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Physical And Sensory Quality Of Sausages Made From Spent Laying Hens Using Purple Sweet Potato Flour (Ipomoea Batatas L)

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A B S T R A C T

This study investigated the effect of purple sweet potato (Ipomoea batatas L.) flour as a filler on the physical and sensory qualities of sausages produced from spent laying hens and determined the optimum inclusion level. A Completely Randomized Design (CRD) with five treatment levels of purple sweet potato flour and four replications was employed for physical quality evaluation, while sensory attributes were assessed by 25 semi-trained panelists. The observed physical parameters included water-holding capacity and cooking shrinkage, whereas sensory evaluation covered color, aroma, texture, and flavor. Data were analyzed using analysis of variance (ANOVA), followed by the Bonferroni test to identify significant differences among treatments. The results demonstrated that the addition of purple sweet potato flour significantly improved water-holding capacity, reduced cooking shrinkage, and enhanced the color and flavor of the sausages ($P < 0.01$). However, no significant effects were observed on aroma and texture ($P > 0.05$). Among all treatments, the addition of 40 g of purple sweet potato flour (T4) produced the most favorable physical and sensory characteristics, receiving the highest consumer preference scores. These findings indicate that incorporating up to 40 g of purple sweet potato flour effectively improves the quality, nutritional value, and overall acceptability of sausages made from spent laying hens, providing a promising approach for developing functional and value-added poultry products

INTRODUCTION

Chicken meat is a source of animal protein that is highly nutritious, readily available, and widely consumed by the public. In addition to broiler chickens, culled laying hens also have significant potential as raw materials for processed meat products. Culled laying hens are hens whose egg-laying cycle has ended, making it no longer economically viable to keep them. The relatively abundant supply of culled laying hens presents an opportunity to utilize them as raw materials for the food industry, including in the production of processed sausage products. Their use as food ingredients can increase added value while reducing waste from the poultry sector. However, the longer rearing period causes more connective tissue to develop in the meat, resulting in a tougher texture compared to broiler chickens (Mandagi et al., 2025). These characteristics can affect the quality of processed products—particularly their texture, water-holding capacity, and consumer acceptance—so efforts are needed to improve The sensory and bodily attributes of processed products manufactured from laying hens that have been culled so that they can compete with other processed products on the market.

Sausage is a popular processed meat product because it is convenient, has a distinctive flavor, and can be made from various types of meat. Sausage production requires fillers, which play a role in forming the emulsion structure, improving texture, enhancing water-holding capacity and product yield, and influencing the product's sensory characteristics (Sasahan et al., 2021). Commonly used fillers include tapioca starch and wheat flour; however, the use of starch derived from local food ingredients offers an alternative that is expected to enhance functional value while supporting food diversification. One local ingredient with potential for use as a Purple sweet potato flour (Ipomoea batatas L.) is used as a filler. This flour contains starch, which plays a role in texture formation, as well as anthocyanins, which function as natural colorants and antioxidants (Ratulangi et al., 2022). Its use is expected to enhance the physical and sensory Sausage quality while enhancing the product's functional value. Numerous Research has been conducted on the application of various types of flour as sausage fillers, but information on Purple sweet potato flour's application in sausages made from culled laying hens remains limited, particularly regarding its effects on water-holding capacity, color, aroma, and cooking shrinkage, texture, and flavor. Therefore, this study was conducted to investigate the impact of purple tuber flour on the physical and sensory quality of sausages made from culled laying hens and to determine the optimal level of addition that produces high-quality and palatable sausages.

This study is novel in its use of culled laying hens and purple tuber flour as local raw materials in sausage formulations. It is anticipated that the findings of this study will form the foundation for the creation of value-added, high-quality processed meat products that support food diversification based on local resources.

LITERATURE REVIEW

The development of value-added meat products from spent laying hens has gained increasing attention as a sustainable strategy to improve the economic

value of poultry by-products while reducing food waste. Although spent laying hen meat has a nutritional composition comparable to broiler meat, its tougher texture and lower consumer acceptance require processing innovations to enhance its marketability. According to the Indonesian Food Composition Tables, spent laying hen meat contains high-quality protein with relatively low fat content, making it a suitable raw material for processed meat products despite its reduced tenderness (Anonymous, 2018). Converting spent laying hen meat into sausages represents an effective approach to improve its sensory quality and commercial value while extending shelf life.

