INTERNASIONAL CONFERENCE ON
MULTIDISCIPLINARY APPROACHES IN HEALTH SCIENCE
VOLUME 2 , ISSN 3032-4408 (Online)
https://ejournal.poltekkes-denpasar.ac.id/index.php/icmahs

Formulation of Lemuru Fish Flour (*Sardinella lemuru*) Affects the Characteristics of *Kasteru*

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Article history
Posted : 2024-12-12
Reviewed : 2024-10-29
Received : 2023-10-03

ABSTRACT

Lemuru fish (*Sardinella lemuru*) is one of the small pelagic fish species commonly found in the sea of Bali Strait. The protein content in lemuru fish can be utilized to prevent and resolve toddler nutrition problems such as chronic energy deficiency and stunting, as well as a high energy high protein diet formula for cancer patients. This research developed products named *Kasteru*, which are kastengel cookies formulated with lemuru fish flour. The purpose of this study was to determine the effect of lemuru fish flour formulation on the characteristics of *Kasteru*. The type of research used is group randomized design (GRD) with 5 different treatments of lemuru fish flour formulation on wheat flour using analysis of variance (Anova). Lemuru fish flour formulation in *Kasteru* had a significant effect on color, aroma, texture, taste, overall acceptance, color quality, aroma quality, and taste quality, but had no significant effect on protein content and water content of *Kasteru*. The best treatment for *Kasteru* based on subjective and objective characteristics was treatment 3, which is a formulation of 10% lemuru fish flour and 90% wheat flour. Treatment 3 had a brownish yellow color, slightly savory aroma, and fish flavor with a protein content of 16.59% and a water content of 6.41%.

Keywords : Lemuru fish flour, kastengel, organoleptic, protein, water content

Introduction

Indonesia has extensive territorial waters that are rich in resources, one of which is in the fisheries sector. The potential of fish resources in Indonesia is very abundant. However, this potential is not accompanied by the rate of fish consumption in the society. Indonesia has an average fish consumption rate of 41 kg per capita/year. Based on statistics from the Ministry of Maritime Affairs and Fisheries, Indonesia's fish consumption rate has increased every year, reaching 56.48 kg per capita in 2022. Despite the increasing rate, Indonesia's fish consumption is still far behind Malaysia with an average of 70 kg per capita/year and Singapore with an average of 80 kg per capita/year. Indonesia's fish consumption is also very far below Japan with an average of close to 100 kg per capita/year (Daroedono, 2019). Fish consumption rates in Indonesia, are influenced by a variety of factors including food availability, socioeconomic conditions, differences in topography and geography, disease, level of knowledge and income of parents, and taste (Azkia et al., 2020; Tiffany et al., 2020). Therefore, it is necessary to process fish into a form of food that is preferred by community.

Lemuru fish (*Sardinella lemuru*) is one of Bali's marine commodities. This fish has a highly strategic role, including being the main source of income for the local community, driving regional economic activities by absorbing labor ranging from fishing, processing, transportation services, to sales, providing basic materials for the processing industry, as well as a source of original regional income (Simbolon et al., 2011).

Lemuru is the most dominant small pelagic fish species in the Bali Strait, reaching 85.40 - 91.47% of all small pelagic fish production (Setyohadi & Wiadnya, 2018). Lemuru fish has a relatively low price and high nutritional content. 100 grams of lemuru fish contains 112 kcal of energy, 20 g of protein, and 3 g of fat (Kemenkes RI, 2018). Considering these nutrients, especially protein, lemuru fish can be utilized as a high-protein food that can prevent and overcome nutritional problems in children such as stunting and Chronic Energy Deficiency (CED), as well as a high energy high protein diet formula for cancer patients. Lemuru fish is commonly used as the main raw material in the sardine industry. Lemuru fish can also be processed at the household level as a side dish since it is easily available in the market.

