



Crackers Made from Nagara Bean (*Vigna unguiculata* L.) and Three-Spot Gourami (*Trichopodus trichopterus*) Flours as Complementary Food for Stunting Prevention

Meilla Dwi Andrestian^{1#}, Zulfiana Dewi¹, Neni Oktiyani², Noraini Noraini¹

^{1#} Department of Nutrition, Polytechnic of Health-Ministry of Health Banjarmasin, Banjarbaru, Indonesia.

²Department of Medical Laboratory Technology, Polytechnic of Health-Ministry of Health Banjarmasin, Indonesia.

[#]Corresponding author: E-mail: meilladwi74@gmail.com

Abstract— Nagara beans (*Vigna unguiculata* L.) (NB) and three-spot gourami (*Trichopodus trichopterus*) (TS) can be used as blended flour, namely “Kanasawa” blended flour (KBF). The KBF is developed into complementary food products, such as crackers, namely “Kanasawa Crackers”, to prevent stunting. This study aimed to investigate the sensory quality, proximate and amino acids profile, Calcium and Phosphorus levels of “Kanasawa Crackers” from KBF. This study is an experimental research that used a Complete Random Design with five formulas of proportion between KBF and mocaf flour, namely: C1 (0:100), C2 (25:75), C3 (50:50), C4 (75:25), C5 (100:0). The best crackers formula was selected using de Garmo analysis. The most preferred cracker product is C2. The best Kanasawa crackers formula consisted of 7.81% water, 3.58% protein, 23.68% fat, 4.90% ash, 2.25% crude fibre, 52.09% carbohydrate, 18 types of amino acid, 0.52% Calcium, and 0.56% Phosphorus. “Kanasawa Crackers” with a KBF-to-mocaf flour ratio of 25:75 are suitable as a complementary food to prevent stunting.

Keywords— Crackers; Nagara beans; Kanasawa flour; Three spot gourami; Stunting

Manuscript received Aug 19, 2025; revised Feb 20, 2026; accepted Feb 22, 2026. Available online July 27, 2026
Indonesian Food Science and Technology Journal is licensed under a Creative Commons Attribution 4.0 International License



I. INTRODUCTION

Complementary foods play a vital role in bridging the nutritional gap once infants transition from exclusive breastfeeding. The introduction of diverse and nutrient-rich complementary foods is essential for meeting the energy and nutritional needs of growing children. Locally sourced ingredients can enhance the quality of these foods while supporting community health initiatives aimed at stunting prevention [1]. The use of composite flours made from nutrient-dense ingredients like Nagara beans (*Vigna unguiculata* L.) and fish such as Three-Spot Gourami (*Trichopodus trichopterus*) can provide an effective solution to improve dietary diversity and nutritional adequacy.

Nagara beans, also known as cowpeas, originate from the Nagara region in South Kalimantan, Indonesia. Its offer several nutritional advantages that make them an excellent choice for complementary foods, particularly in addressing malnutrition and stunting in vulnerable populations. Nagara beans flour are rich in protein, phosphorus, calcium and found to contain 18

types of amino acids [2]. The amino acid profile of Nagara beans flour is favorable, containing significant amounts of essential amino acids such as valine, methionine, and phenylalanine [3]. These amino acids are vital for various body functions, including protein synthesis and metabolic processes. The presence of these essential nutrients makes Nagara beans a valuable food source for individuals who may have limited access to animal proteins. Meanwhile, Hustiany [4] reported in roasted cowpea beans, the protein content can increase to approximately 18.42%, and when processed into flour, it can reach 24.16%. This high protein level is crucial for growth and development, especially in children who require adequate protein for muscle development and overall health. Furthermore, Andrestian *et al* [5] stated that the mineral P content in Nagara bean flour is 1.98%, while the Ca content is 1.85%. These minerals are particularly important in the context of stunting prevention, as they support skeletal growth during childhood.

South Kalimantan-Indonesia, is a source of fishery commodities, especially river and swamp fisheries. Three-Spot

Gourami is a freshwater fish that offers several nutritional advantages, making it a valuable ingredient for complementary foods, particularly for addressing the dietary needs of children and vulnerable populations. Here are the key nutritional benefits. This high protein level is essential for growth and development, especially in children who require adequate protein for muscle development and overall health. Additionally, some studies indicate that processed forms of this fish can have even higher protein levels, making it a potent source of this macronutrient. Putra *et al* [6] stated three-spot gourami has 5.08% protein, 3.50% fat, 79.27% water content, and contains 18 types of amino acids. Three-Spot Gourami is also rich in essential micronutrients, such as Calcium (77.3 mg/100g) [7] and Phosphorus (0.40 %) [8].

Like Nagara beans, three-spot gourami can be processed in various ways, such as drying or made into flour/powder, enhancing its shelf life and making it easier to incorporate into different recipes. Its adaptability enables its use in various culinary applications, enhancing its appeal as a complementary food. Ho *et al.* [9] stated that the ingredients are made into composite flour to increase the food's nutritional and functional value, especially as a product to prevent stunting. Andrestian *et al.* [10] found that Nagara bean flour can be mixed with three-spot gourami flour into Kanasawa blended flour (KBF). Kanasawa blended flour contains macro- and micronutrients, making it suitable as an ingredient for making weaning foods for breastfeeding or snacks for toddlers.

II. MATERIAL AND METHODS

A. Material

Kanasawa Blended Flour (KBF)

The material used to make KBF is dried Nagara beans sourced from the Banjarbaru Batuah Market in South Kalimantan, Indonesia. Meanwhile, three-spot gourami is obtained from the Martapura Sekumpul Market, South Kalimantan, Indonesia. Other ingredients needed are baking soda (NaHCO_3) and lime juice. The tools used are a basin, a nut-breaking tool, a Chin KU AS-1060G autoclave, a GTK electric oven, a blender, a food processor, an 80-mesh sieve, and a 40-mesh sieve.

Kanasawa Crackers

The tools used are scales, plates, small containers, basins, spoons, plastic, rooling pin, knives, baking sheets, ovens, brushes, and baking paper. Kanasawa crackers are made using ingredients consisting of KBF, mocaf flour, skimmed milk, egg whites, margarine, sugar, salt, baking powder, and water. For more details in the **Table 1**.

TABLE 1
KANASAWA CRACKERS COMPOSITION

Material	Formulas				
	KBF : Mocaf Flour				
	C1(g) 0:100	C2(g) 25:75	C3(g) 50:50	C4(g) 75:25	C5(g) 100:0
KBF	0	25	50	75	100
Mocaf Flour	100	75	50	25	0
Egg White	10	10	10	10	10
Margarin	40	40	40	40	40
Sugar	3	3	3	3	3
Salt	2	2	2	2	2
Skimmed milk	4	4	4	4	4
Baking powder	0,2	0,2	0,2	0,2	0,2
Water	25	25	25	25	25

B. Methods

This study is an experimental research used a Complete Random Design with five formulas of proportion between KBF and mocaf flour, namely: C1 (0:100), C2 (25:75), C3 (50:50), C4 (75:25), C5 (100:0). The formulas for the determination of the Kanasawa Crackers was selected based on the study of nutritional content and subjective quality to obtain the best product.

Kanasawa blended flour

The procedur of KBF refers to Andrestian *et al.* [11]. KBF is a blended flour between Nagara bean flour and three-spot gourami fish. The following is the procedure for making KBF. The processing process of Nagara bean flour which begins with sorting beans and then washing them thoroughly and draining. The clean beans are then soaked with water that has been mixed with a 1% NaHCO_3 solution to softens the seed coat, enhances hydration and dehulling, improves milling efficiency and flour functional properties, and helps reduce certain antinutritional factors when the concentration and time are controlled to avoid nutrient loss and off-flavors [12,13]. Soaking the beans lasts for 12 hours. Next, the beans are steamed for 10 minutes at a temperature of 60°C to inactivate heat-labile enzymes and antinutritional factors, reduce microbial load, improve hydration and ease dehulling, and stabilize quality without extensive protein denaturation, thereby improving processing outcomes and flour functionality [14]. The beans are then separated from the coat and baked using an electric oven for 4 hours at a temperature of 60°C for drying and reduce moisture and surface microbial activity, partially inactivate quality-degrading enzymes, and loosen the seed coat while avoiding starch gelatinization, protein denaturation, color darkening, and nutrient losses, thereby preserving functional properties and ensuring uniform drying before milling [15]. The dried beans are then ground using a *blender* and then sifted using an 80 mesh sieve.

The best quality fish is cleaned of scales and gills. After washing thoroughly, the fish is given a squeeze of lime juice

and let it sit for 10 minutes. After that, it is washed again until it is clean. The fish is placed in an autoclave at 121°C with 1 ATP for 60 minutes until the fish becomes soft. Next, the fish is put in an electric oven with a temperature of 60°C for 4 hours until the fish becomes dry. The dried fish is then mashed using a *blender* then sifted using a 40 mesh sieve (Image 2). The process of making blended flour is to mix both types of flour according to the formulas. Homogenization of flour is carried out using a food processor.

Kanasawa Crackers

The preparation of Kanasawa crackers follows Ramadhani *et al.* [16] with modifications and begins by weighing all the ingredients. KBF, mocaf flour, skimmed milk, and sugar are mixed evenly. Egg whites, water, and salt are stirred until combined. Margarine is added to the flour mixture, and the egg white solution is slowly incorporated until a smooth dough forms. The dough is rolled out to a thickness of 2 mm, forming a sheet. The dough is sprinkled over 1/2 of the sheet, then folded and flattened again up to 3 times (coating ingredients: 15 g mocaf, 0.2 g salt, and 0.05 g baking powder). Print the dough with a uniform size and arrange it on a baking sheet that has been given baking paper. Finally, the crackers dough is baked in an oven at 150°C for 15 minutes.

Sensory Quality Analysis and Best Formulas

The sensory quality test was carried out using 30 semi-trained panelists from Nutrition Department students who had received sensory testing training. The color, aroma, texture, and taste of each sample will be judged by panelists. After a sensory quality test is carried out, the data will be calculated using the deGarmo analysis [17] method for the best result. The next stage was the proximate, calcium, phosphorus, and amino acid level of Kanasawa Crackers which were then be analyzed descriptively.

The data are processed using the ANOVA test ($\alpha=0.01$). The best formulas is carried out by the deGarmo test method and by considering the content of existing nutrients from various formulas. The de Garmo test is a method to determine the best formulas based on the effectiveness value. The De Garmo test begins by determining the weight of the panelists' scores, calculating the productivity value (PV) of all parameters, summing the outcome values of all parameters, and the best formula is taken from the formula that has the highest productivity value (PV).

