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Nutritional Composition of Underutilized Local Food Resources for Rice Substitution and Gluten-Free Product

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Abstract—Rice continues to be the staple food for most Indonesians. Because Indonesians have such ingrained consumption patterns, switching to other food sources besides rice can be difficult, contributing to the country's high rice consumption. Indonesia has plenty of local food resources that can be used as a carbohydrate source and staple food. However, a lack of understanding about the foods' potential use and nutritional content has caused many of them to grow wildly in nature, neglected, and underutilized. Most recently, there has been an increase in studies examining the potential of underutilized carbohydrate sources, including their nutritionally rich compounds, following the 2018 agriculture policy in promoting agriculture and food diversification. Taro beneng (*Xanthosoma undipes K. Koch*), sago (from the genus Metroxylon), sweet potato (*Ipomea batatas L.*), and sorghum (*Sorghum bicolor L.*) are the local sources of carbohydrates and have the potential to be utilized as a healthy alternative to white rice, gluten-free product, or as an ingredient of supplementary or complementary foods. To find out if underutilized foods in Indonesia have the potential to substitute rice and gluten-free products and also to assist with food diversification initiatives, a comparison of their nutritional compositions was conducted using a literature review. Taro beneng, sago, sweet potatoes, and sorghum can be used as healthy alternatives for substituting rice and gluten-free products. This underutilized food offers diverse nutrients and many possibilities for product diversification, such as analog rice, symbiotic yogurt, gluten-free biscuits, and noodles.

***Keywords*—Underutilized food; food diversification; taro beneng; sago; sweet potato; sorghum; gluten-free product.**

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I. INTRODUCTION

Rice continues to be the staple food for most Indonesians. Because Indonesians have such ingrained consumption patterns, switching to other food sources besides rice can be difficult, contributing to the country's high rice consumption. This is because most Indonesians believe that rice is the primary food source of carbohydrates. According to Food Security Agency data, rice consumption in 2019 averaged 114.3 kg per person annually, above the suggested optimal consumption level of 100.4 kg per person [1]. Meanwhile, the population growth rate has accelerated significantly, with an average annual increase of 1.25% recorded from 2010 to 2020. This is due to the growing availability of rice, which will cause overindulgence in the grain and compel the Indonesian government to import more to keep up with demand.

Farm intensification, land extension, and food diversification can be used to meet the demand for staple foods [2]. The term "intensification" describes the planned execution of different activities meant to maximize the potential and productivity of land. The previously mentioned state will eventually reach the maximum production activity, including land management strategies, irrigation techniques, fertilization practices, and seed selection. Extensification is the intentional process of expanding the available land area to meet the demand for food. The land's condition should be considered to reduce potential financial and environmental risks. Regarding eating habits, "food diversification" is the conscious effort to obtain the necessary amount of carbohydrates from foods other than rice. This food selection process prefers a variety of food components in addition to being reliant on a single food type.

Indonesia boasts a wide range of locally available food resources, including tubers, corn, sorghum, spices, and other staple foods, that can be significant sources of carbohydrates. 77 different types of carbohydrates can be consumed freely and extensively, such as arrowroot, sago, sweet potato, canna, breadfruit, *gembili,* taro, *kimpul, gadung,* Java potato, cassava, *huwisawu,* corn [1]–[6]. However, many of the items have grown wildly in nature, have been ignored, and have been misused because of a lack of knowledge about their potential uses and nutritional value. In light of the 2018 agriculture policy that promotes food diversification and agriculture [7]. The potential of underutilized sources of carbohydrates, particularly their highly nutritious compounds, is attracting increasing attention. This study set out rice substitution and gluten-free products to support food diversification initiatives and ascertain the nutritional makeup of Indonesia's underutilized food supply. This paper focuses on finding out if underutilized foods in Indonesia have the potential to substitute rice and gluten-free products and assist with food diversification initiatives.

II. Materials and Method

A literature review methodology was employed to compare the nutritional content of underutilized foods in Indonesia. Keyword combinations such as "nutritional" AND "value" AND "Metroxylon *sagu*", "sago" AND "carbohydrates", and "nutritional" AND "composition" AND "taro beneng" AND "*Xanthosoma undipes K. Koch*" were used in the literature research. The following criteria were used to choose the documents for inclusion: (1) full-text articles from online journals; (2) publishing in English or Indonesian; (3) published between 2013 and 2023; and (4) the papers' applicability to the objectives of the study. From August to September 2023, a literature search was conducted using the chosen keywords on the Science Direct, Scopus, and Google Scholar databases. Every article that met the criteria found through a literature search was compiled into a table and then used to discuss the findings of pertinent studies.

III. Results and Discussion

Indonesia is a biodiverse country where the government promotes underutilized local resources such as sago, corn, and tubers (also known as sources of carbohydrates) as potential rice substitutes. Tubers are a well-known source of carbohydrates for the general public. Numerous tubers, including taro beneng, sago, sweet potatoes, *gembili*, and others, are widespread and have historically been utilized as food sources.

The province of Banten has begun recognizing its underutilized local food resources and developing creative new uses for them. Taro beneng (*Xanthosoma undipes K. Koch*) is the local source of carbohydrates and can be utilized as an ingredient in extra or supplemental diets or as a nutritional substitution for white rice. Taro beneng offers several benefits. It has more protein and dietary fiber than other taro varieties like butter, polished, and green taro. Dietary fiber and starch are the two primary forms of carbohydrates found in taro beneng [8], [9].

The taro beneng tuber measures 20.93 cm in length, 5.64 cm in diameter, weighs 832.23 g, and is yellowish white in color. The large's diameter and length will impact the weight it produces. The yellowish-white color of taro beneng is a result of the pigments called β-carotene. The yellowish taro tubers have approximately 0.0213 mg of β-carotene per 100 g. One of the key characteristics that determines an ingredient's quality in cooking is its color. Taro beneng Starch's color attributes are L* 100, a* 10.92, and b* -15.54. The L* value shows that the taro beneng starch's whiteness level is higher than the tapioca color standard. This perfect white hue is obtained because the starch extraction method did not separate any other elements, such as colors [10].

