Characteristics and Added Value of Fortified Sago Analog Rice Enriched with Nutritious Fish Oil Supplement

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Abstract. Analog rice is a food product resembling rice made from starch sources other than rice, such as starch from tubers (taro), corn and sago. The advantage of analog rice is that it has a lower glycemic index than rice. This analog rice product can help efforts to diversify the food consumption patterns of people in Indonesia in order to improve the nutritional quality of the food consumed and at the same time considering that analog rice is currently rich in carbohydrates and poor in other nutrients such as protein, fat and fiber, the product needs to be fortified with functional components of food. Functional components of food are foods that contain bioactive components that provide multifunctional physiological effects for the body, including strengthening the body's immune system, regulating the rhythm of physical conditions, slowing aging, and improving people's nutritional status and reducing dependence on imported rice. For this reason, alternative food is needed, namely analog rice with high nutritional content. This study aims to analyze the characteristics and added value of processing sago analog rice fortified with high nutritional fish oil supplements as a superior product in the Riau region, because Riau is one of the highest sago producing regions nationally. The research method used is an experimental method, which is to experiment with making sago analog rice fortified with nutrient-rich fish oil supplements from previous research. The treatment given was in the form of analog rice formulation with two levels, namely: sago analog rice fortified with 3% fish oil (M1S), and sago analog rice fortified with 5% fish oil (M1S). Data obtained were homogenized, then tabulated and analyzed quantitatively descriptively. The results showed that based on organoleptic preference test, and proximate composition, sago analog rice (M1S) was the best analog rice, namely sago analog rice fortified with 5% fish oil and met SNI quality standards. Furthermore, the added value produced to produce sago analog rice is IDR 3,000/kg and analog rice mixed with sago and taro is IDR 11,000/kg.

1. Introduction
Currently, most people have tended to choose their basic food needs on functional food. Analog rice (a product similar to rice) is a functional food product which is generally made from carbohydrate sources other than rice [1], namely tuber starch [2], corn and sago [3]. The advantage of analog rice is that it contains a lower glycemic index than rice [4] [5]. In addition, analog rice is used as an effort to diversify people's food consumption patterns in Indonesia and at the same time to improve the nutritional quality of food so that ultimately the nutritional status of the community
increases. Besides that, to reduce people's dependence on rice, which is still a national problem, because rice is still imported.

Riau Province is one of the largest sago producers in Indonesia, amounting to 274,807 tons in 2021 [6], so that sago commodities have the potential to be the main source of raw material for sago analog rice. The weakness of sago analog rice is rich in carbohydrates and poor in other nutrients needed by the human body, therefore these products need to be fortified with functional food components, like fish protein concentrate (FPC) [7]. Functional components of food are food ingredients that contain bioactive components that provide multifunctional physiological effects for the body, including strengthening the immune system, regulating the rhythm of physical conditions, slowing aging, and helping prevent disease. These bioactive components are compounds that have certain physiological functions other than basic nutrients [8] [9].

Fish oil supplements are one of the functional components of food that are needed for the body to function properly [10]. Therefore, supplements are not a complete substitute for drugs and food. Means health food supplements are intended to complement or increase food intake. The results of previous research [11] have found a nutrient rich fish supplement formula made from catfish (omega-9), shark (omega-3) and red palm oil (vitamin A) which are components of rich functional food nutrients. Therefore, this follow-up research is designed to create an economic multiplier effect through the development of making sago analog rice to serve as a superior product.

In an effort to develop a reliable agro-industrial system, Riau province was chosen as a center for freshwater fish production, especially catfish. In addition, Riau is known as a source of palm oil. Thus, it is hoped that these commodities can be developed to be fortified in nutrient-poor food products, one of which is sago analog rice. Considering that this potential has not been utilized optimally, therefore this research is designed to create an economic multiplier effect through the development of high nutritional products as superior products in the Riau province. A potential functional food component of fish is the content of essential fatty acids containing omega-3, omega-6 and omega-9 fatty acids. The results of previous research, namely the extraction of catfish oil showed that catfish oil was rich in omega-9 fatty acids (23%) [10].

Recently, analog rice has begun to be in demand by the public, especially for diabetics, because it is believed to be able to maintain optimal and effective health. However, this potential has not been optimized, especially from the economic aspect. One of the efforts that can be done is to utilize abundant local raw materials into processed products such as sago analog rice, taro and their mixtures. The results of the processing can have added value, but it is not known exactly how much the added value will be. So the formulation of the problem is whether sago starch can be used as raw material for sago analog rice and what are the characteristics and added value to produce sago analog rice. Therefore, the objectives of this research are: (1) Studying the characteristics of the products produced by organoleptic and proximate composition; (2) Conducting value added analysis and business development of sago analog rice; and (3) This research is expected to be applied by partners to increase their business capacity and become a regional superior product.

