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Analysis of nutritional quality and sensory quality of an omega- 3-rich mocaf-based snack bar with the addition of Sacha (*Plukenetia Volubilis L.*) for elementary school-aged children

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Abstract

The nutritional status of elementary school-aged children is a major concern because it affects their growth, cognitive development, and academic achievement. Children's snack consumption patterns in Indonesia tend to be unhealthy, thereby increasing the risk of malnutrition and stunting. This study aims to analyze the effect of adding Sacha Inchi oil on the organoleptic quality and nutritional content of omega-3-rich *mocaf* flour-based *snack bars* as a functional food alternative for elementary school children. The study employed a laboratory experimental design with three different formulations varying the proportions of *mocaf* flour and Sacha Inchi oil. Organoleptic and hedonic tests were conducted on 30 semi-trained panelists to evaluate attributes such as color, taste, aroma, and texture. Nutritional analysis was performed via proximate analysis (carbohydrates, protein, fat, moisture, ash) and omega-3 testing at the BRIN laboratory. The results showed that *the snack bar* formulation with a 30% *mocaf* flour and 4% Sacha Inchi oil ratio (F3) was most preferred by panelists in terms of color, taste, aroma, and texture. ANOVA statistical analysis revealed significant differences in color and taste attributes, but no significant differences in aroma and texture among the formulations. The nutritional content of the best formulation (F3) per serving (50 g) is as follows: energy 218 kcal, protein 3.7 g, fat 8.96 g, fiber 30.78 g, and omega-3 75 mg. The study indicates that the addition of Sacha Inchi oil to *mocaf-based snack bars* can improve organoleptic quality and nutritional content, making them a potential healthy snack alternative to support the nutritional status of elementary school-aged children. Further research is recommended to test the product's shelf life and nutritional stability during storage.

Keywords: Elementary school children, Mocaf flour, Omega-3, Sacha Inchi oil, Snack bar.

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1. Introduction

Children's nutritional status is a key indicator of a nation's human capital quality. Elementary school-aged children are in a phase of active growth and rapid cognitive development, requiring adequate intake of both macro- and micronutrients. Consumption of healthy, nutritionally balanced foods plays a vital role in supporting brain development, immune function, and academic achievement [1].

In Indonesia, nutritional issues remain a serious challenge. According to the 2022 Indonesian Nutrition Status Survey (SSGI), the national prevalence of stunting reached 21.6%. Although nutritional intervention programs have focused on the first 1,000 Days of Life (HPK), school-aged children who have already experienced stunting still require long-term nutritional improvement , particularly through supplementary foods containing high-quality protein, iron, vitamin A, zinc, and essential fatty acids such as omega-3 [2, 3]. Unfortunately, schoolchildren's dietary patterns are often unhealthy. Many of them prefer convenient snacks that are high in sugar, saturated fat, and salt but low in nutritional value [4].

This situation poses risks to metabolic health, early-onset obesity, and cognitive dysfunction. Therefore, the development of healthy snacks based on local foods is a promising strategy for sustainably improving the nutritional status of schoolchildren. This strategy not only supports daily nutritional adequacy but also strengthens local food security and empowers the local economy. By utilizingnutrient-rich local ingredients such as legumes, tubers, fish, and vegetables, healthy snacks can be developed into products that are appealing, affordable, and popular with children.

In addition, nutrition education for students, parents, and school officials is crucial for encouraging changes in eating habits toward a healthier and more nutrition- conscious diet.

Based on this background, the researcher was interested in addressing this topic in a study titled "Analysis of the Nutritional Quality and Sensory Quality of Omega-3-Rich Mocaf Flour-Based Food Bars with Added Sacha Inchi Oil (Plukenetia volubilis L.) for Elementary School-Aged Children."

2. Research Method

2.1. Materials and Equipment

The materials used in this study consisted of main ingredients and supporting ingredients. The main ingredients included mocaf flour derived from fermented cassava, as well as sacha inchi oil (Plukenetia volubilis L.) extracted using the cold-press method to preserve its nutritional content.