Table I shows the nutritional value of taro beneng compared to other underutilized food ingredients in Indonesia. Taro beneng has a high content of carbohydrates (26.56-84.10%) and fiber (2.47-14.3%), but comparatively low levels of fat (0.45-10.56%) and protein (0.66-9.29%). Because taro beneng has a low protein content, it can be utilized as an ingredient in foods like cookies, vermicelli, glass noodles, and other products that don't require development [10]. In the meantime, food with a high-fat content will lose quality faster due to rancidity. Starch and high-fat flour prevent starch from gelatinizing because of the fat-forming complex that amylose forms with starch. Along with other qualities like elasticity and hydrophobicity, fat also prevents amylose from absorbing water. This would result in increased density of the granules and a decrease in the pasting capacity of the starch [11].

Taro beneng carbohydrate is classified as starch. Taro beneng contains a range of amylose (0.5-28.91%) and amylopectin (15.52-65.3%). Amylopectin is a polymer with both α-(1,4)-glycosidic bonds and α-(1,6)-glycosidic bonds at its branching site. On the other hand, amylose is a polymer component that consists of α-(1,4) bonds and forms a straight chain with a length ranging from 500 to 2000 D-glucose units. The contents of amylose and amylopectin influence the solubility and swelling power of starch; amylose contributes more to solubility and amylopectin more to swelling power [12].

Taro beneng has an ash content ranging from 0.25 to 4.3%, whereas SNI 3451:2011 specifies a maximum ash content of 0.5% for tapioca. Flour with a higher ash content is of lesser quality. Moreover, a high ash content in the flour or starch intended for culinary usage might affect the final result, especially bread goods, as well as the color, strength, and activity of the fermentation process [10].

With the moisture content ranging from 6.21 to 11.9%, taro beneng needs a proper processing to achieve desired outcomes. Adhesion, hardness, and cohesiveness are rheological properties significantly regulated by moisture content. According to [13]These characteristics would affect the mass's solidity, and the substance becomes less dense and more liquid-like in consistency as its moisture content rises. Conversely, a lower moisture content would impact shelf life because of more stable water activity. Because the respiration process and microbial activity are restricted in products with low moisture content, there is minimal degradation of product quality.

When it comes to taro, taro beneng has the highest oxalate content. Eating taro beneng may result in tongue, lips, and throat irritation and itching. Raphide, a minute crystal composed of calcium oxalate in the shape of minuscule needles, is responsible for the pruritus that triggers irritation in the skin and mouth cavity. [10] state that immersing taro beneng in a 1% NaCl salt solution for approximately one hour could reduce the oxalate concentration. Taro beneng underwent a 1% NaCl salt solution immersion for about one hour, significantly reducing 97.4%.

Taro beneng offers several advantages that could position it as a substitute for rice and gluten-free product. Its unique combination of low protein, high carbohydrates, suitable starch characteristics, and potential for oxalate reduction make it a versatile ingredient. Taro beneng can effectively contribute to the nutritional profile of various foods while providing functional benefits in food processing and preparation. However, careful consideration of its unique properties, such as oxalate management and moisture content, is essential to optimize its use in different food application.

Sago, a plant belonging to the Palmae family and *Metroxylon* genus, is indigenous to Indonesia, occupying around 1.28 million hectares, which accounts for 51.3% of the global sago land area. A naturally occurring sago palm forest covers much of Indonesia's sago region.

TABLE I
NUTRITIONAL CONTENT OF UNDERUTILIZED FOOD IN INDONESIA

Local Food	**Nutritional Content (%)**													**Reference**
	Moisture	**Ash**	**Fat**	**Protein**	**Carbohydrate**	**Dietary Fiber**	**Crude Fiber**	**Total Sugar**	**Amylose**	**Amylopectin**	**Starch**	**Resistant Starch**	**Oxalate**	
Taro beneng flour	11.9	4.32	0.9	6.86	-	2.47	3.24	2	14.9	65.3	-	-	-	[2]
Taro beneng starch	6.21	0.25	10.56	0.66	82.32	-	-	-	28.91	53.41	-	-	-	[10]
Taro beneng flour	7.45	3.43	0.45	4.55	84.10	9.52	-	-	-	-	-	-	2.42	[14]
Taro beneng flour	9.89	-	0.8	9.29	26.56	14.3	-	-	0.7	17.33	-	-	-	[15]
Sago starch	12.47	1.34	0.80	1.01	96.85	2.54	-	-	43.69	56.31	-	-	-	[16]
Sago starch	14.59	0.23	5.58	5.36	86.59	1.5	0.41	0.32	32.99	53.6	-	-	-	[2]
Sago starch	6.8	7.370	0.994	0.92	83.92	-	0.87	-	-	-	-	-	-	[17]
Sago tanah flour	14.52	0.09	0.87	0.22	84.32	0.76	-	-	-	-	-	-	-	[18]
Sago baruk flour	39.99	0.07	0.22	0.22	59.54	0.63	-	-	-	-	-	-	-	[18]
Gembili	21.20	0.39	0.97	0.50	68.14	1.62	-	-	-	-	-	-	-	[18]
Dalugha sangihe	20.07	1.14	0.27	0.32	78.22	2.77	-	-	-	-	-	-	-	[18]
Dalugha talaud	29.08	0.60	0.42	0.33	69.56	1.73	-	-	-	-	-	-	-	[18]
Banggai tubers	16.15	0.28	0.38	0.83	82.32	1.43	-	-	-	-	-	-	-	[18]
Sago starch	7.21	0.11	0.56	0.36	91.76	-	0.37	-	-	-	80.69	-	-	[19]
Arrow root starch	9.9	0.27	0.36	0.65	-	2.67	0.49	1.03	28.55	65.98	-	18.31	-	[2]
Canna starch	16.86	0.20	0.45	0.69	-	2.38	0.57	1.47	37.3	56.68	-	-	-	[2]
Orange sweet potato peel	4.9	11.6	3.2	8.3	70.9	-	18.7	-	-	-	-	13.3	-	[20]
Sweet potato flour	5.66	2.93	2.23	6.8	78.61	-	3.77	-	-	-	-	-	-	[21]
White sweet potato flour	7.26	1.96	0.59	5.52	-	2.34	2.57	4.32	25.28	57.43	-	-	-	[2]
Purple sweet potato	9.2	1.9	0.6	3.1	74.7	5.9	-	-	-	-	-	-	-	[22]
Orange-flesh sweet potato	12.2	1.8	1.8	2.4	75.6	5.7	-	-	-	-	-	-	-	[22]
Sorghum flour	11.28	0.54	0.96	6.39	-	4.65	0.80	1.10	27.57	58.34	-	-	-	[2]
Wheat flour	13.09	0.32	1	12.7	72.89	-	-	-	-	-	-	-	-	[23]
Brown rice	11.37-16.4	1.2-1.7	1.9-3.9	6.5-10	85.2-88.9	3.9	0.7-1.2	-	-	-	77.2	-	-	[24]
Milled rice	12.31-15.5	0.3-0.9	0.3-0.65	7.3-8.3	91.07	0.5-2.8	0.2-0.6	-	-	-	90.2	-	-	[24]