Sausages are one of the most widely consumed processed meat products because of their convenience and consumer acceptance. However, conventional sausages generally contain high fat and low dietary fiber, creating opportunities for incorporating plant-based ingredients to improve their nutritional quality. The Indonesian National Standard (SNI 3820:2015) specifies quality requirements for meat sausages, emphasizing acceptable physical, chemical, microbiological, and sensory characteristics to ensure consumer safety and product consistency (National Standards Agency, 2015). Therefore, selecting appropriate fillers and functional ingredients is essential for producing high-quality sausage products.

The use of fillers has an important role in improving sausage quality. Bulkaini et al. (2020) reported that tapioca flour functions as an emulsion stabilizer, enhances water-holding capacity, reduces cooking loss, and improves product texture in sausages made from spent laying hens. Improved water retention contributes to better tenderness and juiciness while minimizing nutrient losses during thermal processing. These findings suggest that replacing or complementing conventional fillers with functional plant-based flours may further enhance sausage quality.

Purple sweet potato (Ipomoea batatas L.) has attracted considerable interest as a functional food ingredient due to its rich nutritional composition. Astawan and Widowati (2005) explained that purple sweet potato contains carbohydrates, dietary fiber, vitamins, and bioactive compounds that support its development as a functional food ingredient. Similarly, Rijal et al. (2019) demonstrated that purple sweet potato flour retains significant levels of carbohydrates, dietary fiber, and minerals after processing, making it suitable as a natural filler in processed food products.

One of the most valuable components of purple sweet potato is its anthocyanin content, which functions as a natural antioxidant. Ratulangi et al. (2022) reported that incorporating purple sweet potato flour into chicken nuggets significantly increased antioxidant activity while maintaining desirable chemical quality. Anthocyanins not only contribute health-promoting properties but also provide a stable natural purple pigment, allowing food manufacturers to reduce dependence on synthetic colorants while enhancing product appearance.

Several previous studies have investigated the application of purple sweet potato flour in meat products. Sasahan et al. (2021) found that adding purple sweet potato flour improved the sensory properties of chicken sausages, particularly color and overall acceptability, without negatively affecting aroma. Likewise, Ratulangi and Rimbing (2021) demonstrated that supplementation

with purple sweet potato flour improved the sensory quality and physical properties of chicken nuggets, producing products with favorable texture and consumer acceptance. These findings indicate that purple sweet potato flour has broad potential as a functional ingredient in processed poultry products.

Storage stability has also been examined in relation to purple sweet potato supplementation. Ratulangi et al. (2024) reported that chicken nuggets containing purple sweet potato flour maintained acceptable quality during different storage periods, suggesting that the flour contributes not only nutritional benefits but also product stability. The antioxidant properties of anthocyanins may help reduce oxidative deterioration during storage, thereby extending product shelf life.

Previous research has also explored the fortification of spent laying hen sausages using vegetable-based ingredients. Palandeng et al. (2016) reported that carrot paste improved the physicochemical characteristics and sensory acceptability of sausages produced from spent laying hens, demonstrating that plant-derived ingredients can successfully enhance processed poultry products. This supports the concept that combining animal protein with nutrient-rich plant materials can simultaneously improve nutritional quality and consumer preference.

The physical quality of processed meat products is strongly associated with water-holding capacity and cooking loss. According to Soeparno (2005), higher water-holding capacity generally results in lower cooking loss, better tenderness, and reduced nutrient loss during cooking. Supporting this view, Ismanto et al. (2020) found that improved water retention significantly enhanced the physical characteristics and overall quality of chicken sausages, indicating that ingredient selection plays a crucial role in determining product performance.

Consumer acceptance ultimately depends on sensory characteristics such as color, aroma, texture, and flavor. Setyaningsih et al. (2010) emphasized that sensory evaluation using hedonic testing remains the most reliable approach for determining consumer preferences in food product development. Color is often the first quality attribute influencing purchasing decisions, followed by texture, aroma, and taste. Consequently, incorporating natural ingredients that simultaneously improve nutritional value and sensory quality is highly desirable for modern functional food development.