Proximate, Calcium, and Phosphorus Levels of Kanasawa Crackers Analysis

Laboratory analysis of Kanasawa crackers was carried out at the IPB University Integrated Laboratory. Proximate analysis consisted of fat content testing whose procedure referred to SNI 01 - 2891- 1992 item 5.1, AOAC (2012) 930.15 (Temperature 135°C), SNI 01 - 2891- 1992 (Direct extraction), AOAC (2012) Official Method 991.36 or 39.108 (Soxhlet Extraction Method), and AOAC (2012) 989.05 (33.2.26)- Modified Mojonnier Ether Extraction method [18,19]. The ash content test procedure refers to SNI 01 - 2891- 1992, item 6 (Temperature 550°C) (Total Ash Content) [20]. The protein test procedure refers to AOAC (2005) 960.52 and SNI 01 - 2891- 1992 [21,22]. The

moisture content test procedure refers to SNI 01 - 2891- 1992 item 5.1, AOAC (2005) 930.15 (Temperature 135°C), and SNI 2970-2015 [23-25]. The coarse fiber test procedure refers to SNI 01-2891-1992 point 11 [26]. As for the carbohydrate content test, *use by different*.

The calcium analysis procedure with the AAS method refers to AOAC (2015) Official Method 968.08 (AOAC 4.8.02) [27]. The phosphorus analysis procedure by spectrophotometry method refers to AOAC (2012) Official Method 965.17 (AOAC 4.8.14) [28]. Amino acids were analyzed using a procedure with reference to the In house method (ICI Intrument Method, 1988) [29].

III. RESULT AND DISCUSSION

C. Sensory Quality of Kanasawa Crackers

Kanasawa crackers in this research consist of five formulas of proportion between KBF and mocaf flour, namely C1 (0:100), C2 (25:75), C3 (50:50), C4 (75:25), C5 (100:0). Visual results of various Kanasawa Crackers formulas can be seen in **Figure 1**.

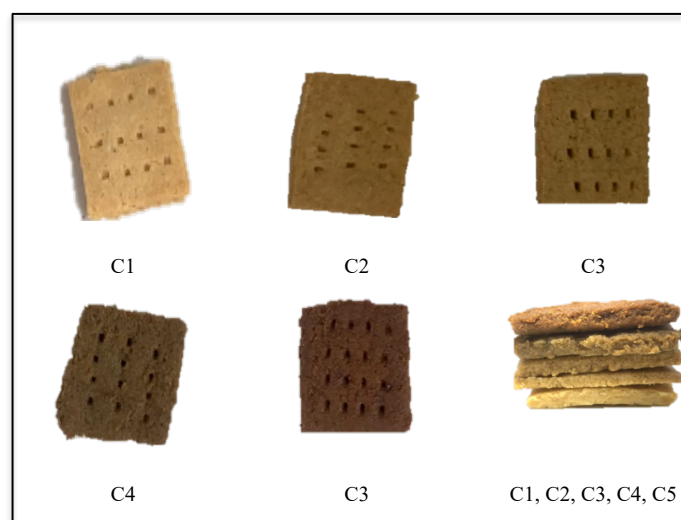


Fig. 1 Visual of Kanasawa Cracker. Top view (above) and side view (below) with a proportion formulas between Mocaf and KBF, namely C1 (100:0), C2 (75:25), C3 (50:50), C4 (25:75), and C5 (0:100)

Color

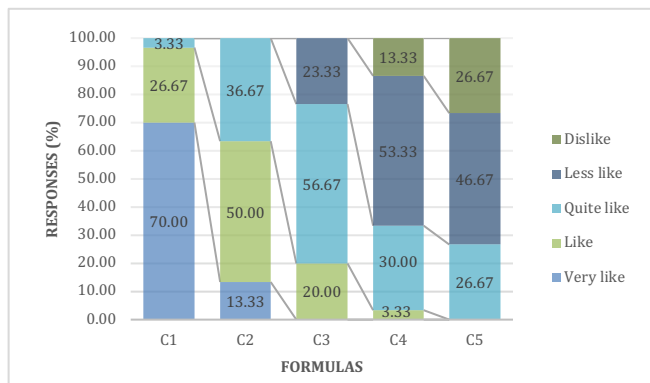
Sensory quality of color is used during product development to optimize the color profile of food products. This involves the use of sensory panels and instrumental analysis to understand the impact of various ingredients and processing conditions on product color [30]. Understanding consumer preferences for food color is essential in ensuring the quality and acceptance of food products in the market because the first aspect assessed in the acceptance of a food is its visual. In this case, the earliest visual aspect of the product assessed is color.

The colour of crackers largely results from non-enzymatic browning reactions during baking, notably the Maillard reaction between sugars and amino acids/proteins and

caramelization of reducing sugars, which produce brown pigments that influence consumer colour acceptance. Higher levels of protein (e.g., egg white or other proteins) and reducing sugars can accelerate browning and lead to darker surfaces; water activity and ingredient composition alter the rate and extent of these reactions. Additionally, inherent colour of added ingredients (e.g., milk solids or other enriched flours/fats) and their interactions during heat-induced browning can shift lightness and hue, affecting visual preference in sensory panels [31,32].

The results of the quality sensory of color in this study showed that panelists preferred crackers with brighter colors. In addition to the control crackers (C1, 100% mocaf flour), panelists also gave a positive response to crackers C2 (75% mocaf flour: 25% KBF). The number of panelists who showed a very liking and liking response to crackers C2 was 4 people (13%) and 15 people (50%). Thus, the color of crackers C2 was preferred by 19 people (63%).

Statistical tests resulted in the conclusion that there was an effect of the proportion of KBF on the sensory quality of the color ($p = 0.00$, $\alpha = 0.05$). **Figure 2** shows the results of the responses of all panelists to the color of Kanasawa crackers.



Significant ($p=0.00$, $\alpha=0.05$)

Fig. 2 Color Quality of Kanasawa Crackers with proportion formulas between Mocaf and KBF, namely C1 (100:0), C2 (75:25), C3 (50:50), C4 (25:75), and C5 (0:100)

The results of the color sensory quality test in this study showed a clear preference among panelists for crackers with brighter colors. This phenomenon is common in food products, where color is often an early indicator of quality and freshness and influences consumer perception of taste and texture. Bright colors can be associated with clean raw materials, controlled processing, and visually appealing end products.

Specifically, crackers C2 received a significant positive response from the panelists compared to other formulations. This finding indicates that the proportion of 25% KBF in the cracker dough, dominated by mocaf flour, produces the color most preferred by the panelists. The high proportion of mocaf flour (75%) in the C2 formulation likely contributes to the brighter color, considering that mocaf flour generally has a white to light cream color. Khoirunnida *et al.* [33] stated that

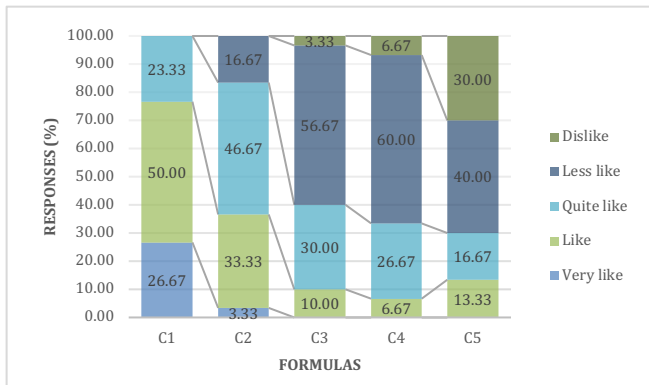
initial mocaf flour has a higher lightness, which then decreases along with the Maillard reaction and caramelization due to baking. Meanwhile, Unayah *et al.* [34] also stated that the mocaf flour formulation affects the color, aroma, and taste of the cake. This shows that mocaf flour has a clear impact on the color characteristics of processed products.

The study also showed that the higher the proportion of KBF formula, the less preferred Kanasawa crackers were by the panelists. This strengthens the hypothesis that the addition of large amounts of KBF negatively affects the final color of the product, making it less attractive to consumers. Given that KBF is a formulation of cowpea flour and three-spot gourami flour, there are several factors that can cause undesirable color changes. Cowpea flour and especially three-spot gourami flour, have darker natural pigments or tend to produce a brownish color after the drying and milling process into flour. The more KBF is added, the more dominant the dark color of this raw material becomes. The results of Andrestian *et al.* [35] stated that the yellow color of "Kanasawa" flour comes from three-spot gourami which goes through a drying process that induces the Maillard reaction. This reaction, driven by the presence of reducing sugars and amino acids, produces the brown color seen in fishmeal. In addition, according to Lee *et al.* [36], the baking process of crackers can trigger the Maillard reaction between reducing sugars and amino acids, as well as sugar caramelization, both of which produce brown pigments. The different proportions of protein and sugar in the KBF formulation, compared to mocaf, can accelerate or strengthen this reaction, resulting in a darker color. According to Chen *et al.* [37], during storage or processing, certain pigments in flour can oxidize, causing the color to become darker or duller. These phenomena also occur with KBF, leading to crackers that become darker as the KBF content increases.

Aroma

Food aroma refers to the collection of volatile compounds that give rise to the odor and flavor of food products. These compounds are perceived through the mouth and nose and interpreted by our olfactory system. The sense of smell plays an important role in food evaluation, contributing to the overall sensory experience and influencing food preferences and choices. Food odor can stimulate appetite, trigger physiological responses, and affect food quality [38].

The aroma of food products is also one of the parameters that determines the quality of a product. Assessment of food aroma is an important aspect in controlling food quality and consumer satisfaction. Rondrigues *et al.* [39] stated that aroma analysis is used during product development to optimize the aroma profile of food products. This involves the use of sensory panels and instrumental analysis to understand the impact of various ingredients and processing conditions on product aroma.



Significant ($p=0.00$, $\alpha=0.05$)

Fig. 3 Aroma Quality of Cracker Kanasawa with proportion formulas between Mocaf and KBF, namely C1 (100:0), C2 (75:25), C3 (50:50), C4 (25:75), and C5 (0:100)

The results of the aroma quality in this study showed that panelists preferred crackers with a not too strong aroma or only a small proportion of KBF. The panel liked the control formula crackers, namely C1. In addition, panelists also liked C2 crackers with the number of panelists who really liked and liked with 11 people (37%).

Statistical tests resulted in the conclusion that there was an effect of the proportion of KBF on the sensory quality of the crackers aroma ($p = 0.000$, $\alpha = 0.05$). **Figure 3** shows the results of the panelists' responses to the aroma of crackers.

The characteristic aroma of the three-spot gourami meal, although potentially providing additional nutritional value, is likely the main cause of aroma rejection at higher KBF proportions. A strong 'fishy' aroma is often undesirable in processed products such as crackers, which are generally expected to have a pleasant savory or neutral aroma. Trimethylamine (TMA) is the main compound responsible for the strong fishy aroma of fish. TMA is not present in live fish; it is formed when the fish dies. Most marine fish naturally contain a compound called Trimethylamine N-oxide (TMAO) in their muscles. The three-spot gourami is rich in polyunsaturated fatty acids (e.g., Omega-3) [40-42]. When fat are exposed to oxygen (oxidation), they can break down into smaller, volatile molecules that also contribute to the fishy aroma. This process can produce various aldehydes and ketones that give a 'rancid' or 'fishy' odor distinct from TMA [43,44].