Lemuru fish contains high omega 3 fatty acids and has a texture that is not compact, making lemuru fish susceptible to damage and decay, either due to microbiological activity or autolysis during post mortem. To overcome this, it is necessary to handle lemuru fish intensively, either through direct processing or preservation. One of the efforts that can be made to extend the durability of lemuru is by processing it into fish flour (Ananda et al., 2022). According to the Indonesian Food Composition Table 2017, 100 g of fish flour contains 316 kcal of energy, 60.1 g of protein, and fat. The protein content in fish flour is more than wheat flour, which is 9 g of protein. Fish flour is usually only used as animal feed, but seeing the nutritional ingredients its contains, especially protein, fish flour has the potential to be formulated in a food product.

Dry and crunchy foods are highly favored by the community. One type of well known cookie that is easy to make is kastengel cookies. Kastengel is a type of cookie that has yellow colour, a distinctive aroma and taste of savory cheese. These cookies are commonly served during holiday celebrations in Indonesia, as a treat for guests at home, or as a casual snack (Rahmaniyah & Prasetyawati, 2020). Based on the description above, it is necessary to conduct research on the development of lemuru fish flour formulation into kastengel cookies to increase the nutritional content of the cookies. Through the formulation of *Kasteru* (Lemuru Fish Flour Kastengel), it is expected that there will be an increase in protein content in kastengel

cookies so that it can be used as an alternative high-protein snack that can be consumed by toddlers to deal with stunting and chronic energy deficiency (CED) as well for cancer patients.

This study aims to determine the effect of lemuru fish flour formulation on the characteristics of *Kasteru*.

Research Method

The type of research used is group randomized design (GRD) with 5 different treatments of lemuru flour formulation on wheat flour and 3 replications using analysis of variance (Anova). The treatments conducted are (P1) 5% lemuru fish flour: 95% wheat flour, (P2) 7.5% lemuru fish flour: 92.5% wheat flour, (P3) 10% lemuru fish flour: 90% wheat flour, (P4) 12.5% lemuru fish flour: 87.5% wheat flour, (P5) 15% lemuru fish flour: 85% wheat flour. This study aims to see the effect of lemuru fish flour formulation on the subjective (organoleptic) and objective (nutritional content) characteristics of *Kasteru*.

Manufacturing process of *Kasteru* was conducted at the Food Technology Laboratory of the Nutrition Department Polytechnic of Health Denpasar, Jalan Gemitir No. 72 Kesiman Kertalangu, East Denpasar. The ingredients needed to make lemuru fish flour are lemuru fish (*Sardinella lemuru*), lime, ginger and lemongrass. The tools needed are knive, cutting board, pan, oven, baking sheets, miller machine, bowl, flour strainer, digital scale, and gas stove. The process of making lemuru fish flour is as follows: (1) Clean 250 g of lemuru fish, remove the head, scales, fins, tail, and entrails, (2) Weigh the net weight of lemuru fish, (3) After being cleaned, lemuru fish is given 10 ml of lime juice, then stored for about 1 hour, (4) Boil lemuru fish with 5 cm of ginger and 1 lemongrass stalk at 60°C for 30 minutes, (5) Drain the lemuru fish, remove the skin and fat, and then shred it so that the surface area is smaller, (6) Dry it using an oven at 65°C for 3 hours, then cool it at room temperature for 30 minutes, (7) The dried lemuru fish is then mashed using a miller machine, then sifted using a flour strainer. After the lemuru fish flour is finished, then proceed to make *Kasteru* with the ingredients which are lemuru fish flour, medium protein wheat flour, margarine, egg yolk, and cheese. The composition of the ingredients used in each formulation is presented in Table 1.