METHODS

Research Design

This study is an experimental study using a quantitative approach. The treatments involved varying levels of purple tuber flour addition, which were compared based on physical and sensory quality parameters. Physical quality was evaluated by 25 semi-trained panelists as replicates (Setyaningsih, 2010 in Ratulangi et al., 2022) using a hedonic scale with a score of 1 = strongly dislike, 2 = dislike, 3 = somewhat like, 4 = like, and 5 = strongly like. The study used a Completely Randomized Design (CRD) in which each treatment had an equal chance of being assigned to each experimental unit (Malau, 2023).

Research Materials

The ingredients used were the breast meat of culled laying hens, purple yam flour, red onions, garlic, pepper, cooking oil, flavor enhancer, salt, nutmeg, ginger, cloves, oil, skim milk, cucumber, and ice cubes as needed.

The equipment used included a mixer, a meat grinder, plastic sleeves, an ice crusher, a bench scale, a gas stove, a water bath, wool thread, baking pans, a thermometer, and a refrigerator. Organoleptic testing materials included tissues, water, questionnaire forms, and writing utensils.

Data Collection and Analysis Techniques

Data were obtained through observations and measurements of physical quality, as well as sensory testing. The data were analyzed utilizing analysis of variance (ANOVA) at a 95% confidence level ($\alpha = 0.05$), and where the findings showed noteworthy variations, a Bonferroni test was conducted to determine the best treatment.

Research Variables

Physical attributes, such as water-holding capacity and cooking uniformity, and sensory attributes, such as color, aroma, texture, and flavor, were the factors that were noted.

