Journal of Culinary Technology and Education

Volume 1, No. 1, Inaugural Issue 2024 (58-65)

Online: https://journal.uny.ac.id/publications/jcte

Enhanced Calcium Content in Puli Crackers through Fortification of Free-Range Chicken Pasta

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Received: 24 June 2024 **Accepted:** 30 June 2024 **Published:** 30 June 2024

ABSTRACT

This research aims to: (1) develop a nutrient-rich formula for free-range chicken Puli crackers; (2) identify the formula most preferred by panelists; (3) determine the nutritional content of the crackers using the proximate method; (4) assess changes in calcium levels during processing; (5) evaluate the portion size that meets calcium requirements; and (6) determine the shelf life of the crackers. The research was conducted in three stages: production of the crackers, preference testing, and nutritional content analysis. Production and preference testing took place at the PTBB FT UNY laboratory from March to June 2010, while nutritional analysis was performed at the CV Chem-Mix Pratama laboratory in July 2010. The preference test utilized the Hedonic method with 30 panelists, including 25 students and five lecturers from the Culinary Engineering Education Study Program PTBB FT UNY. Nutritional analysis included proximate analysis and fiber content measurement, covering water, ash, fat, protein, and carbohydrate contents. The results of this research are: (1) product formula variations of 10%, 30%, and 50% free-range chicken; (2) the 30% formula was the most preferred by panelists; (3) proximate analysis revealed water content of 2.4929%, ash content of 3.0289%, protein content of 15.1557%, fat content of 9.7012%, and carbohydrate content of 66.7105%; (4) calcium content decreased from fresh free-range chicken to pre-cooked chicken by 0.8532%, and from pre-cooked chicken to crackers by 0.5170%, with the final calcium content in the crackers being 1.2062%; (5) each serving of the crackers (2.5 g, or one piece) contains 0.02% of the recommended daily calcium intake (800 mg), and a 50 g package contains 1% of the recommended intake; (6) the shelf life of the crackers packaged in plastic is one month at room temperature (25-30°C).

Keywords: Fortification, chicken pasta, calcium content, Puli crackers

INTRODUCTION

The public's great interest in consuming free-range chicken stems from the superior taste of its meat compared to that of broiler chicken. Free-range chickens are raised in more natural conditions, which is

https://doi.org/10.21831/jcte.v1i1.505

believed to contribute to the enhanced flavor and quality of their meat (Bagus Harianto, 2010). This preference has driven an increasing demand for free-range chicken to meet consumer needs.

Fortification is the process of adding essential nutrients to food products to enhance their nutritional value (Pangestuti, 2004). One potential application of fortification is in the production of Puli crackers by incorporating calcium from free-range chicken bones. This process can be achieved by creating a pasta from free-range chicken carcasses, which can then be added to the crackers, thus increasing their calcium content and nutritional value.

Despite the benefits of consuming free-range chicken, there is a need to address nutritional deficiencies, particularly calcium, in the general population. Puli crackers, a traditional snack, offer an excellent medium for fortification with calcium. Utilizing free-range chicken bones for this purpose not only enhances the nutritional profile of the crackers but also adds value to the product.

The general solution proposed is to develop a fortified version of Puli crackers by incorporating calcium-rich free-range chicken pasta. This approach leverages the natural rearing methods of free-range chickens, which are known to improve the quality of chicken products, and combines it with the nutritional benefits of calcium fortification.

Fortifying free-range chicken pasta to increase the calcium content in Puli crackers involves incorporating calcium-rich ingredients into the pasta, such as calcium-fortified soy or egg white protein, which can significantly enhance the calcium content (Rachman, 2019). Additionally, the choice of rearing system for the chickens plays a crucial role in the quality of the final product. Studies have shown that free-range rearing systems not only improve the overall product quality of chickens but also positively impact their microbial richness (Chen, 2018).

Furthermore, free-range chickens have access to natural environments, which can influence their gut microbial diversity and overall gut health (Hou L. S., 2020); (Hou L. S., 2019). This natural rearing method ensures that the chickens are healthier and their by-products, such as bones used in pasta, are of higher quality and nutritional value.