Table 1. The Formulation of Kasteru

Ingredients	P1	P2	P3	P4	P5
	Quantity (g)				
Lemuru fish flour	10	15	20	25	30
Wheat flour	190	185	180	175	170
Margarine	175	175	175	175	175
Egg Yolks	30	30	30	30	30
Cheese	60	60	60	60	60

Tools required are a large bowl, flour strainer, whisker or mixer, cheese grater, spatula, rolling pin, baking paper, cookie molds, brush, oven. The steps in making *Kasteru* are as follows: (1) Formulate lemuru fish flour and wheat flour in the ratio of 5%:95%, 7.5%:92.5%, 10%:90%, 12.5%:87.5%, and 15%: 85%, (2) Whisk egg yolks and margarine until they turn pale in color, (3) Add grated cheese to the batter, whisk until smooth, (4) Add lemuru fish flour and wheat flour formulation by sifting it first, (4) Mix the dough until smooth, (5) Take out the dough then place it on the table, roll it out and flatten it using a rolling pin with a thickness of $\pm$ 1 cm, (6) Shape the dough using a flower-shaped cookie mold, brush with egg yolk and sprinkle with cheese, (7) Spread margarine on the baking sheet then bake the kastengel in the oven at 150°C for 40 minutes until golden brown, (8) Take out of the oven and cool, serve immediately or store in an airtight container.

The organoleptic test was conducted at the Organoleptic Laboratory of the Nutrition Department Polytechnic of Health Denpasar. The product is tested through an organoleptic test using the hedonic test which assesses the level of panelist preference for the product in terms of color, aroma, texture, taste, and overall acceptance using five-point scales, namely (1) strongly dislike, (2) dislike, (3) neutral, (4) like, and (5) strongly like. It also tested the hedonic quality which assesses the quality of the product in terms of color quality, aroma quality, and taste quality using three-point scales. This study used 30 moderately trained panelists who were students of the Nutrition Department Polytechnic of Health Denpasar.

The nutritional content of *Kasteru* was analyzed through laboratory tests conducted at the Food Analysis Laboratory, Faculty of Agriculture, Udayana University, Jalan PB. Sudirman, West Denpasar. The nutritional content to be assessed is protein through Kjeldahl test and water content through thermogravimetric test.

Results and Discussions

Kastengel, originally named *kaasstengels* (cheese bars), is a type of pastry originating from the Netherlands with a size of 30 cm, but is usually smaller at 4 cm in Indonesia (Sari & Mulyatiningsih, 2020). In this study, the formulation of lemuru fish flour in kastengel resulted in a product called *Kasteru*. Kastengel, which is generally in the form of bars, is molded in the shape of a flower a diameter of 5 cm to make it look more attractive to children.

Subjective analysis (organoleptic) includes hedonic test and hedonic quality test. The average score of the hedonic test assessment results (preference) of *Kasteru* can be seen in Table 2. Through analysis of variance (Anova) at the 5% and 1% levels, it is known that there is an effect of lemuru fish flour formulation on the level of preference for color, aroma, texture, taste, overall acceptance, color quality, aroma quality, and taste quality of Kasteru ($F_{statistic} > F_{table}$ 5%). Furthermore, the data was analyzed through the least significant difference (LSD), it was found that there were significant differences between the *Kasteru* treatments for color, aroma, taste, overall acceptance, color quality, aroma quality, and taste quality while there were no significant differences between the *Kasteru* treatments for texture.

Table 2. Organoleptic Test Average Score of Kasteru

Indicators	P1	P2	P3	P4	P5
	Average Score				
Color	3,41a	4,13a	4,18a	3,07b	2,20c
Aroma	3,91a	3,67ab	3,64ab	3,09bc	2,73c
Texture	3,87a	3,76a	3,73a	3,51a	3,33a
Taste	3,67a	3,67a	3,49a	2,96ab	2,49b
Overall Acceptance	2,99b	3,57ab	3,70a	2,97b	2,26c
Color Quality	2,43a	2,47a	2,44a	1,51b	1,00c
Aroma Quality	2,29a	2,16a	1,98ab	1,51b	1,51b
Taste Quality	2,16ab	2,16ab	2,20a	1,62bc	1,42c
Total 'a' notation	**6**	**8**	**8**	**2**	**1**

Notes: Different letters behind means indicate significant differences based on the LSD test for the 5% level (P>0.05)

Objective analysis of *Kasteru* is a test of nutrient content including protein and water content in the laboratory which is carried out to determine the characteristics of the product chemically. The average value of the objective analysis results of *Kasteru* can be seen in the Table 3.