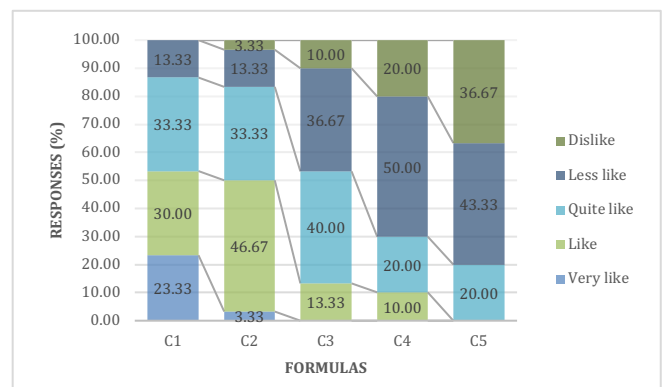
Similarly, while cowpeas possess their own distinctive aroma profile, cowpea flour can also exhibit an unpleasant, often described as 'beany,' flavor. These desirable and undesirable aromas are largely derived from volatile compounds formed through various biochemical pathways during the growth, storage, and processing of the beans. Lipid Oxidation Compounds this is the most significant group of compounds and is often the primary cause of the undesirable "beany flavor" in beans. Cowpeas contain the highly active enzyme lipoxygenase, which oxidizes the polyunsaturated fatty acids (such as linoleic and linolenic acids) present in the seed lipid. This oxidation yields aldehydes (e.g., hexanal, nonanal,

pentanal, octanal) and ketones. Hexanal and hexanol, in particular, are frequently associated with strong, sometimes unpleasant, "green" or "grassy" aromas. These compounds possess a very low odor detection threshold, meaning even small concentrations can produce a noticeable aroma [45-47]. Free amino acids in cowpea can also degrade, producing volatile compounds. Amino acid degradation pathways (such as those involving isoleucine, valine, and alanine) can yield various alcohols, aldehydes, and esters that contribute to the overall aroma [48-50].

Texture

Food texture is based on multiple parameters. Some parameters are regulated when the food is put into the mouth while most parameters are perceived when the food changes shape during chewing and are detected through multiple senses [51].

The results of the sensory quality of texture in this study showed that panelists preferred crackers with a harder and crispier texture. Control crackers (C1) and crackers C2 had a harder and crispier texture. Panelists preferred control formula (C1), but also gave positive responses to crackers C2. The number of panelists who preferred crackers C2 with the categories of very much like and like was 14 people (50%).



Not significant ($p=0.301$, $\alpha=0.05$)

Fig. 4 Texture Quality of Cracker Kanasawa with proportion formulas between Mocaf and KBF, namely C1 (100:0), C2 (75:25), C3 (50:50), C4 (25:75), and C5 (0:100)

The statistical test concluded that there was no effect of the proportion of KBF on the texture of crackers ($p = 0.301$, $\alpha = 0.05$). **Figure 4** shows the results of the responses of all panelists to the texture of Kanasawa crackers. A clear trend emerged: as the proportion of KBF flour increased, the texture of the crackers became less acceptable. Formulas C3 (50% mocaf flour : 50% KBF), C4 (25% mocaf flour : 75% KBF), and C5 (0% mocaf flour : 100% KBF) exhibited a gradual decrease in texture acceptance by panelists. This was likely due to the physicochemical properties of cowpea flour and three-spot gourami flour, which may make the crackers' texture softer or less crispy as their concentrations increase. These flours may have higher protein or fiber content, potentially affecting the formation of the gluten matrix or crumb structure of crackers, thereby reducing their hardness and crispiness.

Protein is a significant component in fishmeal. It has the ability to form a cohesive matrix and can form a gel, which contributes to the compactness and binding power of food products. The higher the protein content, the greater its potential to affect hardness and binding power [52,53]. The water content in fishmeal is very crucial. Good fishmeal has a low water content, which is inversely correlated with its water absorption capacity. This low water content is important to maintain texture stability, allowing the product to remain dry and crispy [54-56]. Since three-spot gourami fishmeal is made from the whole fish, including bones and heads, the ash content (which reflects minerals such as calcium and phosphorus) becomes very relevant. Fish bones are a rich source of calcium and phosphorus. Research shows that the addition of fish bone meal can significantly increase hardness and crispiness. Higher ash content, which comes from bones and heads, tends to be positively correlated with texture hardness [57].

In general, legume flours, including cowpea, can impart a denser, slightly gummy, or crumbly texture to the final product, depending on the proportion used and the matrix of other ingredients. In the context of crackers, the addition of cowpea flour may reduce the level of crispiness and hardness when compared to products made with pure wheat or mocaf flour, unless a special formulation is employed to overcome this [58-60].

Cowpea protein can absorb significant amounts of water. This high water absorption capacity affects the hydration of dough, which in turn can result in a softer or less crispy texture because the bound water makes the matrix very moist [61-63]. Cowpea contains a high amount of dietary fiber, both soluble and insoluble. Insoluble fiber has the ability to retain water, which can increase the hardness and density of the dough and reduce crispiness if not managed properly. Soluble fiber can form a softer gel and contribute to viscosity. The presence of fiber can alter the gluten network (if present, as in crackers with a mixture of wheat flour) or other matrices, ultimately affecting texture, crumb, and hardness [64-66]. Increased water absorption by cowpea protein and fiber may make the dough more moist or dense, potentially reducing the hardness and crispiness preferred by panelists. Cowpea protein and fiber may also interfere with the formation of the desired crisp matrix, making it more crumbly, dense, or sticky [67-70].

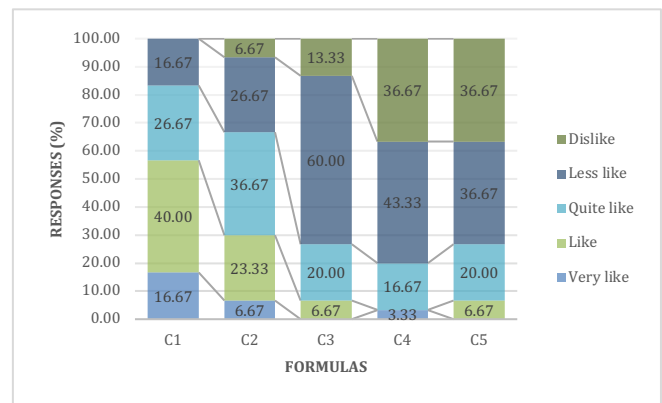
Taste

Taste parameters are very important in evaluating a product because they can affect consumer preferences. The addition of KBF can modify the taste of the product (Kanasawa crackers) being developed. Therefore, a sensory quality test was conducted on the taste of Kanasawa crackers.

The results of the sensory quality assessment of taste in this study showed that panelists liked crackers with a taste that was not too savory, and tended not to like crackers with a taste that was too strong for fish. Panelists liked the control crackers (C1), but also gave a positive response to crackers C2. The number of panelists who liked crackers C2 in the category of very much like and like was 9 people (30%).

The statistical test resulted in the conclusion that there was an effect of the proportion of KBF on the sensory quality of the taste of crackers ($p = 0.028$, $\alpha = 0.05$). **Figure 5** shows the results of the panelists' responses to the taste of Kanasawa crackers.

On the other hand, increasing the proportion of KBF significantly correlated negatively with panelists' preference. Variants C3, C4, and C5, which had higher proportions of KBF, showed lower levels of acceptance. This further strengthens the hypothesis that the strong fish flavor and possibly the unpleasant taste of three-spot gourami in KBF are the main rejection factors for panelists. The higher the concentration of KBF, the more intensely the fish flavor is perceived, and the less it is preferred by panelists.



Not significant ($p=0.301$, $\alpha=0.05$)

Fig. 5 Taste Quality of Cracker Kanasawa with proportion formulas between Mocaf and KBF, namely C1 (100:0), C2 (75:25), C3 (50:50), C4 (25:75), and C5 (0:100)

Cowpea flour generally has a fairly bland to slightly sweet flavor profile and a distinctive nutty aroma. Its carbohydrate content, mainly starch and simple sugars like glucose and fructose, contributes to its sweet taste [71]. Protein, through the presence of free amino acids such as glutamic acid, contributes to an umami (savory) taste [72]. Although cowpeas are not particularly high in oil, oil oxidation can produce rancid or off-flavors [73,74].

Three-spot gourami flour is generally described as having a distinctive fishy aroma and a mildly sweet taste. However, in the context of crackers in this study, panelists tended to dislike the overly strong fish flavor, suggesting a high proportion of less preferred flavor components. This strong taste can be associated with the 'fishy' taste common in fish products [75,76].

Three-spot gourami fish is very rich in protein. During processing into flour, protein can be hydrolyzed into free amino acids. Some amino acids have specific tastes. For example, glutamic acid and aspartate provide an umami (savory) taste. Histidine can contribute to a bitter or metallic taste. Sulfur amino acids (e.g., cysteine, methionine) can produce sulfur-smelling volatile compounds that contribute to the fishy/typical

fish aroma. Proteins and amino acids are also involved in the Maillard reaction during heating, which can produce aromatic volatile compounds [77-79].

Lipid oxidation (lipolysis and oxidation) is the main cause of fishy/rancid odor and taste in fish products. Lipid oxidation products include aldehydes, ketones, alcohols, and hydrocarbons, all of which are volatile compounds and contribute to off-flavors or undesirable flavors, especially the "overly strong fishy taste" described by panelists. The high fat content in fish makes fishmeal go rancid more quickly and susceptible to fatty acid oxidation. The characteristic (or fishy/unpleasant) aroma of fish comes from various volatile compounds formed from the degradation of fish components, especially fat and protein. The volatile compound groups often detected in fish products include hydrocarbons, aldehydes (e.g., trimethylamine, TMA – often associated with fishy odor), ketones, alcohols, and acids (e.g., acetic acid, butyric acid). The formation of these compounds is influenced by factors such as enzymatic reactions, lipid oxidation, and environmental/processing conditions [80-82].

Panelists' rejection of increasing proportion of KBF is most likely due to the accumulation of volatile compounds derived from fat oxidation and protein degradation, resulting in an overly dominant fishy taste when the concentration of KBF increases. The taste of three-spot gourami meal at low proportions may still be acceptable, but as the concentration increases, undesirable off-flavors become more prominent [83-85]. Meanwhile, the flavor profile of cowpea flour tends to be neutral with a slight touch of nuts or even bitterness. This may not provide a significant positive contribution to masking the strong taste of fish, or it may even exacerbate off-flavors if the bitterness is prominent [86,87].

D. Determination of the Best Kanasawa cracker products

To determine the best formula overall, an effectiveness test analysis De Garmo was used [88]. The effectiveness test is carried out by determining the best and worst values based on the highest and/or lowest productivity values in each parameter (Table 1).

The C2 formulation, with a ratio of 75% Mocaf and 75% KBF, showed optimal characteristics in terms of nutrient balance and sensory acceptability. The addition of KBF at a ratio of 25% is likely to enhance the nutrient profile without compromising the functional and sensory qualities that are usually desired in fishmeal-based products [89].

Adding KBF, increases the protein content, essential amino acid profile, and dietary fiber content in blended flours. Nagara Beans are also a source of bioactive compounds, including phenolic compounds and antioxidants, which contribute to health benefits and product stability, reducing lipid oxidation that is common in fish-based flours [90].