These regions are Papua, Sulawesi, Kalimantan, Sumatra, and Maluku. Sago is a staple food for Papua New Guineans and native Papuans, and it's also a crucial part of their customs and traditional rituals. Unlike Sumatra, Sulawesi lacks substantial sago development, and its sago reserves are less extensive than those of Papua and Maluku. In addition, Sulawesi, and particularly North Sulawesi, is an archipelago rich in endemic biodiversity that holds great promise for use as a source of functional foods and staple carbohydrates. Some potential staple foods include sago baruk (*Arenga microcarpha*), dalugha (*Cyrtosperma merkusii*), and sago tanah (*Tacca leontopetaloides*) among the native plants of North Sulawesi (Island of Sangihe and Taulud). While sago tanah and sago baruk are starch staples derived from the perimedular of the plant, dalugha are starch based on tubers [18].

Sago has excellent potential for use as a staple diet. It has an advantage over other sources of carbohydrates in that it can be harvested when desired. Other crops that produce carbohydrates find it challenging to grow in marshes and tides, but the sago palm does well there. Harvesting depends on the season, and the agronomic requirements are simpler than other crops.

Sago has both culinary and non-culinary uses. Among its culinary applications are Sago flour, starch, and other processed food items. Functional foods also include processed foods and starches such as sago flour. The superior nutritional value of sago, particularly its high carbohydrate content, forms the basis of consideration. Sago's high carbohydrate content, up to 90%, makes it a viable substitute for rice as a raw material. Table I shows the nutritional composition of sago and other underutilized food items in Indonesia.

Sago is rich in carbohydrates and has relatively low fat and protein levels. Sago has more carbohydrates than rice and a few other carbohydrate-rich foods. Sago has a carbohydrate content ranging from 59.54 to 96.85%. The protein content (0.22–5.36%) and fat content (0.2–5.58%) are comparatively low. The range of amylopectin in sago is 53.6–65.98%, while the range of amylose is 28.55–43.69%. Meanwhile, sago's ash and moisture content ranges are 0.07–7.37% and 7.21–39.99%, respectively.

Resistant starch is one kind of dietary fiber included in sago. Unlike starches that are broken down by the digestive system's amylase, which is known as digestible starches, resistant starches are not broken down by amylase and need the help of colon microbes to be broken down by glycolysis [25]. Carbon dioxide, hydrogen, short-chain fatty acids, and methane are produced by resistant starch. Microbial fermentation produces short-chain fatty acids that enter the liver fast, and it's thought that the fermentation of propionic acid prevents the liver from synthesizing cholesterol. The glycemic index and sugar absorption would be influenced by resistant starch [26]. Sago also contains butyrate, which lowers the risk of obesity and lung cancer, enhances immunity and supports excretion.

Sago presents significant potential for rice and gluten-free products. Its high carbohydrate content, low fat and protein levels, and unique starch composition make it suitable for various products, from baked goods to noodles and functional foods. Sago's cultural significance and sustainable harvesting further reinforce its role as a viable alternative to rice and nutritional and cultural preferences in different regions.

Sweet potato (Ipomoea *batatas* L.), which comes in a variety of colors, has the potential to be a good source of carbohydrates, pro-vitamin A, and antioxidants. A significant tuber in Indonesia, sweet potatoes rank fourth in the world regarding growth and yield. Using appropriate farming techniques, the average crop output can reach 20–30 metric tons per hectare. However, the current national average productivity averages 107 metric tons per hectare. The West Java province is home to Indonesia's largest sweet potato growing region, covering 27931 hectares of harvested land, with a productivity of 15.3 t/ha and a total production of 429.378 in 2010 [27]. Sweet potato flour contains 5.66% moisture, 2.93% ash, 6.8% protein, 2.23% fat, 3.77% crude fiber, and 78.61% carbohydrate [28].