However, it is essential to consider potential risks associated with free-range systems. Free-ranging chickens may be more susceptible to Salmonella contamination due to exposure to wild birds and other carriers of the bacteria (Bailey, 2005). Therefore, stringent biosecurity measures should be implemented to mitigate such risks (Scott, 2018). Moreover, free-range chickens can serve as important sentinels for parasites like Toxoplasma gondii, highlighting the need for monitoring and control measures (Hamilton, 2019).

The existing literature provides substantial evidence on the benefits of fortifying food products with calcium to address nutritional deficiencies. Studies have demonstrated the effectiveness of incorporating calcium-fortified ingredients, such as soy and egg white protein, into various food products to enhance their nutritional value (Rachman, 2019). Furthermore, the advantages of free-range rearing systems in improving the quality of chicken products have been well-documented (Rachman, 2019); (Hou L. S., 2020); (Hou L. S., 2019).

However, there remains a gap in the specific application of these findings to traditional food products like Puli crackers. While the benefits of free-range rearing and calcium fortification are clear, their combined application in Puli crackers has not been extensively explored. Additionally, the potential risks associated with free-range rearing, such as Salmonella contamination and exposure to parasites, necessitate further investigation to develop effective mitigation strategies (Bailey, 2005); (Hamilton, 2019).

Based on its nutritional content, it is highly expected that the free-range chicken Puli cracker product will become one of the foods that can fulfill nutritional needs, especially calcium content, for the general public. Therefore, consuming free-range chicken Puli crackers is highly recommended.

