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Nutritional Study of RUTF Snack Bar from Jackfruit Seed Flour, Durian Seed Flour, and Cempedak Seed Flour.

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A B S T R A C T

Ready-to-Use Therapeutic Food (RUTF) is a nutrient-dense, ready-to-eat product with a long shelf life, making it highly effective for emergency nutrition interventions and malnutrition recovery programs. This study aims to determine the optimal combination of seed-based flour and mackerel fish flour to enhance the physicochemical and organoleptic properties of RUTF snack bars. Jackfruit, durian, and cempedak seeds were selected for their rich nutritional profiles, including protein, fiber, vitamins, and minerals. Mackerel fish flour, with a high protein content (72.96%), was incorporated to improve the protein quality of the formulation. A completely randomized design (CRD) with a factorial arrangement was applied, consisting of two factors: the ratio of fish flour to seed flour (5:95, 10:90, 15:85) and the type of seed flour (jackfruit, durian, cempedak), with two replications. Data were analyzed using ANOVA at a 5% significance level, followed by the DMRT test for significant interactions. The best formulation was achieved using 85% durian seed flour and 15% mackerel fish flour, yielding a moisture content of 2.88%, ash content of 4.01%, protein content of 41.53%, fat content of 44.84%, crude fiber content of 26.23%, starch content of 43.74%, amylose content of 20.33%, carbohydrate content of 9.60%, hardness of 134.2 gf, and total caloric value of 608 kcal. These findings highlight the potential of seed-based flours and fish protein in developing nutritious, shelf-stable RUTF snack bars.

Contribution to Sustainable Development Goals (SDGs):
SDG 2: Zero Hunger
SDG 3: Good Health and Well-
SDG 13: Industry, Innovation, and Infrastructure
SDG 15: Responsible Consumption and Production

1. INTRODUCTION

1.1. Research Background

Malnutrition or undernutrition is a serious issue that can have long-term impacts on children's health and development. The government's efforts to address malnutrition cases are outlined in Presidential Regulation Number 72 of 2021 concerning the Acceleration of Stunting Reduction. Article 2, paragraph (2) of the regulation states that this strategy aims to reduce the prevalence of stunting and ensure adequate nutritional intake. The provision of supplementary feeding (PMT-P) has shown benefits in increasing the weight of malnourished toddlers after receiving additional food [1].

A snack bar is a type of light food in the form of a bar. It is typically made by mixing dried fruits, nuts, and cereals to enhance its nutritional value, then combined into a single unit using a binding agent [2]. Ref. [3] RUTF (Ready to Use Therapeutic Food) is a therapeutic food recommended by WHO as an alternative food that can be given to children with severe

acute malnutrition. Research has shown that RUTF products are highly effective in feeding children suffering from severe acute malnutrition.

Mackerel is commonly found in Indonesian waters and has a nutritional value equivalent to salmon. It has several advantages, including being relatively affordable and highly nutritious. Its nutritional content includes 71.4 g of water, 125 kcal of energy, 21.3 g of protein, 3.4 g of fat, 9 g of carbohydrates, 136 mg of calcium, 69 mg of phosphorus, 0.8 mg of iron, 214 mg of sodium, 0.20 mg of copper, and 1.1 mg of zinc [4]. However, the utilization of mackerel in RUTF products is still relatively rare. Mackerel can be processed into fish flour, which can serve as a key component in the formulation of a highly nutritious RUTF snack bar.

In addition to containing protein, RUTF products also require high amounts of carbohydrates and fiber. The potential of jackfruit seed flour (Artocarpus heterophyllus), durian seed (Durio zibethinus Murr), and cempedak seed (Artocarpus integer) as alternative raw materials is also an interesting research subject. [5] The nutritional value of every 100 grams of jackfruit seed flour contains 2.74 grams of fiber, 50 mg of calcium, and 1.5 mg of iron. [6] It is stated that durian seed flour has several better nutritional contents compared to wheat flour, including 365 kcal of energy, 8.9 g of protein, 1.3 g of fat, 77.3 g of carbohydrates, 16.0 mg of calcium, 106 mg of phosphorus, and 1.2 mg of iron. [7] Cempedak seed flour contains approximately 55.64% dry basis (db) carbohydrates, 26.48% dry basis (db) dietary fiber, and 14.77% dry basis (db) resistant starch.