Supporting ingredients consisted of honey as a natural sweetener, eggs as a binding agent, dark chocolate, almonds, as well as raisins and dates, which served as sources of fiber and natural sweeteners. The tools used in the snack bar production process include a mixer, spatula, baking pan, digital scale, spoon, and knife.

The tools used in the chemical analysis included hexane as a solvent for fat extraction, Kjeldahl reagent for protein analysis, and boric acid solution in the nitrogen distillation process.

2.2. Research Method

This study employed a laboratory experimental design using a Completely Randomized Design (CRD) approach. Data analysis in this study utilized statistical software (SPSS), and data tabulation was processed using Microsoft Office Excel. In this study, the data evaluated included organoleptic quality (color, aroma, taste, and texture).

3. Results and Discussion

3.1. Results of Panelists Acceptance of Snack Bar

Based on the data collection activities, the results of the panelists acceptability analysis of the three formulations provided can be presented. The results of the panelists' acceptability analysis regarding acceptability (color, taste, aroma, and texture) can be seen in the following table.

3.2. Color

Table 1.
Results of Panelists' Color Acceptability of *Mocaf* Flour + Sacha Inchi *Snack Bars.*

Treatment	Mean ± SD	p	Note
F1	6.20 ± 1.5		
F2	6.70 ± 1.2	0.05	There is a significant
F3	5.80 ± 1.5		

Based on the results of the hedonic ANOVA statistical analysis in Table 1 regarding the color attributes of the three mocaf flour-based snack bar formulations with the addition of Sacha Inchi oil, the following values were obtained: significance $p < 0.05$. Page this indicates a significant difference in the panelists' acceptance of color quality among the formulations. To identify which formulations differed significantly, a further analysis was conducted using Duncan's test.

Table 2.
Results of Duncan's Test on Color Quality.

Sample	Subset	
	1	**2**
F3	5.80	
F1	6.20	6.20
F2		6.70

Based on the results of the Duncan test, it was found that treatment F3 was not significantly different from F1, F1 was not significantly different from F2, but F3 showed a significant difference from F2. Based on this test, the best formulation for the color attribute is F2. The results of the hedonic test on mocaf flour-based snack bars with added Sacha Inchi oil regarding the color aspect (Table 2) show that the highest average score was obtained by F2, which was 6.70.

3.3. Taste

Table 3.
Results of Panelists' Taste Acceptance of *Mocaf* Flour + Sacha Inchi *Snack Bars.*

Treatment	Mean ± SD	p	Note
F1	6.20 ± 1.54	0.056	There is a difference in significant
F2	7.00 ± 1.20		
F3	6.37 ± 1.24		

Based on the results of the hedonic ANOVA statistical analysis in Table 3 regarding the taste attributes of the three snack bar formulations made from mocaf flour with the addition of Sacha Inchi oil, the following values were obtained: significance $p < 0.05$. Page this indicates a significant difference in panelists' acceptance of taste quality among the formulations. To identify formulations that differed significantly, a follow-up test was conducted using Duncan's test.

Table 4.
Results of Duncan's Test on Taste Quality.

Sample	Subset	
	1	**2**
F1	6.20	
F3	6.37	6.37
F2		7.0

Based on the results of Duncan's test, it can be concluded that the results of treatment F1 are not significantly different from F3, while F3 is not significantly different from F2, but F1 is significantly different from F2 ( ), based on Duncan's test the best formula is found in F2, which is 7.00.