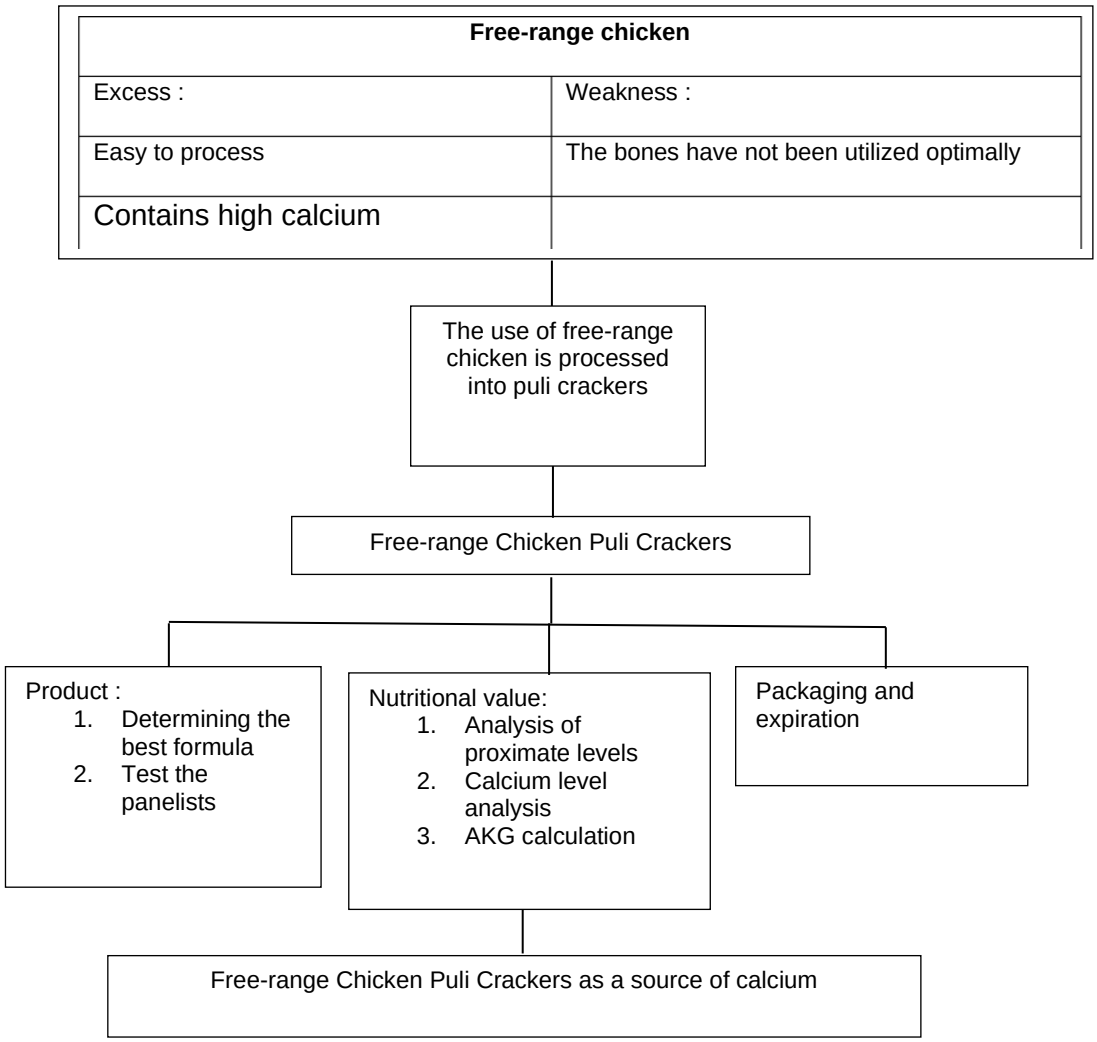

Figure 1. Framework Flowchart

The objective of this study is to develop a fortified version of Puli crackers by incorporating calcium-rich free-range chicken pasta. This innovative approach aims to enhance the nutritional value of Puli crackers, particularly their calcium content, to better meet the dietary needs of the general public. The novelty of this research lies in the unique combination of free-range chicken rearing and calcium fortification in a traditional food product, which has not been extensively studied.

The scope of the study includes evaluating the calcium content and overall nutritional profile of the fortified Puli crackers, assessing the quality and safety of the free-range chicken pasta, and examining consumer acceptance of the fortified product. By addressing these aspects, the study aims to contribute to the development of nutritious, high-quality food products that can enhance public health and meet consumer demands.

PURPOSE OF THE STUDY

The aim of this research are as follows: (1) Develop a nutrient-rich formula for free-range chicken Puli crackers; (2) Identify the most preferred formula among panelists; (3) Analyze the nutritional content

using the proximate method; (4) Assess changes in calcium levels during processing; (5) Determine the portion size required to meet daily calcium needs; (6) Establish the shelf life of the crackers.

RESEARCH METHODS

The materials used in this research included free-range chicken carcasses obtained from local farms, used for making the chicken pasta. Other ingredients required for making the Puli crackers were rice flour, water, and seasoning, which were sourced from standard suppliers. For the fortification process, calcium-fortified ingredients such as soy and egg white protein were utilized, as highlighted in previous studies (Rachman, 2019). The reagents and chemicals for the proximate analysis and fiber content analysis were procured from certified suppliers to ensure accuracy and reliability in the nutritional analysis (Hou L. S., 2020).

Participants

The sample preparation involved three stages: making the free-range chicken Puli crackers, conducting liking tests, and analyzing nutritional content. Initially, the free-range chicken carcasses were processed into pasta using a milling or blender process. This pasta was then mixed with rice flour and other ingredients to create the cracker dough. The dough was shaped into crackers and baked until crisp. Three samples were prepared with varying percentages of free-range chicken pasta (10%, 30%, and 50%), coded as 100, 101, and 102, respectively. These samples were prepared at the PTBB FT UNY laboratory from March to June 2010.

The experimental set-up for this research comprised three main stages: production, preference testing, and nutritional analysis. The production of the free-range chicken Puli crackers involved creating three different formulations with varying levels of chicken pasta. Preference testing was conducted using the Hedonic method, involving 30 panelists (25 students and five lecturers from the Culinary Engineering Education Study Program at PTBB FT UNY). The panelists rated the samples based on appearance, texture, taste, and overall acceptance. Nutritional content analysis was performed at CV Chem-Mix Pratama laboratory in July 2010, using proximate analysis to determine water, ash, fat, protein, and carbohydrate content (Bailey, 2005); (Scott, 2018).