Table 3. Objective Analysis Average Value of Kasteru

Nutrient	P1	P2	P3	P4	P5
	Average (%)				
Protein	16,06	16,04	16,58	17,75	18,23
Water Content	5,41	6,41	6,41	6,42	6,41

Table 3 shows that the treatment with the highest average of water content is treatment 4 (6.44%), which is a formulation of 12.5% lemuru fish flour and 87.5% wheat flour. Meanwhile, the treatment with the lowest average water content was treatment 1 (5.41%), which is a formulation of 5% lemuru fish flour and 95% wheat flour. Through analysis of variance (Anova) at the 5% and 1% levels, it was found that there was no effect of lemuru fish flour formulation on the water content of *Kasteru* ($F_{statistic} < F_{table}$) so it was not continued with LSD testing.

The best treatment of *Kasteru* was determined by looking at the treatment that had the most 'a' notations on the average score of the subjective analysis. Table 2 shows that the best treatments based on subjective characteristics are treatments 2 and 3. Treatments 2 and 3 were the most preferred treatments by panelists based on aspects of color, aroma, texture, taste, overall acceptance, color quality, aroma quality, and taste quality. Based on the objective analysis results, treatment 3 has higher protein content than treatment 2. Treatment 2 has a protein content of 16.05%, while treatment 3 has a protein content of 16.59%. So that between the two treatments, the best treatment based on subjective and objective characteristics is treatment 3, which is a formulation of 10% lemuru fish flour and 90% wheat flour.

Subjective Characteristics of Kasteru

Through analysis of variance on subjective characteristics, it is known that there is an effect of lemuru fish flour formulation on color, aroma, texture, taste, overall acceptance, color quality, aroma quality, and taste quality of *Kasteru*.

Color is a psychological response to the stimulus produced by the physical properties of food seen by the human eye and is one of the important aspects in the acceptance of a product (Husain et al., 2023). Color is the first thing that consumers can judge when looking at a product. The results of the hedonic test on the color of *Kasteru* showed an average score in the range of 2.20 - 4.18. The highest score is 4.18 with the category of like obtained by treatment 3 and the lowest score is 2.20 with the category of dislike obtained by treatment 1. The results of the hedonic quality test on the color of the *Kasteru* show an average score in the range of 1.00 - 2.47. The highest score was 2.47 with the category of brownish yellow color obtained by treatment 2 and the lowest score was 1.00 with the category of brown color obtained by treatment 5. Through analysis of variance, it is known that the formulation of lemuru fish flour affects the level of panelists' preference for color and affects the color quality of *Kasteru*.

Kasteru has a color difference that can be easily observed. Treatment 1 has a yellow color and treatment 5 has a brown color. The higher the concentration of lemuru fish flour, the browner the color of the product. And the higher the concentration of lemuru fish, the lower the

level of panelists' preference for the color of *Kasteru*. These results are in line with research from Ramadhan et al., (2019), namely there is an effect of anchovy substitution on the color acceptability of PMT-P anchovy cookies where the more the substitution of anchovy flour, the color acceptability of the cookies decreases. The brown color of *Kasteru* is due to the formulation of lemuru fish flour into the product. Most biscuits that are substituted with fish flour will have a darker color. This is influenced by the reaction between reducing sugars with amine groups of free amino acids bound to the protein peptide structure called the Maillard reaction so that the color becomes darker (Husain et al., 2023).

Aroma is an odor that is difficult to measure, which generally causes differences of opinion in the assessment of aroma quality. This different opinion is because each individual has different olfactory abilities and preferences (Loaloka et al., 2020). Besides assessing product acceptance, the sense of smell can also be an indicator of damage to food products (Husain et al., 2023). The results of the hedonic test on the aroma of *Kasteru* showed an average score in the range of 2.73 - 3.91. The highest score is 3.91 with the category of like obtained by treatment 1 and the lowest score is 2.73 with the category of neutral obtained by treatment 5. The results of the hedonic quality test on the aroma of *Kasteru* show an average score in the range of 1.51 - 2.29. The highest score was 2.29 with the category of mildly savory aroma obtained by treatment 1 and the lowest score was 1.51 with the category of mildly savory aroma obtained by treatment 5. Through analysis of variance, it is known that the formulation of lemuru fish flour affects the level of panelists' preference for aroma and affects the aroma quality of *Kasteru*.

