 | 6.71±0.52 | 0.781   |
| Tenderness (mm/g/second) | 0.153±0.01<sup>a</sup> | 0.110±0.01<sup>b</sup> | 0.118±0.17<sup>b</sup> | 0.098±0.15<sup>b</sup> | 0.082±0.01<sup>c</sup> | 0.001   |

<sup>a,b,c</sup> Different superscript in the same row indicates they are significantly different (P<0.05).

The WHC value of the meatballs began to reduce at 7.5% (P3), due to higher pH variation, compared to the control (P0). This indicated a reduction in the water binding capacity and overall quality, in line with the research by Momongan et al. [23], where the addition of taro flour up to 25%, demonstrated a very significant effect on the water binding capacity. According to Swatland [26], changes in the WHC are also related to pH, consequently resulting in variation in the isoelectric point of meat myofibril protein.

The subsequent introduction of taro up to 10% (P4) did not influence cooking loss, indicating similar physical quality as the control. Moreover, inclusion of filler causes proper water binding. However, a study on the value of cooking loss conducted by Hadju dan Ma’aruf [27], discovered that the use of separate flours tends to affect the meatball quality. This was due to the existing disparities in water absorption capacity. The substitution of tapioca flour with corn starch and white glutinous rice up to a level of 10% did not indicate any significant change, but there was a significant difference in cooking loss when tapioca flour was replaced with wheat flour and sago flour. Therefore, the quality variation of beef meatballs was determined by the formulation, including flour addition [28].

The decrease in tenderness with 10% taro flour addition was probably due to high amylopectin content. Taro flour is generally comprised of 16.5% amylose and 83.49% amylopectin, with a gelatinization temperature between 69-72°C [29]. Also, the nature of amylopectin showed a tendency of absorbing water and hydrophilic protein. However, the challenge of gelatinization using amylopectin revealed that the properties are expected to solidify during cooking in order to produce tougher meatballs. Winarno [30] described that the starch and gluten content in the flour is able to gelatinize when heated to form compact texture products. The results obtained were known to match the research of Rachmawan et al. [31], where an increase in taro addition may have potentially decreased the nugget tenderness, which was related to the decrease in WHC content. Ockerman [32] reported that an improvement in WHC was followed by an increase in tenderness. The result of this current study did not correlate with the conclusions of Nullah et al. [22], which found that using 25% taro flour did not significantly influence the tenderness of post layer chicken meatballs. In this study, meatballs were produced from chevon meat, while Nullah et al. [22] used post laying hen. Furthermore, Soeparno [17] stated that the tenderness of cooked meat increases from pH 6.0-7.0. Current findings indicated a negative correlation between pH value and tenderness. In other words, the pH increase resulted in a decrease in meatball tenderness.

4. Conclusion

Based on results and discussions, the addition of taro flour up to a level of 5%, is possible to increase the WHC and tenderness of chevon meatballs, while also retaining the cooking loss. In summary, taro
flour has the potential to be applied in producing chevon meatballs up to a level of 5% while maintaining the physical quality.

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