The Process of Making Purple Tuber Flour

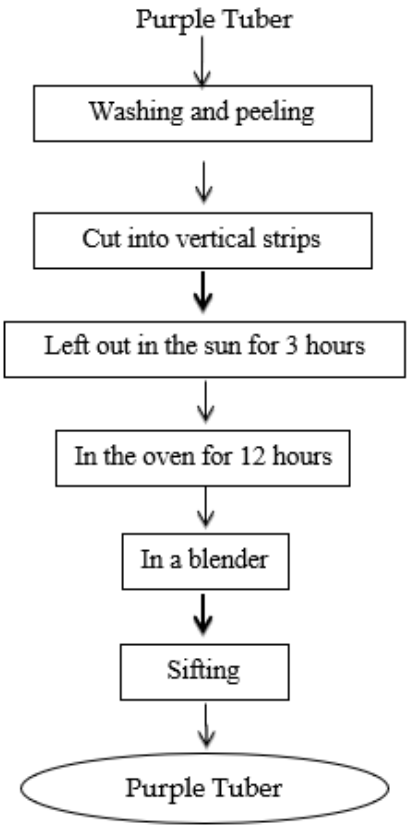

Figure 1. Flowchart of The Purple Tuber Flour Production Process

The Process of Making Sausage from Culled Laying Hens

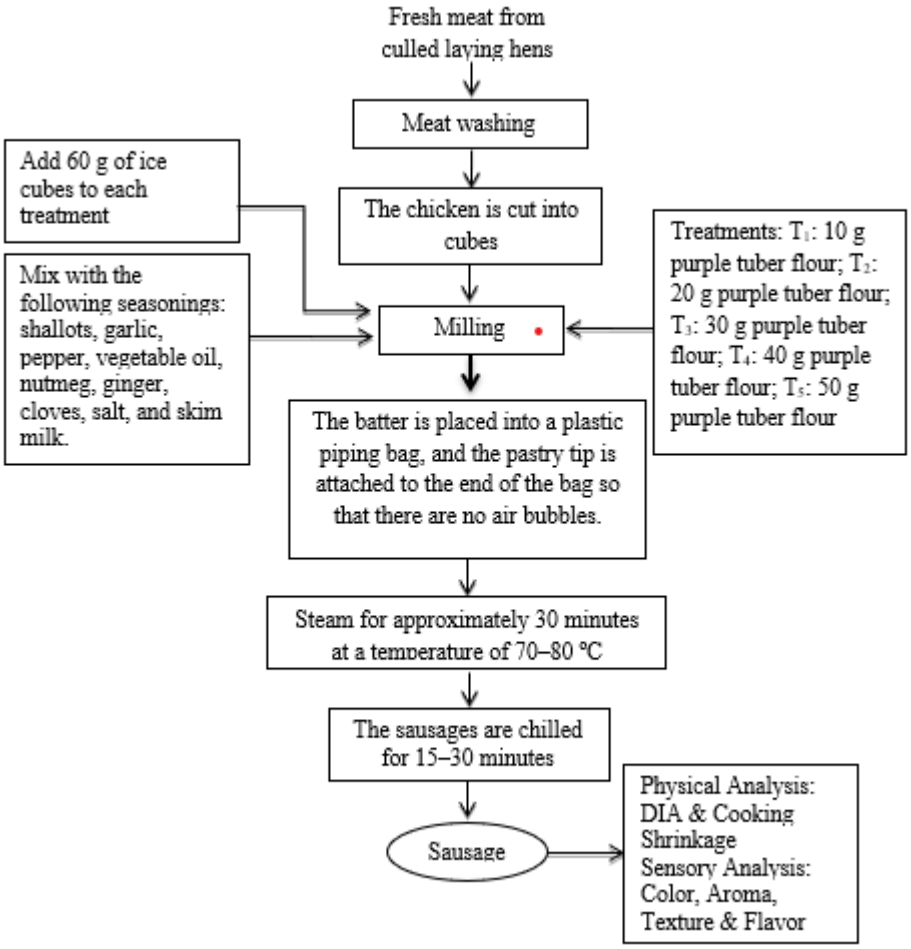

Figure 2: Flowchart of the Process for Making Purple Tuber Flour Sausag

RESULTS

Table 1 shows information on how adding purple tuber flour affected the cooking loss and water-holding capacity of sausages manufactured from culled laying hens.

Table 1. Average Values for the Physical Characteristics of Cooking Shrinkage and Water-Holding Capacity of Sausages Manufactured from Culled Laying Hens with Purple Tuber Flour.

Variable	Treatment				
	T_1	T_2	T_3	T_4	T_5
Water-Binding Capacity	31,59 [a]	35,72[b]	37,85[c]	40,86[d]	37,90[ce]
Cooking Shrinkage	11,38 [a]	9,20 [b]	7,84 [c]	3,94[d]	3,98[de]

Note: A statistically significant difference is shown by different superscripts on the same row. ($P<0.05$)

Water-Binding Capacity of Sausages Made from Culled Laying Hens

Observation The physical quality of the water-binding capacity of sausages manufactured from the meat of culled laying hens supplemented with purple yam flour ranged from 31.59% to 40.86%, with treatment T1 having the lowest average value at 31.59% and treatment T4 having the greatest average value at 43.86%. As more purple tuber flour was utilized, the water-binding capacity parameter's value increased. With each addition of purple tuber flour, the water-binding capacity value increased from 31.59% in treatment T1 to 40.86% at a level of 40 g in treatment T4.

The analysis of variance's findings for chicken sausage made from culled laying hens with Purple's addition tuber flour showed a significant impact ($P < 0.05$). The post-hoc test for honest significant differences revealed that treatment T1 differed significantly from treatments T2, T3, T4, and T5. Treatment T2 differed significantly from treatments T3, T4, and T5. Treatment T3 differed from T4 but was the same as T5, and treatment T4 differed from T5. Based on the BNJ post-hoc test, treatment T4—the addition of 40 g of purple tuber flour—was the best treatment for the water-binding capacity of sausages made from culled laying hens. This suggests that because purple tuber flour contains starch, it can improve the water-binding capability of sausages manufactured from culled laying hens. Hidayat and associates (2023) state that high water-binding capacity results in a gel with higher viscosity, which increases the product's elasticity and thus affects its tenderness.

Cooking Shrinkage of Sausages Made from Culled Laying Hens

The observed physical quality data for cooking shrinkage of chicken sausages made from culled laying hens and supplemented with purple tuber flour ranged from 3.94% to 11.38%, The cooking shrinkage parameter is inversely related to water-binding capacity, with treatment T4 having the lowest mean value at 3.94% and treatment T1 having the highest mean value at 11.38%. The cooking shrinkage value decreases as more purple yam flour is applied. The analysis of variance (ANOVA) findings on the effect of purple yam flour addition to sausages made from culled laying hens showed an important impact ($P < 0.05$). Furthermore, based on Purple yam flour was added to the treatment, and the results of the post-hoc test for significant differences T1 differed significantly from T2, T3, T4, and T5, while treatment T2 differed significantly from T3, T4, and T5, treatment T3 differed significantly from T4 and T5, but treatment T4 did not differ significantly from T5.