Sweet potatoes exhibit a diverse spectrum of colors. The flash can be any of the following colors: white, yellow, orange, purple, red, or brown. White sweet potatoes are dryer, white in color, mildly nutty, and have orange flesh and more moisture than orange sweet potatoes. White sweet potato flour contains 7.26% moisture, 1.96% ash, 0.59% fat, and 5.52% protein, according to [2]. White sweet potatoes contain 25.28% and 57.43% of amylose and amylopectin, respectively. Purple sweet potato flour contains 9.2% moisture, 3.1% protein, 74.7% carbohydrate, 0.6% fat, 5.9% fiber, and 0.9 anthocyanin [22]. The concentration of anthocyanins, which can perform some biological tasks, such as free radical scavenging and anti-cancer qualities, is what gives sweet potatoes their rich purple color [29]. In the meantime, orange-flesh sweet potato is a nutrient-dense food that can help prevent malnutrition by providing vitamins and minerals. Furthermore, research has shown that sweet potato flour with orange flesh has a higher β-carotene content than wheat flour [30]. Orange-flesh sweet potato contains 12.2% moisture, 2.4% protein, 75.6% carbohydrate, 1.8% fat, and 5.7% fiber [22].

Sweet potatoes offer significant potential as a substitute for rice and gluten-free products. Their rich nutritional profile, diverse color variations, and functional properties in processed forms like flour make them versatile ingredients. Sweet potatoes provide essential carbohydrates and contribute vitamins, minerals, and antioxidants, which can address nutritional deficiencies and enhance overall dietary diversity. However, processing methods, regional preferences, and market acceptance will influence the successful integration of sweet potatoes as a staple food alternative to rice.

In addition to tubers, one of the carbohydrate sources that can be grown and developed in Indonesia to replace rice as a staple food is sorghum (*Sorghum bicolor* L.). The main factors contributing to sorghum's potential are its high yield (up to 10 tons/ha), low input crop (needed less fertilizer), increased resistance to drought and other unfavorable weather, and high nutritional content. Sorghum flour has 11.28% moisture content, 0.54% ash, 0.96% fat, 6.39% protein, and 4.65% dietary fiber, according to the data in Table I. Sorghum contains 27.57% amylose and 58.34% amylopectin, respectively.

Sorghum presents significant advantages as a substitute for rice and gluten-free products due to its high yield, resilience to adverse conditions, and nutritional value. Its ability to thrive with minimal inputs makes it an economically viable choice for farmers. Sorghum represents a promising alternative that could complement or substitute rice and gluten-free products, contributing to sustainable agriculture and resilient food systems.

It is evident from Table I's data that Indonesian local cuisine has a noticeably higher carbohydrate content. As such, these food sources can improve the diversity of foods. A workable solution to meeting the demand for staple foods other than rice is food diversification. Creating analog rice could result in various goods made from distinct grain varieties, adding more functionality and nutrients. Often referred to as artificial rice or analog rice, this synthetic product is made to look like rice grains. It is made up of parts that resemble rice's visual qualities. Analog rice using local food resources is shown in Table II.

TABLE II
PRODUCTS USING UNDERUTILIZED LOCAL FOOD RESOURCES

Products	Formulation	Result	Reference
Sago analog rice made from the combination of sago flour (SF), corn starch (CS) and mung bean flour (MGF),	• AR-1 (60% SF, 30% CS, 9.6% MGF, 0.4% CMC) • AR-2 (55% SF, 30% CS, 14.6% MGF, 0.4% CMC) • AR-3 (50% SF, 30% CS, 19.6% mung bean flour, 0.4% CMC) • AR-4 (60% SF, 30% CS, 9.6% MGF, 0.4% skim milk) • AR-5 (55% SF, 30% CS, 14.6% MGF, 0.4% skim milk) • AR-6 (50% SF, 30% CS, 19.6% MGF, 0.4% skim milk) • AR-7 (60% SF, 30% CS, 9.2% MGF, 0.4% skim milk, 0.4% CMC) • AR-8 (55% SF, 30% CS, 14.2% MGF, 0.4% skim milk, 0.4% CMC) • AR-9 (50% SF, 30% CS, 19.2% MGF, 0.4% skim milk, 0.4% CMC) • AR-10 (50% SF, 30% CS, 19.2% MGF, 0.4% skim milk, 0.4% CMC) • AR-11 (50% SF, 30% CS, 19.2% MGF, 0.4% skim milk, 0.4% CMC) • AR-12 (50% SF, 30% CS, 19.2% MGF, 0.4% skim milk 0.4% CMC) • AR-13 (50% SF, 30% CS, 19.2% MGF, 0.4% skim milk 0.4% CMC) • AR-14 (50% SF, 30% CS, 19.2% MGF, 0.4% skim milk, 0.4% CMC)	• The panelists' favorite rice analog formula was the one with the highest concentration of sago starch and skim milk. • 50% SF, 30% CS, 19.2% mung bean flour, 0.4% skim milk, and 0.4% CMC were used to create the best analog rice formula (AR-9). • The sample of analog rice had the highest levels of carbohydrates (80.73%) and protein (4.83%). • Analog rice shares characteristics with rice paddies in terms of texture, flavor, aroma, and appearance (IR64 for rice standard). • The texture, aroma, taste, and appearance of analog rice resembles those of rice paddy (IR64 for rice standard).	[17]
Sago analog rice with a combination of red bean flour (functional food)	The composition of each formula consisted of sago starch (%) and red bean flour (%). • 100:0 (BS100) • 95:5 (BSKM5) • 90:10 (BSKM10) • 85:15 (BSKM15) • 80:20 (BSKM20) • 75:25 (BSKM25)	• The more red bean flour is added, the dietary fiber content increases and resistant starch decreases. • The more sago flour added, the more resistant starch and amylose increase. Higher resistant starch and amylose will lower the glycemic index (GI). • BS100 had the lowest GI (40.7). • Sago analog rice represents a potential functional food for type 2 diabetics.	[16]
Non-gluten sago and taro mung bean biscuits	0%, 20%, 40%, and 60% sago flour	• The protein and ash content decrease with increasing sago flour addition. • The amount of fat and carbohydrates increases with the amount of sago flour added. • The color and aroma of the biscuits are more appealing when a higher proportion of sago flour is added. • Biscuits with 60% sago flour had the best formula (moisture: 1.78%, carbohydrate: 63.55%, protein: 3.15%, fat: 29.86%, ash: 1.61%, taste level: 73.3%, color of 96.7%, and aroma: 90%)	[31]
Noodles made from sago flours, sorghum and mung-bean	Each formula consisted of sorghum flour: mung-bean: sago starch F1 = 20:30:50 F2 = 30:30:40 F3 = 40:30:30 F4 = 50:30:20 F5 = 60:30:10	• The noodles had a fat content of 0.17-0.33%, protein of 9.64-11.83%, and carbohydrates of 86.76-88.74%. • The starch in the noodles was approximately 63.16-67.72%, with the composition of amylose and amylopectin of 25.29-27.88% and 35.47-40.7% • Formula F1 had a dietary fiber content (of 13.16%) (the highest), approximately 4.2% soluble dietary fiber (SDF), and about 9.48% insoluble dietary fiber (IDF). • The non-wheat noodles made for this study were a good source of nutrients and could substitute for other staple foods.	[32]