3.4. Scent

Table 5.
Results of Panelists' Aroma Acceptability of *Mocaf* Flour + Sacha Inchi *Snack Bars.*

Treatment	Mean ± SD	p	Note
F1	5.87 ± 1.87		
F2	6.37 ± 1.25	0.321	None difference significant
F3	6.33 ± 1.49		

Based on the results of the hedonic ANOVA statistical analysis in Table 5 regarding the aroma attribute of the three mocaf flour- based snack bar formulations with the addition of Sacha Inchi oil, a significance value of $p = 0.321$ was obtained. This value is greater than 0.05, therefore it can be concluded that there is no significant difference in the panelists' acceptance of aroma quality among the formulations.

3.5. Texture

Table 6.
Results of Panelists' Texture Acceptance of *Mocaf* Flour + Sacha Inchi *Snack Bars.*

Treatment	Mean ± SD	p	Note
F1	6.30 ± 1.24		
F2	6.53 ± 1.41	0.615	None difference significant
F3	6.17 ± 1.68		

Based on the results of the hedonic ANOVA statistical analysis in Table 6 regarding the texture attributes of the three snack bar formulations made from mocaf flour with the addition of Sacha Inchi oil, a significance value of $p = 0.615$ was obtained. This value is greater than 0.05, so it can be concluded that there is no significant difference in the panelists' acceptance of texture quality among the formulations.

4. Discussion

4.1. Color Acceptance

Color is one of the most easily recognizable sensory attributes and serves as a primary indicator in assessing the quality of food products. This aspect provides First impressions significantly influence panelists' decisions to accept or reject a product. In addition to aesthetic value, color also plays a crucial role in product quality and acceptance research, as it can enhance visual appeal, which ultimately impacts consumer preferences [5].

The mocaf flour-based snack bars with added Sacha Inchi oil in this study exhibited color variations ranging from dark brown, light brown, to very light brown. These differences were primarily caused by two main processes, namely:

1. The Maillard reaction – A chemical reaction between reducing sugars (e.g., glucose or fructose) and amino acids (proteins) during the heating process, which produces dark brown melanoidin compounds. Color intensity is influenced by temperature (>140 °C), heating time, pH, and moisture content [6].
2. Caramelization – The process of heating sugar beyond its melting point (>110 °C), which causes the decomposition of sugar molecules and forms brown caramel compounds [7].

Additionally, the use of dark chocolate as an ingredient contributes to a deeper brown color due to its high cocoa content. These findings align with the research by Jayantini, et al. [8] on cookie formulations using ISP flour and mocaf, where the percentage of ingredient substitution affects the product's color intensity.

Based on the sensory test results, Formula 2 was the formulation with the highest color likability compared to Formula 1 and Formula

3. Statistical analysis showed a significant difference between formulations ($p < 0.05$), which was likely influenced by differences raw material composition, resulting in noticeable color variations.

4.2. Taste Acceptance

Taste is the result of the taste buds' response to chemical stimuli that produce sensations such as sweet, bitter, sour, or spicy [9]. This factor plays a major role in determining panelists' acceptance of food products [10]. In the mocaf flour snack bars with added Sacha Inchi oil, the flavor is dominated by the natural sweetness of dates and honey. Dates contain natural sugars in the form of fructose, glucose, and sucrose [11] while honey is dominated by fructose (38–43%) and glucose (30–35%) [12]. Based on sensory testing, Formula 3 received the highest likability rating for the taste attribute, with significant differences among the formulations ($p < 0.05$). This difference was likely influenced by the similar ingredient composition across all three formulas, resulting in less pronounced taste variations.

4.3. Aroma Acceptability

Aroma is a crucial aspect of food product quality because it influences consumers' first impressions and appeal, thereby playing a significant role in product acceptance [10]. In mocaf flour snack bars with added Sacha Inchi oil, the resulting aroma is a blend of subtle dates, mocaf flour, and raisins, which helps mitigate the distinctive aroma of Sacha Inchi oil. Based on panelists' evaluations, Formula 3 received the highest aroma likability score compared to Formulas 1 and 2. However, statistical test results showed no significant difference among the formulations ($p = 0.321$). This is likely due to the relatively small proportion of Sacha Inchi oil in each formula, which did not have a noticeable effect on the product's aroma.