Treatments 1 to 5 had a slightly savory aroma. The more lemuru fish flour formulated into the *Kasteru*, the stronger the fish aroma. This can be seen from the average score of aroma quality which is decreasing. The treatment of lemuru fish flour formulation into *Kasteru* affects the aroma of the product which causes the level of panelist preference to decrease as the concentration of lemuru fish flour increases. These results are in line with research from Rosmini & Astria (2022), namely the treatment of adding eel fish flour to crackers biscuits affects the aroma of the product and the panelists' assessment decreases as the concentration of eel fish flour increases. The formulation of lemuru fish flour into the product contributes to the aroma quality of *Kasteru*. Fishy aroma in fish is a distinctive aroma produced by nitrogenous components such as trimethyl amine oxide (TMAO), guanidine, and derivatives of imidazole (Mukti et al., 2023). The distinctive aroma produced from fish flour is rather difficult to remove and has a tendency to mask the aroma of ingredients mixed into food products (Husain et al., 2023).

Texture assessment of an ingredient is one of the elements in assessing the quality of food that can be felt using the fingertips, mouth, teeth, or tongue (Muntikah & Razak, 2017). The texture of biscuit products is related to the type of raw materials and composition used (Khasanah & Mumpuni, 2021). Kastengel cookies generally have a crunchy and crumbly texture. Hedonic test results on the texture of *Kasteru* showed an average score in the range of 3.33 - 3.87. The highest score was 3.87 with a category of like obtained by treatment 1 and the lowest score was 3.33 with a category of neutral obtained by treatment 5. Through analysis of variance, it is known that the formulation of lemuru fish flour affects the level of panelist preference for the texture of *Kasteru*. LSD test results showed no significant difference in each treatment.

Treatments 1 to 5 have the same texture, which is crunchy and crumbly. Based on the average score of the panelists' preference for the texture of *Kasteru*, it is known that the level

of panelists' preference decreases along with the increase in lemuru fish flour formulation. This is similar to the results of research from (Rosmini & Astria, 2022), namely the higher the addition of eel fish flour concentration, the panelists' assessment of the texture of crackers decreases, this is because the concentration of wheat flour decreases along with the addition of eel fish flour so that the inner layer of crackers does not expand. Wheat flour is the main component in most biscuit doughs, one of which is kastengel. The gluten content of wheat flour can provide an elastic texture to the dough and provide a solid texture after baking (Khasanah & Mumpuni, 2021). In addition to decreasing the concentration of wheat flour, increasing the concentration of lemuru fish flour also increased the protein content of *Kasteru*. The higher the protein content in an ingredient will cause the texture to be hard or less crunchy (Rahmawati et al., 2020).

The human sense involved in taste assessment is the tongue. Taste is an important component for consumers to determine whether a food is delicious so that it can be enjoyed. The basic ingredients used will greatly affect the taste of a food product (Loaloka et al., 2020). Humans have diverse tastes so that taste is a very difficult determining factor for food ingredients (Mukti et al., 2023). The results of the hedonic test on the taste of *Kasteru* showed an average score in the range of 2.49 - 3.67. The highest score is 3.67 with the category of like obtained by treatment 1 and the lowest score is 2.49 with the category of dislike obtained by treatment 5. The results of the hedonic quality test on the taste of *Kasteru* show an average score in the range of 1.42 - 2.20. The highest score was 2.20 with the category of fish taste obtained by treatment 3 and the lowest score was 1.42 with the category of strongly fish taste obtained by treatment 5. Through analysis of variance, it is known that the formulation of lemuru fish flour affects the level of panelists' preference for taste and affects the quality of *Kasteru* taste.