Products	Formulation	Result	Reference
Mocaf noodles with latoh added and sago flour substituted	Each formula's ingredients were wheat flour (%), sago starch (%), and mocaf flour (%). 2% latoh flour is added to every formulation. • 6:1:3 (M1) • 5:2:3 (M2) • 4:3:3 (M3) • 3:4:3 (M4) • 2:5:3 (M5) • 1:6:3 (M6)	• Mocaf noodles contained ash: 1.32-1.77%, protein: 3.9-4.37%, fat: 0.41-0.67%, carbohydrate: 82.39-83.43% with the total calories per 100 g about 339-343 kcal • Formula M3 has substantially more dietary fiber, including soluble dietary fiber at 4.54%, insoluble dietary fiber at 7%, and starch digestibility at 27.74%. It also has the highest antioxidant activity, at 6.6%, with a total phenolic content of 0.026%.	[33]
Sago noodles with the additional fish meal, skipjack tuna	Each formula consisted of sago flour (%) and fish meal (%). • 100:0 (A0) • 100:8 (A8) • 100:10 (A10) • 100:12 (A12) • 100:14 (A14)	• The more fish meals are added, the more cooking time for sago noodles decreases. • The darker shade of noodles will result from adding more fish meal • Formula A 14 is the best formulation with the nutritional content of moisture: 11.01%, ash: 2.16%, protein: 7.70%, fat: 0.17%, and carbohydrate: 78.96%.	[34]
Sago noodles with the enrichment of Biang fish	Each formula consisted of sago flour (g) and biang fish flour (% b/b). • 500:0 (M0) • 500:6 (M1) • 500:8 (M2) • 500:10 (M3)	• Formula M2 was the most successfully treated in terms of the appearance of whole sago noodles: The dish has a pleasing grayish-white hue, a unique smell of sago noodles with a hint of fish, a taste that is characteristic of both sago noodles and fish, and a texture that is slightly chewy but delicious. sensory assessment with scores of 8.9 for taste, 8.6 for aroma, 8.9 for visual, and 8.8 for texture. The protein made up 5.58% of its nutritional content, followed by ash (1.69%), fat (1.41%), and carbohydrate (68.29%).	[35]
Symbiotic yoghurt with taro beneng flour (TBF)	Yogurt manufacturing • Y1 (milk without TBF, S1) • Y2 (milk with 1% TBF, S1) • Y3 (milk without TBF, S2) • Y4 (milk with 1% TBF, S2) • Y5 (milk without TBF, S3) • Y6 (milk with 1% TBF, S3) Preparation of yoghurt starter (S1, S2 and S3) • *Lactobacillus bulgaricus* + *Streptococcus thermophilus (S1)* • *Lactobacillus bulgaricus* + *Lactobacillus achidophillus* + *Streptococcus thermophilus (S2)* • *Lactobacillus bulgaricus* + *Lactobacillus achidophillus* + *Streptococcus thermophillus* + *Lactobacillus casei* + *Bifidus longum (S3)*	• Yoghurt formulated with taro beneng 1% had more sour than original yogurt but still acceptable. • S2 had the best combination starter to produce yogurt (for acceptability and economic reasons).	[36]
High-fiber analog rice form taro beneng flour	Each formula consisted of taro beneng flour, corn flour, and soybean flour. • 15:5:1 (F1) • 10:10:1 (F2) • 5:15:1 (F3)	• The more soybean flour added, fat and protein content of the analog rice increase. • The more beneng taro flour added, total amount of carbohydrates of analog rice increase. • Due to its high nutrient content and high dietary fiber content (76% carbohydrates; dietary fiber that satisfies BPOM standard (2022) number 1 with high-fiber products (18.6 g > 6 g/100 g)), F1 received the best treatment level.	[37]