KBF at a concentration of 25% provides the main protein matrix and essential micronutrients such as calcium, phosphorus, and

fatty acids. The high proportion of KBF not only increases the protein content of the product but also provides a distinctive flavour profile associated with fish-based products, which is often preferred by certain consumer segments. However, too high a concentration of fishmeal can sometimes lead to undesirable flavour intensity or texture limitations [91]. Therefore, a 75:25 ratio likely balances the sensory attributes well, making it acceptable to the consumer base.

TABLE 1
 DE-GARMO TEST RESULTS TO DETERMINE
 THE BEST PROPORTION OF KANASAWA CRACKERS

Formula	Total		Rank
	EV	PV	
C1	16,27	4,57	1
C2	13,58	3,77	2
C3	10,46	2,92	3
C4	8,76	2,40	4
C5	7,96	2,16	5

EV=Effectiveness Value, PV=Productivity Value,
 Proportion of mocaf and KBF: C1=100:0, C2=75:25,
 C3=50:50, C4=25:75, C5=0:100

E. Proximate, Calcium, and Phosphorus Levels of Kanasawa Crackers

Proximate analysis are intended to determine the basic chemical composition of a material, especially in terms of nutritional content. Proximate testing includes basic parameters such as water content, protein, fat, ash content, crude fiber, and carbohydrates. Information on the chemical composition of a material can help determine nutritional value and can be used to control product quality. In addition to proximate analysis, this study also analyzed the levels of calcium and phosphorus minerals because composite flour was prepared for the development of food products to prevent stunting.

The results of proximate analysis, calcium and phosphorus of Kanasawa crackers are presented in Table 2. C1 is a cracker with 100% mocaf flour containing more carbohydrates (66.74%). The less mocaf flour added in making crackers, the less carbohydrate content will be. This is because the mocaf flour content contains more carbohydrates than KBF, thus affecting the carbohydrate content in crackers.

According to SNI 01-2973-2011 to achieve the quality requirements, crackers must have a minimum protein content of 5%. Based on the results of protein content testing, it shows that crackers with the addition of more KBF will have higher protein content. The formulas of C2, C3, C4, and C5 using KBF contain protein above 5%. This means that in terms of protein content, Kanasawa Crackers are superior and in accordance with SNI. The highest protein content reaches 34.13%, namely C5 (100% KBF). The bioavailability of protein from fish is 5-15% higher than that of plant-based protein sources. Besides the main ingredient, cracker protein also comes from other ingredients such as egg whites, skimmed milk, and a small amount from margarine [92-96].

Based on the results of the proximate analysis (Table 3), it can be seen that the water content of crackers in all formulas varies. However, overall it is still below 15%. Referring to SNI 01-2973-2011, the quality requirements for crackers must have a maximum water content of 5%. Therefore, crackers do not meet the quality standards based on SNI. The lowest water content (7.16%) is in crackers C2 (100% mocaf flour) while the highest water content (13.99%) is in crackers C3 (50% mocaf flour: 50% KBF). Water content is a factor that greatly influences the durability of a processed material. The lower the water content, the slower the growth of microbes, so that the food can last longer. In crackers, the water content originates primarily from added water in the formulation and the inherent moisture of raw materials, and the amount retained after baking depends on ingredient water-binding capacity and baking/drying dynamics, with differences in moisture content reflecting variations in water retention between formulations rather than external sources alone [97]. Kanasawa crackers are formulated with water and eggs as functional ingredients, and the product is subjected to a short-time baking process at a relatively moderate temperature to achieve the desired texture and quality while limiting excessive moisture loss and browning. Therefore, the average water content of Kanasawa crackers for all formulas is still above 5%. According to SNI 01-2973-1992 [98] the quality requirements for fat content in crackers are at least 9.5%, so all formulas meet the quality standards for crackers.

The highest fat content is in C5, which is 32.58% (100% KBF), while the lowest is C1 19.2% (100% mocaf flour). The more KBF, the many fat content, and vice versa, the less KBF, the many fat content. One of the fatty acids found in fish is omega-3 fatty acids. Omega-3 fatty acids are found in high-fat fish (more than 20%) [99]. The fat content in crackers is primarily determined by the amount and type of fat source (such as margarine or shortening) used in the formulation, while ingredients like egg whites, sugar, salt, skim milk, baking powder, and water mainly influence dough properties and fat distribution, but do not directly increase the total fat contents of the finished product [100].

Higher fat in composite flour crackers reflects ingredient composition: The observation that C5 (100% KBF) has the highest fat content (32.58%) while C1 (100% mocaf) has the lowest (19.2%) aligns with scientific findings that the fat content of baked products tends to increase with the proportion of high-fat flours in the formulation, because the fat level of resulting products largely mirrors the fat levels of the component flours used in composite blends. For example, increasing the proportion of oilseed flours in composite bakery products has been shown to raise the final product's fat content due to the inherent fat in those flours [101]. Nutritional analyses of flours and baked products consistently demonstrate that the proximate composition of finished bakery products (including fat content) mainly reflects the composition of the ingredient flours, meaning that higher levels of a flour with greater lipid content in the blend will statistically elevate fat content in the crackers [102].

The results of the ash content analysis of Kanasawa Crackers show that the more KBF composition, the more ash content contained in the crackers. At C1 (100% mocaf flour) the ash content is 2.83% and increases to C5 11.61% (100% KBF). Based on the requirements of crackers SNI 01-2973-1992 has not been met because it exceeds the maximum limit, namely for ash content of only 2%. Ash content is closely related to mineral content, the higher the ash content obtained, the higher the mineral content of the material. In addition, the ash content in food refers to inorganic materials, such as minerals, that remain after a food sample is heated to a very high temperature to remove moisture, volatile substances, and organic materials [103].

Ash content reflects the total mineral content, so ingredients that supply minerals such as salt and milk powders with inherent minerals can raise ash levels, while non-mineral components like egg whites, sugar, and water have little direct effect on ash unless they introduce trace minerals; studies on fortified and enriched crackers show that incorporation of mineral-rich ingredients, such as vegetable powders or seaweed salt, significantly increases ash (mineral) content in the final product compared to controls [104,105]. For example, the incorporation of leaf and seed powders that are rich in calcium, sodium, and magnesium increased ash contents in composite crackers, indicating that ingredient mineral composition is a key determinant of ash content, and research also notes that baking powder additives containing phosphate salts may contribute minerals detectable in ash analysis [106,107].

The fiber content of the crackers ranged from 1.88% to 2.25%, with the highest value observed in C2 (2.25%) and the lowest in C4 (1.88%), indicating that formulation differences influenced the relative contribution of dietary fiber. Similar trends have been reported in composite and protein-enriched crackers, where increasing substitution with protein- or fat-rich ingredients does not necessarily increase fiber content due to a dilution effect, in which fiber-rich carbohydrate fractions are proportionally reduced in the final product [108]. The relatively narrow range of fiber values among formulations suggests that the main cereal or tuber flour remains the dominant source of dietary fiber, while increasing levels of protein-rich ingredients contribute mainly to protein and fat rather than fiber. This phenomenon has been widely observed in biscuit and cracker formulations enriched with legume or animal protein flours, where increases in protein and fat content are often accompanied by stable or slightly reduced fiber levels [109]. In addition, thermal processing during baking may influence measured crude fiber values, as heat treatment can modify insoluble fiber structure and reduce analytical recoverability without necessarily reducing physiological fiber functionality. Recent studies on baked cereal products report modest decreases or minimal changes in crude fiber following baking, supporting the observed limited variation in fiber content across cracker formulations

Based on SNI 01-2973-1922 the maximum crude fiber content in crackers is 0.5%. From the results of the crude fiber analysis in crackers, it has not met the SNI requirements. The highest crude fiber content is on average in products with a higher mocaf flour composition, this is due to the higher crude fiber content in mocaf flour. Mushthofa and Achadiyah [110] also stated that the higher the mocaf flour substitution, the higher the crude fiber content produced.

Although non-fiber ingredients such as egg whites, margarine, sugar, salt, skim milk, baking powder, and water do not directly contribute to dietary fiber, they can indirectly influence measured fiber content by diluting or concentrating the relative proportion of fiber in the final product when used in different amounts or when substituting for fiber-rich flour components because total dietary fiber is largely determined by the fiber levels of the base flours and added high-fiber ingredients like bran or vegetable powders rather than by these non-fiber components themselves [111,112]. Additionally, changes in water and other ingredient levels can affect dough structure and distribution of fiber sources, but ingredient formulation must include fiber-rich components to raise fiber content in crackers [113].

TABLE 2
 PROXIMATE, CALCIUM, AND PHOSPHORUS LEVELS OF KANASAWA
 CRACKERS

Nutrients	Levels (%)				
	C1	C2	C3	C4	C5
Water	7,64	7,81	13,99	9,77	11,59
Protein	3,58	11,52	19,68	27,76	34,13
Fat	19,2	23,68	24,68	30,66	32,58
Ash	2,83	4,9	7,35	9,33	11,61
Fiber	2,07	2,25	2,21	1,88	1,99
Carbohydrate	66,74	52,09	34,11	22,48	10,09
Calcium	0,11	0,52	0,78	1,15	1,36
phosphorus	0,14	0,56	1,06	1,47	1,94

*Significant: Ca, P, Protein, Fat, Ash, Carbohydrate ($p=0,000$, $\alpha=0,05$)
 Proportion of mocaf and KBF: C1=100:0, C2=75:25, C3=50:50, C4=25:75, C5=0:100

The results of the analysis of the calcium and phosphorus content of Kanasawa Crackers (Table 3) show that the more KBF composition is added, the higher the calcium and phosphorus content will be. The highest calcium and phosphorus content is in C5 (100% KBF), which is 1.36% and 1.94%. The calcium and phosphorus contents of Kanasawa Crackers are influenced by the types and quantities of mineral-rich ingredients used in the formulation. Crackers made with fortified bone-derived powders or other calcium sources show significantly higher mineral levels compared to non-fortified counterparts, demonstrating that ingredient selection directly affects mineral profiles in baked snacks [114,115]. For example, incorporation of bone meal from fish sources such as sailfin catfish increased calcium and phosphorus in fortified crackers to 4.37% Ca and 2.64% P, compared with very low levels in control samples, indicating that bone-based fortification is an effective strategy to enhance these essential

minerals in snack products without compromising acceptability [116].

Research also shows that fortification with bio-calcium powders from fish bone can raise calcium and phosphorus concentration while affecting physical properties like density and elemental distribution, further supporting the idea that mineral-rich fortificants contribute strongly to the Ca and P contents of crackers and can potentially help address dietary deficiencies when properly formulated [117].

The inclusion of high-mineral ingredients such as egg products, milk derivatives, and bone or shell powders can significantly increase the calcium and phosphorus content of crackers and other baked goods, as these ingredients are naturally rich in mineral content and contribute ash and mineral fractions during processing. Other functional ingredients like sugar, salt, margarine, baking powder, and water mainly influence the physical properties (texture, moisture, leavening) rather than directly altering mineral levels, although they can indirectly affect mineral retention and distribution during baking. [118].