2. Methodology

2.1. Materials and Methods

The main raw materials used in this study were sago starch and nutrient-rich fish oil supplements made from catfish (omega-9), shark (omega-3) and red palm oil (vitamin A) which are components of nutrient rich functional food. This research was conducted using an experimental method, namely conducting experiments in the manufacture of sago analog rice fortified with nutrient rich fish oil supplements containing functional food components. The experimental design used was a non-factorial Completely Randomized Design (CRD), namely fish oil treatment with 2 levels (3% and 5% concentration). The combination of treatments and composition of analog rice formulation ingredients can be seen in Table 1 below.
Table 1. Combination of fortified sago analog rice treatment fish oil

| No. | Material      | Treatment level (%) | (M<sub>3</sub>S) | (M<sub>5</sub>S) |
|-----|---------------|---------------------|------------------|------------------|
| 1.  | Sago Starch   | 100                 | 100              |                  |
| 2.  | Fish oil      | 3                   | 5                |                  |

Furthermore, the Fish oil flow chart for making analog rice according to treatment can be seen in Figure 1 below.

![Flowchart](image)

**Figure 1.** Flowchart of making sago analog rice fortified with nutrient rich fish oil.

2.2. Parameter

The product quality parameters analyzed include organoleptic testing and proximate composition. To find out the level of panelists’ acceptance of analog rice, a preference test is carried out on analog rice products using a scale of 2 (= dislike), 3 (= neutral/like), 4 (= prefer) and 5 (= really like). This organoleptic test involves 25 semi-trained panelists. The parameters assessed in this test include preference for taste, flavour, color, and texture of analog rice [12]. The parameters assessed for analog rice products with four formulation are analyzed for its chemical composition, namely: proximate [13]. After knowing whether or not there is added value in the manufacture of sago analogue rice fortified with nutrient rich fish oil, then calculate the feasibility and efficiency of the business using R/C analysis namely the ratio between revenue (Revenue, R) and total cost (Cost,
C). Based on the considerations, if R/C > 1 then the business is profitable, whereas if R/C = 1 then break even and if R/C < 1 means the business is not profitable [14].

2.3. Observation Analysis

The data obtained will be processed if the data are tabulated and graphed. Afterwards, the processed data will be analyzed descriptively and statistically simple.

3. Results and Discussion

3.1. Characteristics of the main raw materials of Analog Rice

The main raw materials used in the manufacture of analog rice are sago starch and nutrient-rich fish oil from previous studies. The characteristics of these raw materials can be seen in Table 2 below.

**Table 2.** Proximate composition of sago starch used in the manufacture of sago analogue rice.

| Material | Proximate composition (%) |   |
|----------|---------------------------|---|
|          | Waters | Protein | Fat | Ash | Crude Fibre | Carbohydrate |
| Sago     | 0.52   | 0.07    | 0.68| 0.30| 0.56        | 97.87        |

In Table 2 above, it can be seen that sago starch is rich in carbohydrates (97.87% by different methods) and poor in other nutritional elements, especially fat (0.68%). This is used as the basis for this research, so it needs to be fortified with fat sources such as nutrient-rich fish oil in the form of softgel capsule supplements with the following chemical composition (Table 3).

**Table 3.** Characteristics of the organoleptic quality of oil fortified sago analogue rice nutrient rich fish

| Repeat | Appearance | Texture | Taste | Flavor |
|--------|------------|---------|-------|--------|
|        | MS         | MS      | MS    | MS     | MS     | MS     | MS     |
| 1      | 6.52       | 7.32    | 6.00  | 7.36   | 6.36   | 7.88   | 6.60   | 7.00   |
| 2      | 6.24       | 7.32    | 6.36  | 7.92   | 6.72   | 7.40   | 6.92   | 7.88   |
| 3      | 6.24       | 7.44    | 6.92  | 7.80   | 6.52   | 7.88   | 6.20   | 7.72   |
| Average| 6.33       | 7.36    | 6.43  | 7.69   | 6.53   | 7.72   | 6.57   | 7.53   |

In Table 3, it can be seen that the organoleptic assessment of sago analogue rice was acceptable to the panelists, and nutrient rich fish oil fortification on sago analog rice resulted in differences in organoleptic values, where 5% fish oil fortification (M,S) showed a better value than oil fortification fish 3% (M,S). The relationship between the amount of impression obtained and the concentration of fish oil is directly proportional, the higher concentration of fish oil, the higher the magnitude of the impression [15]. Furthermore, the quality characteristics of the proximate composition of sago analog rice fortified with nutrient rich fish oil can be seen in Table 4 below.