4.4. Nutritional Content of the Best Snack Bar

Energy content according to Badan Standardisasi Nasional [13] quality standards for snack bars is 200–400 kcal, while according to U.S. Department of Agriculture Agricultural Research Service [14] it is 403 kcal. The best snack bar meets the SNI standard but remains below the USDA standard. The snack bar formulation made with mocaf flour and Sacha Inchi oil contains 14.46 g of protein per serving. This value falls within the standard protein content range for snack bars according to SNI, which is 9–25% [15] so this product qualifies as a snack. Given that the daily protein requirement for school-age children is approximately 37 g (0.9–1.0 g/kg body weight), one serving of this snack bar can contribute about 50–55% of the total daily protein requirement.

One serving of a mocaf flour snack bar with added Sacha Inchi oil (50 g) contains 12.6 g of fat. According to SNI standards for the snack bar category, the required fat content is 9– 25%. Proximate analysis results show a fat content of 21.06%, meaning this product meets SNI quality standards. With the daily fat requirement for school-age children at approximately 52.7 g, one serving of this snack bar can contribute about 24% of the daily fat requirement. The fat content primarily comes from the use of Sacha Inchi oil and almonds as the main ingredients.

A mocaf flour snack bar formula with added sacha inchi oil contains 21.5 grams of carbohydrates per serving. The daily carbohydrate requirement for school-age children is 318.25 grams per day. Consuming one serving of this snack bar (50 grams per serving) provides 9.7% of a school-age child's daily requirement. The food ingredient used in making the snack bar that contains the highest carbohydrate content is mocaf flour.

Laboratory test results show that the mocaf flour snack bar formula with the addition of Sacha Inchi oil contains 3.3 g of omega-3 per 100 g. Given that the daily omega-3 requirement for school-aged children is approximately 1.2 g,

consuming one serving (50 g) can meet about 83.33% of that requirement. According to the Codex Alimentarius [16] this product can be claimed as a high source of omega-3. Omega-3 fatty acids, particularly DHA, play a crucial role in the brain, increasing neuronal membrane fluidity by up to 30%, and supporting the improvement of cognitive function [17].

5. Conclusion

1. Formulation snack bar with the addition of of Sacha Inchi oil by 4% and 30% mocaf flour (F3) produced the product with the best organoleptic quality—specifically, the color, taste, aroma, and texture most preferred by the panelists—as indicated by the results of the hedonic test and statistical analysis showing significant in color and taste.

2. The organoleptic properties of the mocaf flour snack bar formulas with added sacha inchi oil—including color, aroma, taste, texture, and overall appeal— indicate that formula F3 is preferred over formulas 1 and 2.

3. The nutritional content of the best snack bar meets the nutritional needs of elementary school-aged children best among the three formulas, namely F3, with the following nutritional content: energy: 218 kcal, protein: 3.7 g, fat: 8.96 g, carbohydrates: 30.78 g, omega-3: 0.75 g

4. The addition of sacha inchi oil to each snack bar formulation has a significant effect on color, taste, aroma, texture, and overall quality.

6. Recommendations

1. Further research is recommended to test the shelf life of snack bars with added Sacha Inchi oil to ensure quality stability and nutrient content during long-term storage.

2. Long-term consumption studies should be conducted on elementary school-aged children to evaluate the actual effects of consuming these snack bars on nutritional status and the prevention of stunting.

3. It is recommended to conduct further studies on Sacha Inchi oil encapsulation techniques to maintain the stability of omega-3 nutrients during processing and storage

References

[1] World Health Organization, *How school systems can improve health and well-being: Topic briefs: Nutrition*. Geneva, Switzerland: World Health Organization, 2023.

[2] Badan Kebijakan Pembangunan Kesehatan, *Pocketbook of the results of the 2022 Indonesian nutritional status survey*. Jakarta, Indonesia: Badan Kebijakan Pembangunan Kesehatan, 2022.