Calcium is the main mineral needed in the bone formation process. A balanced ratio between calcium and phosphorus can help calcium absorption. The results of the study by Sari *et al.*, also showed that children who consumed calcium and phosphorus had normal height and were not stunted. Compared to children who consumed less calcium and phosphorus, the percentage of children who were stunted was greater [119].

Kanasawa Crackers containing more KBF have a higher calcium content because KBF contains 90% three-spot gourami, thus contributing to increased calcium and phosphorus in the product. The calcium content in *T. trichopterus* flour significantly affects its usefulness in food products in several ways, including: increasing the nutritional profile and functional benefits in food products. Shkembi and Huppertz [120] explained that the high calcium content in *T. trichopterus* flour contributes to the overall calcium levels in food products, making it more beneficial for consumers, especially those who require higher calcium intake for bone health and metabolic function. However, the absorption of calcium from food products can vary based on the food matrix and other components present. Statistical tests resulted there was an effect of the proportion of KBF on the levels of calcium, phosphorus, protein, fat, ash, and carbohydrates in crackers ($P = 0.000$, $\alpha = 0.01$). While on the water content, and crude fiber did not show any effect of the proportion of KBF ($P = 0.298$ and 0.243 , $\alpha = 0.01$).

D. Amino Acid Profile of Kanasawa Crackers

Based on the results of 18 types of amino acids analysis, it was found that the total amino acid content increased in line with the increase in the proportion of KBF. It can be seen from the results that C1 (100% mocaf flour) was only 2.97% and continued to increase to C5 (100% KBF) which was 33.38%. Protein intake provides the amino acids needed by the body to build bone matrix and affects bone growth because protein

functions to modify the secretion and action of the osteotropic hormone IGF-I, so that protein intake can modulate the genetic potential of achieving peak bone mass. Low protein intake has been shown to impair bone mass mineral acquisition by impairing the production and effects of IGF-I. IGF-I affects bone growth by stimulating the proliferation and differentiation of chondrocytes in the epiphyseal growth plate and directly affecting osteoblasts [121]. In addition, IGF-I increases the renal conversion of 25 hydroxyvitamin D3 to the active hormone 1,25 dihydroxy-vitamin D3 and thus contributes to increased absorption of calcium and phosphorus in the intestine [122,123]. Statistical tests resulted in the conclusion that there was an effect of the proportion of KBF on amino acid levels ($P=0.000$, $\alpha=0.01$). **Table 4** shows the results of the analysis of amino acids in crackers of all formulas.

TABLE 3
 AMINO ACID LEVELS OF KANASAWA CRACKERS

Parameters	Level of Amino Acids (%w/w)				
	C1	C2	C3	C4	C5
Aspartic Acid	0,17	0,79	1,64	2,81	3,59
Threonine	0,10	0,41	0,78	1,17	1,39
Serine	0,12	0,41	0,76	1,14	1,35
Glutamate	0,40	1,58	3,04	4,73	5,75
Proline	0,12	0,53	0,99	1,40	1,74
Glycine	0,10	0,62	1,30	2,12	2,63
Alanine	0,13	0,61	1,21	1,90	2,29
Cystine	0,05	0,09	0,13	0,16	0,20
Valine	0,12	0,44	0,81	1,23	1,47
Methionine	0,03	0,16	0,35	0,57	0,75
Ileucine	0,10	0,42	0,80	1,21	1,44
Leucine	0,18	0,74	1,42	2,19	2,61
Tyrosine	0,04	0,22	0,46	0,75	0,95
Phenylalanine	0,10	0,42	0,79	1,20	1,44
Histidine	0,47	0,63	0,70	0,58	0,95
Lysine	0,15	0,55	1,12	2,17	2,53
Arginine	0,58	1,46	1,36	1,72	2,28
Tryptophane	0,01	0,02	0,09	0,05	0,05
Total	2,97	10,11	17,75	27,09	33,38

*Significant ($p=0.000$, $\alpha=0.05$)

Proportion of mocaf and KBF: C1=100:0, C2=75:25, C3=50:50, C4=25:75, C5=0:100

IV. CONCLUSION

The most preferred Kanasawa crackers base on sensory quality is C2 (25% KBF). The best crackers formula consisted of 7.81% water, 3.58% protein, 23.68% fat, 4.90% ash, 2.25% crude fibre, 52.09% carbohydrate, 18 types of amino acid, 0.52% Calcium, and 0.56% Phosphorus. Kanasawa Crackers" with proportion between KBF and mocaf flour of 25:75 is suitable as complementary food to prevent stunting.

ACKNOWLEDGMENT

Thanks to the Director and the Head of the Center for Research and Community Service of the Polytechnic of Health, Ministry of Health, Banjarmasin for motivational and financial support.

CONFLICT OF INTEREST

The authors declare no conflicts of interest.

REFERENCES

- [1] E. F. Grathima, E. Yunitasari, and R. Indarwati, "The Impact Of Complementary Food Interventions On Adolescence Stunting Prevention: A Systematic Review," *Indonesian Journal of Community Health Nursing*, vol. 9, no. 2, pp. 62–66, Aug. 2024, doi: <https://doi.org/10.20473/ijchn.v9i2.47246>.
- [2] M. D. Andrestian, Z Dewi, N Oktiyani, and N Noraini, "'Kanasawa' composite flour from *Nagara* beans (*Vigna unguiculata* L.) and snake-skin gouramy fish (*Trichopodus trichopterus*) as calcium and phosphorus source," *IOP Conference Series Earth and Environmental Science*, vol. 1482, no. 1, pp. 012041–012041, Apr. 2025, doi: <https://doi.org/10.1088/1755-1315/1482/1/012041>.
- [3] R Hustiany, "Sustainability of protein potential in *Nagara* beans (*Vigna unguiculata* ssp *Cylindrica*) from South Kalimantan," *IOP Conference Series Earth and Environmental Science*, vol. 1302, no. 1, pp. 012085–012085, Feb. 2024, doi: <https://doi.org/10.1088/1755-1315/1302/1/012085>.
- [4] R Hustiany, "Sustainability of protein potential in *Nagara* beans (*Vigna unguiculata* ssp *Cylindrica*) from South Kalimantan," *IOP Conference Series Earth and Environmental Science*, vol. 1302, no. 1, pp. 012085–012085, Feb. 2024, doi: <https://doi.org/10.1088/1755-1315/1302/1/012085>.
- [5] M. D. Andrestian, Z Dewi, N Oktiyani, and N Noraini, "'Kanasawa' composite flour from *Nagara* beans (*Vigna unguiculata* L.) and snake-skin gouramy fish (*Trichopodus trichopterus*) as calcium and phosphorus source," *IOP Conference Series Earth and Environmental Science*, vol. 1482, no. 1, pp. 012041–012041, Apr. 2025, doi: <https://doi.org/10.1088/1755-1315/1482/1/012041>.
- [6] W. P. Putra, R. Nopianti, and H. Herpandi, "Kandungan Gizi dan Profil Asam Amino Tepung Ikan Sepat Siam (*Trichigaster pectoralis*)," *Jurnal Fishtech*, vol. 6, no. 2, pp. 174–185, Jul. 2018, doi: <https://doi.org/10.36706/fishtech.v6i2.5849>.
- [7] Purnomo *et al.*, "Three-Spot Gourami (*Trichogaster trichopterus*) Chips With Different And Duration Cooking Method," *DOAJ (DOAJ: Directory of Open Access Journals)*, Aug. 2022.
- [8] H. Syandri, A. Azrita, E. Sumiarsih, and E. Elfiondri, "Nutrient loading and farm characteristics of giant gourami fish aquaculture systems in Lake Maninjau, Indonesia: basic knowledge of production performance," *F1000Research*, vol. 10, pp. 378–378, Sep. 2021, doi: <https://doi.org/10.12688/f1000research.52613.2>.
- [9] H. L. Hoon. "Composite flour as a new approach to improve the nutritional value of foods: Product quality challenges." 2018. 141-174.