Treatment 5 had the strongest fish taste. The higher the concentration of lemuru flour, the stronger the fish taste. Increasing the concentration of lemuru fish flour decreased the level of panelists' preference for the taste and taste quality of *Kasteru*. This is similar to the results of research by Ramadhan et al., (2019), where the panelists' acceptance score of the taste of anchovy cookies decreased with the addition of anchovy flour to the product. Kastengel generally has a distinctive savory taste from cheese. The formulation of lemuru fish flour in *Kasteru* caused a change in taste to savory fish flavor. Panelists are still not accustomed to biscuit products with a dominant fish flavor because such products have not been widely circulated in the community (Mukti et al., 2023). In addition, not all panelists have the same taste preferences and tolerance level for fishy taste.

Overall acceptance of *Kasteru* includes assessment of color, aroma, texture, and taste. The average score of panelists on the overall acceptance of *Kasteru* was in the range of 2.26 - 3.70. The highest mean score is 3.70 with the category of like, obtained by treatment 3. The lowest mean score is 2.26 with a category of dislike obtained by treatment 5. Based on the results of the variance test, the formulation of lemur flour has an influence on the overall acceptance of *Kasteru*. Treatment 3 was more preferred by the panelists because it had an acceptable color, taste, and aroma compared to treatments 4 and 5 which had a higher concentration of lemuru fish flour. In addition, treatment 3 excelled in the color aspect, where this treatment had a brownish yellow color. For panelists, this color was more attractive than the pale yellow color of treatment 1 and the brown color of treatments 4 and 5.

Objective Characteristics of Kasteru

The output of this objective analysis is the average protein and water content (%). After conducting a variance test on the objective analysis results, it was found that there was no effect of lemuru fish flour formulation on the protein and water content of *Kasteru*.

Protein is an important nutrient for the human body, because protein not only provides energy for the body, but also plays a role as a builder and regulator. Protein consists of long chains of amino acids, which are bound to each other in peptide bonds (Almatsier, 2016). One of the high protein food sources is fish, one of which is lemuru fish. Fish contains proteins that are easier to digest and contain essential and non-essential amino acids that are needed in the human body. The protein content in *Kasteru* was analyzed using the Kjedahl method. Based on the results of laboratory analysis, it is known that the average protein content in *Kasteru* is in the range of 16.05% - 18.23%. The lowest protein level is 16.05% obtained by treatment 2, while the highest protein level is 18.23% obtained by treatment 5. The results of the analysis of *Kasteru* protein content show that all formulations have met the quality requirements of biscuits in SNI 2973: 2011, which contains at least 5% protein (BSN, 2011).

After the analysis of variance (ANOVA), it was found that there was no effect of lemuru flour formulation on the protein content of *Kasteru*. Although the statistical analysis did not show any effect, but based on the average value, the protein content in *Kasteru* tends to increase along with the increase in lemuru fish flour formulation. This is similar to the results of Khasanah & Mumpuni's (2021) research, where the making of biscuits with the proportion of wheat flour, haruan fish flour, seed flour and pumpkin fruit has no effect on protein content but can increase protein content when compared to control biscuits (P0) which only consists of 100% wheat flour. This is because the formulation of lemuru fish flour, which is a potential source of protein, was not significantly different between each treatment as well as the possibility of denatured protein during the flour making and baking process.

Based on the Nutrition Adequacy Rate in 2019, the daily protein requirement for children aged 1-3 years is 20 g and children aged 4-6 years is 25 g (Kemenkes, 2019). The average protein adequacy for toddlers is 22.5 g in one day. Based on the principle of a high energy high protein diet, the recommended protein requirement in a day is 100-125 g. Snacks should fulfill at least 10% of the total energy, protein, fat, and carbohydrate needs in a day. The protein content of the best formulation of *Kasteru* products, namely treatment 3, is 16.59 g/100 g. By consuming 1 serving of *Kasteru*, which is 24 g (4 pieces), it can contribute to the intake of 3.98 g of protein and has fulfilled 17.5% of the protein adequacy rate for toddlers in a day. To meet at least 10% of the protein requirement of a high energy-high protein diet, 66 grams (11 pieces) of *Kasteru* would be required. 11 pieces of Kasteru is a very large amount to be eaten as a snack, so further development of the *Kasteru* formulation is needed so that this product can be utilized as a high-protein food formula for cancer patients.