Products	Formulation	Result	Reference
Analog rice made from combination of sago starch, arrowroot flour, white sorghum flour and germinated red kidney bean	Each formula consisted of arrowroot flour: modified arrowroot flour with resistant starch type 3: red kidney bean flour: white sorghum flour, and sago starch. • 7:1:4:4:4 (F1) • 6:1:4:4:5 (F3) • 5:1:4:4:6 (F3)	• F3 analog rice (moisture: 9.71%; ash: 3.38%, protein: 8.07%, lipid: 1.01%, dietary fiber: 19.81%, carbohydrate: 68.74%, resistant starch: 3.43,%, amylose: 18.25%, and amylopectin: 49.94%) had the most panelist-selected optimal formulation. • The high in fiber and protein can be used as substitute of commercial rice.	[38]
Simulated rice grain from composite non-rice carbohydrate sources	Ten carbohydrate source materials were developed specifically to be used as SRG material: arrowroot starch, canna starch, taro beneng flour, white sweet potato flour, tapioca flour, white corn flour, sago starch, sugar palm starch, sorghum flour, and breadfruit flour. Next, Goal Linear Programming was used to optimize the SRG flour formula (GLP).	• The physicochemical properties of SRG flour, which is made up of 28% sorghum, 42% taro beneng flour, and 30% arrowroot starch, are comparable to those of flour made from the Ciherang variety of local rice.	[2]
Gluten-free noodles	Each formula consisted of wheat flour (WF), sweet potato flour (SPF), corn flour (CF), pre-gelatinized starch (PGS), whey protein concentrate (WPC), egg-white protein (EWP), HPMC, ascorbic acid, soybean polysaccharide, chitosan, and water. • 100:0:0:0:0:0:0:0:0:0 (WF) • 0:0:50:32:7,5:7,5:1,5:0,1:0,75:0,65:40 (CF) • 0:10:40:32:7,5:7,5:1,5:0,1:0,75:0,65:40 (SC1) • 0:20:30:32:7,5:7,5:1,5:0,1:0,75:0,65:40 (SC2) • 0:30:20:32:7,5:7,5:1,5:0,1:0,75:0,65:40 (SC3) • 0:40:10:32:7,5:7,5:1,5:0,1:0,75:0,65:40 (SC4) • 0:50:0:32:7,5:7,5:1,5:0,1:0,75:0,65:40 (SC5)	• Ash, crude fiber, methionine, lysine, and threonine content, as well as cooked weight and cooked volume, all increase with increasing SPF extent. • The SPF formula's springiness and chewiness were also enhanced. • SC2, SC3, and SC4 were the innovative concepts for building with a consistent, chewy structure, acceptable sensory qualities, and high phenolic content.	[39]

An analog rice was created using sago [16]. With 100% sago flour, the analog rice formula was the best. The findings indicated no discernible flavor, scent, or texture variations. Among the various formulations, the analog rice has the highest starch content (86.58%). Analog rice has a moisture content of 11.78%, less than the safe level of paddy rice (<14%). It requires additional protein sources, like red bean flour, to improve its nutritional qualities because its protein content is currently relatively low (2.54%). Red bean flour (24.98%) has higher protein levels than sago starch (0.9%), so adding it to the sago rice formulation increased the amount of protein [40].

Analog rice was created using taro beneng, yellow corn, and soybean flour [37]. The results show that the moisture content of the taro beneng analog rice varied between 12 and 13%. The analog rice can be stored safely because its moisture content is less than the advised threshold of 14%. Taro beneng contains comparatively little fat (1-2%) and protein (9–12%). However, the protein and fat levels of the analog rice will increase when soybean flour is added to each formulation. This rice analog has a carbohydrate content of 76-77%. The high carb content suggests that the analog of produced rice can serve as a rice substitute by providing an equivalent amount of carbohydrates. This analog rice meets the BPOM standard for high-fiber products because it has a high dietary fiber content (11.4–18.6%) in addition to carbohydrates. Taro beneng is known to have a higher dietary fiber content compared to other varieties. A mixture of 1500 g of taro beneng flour, 500 g of maize flour, and 100 g of soybean flour was used to generate the optimal analog rice formula due to their high nutrient and dietary fiber content (76% of carbohydrates, 18.6% of dietary fiber, 9% of protein, 1% of fat, and 2% of ash).

Sago, mung beans, and maize flour rice were combined to create an analog rice [17]. The best analog rice formula was made with 50% sago flour, 30% corn flour, 19.2% mung bean flour, 0.4% skim milk, and 0.4% CMC. The panelists' favorite was the rice analog formula with the highest sago starch and skim milk concentration. The analog rice sample with the highest protein content (4.83%) and highest carbohydrate content (80.73%) was the most appropriate for use as a staple diet. Analog rice shares characteristics with rice paddies regarding texture, flavor, aroma, and appearance (IR64 for rice standard). As a result, regular rice can be replaced with analog rice.

Fig. 1 Best analog rice (AR-9) before (a) and after cooking (b), source [17]

To create a simulated rice grain (SRG), taro beneng flour, arrowroot starch, and sorghum flour were combined. SRG is designed to replace rice with non-rice sources of carbohydrates. The findings demonstrated that the ideal composition of the SRG formula consisted of 30% arrowroot starch, 42% taro beneng flour, and 28% sorghum flour. Resulted in 11.78% moisture content, 1.32% fat, 6.22% protein, 1.97% ash, 1.46% total sugar, 1.74% crude fiber, 1.28% food fiber, 22.52% amylose, and 63.48% amylopectin were found in the SRG sample. The physicochemical characteristics of this formula are comparable to those of the local Ciherang variety of rice [2]. Analog rice was also made with arrowroot, sago starch, white sorghum flour, and a combination of red kidney bean flour [38]. According to the results, analog rice has a high protein content (8.07%) and fiber content (19.81%), making it a viable alternative to commercial rice.

According to Table II, in addition to the local analog rice, which is processed into flour that can be used to make a variety of high-value food products like yogurt, biscuits, and noodles, there is also non-gluten rice. Symbiotic yogurt has been made with beneng taro. Probiotic microorganisms and prebiotic substances are both components of symbiotics. Antimicrobial, anticancer, antiallergic, and immune-stimulating qualities are all symbiotic. Yogurt containing 1% beneng taro tasted sourer than the original yogurt, which had a fluid texture, according to [36].

A study by [31] developed sago and mung bean flour to make non-gluten biscuits. The best combination of ingredients, shows 1.78% moisture, 3.15% protein, 29.86% fat, 1.61% ash, 63.55% carbohydrates, 73.3% taste level, 96.7% color, and 90% aroma, was found in biscuits made with 60% sago flour. The biscuits become more visually and olfactorily enticing as the percentage of sago flour increases.