- [10] M. D. Andrestian, Z Dewi, N Oktiyani, and N Noraini, "'Kanasawa' composite flour from *Nagara* beans (*Vigna unguiculata* L.) and snake-skin gouramy fish (*Trichopodus trichopterus*) as calcium and phosphorus source," *IOP Conference Series Earth and Environmental Science*, vol. 1482, no. 1, pp. 012041–012041, Apr. 2025, doi: <https://doi.org/10.1088/1755-1315/1482/1/012041>.
- [11] M. D. Andrestian, Z Dewi, N Oktiyani, and N Noraini, "'Kanasawa' composite flour from *Nagara* beans (*Vigna unguiculata* L.) and snake-skin gouramy fish (*Trichopodus trichopterus*) as calcium and phosphorus source," *IOP Conference Series Earth and Environmental Science*, vol. 1482, no. 1, pp. 012041–012041, Apr. 2025, doi: <https://doi.org/10.1088/1755-1315/1482/1/012041>.
- [12] W. B. Nagessa, B. Chambal, and C. Macuamule, "Effects of processing methods on phytate and tannin content of black small common beans (*Phaseolus vulgaris* L.) cultivated in Mozambique," *Cogent Food & Agriculture*, vol. 9, no. 2, 2023, doi: [10.1080/23311932.2023.2289713](https://doi.org/10.1080/23311932.2023.2289713).
- [13] S. Abdallah, D. Yahaya, and M. Alhassan, "Effects of processing techniques on the nutritional quality of cowpea (*Vigna unguiculata* L.) varieties," *J. Agric. Food Environ.*, vol. 3, no. 2, pp. 34–39, 2022, doi: [10.47440/JAFE.2022.3207](https://doi.org/10.47440/JAFE.2022.3207).
- [14] B. H. Vagadia, S. K. Vanga, A. Singh, Y. Gariepy, and V. Raghavan, "Comparison of conventional and microwave treatment on soymilk for inactivation of trypsin inhibitors and in vitro protein digestibility," *Foods*, vol. 7, no. 1, p. 6, 2018, doi: [10.3390/foods7010006](https://doi.org/10.3390/foods7010006).
- [15] C. C. Tadini and J. A. W. Gut, "The importance of heating unit operations in the food industry to obtain safe and high-quality products," *Front. Nutr.*, vol. 9, p. 853638, 2022, doi: [10.3389/fnut.2022.853638](https://doi.org/10.3389/fnut.2022.853638).
- [16] W. Ramadhani, I. Indrawan, and S. Seveline, "Formulasi Crackers Mocaf Dengan Penambahan Tepung Udang Rebon Serta Karakteristiknya," *Jurnal Bioindustri*, vol. 4, no. 2, pp. 93–108, May 2022, doi: <https://doi.org/10.31326/jbio.v4i2.1238>.
- [17] E.P. De Garmo, W.G. Sullivan, Canada, J.R. Engineering Economy The 7th Edition Macamillan Publishing Comp. New York (1984)
- [18] Badan Standardisasi Nasional, *SNI 01-2891-1992: Cara Uji Makanan dan Minuman*. Jakarta, Indonesia: Badan Standardisasi Nasional, 1992.
- [19] Association of Official Analytical Chemists (AOAC), *Official Methods of Analysis of AOAC International*, 19th ed. Gaithersburg, MD, USA: AOAC International, 2012.
- [20] Badan Standardisasi Nasional, *SNI 01-2891-1992: Cara Uji Makanan dan Minuman*. Jakarta, Indonesia: Badan Standardisasi Nasional, 1992.
- [21] Badan Standardisasi Nasional, *SNI 01-2891-1992: Cara Uji Makanan dan Minuman*. Jakarta, Indonesia: Badan Standardisasi Nasional, 1992.
- [22] Association of Official Analytical Chemists (AOAC), *Official Methods of Analysis of AOAC International*, 18th ed. Gaithersburg, MD, USA: AOAC International, 2005.
- [23] Badan Standardisasi Nasional, *SNI 01-2891-1992: Cara Uji Makanan dan Minuman*. Jakarta, Indonesia: Badan Standardisasi Nasional, 1992.
- [24] Association of Official Analytical Chemists (AOAC), *Official Methods of Analysis of AOAC International*, 18th ed. Gaithersburg, MD, USA: AOAC International, 2005.
- [25] Badan Standardisasi Nasional, *SNI 2970:2015: Biskuit*. Jakarta, Indonesia: Badan Standardisasi Nasional, 2015.
- [26] Badan Standardisasi Nasional, *SNI 01-2891-1992: Cara Uji Makanan dan Minuman*. Jakarta, Indonesia: Badan Standardisasi Nasional, 1992.
- [27] Association of Official Analytical Chemists (AOAC), *Official Methods of Analysis of AOAC International*, 20th ed. Gaithersburg, MD, USA: AOAC International, 2015.
- [28] Association of Official Analytical Chemists (AOAC), *Official Methods of Analysis of AOAC International*, 19th ed. Gaithersburg, MD, USA: AOAC International, 2012.
- [29] ICI Instrument Method, *In-House Method for Amino Acid Analysis*. Jakarta, Indonesia: ICI Instrument, 1988.
- [30] G. F. Ünal Şengör, M. O. Balaban, B. Topaloğlu, Z. Ayvaz, Z. Ceylan, and H. Doğruyol, "Color assessment by different techniques of gilthead seabream (*Sparus aurata*) during cold storage," vol. 39, no. 3, pp. 696–703, Sep. 2019, doi: <https://doi.org/10.1590/fst.02018>.
- [31] D. Arepally, R. S. Reddy, T. K. Goswami, and A. K. Datta, "Biscuit baking: A review," *LWT*, vol. 131, p. 109726, 2020, doi: [10.1016/j.lwt.2020.109726](https://doi.org/10.1016/j.lwt.2020.109726).
- [32] R. E. E. Tay, T. Agatha, G. Somang, O. Yulianti, and E. L. L. Tan, "Structuring wheat flour-based crackers using whey protein isolate," *Int. Dairy J.*, vol. 128, p. 105314, 2022, doi: [10.1016/j.idairyj.2021.105314](https://doi.org/10.1016/j.idairyj.2021.105314).
- [33] Fatma Laili Khoirunnida, Harijono Harijono, S.-Y. Hu, and J. Lin, "Physicochemical Characteristics of Mocaf Flour and Rice Flour-Based Gluten-Free Cookies," *International Journal of Current Science Research and Review*, vol. 07, no. 12, Dec. 2024, doi: <https://doi.org/10.47191/ijcsrr/v7-i12-28>.
- [34] U. Ayu, W. Estuti, and U. Kunaepah. "Use of Local Food Ingredients MOCAF (Modified Cassava Flour) and Rebon (Planktonic Shrimp) in Cookies as an Alternative Supplementary Food for Children. International Journal of Innovation, Creativity and Change". 2020. Special Edition: Safe Communities.
- [35] M. D. Andrestian, Z Dewi, N Oktiyani, and N Noraini, "'Kanasawa' composite flour from *Nagara* beans (*Vigna unguiculata* L.) and snake-skin gouramy fish (*Trichopodus trichopterus*) as calcium and phosphorus source," *IOP Conference Series Earth and Environmental Science*, vol. 1482, no. 1, pp. 012041–012041, Apr. 2025, doi: <https://doi.org/10.1088/1755-1315/1482/1/012041>.
- [36] J. Lee, S. Roux, E. Le Roux, S. Keller, B. Rega, and C. Bonazzi, "Unravelling caramelization and Maillard reactions in glucose and glucose + leucine model cakes: Formation and degradation kinetics of precursors, α -dicarbonyl intermediates and furanic compounds during

- baking,” *Food Chemistry*, vol. 376, p. 131917, May 2022, doi: <https://doi.org/10.1016/j.foodchem.2021.131917>
- [37] H. Cheng, J. Mei, and J. Xie, “Analysis of key volatile compounds and quality properties of tilapia (*Oreochromis mossambicus*) fillets during cold storage: Based on thermal desorption coupled with gas chromatography-mass spectrometry (TD-GC-MS),” *LWT*, vol. 184, p. 115051, Jul. 2023, doi: <https://doi.org/10.1016/j.lwt.2023.115051>.
- [38] I. Djekic, J. M. Lorenzo, P. E. S. Munekata, M. Gagaoua, and I. Tomasevic, “Review on characteristics of trained sensory panels in food science,” *Journal of Texture Studies*, vol. 52, no. 4, pp. 501–509, Jun. 2021, doi: <https://doi.org/10.1111/jtxs.12616>.
- [39] Sandra, L. G. Dias, and A. Teixeira, “Emerging Methods for the Evaluation of Sensory Quality of Food: Technology at Service,” *Current Food Science and Technology Reports*, Jan. 2024, doi: <https://doi.org/10.1007/s43555-024-00019-7>
- [40] A. Noviana, E. Palupi, P.E. Giriwono, and R. Rimbawan, “Decreasing fishy odour from catfish (*Clarias* sp.) flour as a food ingredient by using various soaking solutions,” *Food Research*, vol. 8, no. 1, pp. 349–358, Feb. 2024, doi: [https://doi.org/10.26656/fr.2017.8\(1\).123](https://doi.org/10.26656/fr.2017.8(1).123)
- [41] J. Luo, D. Frank, and J. Arcot, “Creating alternative seafood flavour from non-animal ingredients: A review of key flavour molecules relevant to seafood,” *Food Chemistry X*, pp. 101400–101400, Apr. 2024, doi: <https://doi.org/10.1016/j.fochx.2024.101400>.
- [42] H. Phetsang, W. Panpipat, A. Panya, N. Phonsatta, and M. Chaijan, “Occurrence and Development of Off-Odor Compounds in Farmed Hybrid Catfish (*Clarias macrocephalus* × *Clarias gariepinus*) Muscle during Refrigerated Storage: Chemical and Volatilomic Analysis,” *Foods*, vol. 10, no. 8, pp. 1841–1841, Aug. 2021, doi: <https://doi.org/10.3390/foods10081841>.
- [43] M. Liu, X. Zhao, M. Zhao, X. Liu, Y. Pang, and M. Zhang, “Characterization of the Key Aroma Constituents in Fried Tilapia through the Sensorics Concept,” *Foods*, vol. 11, no. 4, p. 494, Feb. 2022, doi: <https://doi.org/10.3390/foods11040494>.
- [44] H. Cheng, J. Mei, and J. Xie, “Analysis of key volatile compounds and quality properties of tilapia (*Oreochromis mossambicus*) fillets during cold storage: Based on thermal desorption coupled with gas chromatography-mass spectrometry (TD-GC-MS),” *LWT*, vol. 184, p. 115051, Jul. 2023, doi: <https://doi.org/10.1016/j.lwt.2023.115051>.
- [45] C. Trindler, K. Annika Kopf-Bolanz, and C. Denkel, “Aroma of peas, its constituents and reduction strategies – Effects from breeding to processing,” *Food Chemistry*, vol. 376, p. 131892, May 2022, doi: <https://doi.org/10.1016/j.foodchem.2021.131892>.
- [46] A. Karolkowski, E. Guichard, L. Briand, and C. Salles, “Volatile Compounds in Pulses: A Review,” *Foods*, vol. 10, no. 12, p. 3140, Dec. 2021, doi: <https://doi.org/10.3390/foods10123140>.
- [47] T. Manouel, B. G. Subasi, and M. Abdollahi, “Impacts of Harvest Year and Cultivation Location on Off-Flavor Compounds and Functionality of Pea Protein Isolate,” *Foods*, vol. 13, no. 21, pp. 3423–3423, Oct. 2024, doi: <https://doi.org/10.3390/foods13213423>.
- [48] A. Karolkowski, E. Guichard, L. Briand, and C. Salles, “Volatile Compounds in Pulses: A Review,” *Foods*, vol. 10, no. 12, p. 3140, Dec. 2021, doi: <https://doi.org/10.3390/foods10123140>.
- [49] P. Khrisanapant, B. Kebede, S. Y. Leong, and I. Oey, “Effects of Hydrothermal Processing on Volatile and Fatty Acids Profile of Cowpeas (*Vigna unguiculata*), Chickpeas (*Cicer arietinum*) and Kidney Beans (*Phaseolus vulgaris*),” *Molecules/Molecules online/Molecules annual*, vol. 27, no. 23, pp. 8204–8204, Nov. 2022, doi: <https://doi.org/10.3390/molecules27238204>.
- [50] G. Kapravelou, R. Martínez, J. Martino, J. Porres, and I. Fernández-Figares, “Natural Fermentation of Cowpea (*Vigna unguiculata*) Flour Improves the Nutritive Utilization of Indispensable Amino Acids and Phosphorus by Growing Rats,” *Nutrients*, vol. 12, no. 8, pp. 2186–2186, Jul. 2020, doi: <https://doi.org/10.3390/nu12082186>
- [51] S. Rustagi, “Food Texture and Its Perception, Acceptance and Evaluation,” *Biosciences Biotechnology Research Asia*, vol. 17, no. 03, pp. 651–658, Sep. 2020, doi: <https://doi.org/10.13005/bbra/2869>.
- [52] B. N. Gürbüz, L. M. Pastrana, R. N. Pereira, and M. A. Cerqueira, “Alternative Protein-Based Meat and Fish Analogs by Conventional and Novel Processing Technologies: A Systematic Review and Bibliometric Analysis,” *Foods*, vol. 14, no. 3, p. 498, Feb. 2025, doi: <https://doi.org/10.3390/foods14030498>.
- [53] N. Buamard, A. Singh, and S. Benjakul, “Improvement of Surimi Gel Quality Using Protein Cross-Linker, Hydrocolloids and Protease Inhibitor,” *Turkish Journal of Fisheries and Aquatic Sciences*, vol. 24, no. 3, Jan. 2024, doi: <https://doi.org/10.4194/trjfas24808>.
- [54] H. Herdina, A. Putri, E. Handayani, S. Rohmawati, N. K. Isfanaya, and T. Sopandi. “Evaluation of the Nutritional Composition of Fish Meal Production”. *SSRG International Journal of Agriculture & Environmental Science*. 2024. Volume 11 Issue 4, 42-46.
- [55] P. Petikirige, J. Jasmine, A. Karim, and G. Millar. “Review: Effect of drying techniques on quality and sensory properties of tropical fruits”. *International Journal of Food Science and Technology*. 2022. 57, 6963–6979.
- [56] E. M. Gonçalves *et al.*, “Influence of Air-Drying Conditions on Quality, Bioactive Composition and Sensorial Attributes of Sweet Potato Chips,” *Foods*, vol. 12, no. 6, p. 1198, Jan. 2023, doi: <https://doi.org/10.3390/foods12061198>.

