CHEMICAL CHARACTERISTICS OF HIGH NUTRITIONAL VALUE CRISP PRODUCTION WITH THE ADDITION OF CATFISH PASTE AND TOFU PULP FLOUR

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Abstract

The food industry, particularly the snack sector, has witnessed substantial growth over recent decades. Given the current global trend towards healthier and more sustainable food consumption, there is an urgent need for innovation in crisp production. One proposed method to achieve this is by incorporating catfish bone paste and tofu dregs flour into the cracker formulation, a move that is not only innovative but also aligns with the principles of a circular economy, utilizing waste from the fishing and tofu industries as raw materials, thereby increasing resource efficiency and reducing environmental impact. The long-term goal of this research is to develop crisp that sustainably meet the nutritional needs of the population. To achieve this, specific objectives have been set, including the integration of catfish bone paste and tofu dregs flour into the cracker formulation to enhance protein and calcium content, and to contribute to waste reduction, given the significant by-products from catfish and tofu production in the food industry. The research particularly focuses on the chemical characteristically changes of adding these ingredients into the unfortified crisp. The chosen methodology to reach these specific targets is the Randomized Complete Block Design (RCBD) approach. The methodology employed for assessing the nutritional enhancement characteristics of the crisp involved using chemical tests. Chemical tests measured moisture, ash, protein, and calcium content, with set maximum or minimum thresholds for moisture (max 12%), ash (max 0.2%), and protein (min 5%). These tests were crucial for determining the compliance of the crackers with nutritional standards and ensuring their quality. The chemical analysis revealed the following: the fortified crisp moisture content was well below the maximum of 12%, with values ranging around 5.4% to 5.8%. Ash content varied significantly, with some samples exceeding the maximum limit of 0.2%, indicating a potential discrepancy in the production process. Protein content met the minimum requirement of 5%, with percentages ranging from 5.4% to 9.72%, suggesting good nutritional value. For calcium content, there was a progressive increase across the samples, with the highest percentage at 3.801%, which shows a positive correlation with the addition of catfish bone paste and tofu dregs flour.

Keywords: Crisp Nutritional Enhancement, Catfish bone paste, Crisp Fortification , Tofu Dregs Flour,

I. INTRODUCTION

Krupuk (or in english: crisp), is a popular Indonesian snack across all age groups known for its delicious taste and crispiness, is traditionally made from starch mixed with various seasonings and fried (Wiriono,1984). Available in multiple varieties like tapioca, rice, soybean, and shrimp, crisp typically contains nutrients like water (2.18%), ash (0.23%), fat (22.19%), carbohydrates (66.03%), and calcium (0.086%), as per research by Handayani & Kartikawati (2014). To enhance its nutritional value, innovations involving the addition of catfish bone waste and tofu pulp flour have been proposed to increase the content of calcium and protein. Catfish, a widely-consumed and affordable fish, contributes significantly to aquaculture, with production reaching 23.51 million tons in 2017 (Data Pusat Statistik KKP RI, 2017). However, the industry's growth has resulted in underutilized by-products like fish bones, which can be transformed into calcium-rich food products (Pratiwi, 2013). Calcium, a crucial macro mineral, plays a vital role in human health, with deficiencies leading to growth issues in children and adolescents and osteoporosis in adults (Almatsier, 2004).

Studies by Handayani & Kartikawati (2014) reveal that processed catfish bone and head paste in stick production contain 2.743% calcium and 9.79% protein. Meanwhile, research by Fajaria et al. (2020) found that crisp with added patin fish bone flour and oyster mushrooms had a calcium content of 568.354 mg/100g but a low protein level of 1.46%. This is below the Indonesian National Standard (SNI) 2713.1-2009, which mandates a minimum protein content of 5% for fish crackers, indicating the need for additional ingredients to boost protein levels, such as tofu pulp flour. Tofu pulp, a by-product of tofu production, has high moisture content (80-84%), making it susceptible to spoilage if not stored properly (Suprapti, 2005 & Yustina and Abadi, 2012). Representing about 40% of the tofu industry's waste (Faisal et al., 2016), tofu pulp can be preserved and valorized by processing it into flour. Tofu pulp flour has a higher protein content, reaching 15.20% (Sari et al., 2018), and is versatile for creating nutritious, tasty, and safe food products, such as crisp, cookies, and sticks (Hapsari et al., 2016).

This study focuses on the chemical characteristics of crisp with added catfish bone paste and tofu pulp flour. The integration of these ingredients aims to not only address the waste management issues in the fish and tofu industries but also to enhance the nutritional value of crisp, making it a healthier snack option. The innovative approach demonstrates a sustainable utilization of food industry by-products while contributing to improved dietary choices.