The addition of milk in RUTF snack bars serves to enhance the protein content, texture, and color of the product. Protein levels affect the hardness of the snack bar. The higher the protein content, the harder the texture of the snack bar due to the interaction between protein and starch [8]. The use of sunflower seed oil is beneficial because it contains high unsaturated fats, is low in cholesterol, and is rich in vitamins A, D, E, and K [9].

The texture of the snack bar is expected to be compact. [10], The starch content helps maintain the compactness and stability of the snack bar. Starch added to food ingredients functions to form texture and density. [11] Amylose and amylopectin influence the properties of the resulting starch. Several studies on RUTF include the development of RUTF based on cereals and soybeans [12], the RUTF product is in the form of a bar made from mung beans, cereals, and vegetable oil [13], The provision of RUTF products made from catfish flour and mung beans [14], RUTF cookies based on banana flour substituted with legumes [15]. Based on the description above, this study aims to determine the best combination of seed flour types and the ratio of mackerel flour on the physicochemical characteristics of the RUTF snack bar.

2. MATERIALS AND METHODS

2.1. Ingredients

The raw materials used in this study are mackerel, jackfruit seeds, durian seeds, cempedak seeds, full cream milk, sunflower seed oil, eggs, sugar, and peanuts, which were obtained from a traditional market in Surabaya, East Java. The materials used for analysis include distilled water, a selenium mixture, H_2SO_4, NaOH, phenolphthalein (PP indicator), boric acid, HCl, and petroleum benzene.

2.2. Research Procedure

This study uses a Completely Randomized Design (CRD) with a factorial pattern, consisting of two factors and two replications. The first factor is the proportion of mackerel flour (5%, 10%, 15%), and the second factor consists of three types of flour: jackfruit seed flour, durian seed flour, and cempedak seed flour. The data from the analysis are processed using Analysis of Variance (ANOVA) 5% significance level to determine significant differences. If significant differences are found, further testing is conducted using the Duncan Multiple Range Test (DMRT) 5%.

2.3. Snack Bar Preparation

Mix the dry ingredients, which include the formulated seed flours (jackfruit, durian, and cempedak) with the ratio of mackerel flour (5%, 10%, 15%) for a total weight of 100g. Once mixed, add 30% egg, 35% full cream milk, and 2% sugar. Stir until a dough forms, then mix in 22.5% sunflower seed oil and 10% peanuts. Once the dough is well combined, shape it in a baking tray and bake at 120°C for 50 minutes. After 25 minutes of baking, cut the bars to a size of 10×4 cm. Allow the snack bars to cool for 15 minutes.

3. RESULT AND DISCUSSION

3.1. Moisture Content

Table 1 shows that the formulation with the proportion of jackfruit seed flour and cempedak seed flour, combined with the highest addition of Indian mackerel flour, resulted in a higher moisture content. The increase in the moisture content of the RUTF snack bar is also due to the relatively low starch and crude fiber content in jackfruit seed flour compared to durian seed flour. This is because starch has a hygroscopic property, meaning it can absorb and retain water. The higher the starch content in the ingredients, the more water can be absorbed and retained during the dough mixing process. Additionally, the higher the amount of Indian mackerel flour added, the higher the moisture content. This is consistent with previous research [16], which states that the interaction between starch and protein can cause water to not be optimally retained because the hydrogen atoms that should bind water are already used to interact with starch and protein. Therefore, the more starch present in the snack bar product, the lower the moisture content. Conversely, if less starch is added, the moisture content will increase.

3.2. Ash Content

Ash content is a mixture of inorganic or mineral components found in food ingredients. In Table 1, the combination of 85% durian seed flour and 15% fish flour resulted in the highest ash content. An increase in ash content indicates a high mineral content, which enhances the nutritional value of the product and is essential for health, such as calcium for bones and phosphorus for energy metabolism. Ref. [17] The high or low ash content is influenced by the differences in mineral content present in the raw materials. Ash content can also be affected by the use of water during processing, which may reduce the availability of minerals as they dissolve in water [18].