[3] K. G. Dewey and K. Begum, "Long-term consequences of stunting in early life," *Maternal & Child Nutrition*, vol. 7, no. suppl. 3, pp. 5-18, 2011. https://doi.org/10.1111/j.1740-8709.2011.00349.x

[4] Badan Pengawas Obat dan Makanan, *Guidelines for school-age children's snack foods to achieve balanced nutrition (Series 1)*. Jakarta, Indonesia: Badan Pengawas Obat dan Makanan, 2023.

[5] C. Spence, "On the manipulation, and meaning(s), of color in food: A historical perspective," *Journal of Food Science*, vol. 88, no. S1, pp. A5-A20, 2023. https://doi.org/10.1111/1750-3841.16439

[6] N. Asaithambi, S. K. Singh, and P. Singha, "Current status of non-thermal processing of probiotic foods: A review," *Journal of Food Engineering*, vol. 303, p. 110567, 2021. https://doi.org/10.1016/j.jfoodeng.2021.110567

[7] G. Cebrero *et al.*, "Relationship among the minor constituents, antibacterial activity and geographical origin of honey: A multifactor perspective," *Food Chemistry*, vol. 315, p. 126296, 2020. https://doi.org/10.1016/j.foodchem.2020.126296

[8] H. E. Jayantini, A. C. Adi, and E. R. Isaura, "Formulation of high-protein and iron-rich cookies using ISP and MOCAF flour substitution for stunted toddlers," *Jurnal Keperawatan*, vol. 16, no. 2, pp. 581–590, 2024.

[9] A. P. I. Savira, S. Wahyuni, and R. H. F. Faradilla, "Analysis of nutritional content, organoleptic properties, and antioxidant activity of snack bars based on local organic colored rice varieties as an alternative snack for individuals with diabetes mellitus," *Jurnal Sains dan Teknologi Pangan*, vol. 5, no. 6, pp. 3436–3452, 2020.

[10] L. C. Aurelia, B. Ma'rifah, and A. Muhlishoh, "High-fiber and antioxidant-rich snack bar based on purple sweet potato and black rice as an alternative snack for individuals with diabetes mellitus," *Jurnal Gizi dan Pangan Soedirman*, vol. 7, no. 2, pp. 196–216, 2023.

[11] L. González-Mulero, C. Delgado-Andrade, F. J. Morales, E. Olombrada, and M. Mesias, "Study of furanic compound content in common Spanish culinary preparations. Influence of the food preparation setting," *Journal of Food Composition and Analysis*, vol. 110, p. 104532, 2022. https://doi.org/10.1016/j.jfca.2022.104532

[12] T. Forleo *et al.*, "Inorganic elements in Mytilus galloprovincialis shells: Geographic traceability by multivariate analysis of ICP-MS data," *Molecules*, vol. 26, no. 9, p. 2634, 2021. https://doi.org/10.3390/molecules26092634

[13] Badan Standardisasi Nasional, *Formula foods for weight-control diets, SNI 01-4216-1996*. Jakarta, Indonesia: Badan Standardisasi Nasional, 1996.

[14] U.S. Department of Agriculture Agricultural Research Service, "FoodData central," 2019. https://fdc.nal.usda.gov/

[15] Badan Standardisasi Nasional, *Extruded snacks, SNI 2886:2015*. Jakarta, Indonesia: Badan Standardisasi Nasional, 2015.

[16] Codex Alimentarius Commission, *Guidelines for use of nutrition and health claims (CAC/GL 23-1997)*. Rome, Italy: Food and Agriculture Organization of the United Nations and World Health Organization, 1997.

[17] S. M. Jung *et al.*, "A non-probiotic fermented soy product reduces total and LDL cholesterol: A randomized controlled crossover trial," *Nutrients*, vol. 13, no. 2, p. 535, 2021. https://doi.org/10.3390/nu13020535