II. METHODOLOGY

A. Materials and Equipment

The study employed specific materials for the production of crisp (a traditional Indonesian snack) enriched with catfish bone paste and tofu pulp flour. These materials included catfish bone paste, tofu pulp flour, 'Cap Gunung Agung' tapioca, water, 'Cap Millenium' salt, and 'Cap Kupu-kupu' baking soda. For testing purposes, the materials used were selenious acid, concentrated sulfuric acid (H2SO4), 4% boric acid (H3BO3), bromocresol green-methyl red (BCG-MR) indicator, 40% sodium hydroxide (NaOH), 0.1N hydrochloric acid (HCl), distilled water, 2% HCl, phenolphthalein indicator, ammonium oxalate, ammonia, and 0.1N potassium permanganate (KMnO4).

The equipment used included a tray dryer, blender, refrigerator, baking pans, a steamer, a basin, knives, spoons, an analytical balance, gloves, a filter cloth, an 80-mesh sieve for the production process, and porcelain dishes, a scoop, a desiccator, a furnace, an oven, aluminum dishes, tongs, a hot plate, a burette, measuring cups, beakers, Erlenmeyer flasks, a Soxhlet extractor, a distillation flask, funnels, dropper pipettes, volumetric pipettes, a spatula, filter paper, a Kjeldahl flask, a Bunsen burner, organoleptic containers, labels, and writing tools for testing.

B. Location

The research was conducted at the Food Laboratory and Chemistry Laboratory of the Faculty of Halal Food Science, Djuanda University, Bogor.

C. Research Method

In this study, the research methodology encompassed three primary phases: preparation of catfish bone paste, tofu pulp flour production, and crisp (Indonesian crackers) production, each following specific protocols. The catfish bone paste was prepared according to the procedure outlined by Novalina & Gede (2021). Initially, catfish bones were procured from Griya Bukit Jaya Gunung Putri market. The bones were thoroughly cleansed with water to remove any impurities. Subsequently, the cleaned bones were steamed for a duration of 1.5 hours to ensure proper cooking and softening. After steaming, the bones were blended with 80 mL of water to create a consistent paste, which would later be used in the crisp mixture.

For the tofu pulp flour, the methodology was adapted from the research of Wati (2013) and Apriadi et al. (2017). The tofu pulp was obtained from a local manufacturer. The initial step in processing the pulp involved pressing it to extract excess moisture, essential for achieving the desired dryness. The pulp was then subjected to steaming at 100°C for 15 minutes. After steaming, the pulp was dried in a tray dryer set at 65°C for 5 hours. The dried pulp was then ground into a fine powder using a blender. This powder was further refined by sieving through an 80 mesh sieve to ensure a smooth and uniform texture, suitable for mixing into the crisp dough.

The crisp production process was conducted using a Completely Randomized Design (CRD) with one factor, which was the varying levels of catfish bone paste and tofu pulp flour added to the crisp mixture. The experiment included four different levels of incorporation: 0% of both ingredients (0% : 0%), 15% of each (15% : 15%), 20% catfish bone paste and 10% tofu pulp flour (20% : 10%), and 25% catfish bone paste and 5% tofu pulp flour (25% : 5%). The production process commenced with the mixing of tapioca, water (constituting 80% of the mixture), 0.5% baking soda, and 3% salt. This mixture was then combined with the pre-prepared catfish bone paste and tofu pulp flour in the specified proportions. After thorough mixing, the dough was steamed, molded into shape, cooled, and then sliced into pieces measuring 2 mm in thickness, 9.5 cm in length, and 4 mm in width. These pieces were dried in a tray dryer at 65°C for 4 hours. The drying process was crucial to reduce moisture content and prepare the crisp for frying. The final stage involved a two-step frying process, where the first fry was at 130°C, followed by a second fry at 200°C, resulting in the final crisp product.

III. RESULTS AND DISCUSSION

In the study, the chemical characteristics of crisp (Indonesian crackers) with the addition of catfish bone paste and tofu pulp flour were evaluated, focusing on moisture content, ash content, protein content, and calcium content.

3.1. Moisture Content:

The moisture content is a critical factor in determining the shelf life and microbial growth in food products. In this study, the moisture content of crisp varied from 5.41% to 6.61% across different treatments: A1 (0:0), A2 (15:15), A3 (20:10), and A4 (25:5), as shown in Table 1. These values are within the maximum 12% moisture content standard as per SNI 2713.1:2009. Notably, the lowest moisture content was observed in treatment A4 (5.41%), while the highest was in A1 (6.61%). This variation suggests that the addition of catfish bone paste and tofu pulp flour influences the moisture content, likely due to their intrinsic water contents of 70.35% and 14.51%, respectively (Kartikawati & Handayani, 2014; Sari et al., 2018). The frying process also played a significant role in reducing moisture content due to evaporation (Winarno, 2008).