- [57] N. Nurfaidah, A. N. Asikin, K. Kasmianti, and A. Angraeni, "Amino acid profile and potential utilization purposes of albumin from four types of freshwater fish in Makassar, South Sulawesi, Indonesia," *Biodiversitas Journal of Biological Diversity*, vol. 25, no. 11, Nov. 2024, doi: <https://doi.org/10.13057/biodiv/d251119>.
- [58] Z. J. Artina, D. F. Ayu, and Rahmayuni Rahmayuni, "The Crackers of Modified Cassava Flour (MOCAF) and Cowpea Flour: Chemical and Sensory Properties," *Agritekno: Jurnal Teknologi Pertanian*, vol. 12, no. 1, pp. 57–64, Mar. 2023, doi: <https://doi.org/10.30598/jagritekno.2023.12.1.57>.
- [59] B. Syed, Dr. K. Gadhe, Dr. V. Pawar, R. Dhabale, and R. Pandey, "Development and sensory evaluation of bakery products incorporated with pearl millet and cowpea flour," *International Journal of Advanced Biochemistry Research*, vol. 8, no. 10, pp. 648–651, Oct. 2024, doi: <https://doi.org/10.33545/26174693.2024.v8.i10i.2572>.
- [60] S. R. Kesselly, R. Mugabi, and Y. B. Byaruhanga, "Effect of soaking and extrusion on functional and pasting properties of cowpeas flour," *Scientific African*, vol. 19, p. e01532, Mar. 2023, doi: <https://doi.org/10.1016/j.sciaf.2022.e01532>.
- [61] N. Belc, D. E. Duta, A. Culetu, and G. D. Stamatie, "Type and Amount of Legume Protein Concentrate Influencing the Technological, Nutritional, and Sensorial Properties of Wheat Bread," *Applied Sciences*, vol. 11, no. 1, p. 436, Jan. 2021, doi: <https://doi.org/10.3390/app11010436>.
- [62] K. Arora *dkk.*, "Karakteristik fisikokimia, nutrisi, dan fungsional bahan bebas gluten serta dampaknya terhadap tekstur roti," vol. 177, hlm. 114566–114566, Maret 2023, doi: <https://doi.org/10.1016/j.lwt.2023.114566>.
- [63] N. Goldstein and R. Reifen, "The potential of legume-derived proteins in the food industry," *Grain & Oil Science and Technology*, vol. 5, no. 4, Jun. 2022, doi: <https://doi.org/10.1016/j.gaost.2022.06.002>.
- [64] T. Bojňanská, J. Musilová, and A. Vollmannová, "Effects of Adding Legume Flours on the Rheological and Breadmaking Properties of Dough," *Foods*, vol. 10, no. 5, p. 1087, May 2021, doi: <https://doi.org/10.3390/foods10051087>.
- [65] Hasmadi, M., Noorfarahzilah, M., Noraidah, H., Zainol, M. K., & Jahurul, M. H. A. (2020). Functional properties of composite flour: A review. *Food Research*, 4(6), 1820–1831.
- [66] A. Aydogdu, G. Sumnu, and S. Sahin, "Effects of addition of different fibers on rheological characteristics of cake batter and quality of cakes," *Journal of Food Science and Technology*, vol. 55, no. 2, pp. 667–677, Dec. 2017, doi: <https://doi.org/10.1007/s13197-017-2976-y>.
- [67] T. Bojňanská, J. Musilová, and A. Vollmannová, "Effects of Adding Legume Flours on the Rheological and Breadmaking Properties of Dough," *Foods*, vol. 10, no. 5, p. 1087, May 2021, doi: <https://doi.org/10.3390/foods10051087>.
- [68] Chaima Neji, Jyoti Semwal, Endre Máthé, and Péter Sípós, "Dough Rheological Properties and Macronutrient Bioavailability of Cereal Products Fortified through Legume Proteins," *Processes*, vol. 11, no. 2, pp. 417–417, Jan. 2023, doi: <https://doi.org/10.3390/pr11020417>.
- [69] E. M. Gonçalves *et al.*, "Influence of Air-Drying Conditions on Quality, Bioactive Composition and Sensorial Attributes of Sweet Potato Chips," *Foods*, vol. 12, no. 6, p. 1198, Jan. 2023, doi: <https://doi.org/10.3390/foods12061198>.
- [70] H. Gliguem, F. Khamassi, A. Hanafi, W. Hajji, M. H. Esseghaier, and S. Bellagha, "Legume Flour Enrichment of Cereal Products: Effects on Consumer Perception and Physical Quality," *Acta Scientifci Nutritional Health*, vol. 6, no. 1, pp. 03-14, Jan. 2022, doi: <https://doi.org/10.31080/asnh.2022.06.0972>.
- [71] N. S. Affrifah, R. D. Phillips, and F. K. Saalia, "Cowpeas: Nutritional profile, processing methods and products—A review," *Legume Science*, vol. 4, no. 3, Nov. 2021, doi: <https://doi.org/10.1002/leg3.131>.
- [72] N. A. Mahmudah *et al.*, "Potential of Leucaena leucocephala (white leadtree) seed flour as a functional food with umami taste," *Food Research*, vol. 8, no. 4, pp. 53–60, Jul. 2024, doi: [https://doi.org/10.26656/fr.2017.8\(4\).318](https://doi.org/10.26656/fr.2017.8(4).318).
- [73] N. A. Mahmudah *et al.*, "Potential of Leucaena leucocephala (white leadtree) seed flour as a functional food with umami taste," *Food Research*, vol. 8, no. 4, pp. 53–60, Jul. 2024, doi: [https://doi.org/10.26656/fr.2017.8\(4\).318](https://doi.org/10.26656/fr.2017.8(4).318).
- [74] H. J. Clarke, W. P. McCarthy, M. G. O'Sullivan, J. P. Kerry, and K. N. Kilcawley, "Oxidative Quality of Dairy Powders: Influencing Factors and Analysis," *Foods*, vol. 10, no. 10, p. 2315, Sep. 2021, doi: <https://doi.org/10.3390/foods10102315>.
- [75] T. Wu, M. Wang, P. Wang, H. Tian, and P. Zhan, "Advances in the Formation and Control Methods of Undesirable Flavors in Fish," *Foods*, vol. 11, no. 16, p. 2504, Aug. 2022, doi: <https://doi.org/10.3390/foods11162504>.
- [76] A. Noviana, E. Palupi, P.E. Giriwono, and R. Rimbawan, "Decreasing fishy odour from catfish (*Clarias* sp.) flour as a food ingredient by using various soaking solutions," *Food Research*, vol. 8, no. 1, pp. 349–358, Feb. 2024, doi: [https://doi.org/10.26656/fr.2017.8\(1\).123](https://doi.org/10.26656/fr.2017.8(1).123).
- [77] T. Aspevik, S. Steinsholm, B. Vang, M. Carlehög, J. A. Arnesen, and K. Kousoulaki, "Nutritional and Sensory Properties of Protein Hydrolysates Based on Salmon (*Salmo salar*), Mackerel (*Scomber scombrus*), and Herring (*Clupea harengus*) Heads and Backbones," *Frontiers in Nutrition*, vol. 8, Dec. 2021, doi: <https://doi.org/10.3389/fnut.2021.695151>.
- [78] M. Vogelsang-O'Dwyer, A. W. Sahin, E. K. Arendt, and E. Zannini, "Enzymatic Hydrolysis of Pulse Proteins as a Tool to Improve Techno-Functional Properties," *Foods*,