Sweet potato flour was used to make gluten-free noodles. A research by [39] state that sweet potato flour increased the crude fiber, ash, lysine, methionine, and threonine content. Sweet potato flour also increased the cooked volume, cooked weight, springiness and chewiness of the noodles. The orange flesh content of the noodles produced with sweet potato flour resulted in a brighter orange color. A novel concept for building a gluten-free protein network inside noodles with a consistent, chewy structure, acceptable sensory qualities, and a high phenolic content was developed for the noodles that were formulated with 20%, 30%, and 40% sweet potato flour.

Noodles made of mung beans, sorghum, and sago were prepared. Another study [32] stated the nutritional value of the prepared non-wheat noodles and their ability to replace other staple foods. The noodles contained the highest percentages of soluble (4.2%), insoluble (9.48%), and dietary fiber (13.16%) with 50% sago starch, 30% mung bean flour and 20% sorghum flour. Sago was also utilized in place of mocaf noodles [33]. The noodles with the highest antioxidant activity (6.6%) and the highest levels of total dietary fiber (11.54) were those that were formulated with 40% mocaf flour, 30% sago starch, and 30% wheat flour.

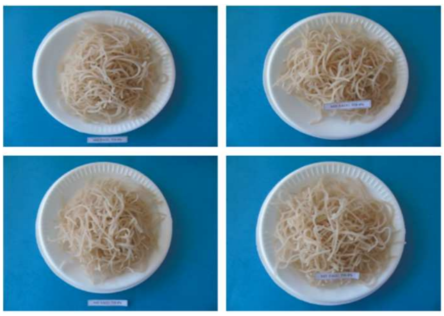

Fig. 2 Sago noodle enrich with biang fish (M0, M1, M2, M3) source [35]

Fish meal Sago noodles were enhanced with skipjack tuna [34]. The findings indicated that the more fish meal added, the shorter the sago noodle's cooking time and the darker its color. Sago noodles with 100% sago and 14% fish meal (11.01% moisture, 2.16% ash, 7.70% protein, 0.17% fat, and 78.96% carbohydrates) are the most nutritious combination that can be used. Sago noodles were additionally enhanced with biang fish [35]. The noodles with their lovely grayish-white color and composition of 500 g sago flour and 6% biang fish flour were the most visually appealing. The noodles were delicious, slightly chewy, and had a distinct taste that is characteristic of sago noodles and fish.

(a) (b)

Fig. 3 (a) sago flour (b) fish meal flour Sources: [34]

IV. Conclusion

Indonesia's high rice consumption rate *results from* the people's regular rice consumption habits, which make it challenging to eat anything else. This has to do with the fact that *more rice will be* available, leading to overindulgence in the grain and forcing the Indonesian government to import more to keep up with demand. Using food diversification, the demand for staple foods can be met. Many local food resources, like tubers and sorghum, are available in Indonesia and can be used for food diversification as a source of carbohydrates and staple foods. Taro beneng, sago, sweet potatoes, and sorghum can be *used as healthy alternatives for substituting rice* and gluten-free products. These underutilized food sources offer *diverse* nutrients and can be valuable substitutes for individuals looking to diversify their diets or follow a gluten-free lifestyle. These underutilized foods offer many possibilities for product diversification*, such as analog rice, symbiotic yogurt, gluten-free biscuits,* and noodles.

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References

[1] Badan Ketahanan Pangan, *Road Map Diversifikasi Pangan Lokal Sumber Karbohidrat Non Beras (2020-2024)*. 2020.

[2] I. Hendrawan, P. Hariyadi, Y. A. Purwanto, and R. Hasbullah, "Optimizing the Formula of Composite Non-Rice Carbohydrate Sources for Simulated Rice Grain Production," *Int. J. Sci. Eng. Res.*, vol. 6, no. 3, pp. 7–13, 2015, doi: 10.14299/ijser.2015.03.010.

[3] F. Fetriyuna *et al.*, "Composite flour from indonesian local food resources to develop cereal/tuber nut/bean-based ready-to-use supplementary foods for prevention and rehabilitation of moderate acute malnutrition in children," *Foods*, vol. 10, no. 12, pp. 1–16, 2021, doi: 10.3390/foods10123013.

[4] F. Fetriyuna *et al.*, "Ready-to-use therapeutic/supplementary foods from local food resources: Technology accessibility, program effectiveness, and sustainability, a review," *Heliyon*, vol. 9, no. 12, p. e22478, 2023, doi: 10.1016/j.heliyon.2023.e22478.

[5] H. Marta, C. Febiola, Y. Cahyana, H. R. Arifin, F. Fetriyuna, and D. Sondari, "Application of Composite Flour from Indonesian Local