Tabel 1. Results of the moisture content (%) in the fortified crisp

Treatment	Test Result (%)
A1 (0:0)	$6{,}61^{a}$
A2 (15:15)	$5{,}83^{b}$
A3 (20:10)	$5{,}44^{b}$
A4 (25:5)	$5{,}41^{b}$

Note : Different letter notation shows significant difference for α = 0,05

3.2. Ash Content:

Ash content, indicative of the mineral content in food, ranged from 2.29% to 7.57% across the treatments. The lowest ash content was observed in treatment A1 (2.29%), and the highest in A4 (7.57%), as detailed in Table 2. This increase in ash content with the addition of catfish bone paste and tofu pulp flour is consistent with their respective ash contents of 7.85% and 2.37% (Kartikawati & Handayani, 2014; Sari et al., 2018). The rising trend of ash content with increased additions confirms that these ingredients contribute significantly to the mineral content of the crisp.

Tabel 2. Result of the ash content (%) in the fortified crisp

Treatment	Test Result (%)
A1 (0:0)	2,29[d]
A2 (15:15)	5,00[c]
A3 (20:10)	6,25[b]
A4 (25:5)	7,57[a]

Note : Different letter notation shows significant difference for $\alpha = 0{,}05$

3.3. Protein Content:

Protein, a vital macromolecule for both biological functions and food quality, showed significant variations in the crisp samples. Treatments ranged from 1.72% to 9.72% protein content, as per Table 3. Treatment A1 had the lowest protein content (1.72%), while A2 had the highest (9.72%). These findings align with the protein contents of catfish bone (6.75%) and tofu pulp flour (15.20%) (Kartikawati & Handayani, 2014; Sari et al., 2018). The study revealed that the protein content in the crisp decreased with lower tofu pulp flour additions, highlighting the flour's significant protein contribution.

Tabel 3 Result of the protein content (%) in the fortified crisp

Treatment	Test Result (%)
A1 (0:0)	1,72[d]
A2 (15:15)	9,72[a]
A3 (20:10)	7,99[b]
A4 (25:5)	5,40[c]

Note : Different letter notation shows significant difference for $\alpha = 0{,}05$

3.4. Calcium Content:

Calcium, the most abundant mineral in the human body, plays a crucial role in bone and teeth formation and in preventing osteoporosis. The calcium content in crisp varied from 0.258% to 3.801% across the treatments, with the lowest in A1 and the highest in A4, as shown in Table 4. The inclusion of catfish bone paste, which has a high calcium content of 9.35%, significantly influenced the calcium levels in the crisp (Kartikawati & Handayani, 2014; Duldjaman, 2004). The results are consistent with prior research, indicating that the addition of catfish bone paste enhances the calcium content in food products (Kaya, 2008; Kartikawati & Handayani, 2014).

Tabel 4. Result of the calsium content (%) in the fortified crisp

Treatment	Test Result (%)
A1 (0:0)	0,258^{d}
A2 (15:15)	1,705^{c}
A3 (20:10)	2,755^{b}
A4 (25:5)	3,801^{a}

Note : Different letter notation shows significant difference for α = 0,05

Thus we show that the incorporation of catfish bone paste and tofu pulp flour significantly affects the chemical composition of crisp, particularly in enhancing its nutritional value through increased protein and calcium contents.

IV. CONCLUSIONS AND NEWNESS

We demonstrated that the addition of catfish bone paste and tofu pulp flour significantly boosts the protein content of crisp, aligning with the respective protein contents of these ingredients. The findings revealed significant modifications in the chemical composition of crisp due to these additions. The moisture content of crisp was observed to vary across different treatments, ranging from 5.41% to 6.61%. This variation highlights the role of catfish bone paste and tofu pulp flour in moisture absorption and retention, with the lowest moisture content found in the treatment with the highest addition of these ingredients (A4). Ash content, indicative of the mineral composition, showed a substantial increase with the incorporation of catfish bone paste and tofu pulp flour, ranging from 2.29% to 7.57%. The highest ash content was observed in treatment A4, which had the greatest proportion of these additives. Protein content, an essential nutritional parameter, exhibited notable variations, with the highest protein content found in treatment A2 (9.72%). Calcium content, crucial for bone health and preventing osteoporosis, also showed a marked increase with the addition of catfish bone paste and tofu pulp flour, ranging from 0.258% to 3.801%. The highest calcium content was observed in treatment A4.

Our research introduces a novel approach in enhancing the nutritional value of crisp by incorporating catfish bone paste and tofu pulp flour, utilizing by-products from the fish and tofu industries. It uniquely boosts the protein and calcium content of a traditional snack, addressing both environmental sustainability and improved nutrition. This innovative combination offers significant implications for sustainable food production and contributes new insights into the impact of food processing techniques on nutritional enhancement.

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