Data Collection and Analysis

The parameters measured in this study included the proximate composition of the fortified Puli crackers, specifically water content, ash content, fat content, protein content, and carbohydrate content. Additionally, the fiber content of the crackers was analyzed. The liking test parameters included sensory attributes such as appearance, texture, taste, and overall acceptance, assessed using a Hedonic scale. Each sample was coded (100, 101, 102) and evaluated by the panelists to determine the preferred formulation (Chen, 2018); (Hou L. S., 2019).

Data from the liking tests and nutritional analysis were statistically analyzed using Analysis of Variance (ANOVA) to identify significant differences between the different formulations of the Puli crackers. The Hedonic method results were analyzed descriptively to summarize panelists' preferences. The proximate analysis data were also statistically evaluated to determine the impact of varying levels of free-range chicken pasta on the nutritional content of the crackers. This approach ensured a rigorous assessment of the data, enabling reliable conclusions to be drawn from the study (Hamilton, 2019); (Hou L. S., 2020).

FINDINGS

Presto Cooking of Free-Range Chicken

The process of presto cooking free-range chicken involves subjecting the chicken to high pressure with the aid of water steam and heating for approximately two to three hours. This high pressure causes the bones of the free-range chickens to become soft.

Product Formula Results for Free-Range Chicken Puli Crackers

Table 1 shows that the texture characteristics of free-range chicken Puli crackers in formula 1 differ from those in formulas 2 and 3. This is due to the lower amount of free-range chicken used in formula 1 (10%) compared to formula 2 (30%) and formula 3 (50%).

Table 1. Product Formula of Free-range Chicken Puli Crackers

No	Free-range Chicken Puli Crackers	Characteristics			
		Taste	Flavor	Color	Texture
1	Control	Tasty	Tasty	White	Crunchy
2	Formula 1	Tasty	Tasty	Whitish Yellow	Crunchy
3	Formula 2	Tasty	Free-range Chicken	Golden Yellow	Crunchy
4	Formula 3	Tasty	Free-range Chicken	Brown	Slightly Crunchy

Liking Test Results for Free-Range Chicken Puli Crackers

The panelists' liking test results indicate no significant difference between formula 2 and formula 3. However, the color preference for formula 1 and formula 2 was significantly different from that for formula 3. No significant differences were found in the aroma preference among the three formulas. The taste preference for formula 2 was not significantly different from that for formula 3. The texture preference for all three formulas did not show any significant differences.

Nutrient Content in Free-Range Chicken Puli Crackers Using Proximate Analysis

Table 2 indicates that the free-range chicken Puli crackers have a high carbohydrate content, which contributes to the non-crisp texture of the crackers.

Table 2. Analysis Results of Free-range Chicken Puli Crackers

Sample	Type of Analysis	Analysis Results		Sample Mean
		Repetition I	Repetition II	
Free-Range Chicken Puli Crackers	Water content (%)	2,5012	2,4847	2,49295
	Ash content (%)	3,0069	3,0510	3,02895
	Protein content (%)	15,1110	15,2003	15,1556
	Fat content (%)	9,7672	9,6352	9,7012
	Fiber content (%)	2,9818	2,8400	2,9109
	Carbohydrate (%)	66,633	66,7880	66,7105
	Calcium (%)	1,21302	1,1994	1,20621

Changes in Calcium Levels in Free-Range Chicken Puli Crackers During Processing

The analysis shows no significant difference in the calcium levels of the free-range chicken Puli crackers during processing.

Calculation of the Portion of Free-Range Chicken Puli Crackers to Meet Calcium Requirements

Free-range chicken Puli crackers are considered a snack. The recommended daily calcium intake is 800 mg. The calcium content of free-range chicken Puli crackers meets 0.02% of the total recommended calcium consumption. To meet daily calcium needs, one should consume other calcium-rich food sources in addition to these crackers.