- vol. 11, no. 9, p. 1307, Apr. 2022, doi: <https://doi.org/10.3390/foods11091307>.
- [79] A. Karolkowski, E. Guichard, L. Briand, and C. Salles, "Volatile Compounds in Pulses: A Review," *Foods*, vol. 10, no. 12, p. 3140, Dec. 2021, doi: <https://doi.org/10.3390/foods10123140>
- [80] A. Noviana, E. Palupi, P.E. Giriwono, and R. Rimbawan, "Decreasing fishy odour from catfish (*Clarias* sp.) flour as a food ingredient by using various soaking solutions," *Food Research*, vol. 8, no. 1, pp. 349–358, Feb. 2024, doi: [https://doi.org/10.26656/fr.2017.8\(1\).123](https://doi.org/10.26656/fr.2017.8(1).123)
- [81] J. Luo, D. Frank, and Jayashree Arcot, "Creating alternative seafood flavour from non-animal ingredients: A review of key flavour molecules relevant to seafood," *Food Chemistry X*, pp. 101400–101400, Apr. 2024, doi: <https://doi.org/10.1016/j.fochx.2024.101400>
- [82] H. Phetsang, W. Panpipat, A. Panya, N. Phonsatta, and M. Chaijan, "Occurrence and Development of Off-Odor Compounds in Farmed Hybrid Catfish (*Clarias macrocephalus* × *Clarias gariepinus*) Muscle during Refrigerated Storage: Chemical and Volatilomic Analysis," *Foods*, vol. 10, no. 8, pp. 1841–1841, Aug. 2021, doi: <https://doi.org/10.3390/foods10081841>.
- [83] M. Mozzon, R. Foligni, C. Mannozi, and S. Vittori, "Assessment of lipid oxidation in fish and fish products processed by cold plasma technologies," *Applied Food Research*, vol. 4, no. 2, p. 100646, Dec. 2024, doi: <https://doi.org/10.1016/j.afres.2024.100646>.
- [84] X. Miao, S. Li, S. Shang, N. Sun, X. Dong, and P. Jiang, "Characterization of volatile flavor compounds from fish maw soaked in five different seasonings," *Food Chemistry: X*, vol. 19, p. 100805, Jul. 2023, doi: <https://doi.org/10.1016/j.fochx.2023.100805>.
- [85] H. Phetsang, W. Panpipat, A. Panya, N. Phonsatta, and M. Chaijan, "Occurrence and Development of Off-Odor Compounds in Farmed Hybrid Catfish (*Clarias macrocephalus* × *Clarias gariepinus*) Muscle during Refrigerated Storage: Chemical and Volatilomic Analysis," *Foods*, vol. 10, no. 8, pp. 1841–1841, Aug. 2021, doi: <https://doi.org/10.3390/foods10081841>.
- [86] Badjona, Abraham, et al. "Faba bean flavor effects from processing to consumer acceptability." *Foods* 12.11 (2023): 2237.
- [87] A. Lippolis, Roland, Ornela Bocova, L. Pouvreau, and L. M. Trindade, "The challenge of breeding for reduced off-flavor in faba bean ingredients," *Frontiers in plant science*, vol. 14, Oct. 2023, doi: <https://doi.org/10.3389/fpls.2023.1286803>.
- [88] De Garmo, E.P., Sullivan W.G., Canada, J.R. Engineering Economy The 7th Edition Macamillan Publishing Comp. New York (1984).
- [89] K. M. Appleton *et al.*, "Sensory and physical characteristics of foods that impact food intake without affecting acceptability: Systematic review and meta-analyses," *Obesity Reviews*, vol. 22, no. 8, Mar. 2021, doi: <https://doi.org/10.1111/obr.13234>.
- [90] B. K. Abebe and M. T. Alemayehu, "A review of the nutritional use of cowpea (*Vigna unguiculata* L. Walp) for human and animal diets," *Journal of Agriculture and Food Research*, vol. 10, p. 100383, Dec. 2022, doi: <https://doi.org/10.1016/j.jafr.2022.100383>.
- [91] A. H. Bakare *et al.*, "Nutritional, Texture, and Sensory Properties of composite biscuits produced from breadfruit and wheat flours enriched with edible fish meal," *Food Science & Nutrition*, vol. 8, no. 11, pp. 6226–6246, Nov. 2020, doi: <https://doi.org/10.1002/fsn3.1919>.
- [92] National Standardization Agency of Indonesia. 2011. SNI 01-2973. Cookies standard quality. BSN. Jakarta. <https://bsn.go.id>.
- [93] S. Réhault-Godbert, N. Guyot, and Y. Nys, "The golden egg: Nutritional value, bioactivities, and emerging benefits for human health," *Nutrients*, vol. 11, no. 3, p. 684, 2019, doi: 10.3390/nu11030684.
- [94] J. Painter, "A nutritional and environmental impact comparison of skim dairy milk and plant beverages: A review," *Med. Res. Arch.*, vol. 13, no. 4, 2025, doi: 10.18103/mra.v13i4.6498.
- [95] C. Weber, L. Harnack, A. Johnson, B. Jasthi, J. Pettit, and J. Stevenson, "Nutrient comparisons of margarine/margarine-like products, butter blend products and butter in the US marketplace in 2020 post-FDA ban on partially hydrogenated oils," *Public Health Nutr.*, vol. 25, no. 5, pp. 1–8, 2021, doi: 10.1017/S1368980021004511.
- [96] K. Kasyani *et al.*, "Biscuit Formulation Substitutes Wheat Flour with Tempeh Flour and Nile Tilapia Fish Flour as Complementary Food to Prevent Stunting," *Indonesian Food Science and Technology Journal*, vol. 8, no. 2, pp. 245–252, Jul. 2025, doi: 10.22437/iftj.v8i2.39090.
- [97] K. Giannoutsos, D. I. Koukoumaki, V. Bountziouka, T. Poriazi, M. Papageorgiou, D. Sarris, K. Gkatzionis, and E. Naziri, "Quality properties of crackers enriched with composite flours: Effect on dough and final product," *Appl. Sci.*, vol. 15, no. 23, p. 12361, 2025, doi: 10.3390/app152312361.
- [98] National Standardization Agency of Indonesia. 1992. Indonesian's National Standard (SNI): Quality and Test Methods for Biscuits. Jakarta. <https://bsn.go.id>.
- [99] H. Mamat and S. E. Hill, "Effect of fat types on the structural and textural properties of dough and semi-sweet biscuit," *J. Food Sci. Technol.*, vol. 51, no. 9, pp. 1998–2005, 2014, doi: 10.1007/s13197-012-0708-x.
- [100] D. M. Abebe and E. O. Keyata, "Effects of blending ratios and baking temperature on physicochemical properties and sensory acceptability of biscuits prepared from pumpkin, common bean, and wheat composite flour," *Heliyon*, vol. 8, no. 10, p. e10848, 2022, doi: 10.1016/j.heliyon.2022.e10848.
- [101] E. A. Irondi, K. K. Olatoye, H. T. Abdulameed, *et al.*, "Physicochemical, in vitro starch digestibility and sensory characteristics of biofortified yellow maize-cowpea

- composite flours and biscuits,” *Food Prod. Process. Nutr.*, vol. 6, p. 15, 2024, doi: 10.1186/s43014-023-00201-9.
- [102] Z. Kusnul and E. Rahmawati, “Pendampingan Keluarga Balita dalam Pemenuhan Nutrisi pada Anak Beresiko Stunting Di Dusun Cangkring Desa Pelem Kecamatan Pare Kabupaten Kediri,” *Jurnal Abdimas Pamenang*, vol. 1, no. 1, pp. 5–9, Dec. 2022, doi: <https://doi.org/10.53599/jap.v1i1.119>.
- [103] A. E. Ujong, N. J. T. Emelike, F. I. Woka, and F. O. JNR, “Formulation of fiber enriched crackers biscuit: Effect on nutritional composition, physical and sensory properties,” *Heliyon*, vol. 9, p. e15941, 2023, doi: 10.1016/j.heliyon.2023.e15941.
- [104] A. Abdullah, N. Nurjanah, A. V. Seulalae, and A. N. Firdaos, “Chemical composition, mineral, and vitamin of prebiotic crackers with addition of seaweed salt,” *J. Pengolahan Hasil Perikanan Indones.*, vol. 26, no. 1, pp. 153–163, 2023, doi: 10.17844/.
- [105] A. E. Ujong, N. J. T. Emelike, F. I. Woka, and F. O. JNR, “Formulation of fiber enriched crackers biscuit: Effect on nutritional composition, physical and sensory properties,” *Heliyon*, vol. 9, p. e15941, 2023, doi: 10.1016/j.heliyon.2023.e15941.
- [106] C. R. Utami and N. Fitriyani, “Antioxidant activity and organoleptic quality of crackers with differences in the addition of black glutinous tape and baking powder,” *J. Nat. Sci. Learn.*, vol. 2, no. 2, pp. 1–9, 2023, doi: 10.30742/jnsl.v2i2.85.
- [107] A. E. Ujong, N. J. T. Emelike, F. I. Woka, and F. O. JNR, “Formulation of fiber enriched crackers biscuit: Effect on nutritional composition, physical and sensory properties,” *Heliyon*, vol. 9, p. e15941, 2023, doi: 10.1016/j.heliyon.2023.e15941.
- [108] M. H. J. Shovon, D. A. Khan, M. M. I. Tareq, et al., “A comprehensive assessment of VCAN transcriptional expression and evaluation as an effective prognostic biomarker against breast cancer: In silico study,” *Bull. Natl. Res. Cent.*, vol. 47, p. 83, 2023, doi: 10.1186/s42269-023-01062-5.
- [109] Y. Sutriyono and U. Pato, “Pemanfaatan Buah Terung Belanda dan Kulit Pisang Kepok dalam Pembuatan Selai,” *Jurnal Online Mahasiswa Fakultas Pertanian Universitas Riau*, vol. 3, no. 2, pp. 1–13, Nov. 2016.
- [110] T. T. T. Tran, L. H. N. Ngo, N. M. N. Ton, T. H. N. Le, T. T. Le, and V. V. M. Le, “High-fiber crackers supplemented with asparagus hard-stem: Impacts of supplementation ratios and water amounts in cracker recipe on the product quality,” *Pol. J. Food Nutr. Sci.*, vol. 74, no. 2, pp. 162–168, 2024, doi: 10.31883/pjfn/188110.
- [111] A. E. Ujong, N. J. T. Emelike, F. I. Woka, and F. O. JNR, “Formulation of fiber enriched crackers biscuit: Effect on nutritional composition, physical and sensory properties,” *Heliyon*, vol. 9, p. e15941, 2023, doi: 10.1016/j.heliyon.2023.e15941.
- [112] S. Lin, “Dietary fiber in bakery products: Source, processing, and function,” in *Advances in Food and Nutrition Research*, vol. 99, W. Zhou and J. Gao, Eds. Academic Press, 2022, pp. 37–100, doi: 10.1016/bs.afnr.2021.12.001.
- [113] S. N. Utami et al., “Characteristics of crackers fortified with the sailfin catfish (*Pterygoplichthys pardalis*) bone meal,” *Egypt. J. Aquat. Biol. Fish.*, vol. 28, no. 4, pp. 401–414, 2024, doi: 10.21608/ejabf.2024.368365.
- [114] A. T. Idowu, S. Benjakul, S. Sinthusamran, J. Pongsetkul, T. Sae-Leaw, and P. Sookchoo, “Whole wheat cracker fortified with biocalcium and protein hydrolysate powders from salmon frame: Characteristics and nutritional value,” *Food Qual. Saf.*, vol. 3, no. 3, pp. 191–199, 2019, doi: 10.1093/fqsaf/fyz012.
- [115] S. N. Utami et al., “Characteristics of crackers fortified with the sailfin catfish (*Pterygoplichthys pardalis*) bone meal,” *Egypt. J. Aquat. Biol. Fish.*, vol. 28, no. 4, pp. 401–414, 2024, doi: 10.21608/ejabf.2024.368365.
- [116] S. Benjakul and S. Karnjanapratum, “Characteristics and nutritional value of whole wheat cracker fortified with tuna bone bio-calcium powder,” *Food Chem.*, vol. 259, pp. 181–187, 2018, doi: 10.1016/j.foodchem.2018.03.124.
- [117] M. M. Salama, S. M. Ghanem, M. M. Kadry, et al., “Utilization of chicken eggshells as a source of calcium to enhance the nutritional value and quality characteristics of crackers,” *Discov. Food*, vol. 5, p. 167, 2025, doi: 10.1007/s44187-025-00467-7.
- [118] Z. Mushthofa, & S. Achadiyah, Perbandingan Tepung Mocaf dan Tepung Tapioka dalam Pembuatan Siomai dengan Penambahan Tepung Jamur Tiram (*Pleurotus ostreatus*) sebagai Sumber Protein. *Agroforetech*, 2023. 1(2), 1147-1168.
- [119] E. M. Sari, M. Juffrie, N. Nurani, and M. N. Sitaresmi, “Asupan protein, kalsium dan fosfor pada anak stunting dan tidak stunting usia 24-59 bulan,” *Jurnal Gizi Klinik Indonesia*, vol. 12, no. 4, p. 152, Apr. 2016, doi: <https://doi.org/10.22146/ijcn.23111>.
- [120] B. Shkemi and T. Huppertz, “Calcium Absorption from Food Products: Food Matrix Effects,” *Nutrients*, vol. 14, no. 1, p. 180, Dec. 2021, doi: <https://doi.org/10.3390/nu14010180>.
- [121] M. Rosa, E. Hambali, M. Rahayuningsih, and , “Nutritional Evaluation of Quail-Based Complementary Food to Prevent Stunting in Early Childhood,” *Jurnal Pangan dan Agroindustri*, vol. 13, no. 3, pp. 146–158, Jul. 2025, doi: 10.21776/ub.jpa.2025.013.03.2.
- [122] E. M. Sari, M. Juffrie, N. Nurani, and M. N. Sitaresmi, “Asupan protein, kalsium dan fosfor pada anak stunting dan tidak stunting usia 24-59 bulan,” *Jurnal Gizi Klinik Indonesia*, vol. 12, no. 4, p. 152, Apr. 2016, doi: <https://doi.org/10.22146/ijcn.23111>.
- [123] Yarmaliza et al., “Local functional food: Stunting prevention in toddlers,” *Canrea Journal: Food Technology, Nutritions, and Culinary Journal*, pp. 43–53, Jun. 2024, doi: 10.20956/canrea.v7i1.1016.