Based on the quality requirements for bar-shaped RUTF products set by Ref. [19], the maximum ash content is 5%.

Therefore, the ash content of the produced snack bars meets the established requirements, ranging from 1.97% to 4.01%.

Table 1. Results of Moisture Content and Ash Content Analysis of RUTF Snack Bar.

Treatment (Seed Flour : Fish Flour)	Moisture Content (%)	Ash Content (%)
Jackfruit		
95% : 5%	2.25	2.71
90% : 10%	2.78	2.91
85% : 15%	3.91	3.31
Durian	2.05	2.98
95% : 5%		
90% : 10%	2.53	3.09
85% : 15%	2.89	4.02
Cempedak	2.79	1.97
95% : 5%		
90% : 10%	3.45	2.28
85% : 15%	4.01	3.17

Table 2. Results of Fat Content and Protein Content Analysis of RUTF Snack Bar.

Treatment (Seed Flour : Fish Flour)	Fat Content(%)	Protein Content(%)
Jackfruit		
95% : 5%	29.56	19.32
90% : 10%	31.82	22.79
85% : 15%	37.74	31.23
Durian		
95% : 5%	28.96	26.16
90% : 10%	30.50	30.71
85% : 15%	44.85	41.53
Cempedak		
95% : 5%	31.01	21.41
90% : 10%	35.59	27.12
85% : 15%	39.57	35.73

3.3. Fat Content

Table 2 shows that the fat content in the RUTF snack bar is influenced by mackerel flour. An increase in the ratio of mackerel flour leads to a higher fat content in the RUTF snack bar. This is due to differences in fat content among the raw materials. The RUTF snack bar formulated with durian seed flour and the highest addition of mackerel flour (15%) resulted in the highest fat content. [20] The fat content in Indian mackerel flour is 14.85 g.

3.4. Protein Content

Table 2 shows that the formulation with durian seed flour and the highest addition of Indian mackerel flour (15%) resulted in the highest protein content. This is because Indian mackerel flour has a higher protein content compared to seed flour. The protein content in fish flour is relatively high as it consists of complex essential amino acid compounds [21]. The moisture content in the product and raw materials can affect the protein content of the snack bar. This is because a decrease in moisture content will result in an increase in protein concentration within the ingredients. Therefore. the drier the ingredient. the higher its protein content.

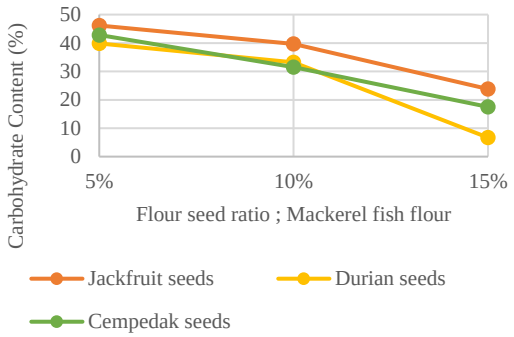

Fig. 1. Average Carbohydrate Content of RUTF Snack Bar.

3.5. Carbohydrate Content

Figure 1 shows that the formulation with jackfruit seed flour and the lowest addition of Indian mackerel flour (5%) resulted in the highest carbohydrate content. This is because durian seed flour contains a relatively high amount of carbohydrates. [22] Carbohydrate content by difference is calculated by subtracting the total content of other components. namely moisture. ash. protein. and fat. from the overall composition. Therefore. if the content of other components is higher. the carbohydrate content will be lower.

4. CONCLUSION

This study concludes that there is a significant interaction ($p \leq 0.05$) in all parameters. Increasing the ratio of Indian mackerel flour can enhance the protein and fat content of the RUTF snack bar. The RUTF snack bar with 85% durian seed flour and a 15% Indian mackerel flour was the best treatment. with a moisture content of 2.89%. ash content of 4.02%. fat content of 44.85%. protein content of 41.53%. and carbohydrate content of 6.71%.

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