In the food industry, water content is very important to determine the quality and resistance of food to the risk of damage that may occur to food or food ingredients (Daud et al., 2019). Water content has a function to determine the level of freshness and durability of food ingredients (Normilawati et al., 2019). The water content in the *Kasteru* was analyzed using the thermogravimetric method. Based on the results of laboratory analysis, the water content of *Kasteru* was in the range of 5.41% - 6.42%. The lowest water content is 6.42% obtained by treatment 1 with a formulation of 5% lemuru fish flour and 95% wheat flour. Meanwhile, the highest water content was obtained by treatment 4 with a formulation of 12.5% lemur flour and 87.5% wheat flour. The

results of the analysis of *Kasteru* water content showed that all formulations did not meet the quality requirements of biscuits in SNI 2973: 2011, which is the maximum water content is 5% (BSN, 2011). The high water content is due to the high protein content in the *Kasteru*. According to Wisme-Pedersen (1971) in Rosmini & Astria (2022), high water content is caused by the protein content in fish which is related to the binding capacity of water by meat protein. The same thing was also conveyed by Purnamasari, et al (2017) in Husain et al., (2023), namely the more the proportion of protein sources, the higher the water content of a product because proteins are hydrophilic so they can bind water molecules.

The results of the analysis of variance (Anova) showed that there was no effect of lemuru fish flour formulation on the water content of *Kasteru*. Judging from the average water content, there was an increase in water content from treatment 1 to treatment 2, but the rest, namely treatments 2 - 5, had water content that tended to be constant. The results of this study are similar to the results of research from (Rosmini & Astria, 2022), namely the treatment of the addition of eel fish concentration has no effect on the water content of eel fish crackers biscuits.

The Best Treatment of Kasteru

The best treatment based on subjective characteristics are treatments 2 and 3. Treatments 2 and 3 are the most preferred treatments by panelists based on aspects of color, aroma, texture, taste, overall acceptance, color quality, aroma quality, and taste quality. Based on objective characteristics, treatments 2 and 3 had the same water content, but the protein content of treatment 3 was higher than treatment 2. Thus, the best lemuru fish flour formulation treatment was treatment 3, namely 10% lemuru flour and 90% wheat flour with a protein content of 16.59% and a water content of 6.41

Conclusion

Lemuru fish flour formulation in *Kasteru* had a significant effect on subjective characteristics including color, aroma, texture, taste, overall acceptance, color quality, aroma quality, and taste quality, but had no significant effect on objective characteristics including protein content and water content. The best treatment based on subjective and objective characteristics is treatment 3, which is a formulation of 10% lemuru fish flour and 90% wheat flour. Treatment 3 had a brownish yellow color, slightly savory aroma, and fish flavor with a protein content of 16.59% and a water content of 6.41%. With the consumption of 1 serving of *Kasteru* (24 g), it can contribute to the intake of 3.98 g of protein and has fulfilled 17.5% of the protein adequacy rate for toddlers in a day. Further development of the *Kasteru* formulation is needed so that this product can be utilized as a high-protein food formula for cancer patients.

It is hoped that future researchers can examine the durability and other nutritional content of *Kasteru* such as carbohydrates, fat, and calcium. In addition, it is hoped that there will be improvements to the formulation of *Kasteru* so that it can fulfill the water content as required by the quality of biscuits according to SNI 2973: 2011 and can be utilized as food formula for cancer patients.

Acknowledgement

The researchers would like to express our gratitude to God Almighty, Polytechnic of Health Denpasar, and all those who have helped this research, so that this research could be completed successfully.

Conflic of Interest

The authors certify that they have no affiliations with or involvement in any organization or entity with any financial interest or non-financial interest in the subject matter or materials discussed in this manuscript.

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