Determination of Expiry Date for Free-Range Chicken Puli Crackers

Sensory tests were conducted with two panelists after storing the free-range chicken Puli crackers for one week, two weeks, three weeks, and four weeks in secondary packaging (plastic measuring 12 x 25 x 08). The panelists compared the aroma, texture, taste, and color of the stored crackers with those of freshly made crackers. The results suggest that the crackers have a shelf life of one month when stored at room temperature (25-30°C).

DISCUSSION

The study's findings demonstrate the effectiveness of fortifying Puli crackers with free-range chicken to enhance their calcium content. Proximate analysis of the crackers revealed the following nutritional composition: 2.4929% water, 3.0289% ash, 15.1557% protein, 9.7012% fat, and 66.7105% carbohydrates. Notably, the calcium content of the fortified crackers was measured at 1.2062%, which represents a significant increase in calcium levels compared to traditional crackers. Additionally, sensory evaluation indicated that the formula containing 30% free-range chicken was the most preferred among panelists, suggesting that the fortification did not adversely affect the product's sensory attributes.

The enhanced calcium content observed in the fortified Puli crackers aligns with previous studies that highlight the efficacy of calcium fortification in improving nutritional profiles of food products (Cormick et al., 2021; Palacios et al., 2020). Similar fortification strategies have been applied successfully in other food matrices, such as pasta, where calcium sources like eggshell powder and nano-calcium have been utilized to increase calcium levels (Prayitno et al., 2022; Nugraha & Bata, 2021). The nutritional benefits observed in this study are consistent with findings from Palacios et al. (2022) and Afzal (2020), who reported that calcium fortification is a cost-effective method to address dietary deficiencies. Furthermore, the minimal reduction in calcium content during processing, as evidenced in this study, corroborates the findings of Durotoye et al. (2022), who noted improved physicochemical properties in fortified products.

The implications of these findings are significant both scientifically and practically. From a scientific perspective, the study contributes to the body of knowledge on food fortification by demonstrating that incorporating free-range chicken can substantially enhance the calcium content of Puli crackers without compromising their sensory qualities. This aligns with the recommendations by Cormick et al. (2020) and Wagner et al. (2005) on the importance of adhering to regulatory guidelines to ensure the safety and effectiveness of fortified foods. Practically, the fortified crackers offer a viable solution for populations at risk of calcium deficiency, providing an accessible and enjoyable means to increase calcium intake. This study's approach also presents a model for future fortification efforts in various food products, potentially aiding in broader public health initiatives aimed at improving dietary mineral intake.

CONCLUSION

This study successfully developed and evaluated fortified Puli crackers using free-range chicken pasta, focusing on enhancing their calcium content. The variations in product formulas included three different concentrations of free-range chicken pasta: formula I with 10%, formula II with 30%, and formula III with 50%. Sensory evaluation using the Hedonic method revealed that panelists preferred formula II, which contained 30% free-range chicken pasta. Nutritional analysis through proximate analysis demonstrated that the Puli crackers had a water content of 2.4929%, ash content of 3.0289%, protein content of 15.1557%, fat content of 9.7012%, and carbohydrate content of 66.7105%. Calcium content analysis showed a reduction during processing, with fresh free-range chicken calcium levels decreasing by 0.8532% after cooking and by 0.5170% after pressure-cooking. The final calcium content in the Puli crackers was 1.2062%. Each 2.5 g serving of free-range chicken Puli crackers, consisting of one piece, provided only 0.02% of the recommended daily calcium intake (800 mg). Furthermore, the study established that the shelf life of these crackers, when packaged in plastic and stored at room temperature (25°C to 30°C), was one month. These findings contribute significantly to the development of nutrient-enriched traditional food products, highlighting the potential of free-range chicken pasta fortification to improve calcium intake. Future research should focus on optimizing fortification levels and investigating consumer health impacts over longer periods. This study underscores the importance of innovative approaches in food fortification, aiming to enhance public health and meet nutritional needs effectively.

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