Treatment T4, with the addition of 40 g of purple tuber flour, was the best treatment for reducing cooking shrinkage in sausages made from culled laying hens. This indicates a reduction in cooking loss in sausages made from culled laying hensimpacted by changes in the quantity of purple sweet potato flour applied; treatment doses range from 10 g (T1) to 50 g (T5). This decrease in cooking loss indicates that purple sweet potato flour has a considerable ability to hold onto the product's moisture content throughout cooking. This is explained by the purple sweet potato flour's capacity to function as a strong binding agent inside the sausage matrix. Because purple sweet potato flour is high in starch and

fiber, it can create a strong gel matrix that reduces water loss while cooking. According to Soeparno (2005) in Masyithoh et al. (2024), meat with lower cooking shrinkage has comparatively better quality than meat with higher cooking shrinkage because there is less nutrient loss while cooking. In a similar vein, the findings of Ismanto's (2020) research show that low cooking loss is linked to higher quality than high cooking loss, which leads to reduced nutritional loss during cooking.

Table 2. Mean Sensory Quality Scores for Color, Aroma, Texture, and Flavor of Sausages Made from Culled Laying Hens Using Purple Tuber Flour.

Variables	Treatments				
	T_1	T_2	T_3	T_4	T_5
Color	$3{,}41^{a}$	$3{,}85^{b}$	$3{,}97^{cb}$	$4{,}79^{d}$	$4{,}81^{de}$
Aroma	3,90	3,93	4,02	3,94	4,05
Texture	3,97	4,03	4,11	4,20	4,18
Flour	$3{,}50^{a}$	$3{,}92^{b}$	$4{,}23^{cb}$	$4{,}67^{d}$	$3{,}94^{be}$

Note: A statistically significant difference is shown by different superscripts on the same row. ($P<0.05$)

Color of Sausage Made from Culled Laying Hens

The sensory evaluation data for the color of sausages made from culled laying hens' meat to which purple tuber flour was added ranged from 3.41 to 4.81, with the lowest mean value of 3.41 (somewhat liked) in treatment T1 and the highest mean value of 4.81 (very liked) in treatment T5; indicating that the level of color preference for the culled laying hen chicken sausage increased with higher levels of purple tuber flour added. The analysis of variance (ANOVA) findings for the inclusion of purple tuber flour demonstrated a notable impact ($P < 0.05$) on the degree of color preference for the culled laying hen chicken sausage. Furthermore, The addition of purple tuber flour in treatment T1 differed significantly from T2, T3, T4, and T5; treatment T2 differed significantly from T4 and T5 but was the same as T3; treatment T3 differed significantly from T4 and T5; and treatment T4 did not differ significantly from T5, according to the findings of the post-hoc test for significant differences.

The degree of fondness for the hue of sausages made from culled laying hens' meat showed that as more purple tuber flour was added up to 50 g, panelists responded with the highest score of 4.81 (like very much), This is due to the natural anthocyanin pigment content found in purple tuber flour; when added as a treatment during the processing of culled laying hen chicken sausage, it produces a very significant purple color effect in the final sausage product. The purple color in the spent layer chicken meat sausages with purple tuber flour added up to 50 g was highly preferred, just as it was at the 40 g level. The appeal of the purple color displayed in treatments T4 and T5 gave the same impression that it was highly preferred compared to the purple color in treatments T1, T2, and T3. According to Ratulangi et al. (2022), anthocyanins are natural pigments that have the potential to provide natural color, resulting in an attractive

appearance in processed products. The natural anthocyanin color from purple sweet potatoes provides a stable intensity of purple color.

The Fragrance of Culled Laying Hen Sausage

The sensory evaluation data for the aroma of sausages made from the meat of culled laying hens supplemented with purple tuber flour ranged from 3.90 to 4.05, with treatment T1 having the lowest mean score of 3.90 (liked) and treatment T5 having the highest mean score of 4.05 (liked). This suggests that the addition of purple tuber flour increased the aroma likability of the culled laying hen chicken sausage.