**Table 4.** Proximate Composition (%) of Oil Fortified Sago Analog Rice Nutrient Rich Fish.

| Proximate Composition (%) | Sago Analog Rice |
|---------------------------|------------------|
| Ash                       | 6.86 4.25        |
| Water                     | 10.6 9.45        |
In Table 4, it can be seen that fish oil fortification 3% (M1S) and 5% (M2S) affect the proximate value of sago analogue rice. Fish oil fortification of 5% on sago analog rice showed a better value than 3% fish oil, this was based on the value of fat and protein. Protein, fat, and carbohydrates contained in food will affect the taste of the food [16]. Non-essential amino acids are one of the most important components in the taste of food [17].

3.2. Value Added Analysis
The value added analysis carried out in the production of sago analogue rice fortified with nutrient rich fish oil can be seen in Table 5 below.

**Table 5. Analysis of Value Added Production of Fortified Sago Analog Rice Nutrient rich fish oil**

| No  | Variable                        | Notation | Analog Rice Type (M1S) | Analog Rice Type (M2S) |
|-----|---------------------------------|----------|------------------------|------------------------|
| 1   | Production Yield (kg/day)       | a = b x m| 36                     | 36                     |
| 2   | Raw Material (kg/day)           | b        | 40                     | 40                     |
| 3   | Labor (Working days /day)       | c        | 2                      | 2                      |
| 4   | Conversion Factor (rendemin)    | a/b = m  | 0.9                    | 0.9                    |
| 5   | Labor Coefficient               | c/b = n  | 0.05                   | 0.05                   |
| 6   | Average Product Price (IDR/kg)  | d        | 15,000                 | 25,000                 |
| 7   | Average wage (IDR/working day)  | e        | 50,000                 | 50,000                 |

**Income and Profit**

| No  | Variable                        | Notation | Analog Rice Type (M1S) | Analog Rice Type (M2S) |
|-----|---------------------------------|----------|------------------------|------------------------|
| 8   | Raw Material Price (IDR/kg)     | f        | 320,000                | 360,000                |
| 9   | Contribution of other inputs    | g        | 100,000                | 100,000                |
| 10  | Product Value (IDR/kg)          | a x d = k| 540,000                | 900,000                |
| 11  | a. Value Added (IDR/kg)         | k-f-g = l| 120,000                | 440,000                |
|     | b. Value Added Ratio (%)        | (l/k)% = h%| 0.8                    | 0.88                   |
| 12  | a. Labor Benefits (IDR/kg)      | p = n x e| 2,500                  | 2,500                  |
|     | b. Labor Share (%)              | (p/l)% = q%| 0.006                 | 0.003                  |
| 13  | a. Entrepreneur's Profit        | r = 1 - (p*a)| 300,000             | 350,000              |
|     | b. Profit Rate (%)              | (r/l)% = o%| 0.79                   | 0.87                   |

In Table 5 it can be seen that the results of the added value analysis in the production of sago analog rice fortified with nutrient-rich fish oil, show the difference in product price per kilogram between sago analog rice fortified with 3% and 5% nutrient-rich fish oil. This difference occurs because there is a difference in prices for fish oil raw materials, where the price of raw material for sago analog rice fortified with nutrient rich fish oil is 3% (IDR 320,000) while sago analog rice fortified with nutrient rich fish oil is 5% (IDR 360,000). Thus, the added value of sago analog rice fortified with 3% nutrient-rich fish oil is IDR 120,000 or IDR. 300,000/kg and the added value of sago analog rice fortified with 5% nutrient-rich fish oil is IDR 440,000 or IDR 11,000/kg.
4. Conclusion
From the results of this study, it was concluded that all the basic formulations of sago analogue rice fortified with 3% and 5% nutrient rich fish oil, organoleptic could be liked or accepted by the panelists (consumers); as well as proximate values. However, sago analog rice fortified with 5% nutrient rich fish oil was preferred by panelists over 3%. The results of the added value analysis also showed the same thing, but the sago analog rice fortified with 5% nutrient rich fish oil had a higher added value than 3%. Although the sago analog rice fortified with fish oil is rich in nutrients, it can increase the functional fat value, but it is still poor in protein content. Therefore, it is suggested that further research is needed to increase the protein content with other food sources.

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