The degree of fragrance likeability of the culled laying hen chicken sausage was not significantly affected ($P > 0.05$) by the addition of purple tuber flour at levels of 10–50 g, according to the analysis of variance data. The sensory preference for the aroma of sausages made from culled laying hens was unaffected by the addition of purple sweet potato flour; that is, the treatment involving the addition of purple sweet potato flour was the same for each treatment. Although the data indicated differences in the sausages' aroma values, these differences were either equivalent or not statistically significant. The deteriorated starch content of sweet potato flour is what gives it its distinctive scent, therefore adding purple sweet potato flour has no effect. Ratulangi et al. (2021) and Ashari et al. (2023) claim that sweet potatoes' degraded carbohydrate content is what gives them their aroma and flavor. According to the observational data, treatments T1 through T5 are regarded as equal since they had no discernible impact on the culled laying hen sausage's aroma.

Texture of Sausage Made from Culled Laying Hens

The sensory evaluation data for the texture of sausages made from culled laying hens' The range of meat with added purple tuber flour was 3.97 to 4.20, with treatment T1 having the lowest mean value of 3.97 (liked) and treatment T4 having the highest mean value of 4.20 (liked). This suggests that adding purple yam flour improved the texture of sausages made from culled laying hens. The texture of the final sausages was not significantly affected ($P > 0.05$) by the addition of purple yam flour at various quantities, according to the analysis of variance data.

The sensory acceptability of the texture of nuggets made from culled laying hens was unaffected by the addition of purple tuber flour, indicating that the purple tuber flour treatment was the same for each treatment. The texture acceptability scores for sausages manufactured from culled laying hens varied, according to the data, but these changes were deemed equal and not statistically significant. Because the purple yam flour was processed correctly, producing a fine-grained and homogenous flour, the treatment including the addition of purple yam flour to spent laying hen chicken sausage products had no influence on texture acceptability. This is consistent with the findings of Ratulangi et al. (2024), who reported that adding purple sweet potato flour to sausage manufacture produces a smooth and soft texture, which is strongly dependent on the amount and fineness of the purple sweet potato flour used. Additionally,

according to Sasahan et al. (2021) and Afifah and Adi (2024), the mixture's composition, processing, and storage all have a significant impact on the soft texture of sausages.

The Flavor of Sausage Made from Culled Laying Hens

The sensory evaluation data for the taste of sausages made from culled laying hens' meat with purple tuber flour added varied from 3.50 to 4.67, with the lowest mean score of 3.50 (somewhat like) in treatment T1 and 4.67 is the highest mean score. (very much like) in treatment T4; indicating that the level of preference for the taste of sausages made from culled laying hens' meat increases with the addition of purple tuber flour. The degree of preference for the color of the meat from culled laying hens was significantly affected ($P < 0.05$) by the addition of purple tuber flour, according to the results of the analysis of variance (ANOVA). Additionally, the inclusion of purple tuber flour in treatment T1 differed considerably from T2, T3, T4, and T5, according to the results of the post-hoc test for significant differences. while treatment T2 differed significantly from T4 but not significantly from T3 and T5; treatment T3 differed significantly from T4 but not significantly from T5; and treatment T4 differed significantly from T5. The sensory liking scores for the flavor of sausages made from culled laying hens' meat indicate that as The panelists gave the maximum score of 4.67 (like very lot) when the amount of purple tuber flour increased to 40 g. The reviewers suggested that adding up to 40 g of purple sweet potato flour to the sausages produced the most favored flavor and offered a distinctive appeal to the flavor. Because it includes sucrose, purple sweet potato flour is a preferred food ingredient in deciding flavor. Purple sweet potato flour includes sucrose, which gives it a sweet flavor, according to Ratulang et al. (2024).

CONCLUSIONS AND RECOMMENDATIONS

Conclusion

The best physical and sensory attributes are produced when sausages manufactured from culled laying hens are combined with up to 40 g of purple tuber flour, which also increases customer acceptance and product quality.

Recommendations

To ascertain whether using purple tuber flour as an additive in the sausage processing industry is feasible, future research is advised to look at the impact of adding purple tuber flour on the product's nutritional content, antioxidant activity, shelf life, and microbiological characteristics.

FURTHER STUDY

This study still has limitations, so further research on Physical And Sensory Quality Of Sausages Made From Spent Laying Hens Using Purple Sweet Potato Flour (Ipomoea Batatas L) is needed to refine this study and enhance the insights of readers and the authors.

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