Tubers in Gluten-Free Pancakes," *Foods*, vol. 12, no. 9, pp. 1–13, 2023, doi: 10.3390/foods12091892.
[6] F. Fetriyuna, S. M. A. Letsoin, I. R. A. P. Jati, and R. C. Purwestri, "Potential of Underutilized Sago for Bioenergy Uses," *Int. J. Adv. Sci. Eng. Inf. Technol.*, vol. 14, no. 1, pp. 144–150, 2024, doi:10.18517/ijaseit.14.1.19202.
[7] Indonesian Center for Agricultural Socio Economic and Policy Studies (ICASEPS), "Indonesia Agriculture Sector Outlook 2018," vol. 11, no. 1, 2018.
[8] F. Fetriyuna, E. Mardawati, and R. Dwiyanti, "Pengaruh Suhu Modifikasi Steam Preassure Treatment Terhadap Sifat Fungsional dan Amilografi Pati Talas Banten (Xanthosoma undipes K.Koch)," *J. Penelit. Pangan (Indonesian J. Food Res.*, vol. 2, no. 1, Feb. 2018, doi:10.24198/jp2.2017.vol2.1.04.
[9] F. Fetriyuna, M. Marsetio, and R. L. Pratiwi, "Pengaruh Lama Modifikasi Heat-Moisture Treatment (HMT) Terhadap Sifat Fungsional dan Sifat Amilografi Pati Talas Banten (Xanthosoma undipes K. Koch)," *J. Penelit. Pangan (Indonesian J. Food Res.*, vol. 1, no. 1, pp. 44–50, 2016, doi: 10.24198/jp2.2016.vol1.1.08.
[10] W. Nurtiana and V. Y. Pamela, "Characterization of Chemical Properties and Color of Starch from Talas Beneng (Xanthosoma undipesh K. Koch) Extraction as A Source of Indigenous Carbohydrate from Pandeglang regency, Banten Province," *IOP Conf. Ser. Earth Environ. Sci.*, vol. 383, no. 1, 2019, doi: 10.1088/1755-1315/383/1/012050.
[11] M. Stasiak, M. Molenda, J. Horabik, P. Mueller, and I. Opaliński, "Mechanical Properties of Potato Starch Modified by Moisture Content and Addition of Lubricant," *Int. Agrophysics*, vol. 28, no. 4, pp. 501–509, 2014, doi: 10.2478/intag-2014-0040.
[12] C. Lerdluksamee, K. Srikaeo, J. A. M. Tutusaus, and J. G. Diéguez, "Physicochemical Properties and Starch Digestibility of Scirpus Grossus Flour and Starch," *Carbohydr. Polym.*, vol. 97, no. 2, pp. 482–488, 2013, doi: 10.1016/j.carbpol.2013.05.001.
[13] A. Quintanar Guzmán, M. E. Jaramillo Flores, R. Mora Escobedo, L. Chel Guerrero, and J. Solorza Feria, "Changes on the Structure, Consistency, Physicochemical and Viscoelastic Properties of Corn (Zea mays sp.) Under Different Nixtamalization Conditions," *Carbohydr. Polym.*, vol. 78, no. 4, pp. 908–916, 2009, doi:10.1016/j.carbpol.2009.07.024.
[14] N. A. Putri, R. A. Riyanto, S. Budijanto, and S. Raharja, "Studi awal perbaikan kualitas tepung Talas Beneng (Xanthosoma undipes K.Koch) sebagai potensi produk unggulan Banten," *J. Trop. AgriFood*, vol. 3, no. 2, p. 63, 2021, doi: 10.35941/jtaf.3.2.2021.6360.63-72.
[15] S. Bintanah, Hagnyonowati, and F. F. Jauharany, "Analisa Zat Gizi dan Tingkat Kesukaan Pada Tepung Talas Bening (Xanthosoma undipes koch) sebagai Pangan Fungsional untuk Menurunkan Kadar Gula Darah," *Pros. Semin. Nas. UNIMUS*, vol. 4, pp. 1689–1697, 2021.
[16] S. B. Wahjuningsih, Y. Marsono, D. Praseptiangga, B. Haryanto, and M. N. Azkia, "Organoleptic, Chemical, and Physical Characteristics of Sago (Metroxylon spp.) Analog Rice Supplemented with Red Bean (Phaseolus vulgaris) Flour as a Functional Food," *Int. J. Adv. Sci. Eng. Inf. Technol.*, vol. 10, no. 3, pp. 1289–1296, 2020, doi:10.18517/ijaseit.10.3.11098.
[17] S. Sumardiono, B. Budiyono, H. Kusumayanti, N. Silvia, V. F. Luthfiani, and H. Cahyono, "Production and Physicochemical Characterization of Analog Rice Obtained from Sago Flour, Mung Bean Flour, and Corn Flour Using Hot Extrusion Technology," *Foods*, vol. 10, no. 12, 2021, doi: 10.3390/foods10123023.
[18] M. E.M, R. D., N. J, and Y. A, "Sulawesi Endemic Tubers and Perimedular Flour Properties an Initial," vol. 6, no. April, pp. 46–52, 2022.
[19] A. Budiyanto, A. B. Arif, and N. Richana, "Optimization of Liquid Sugar Production Process from Sago (Metroxylon spp.)," in *IOP Conference Series: Earth and Environmental Science*, IOP Publishing, 2019, doi: 10.1088/1755-1315/309/1/012052.
[20] H. O. Elkatry *et al.*, "The Chemical, Rheological, and Sensorial Characteristics of Arabic Bread Prepared from Wheat-Orange Sweet Potatoes Flour or Peel," *Foods*, vol. 12, no. 8, p. 1658, Apr. 2023, doi:10.3390/foods12081658.
[21] T. Farzana, M. J. Abedin, A. T. M. Abdullah, and A. H. Reaz, "Exploring the impact of pumpkin and sweet potato enrichment on the nutritional profile and antioxidant capacity of noodles," *J. Agric. Food Res.*, vol. 14, no. October, p. 100849, 2023, doi:10.1016/j.jafr.2023.100849.
[22] N. M. Thuy, T. N. Giau, V. Q. Tien, N. Van THANH, and N. Van TAI, "Developing a nutritious soup product using purple sweet potatoes supplemented with composite of vegetables and freezed-dried chicken," *Food Sci. Technol.*, vol. 43, 2023, doi: 10.1590/fst.119922.
[23] F. Vásquez, S. Verdú, A. R. Islas, J. M. Barat, and R. Grau, "Effect of Low Degrees of Substitution in Wheat Flour with Sorghum, Oat or Corn Flours on Physicochemical Properties of Composite Flours," *Cogent Food Agric.*, vol. 2, no. 1, 2016, doi:10.1080/23311932.2016.1269979.
[24] M. Zhao, Y. Lin, and H. Chen, "Improving Nutritional quality of Rice for Human Health," *Theor. Appl. Genet.*, vol. 133, no. 5, pp. 1397–1413, 2020, doi: 10.1007/s00122-019-03530-x.
[25] G. Li, B. Liu, G. Zhang, J. Zeng, J. Sun, and H. Ma, "Characterization of Digestion Resistance Sweet Potato Starch Phosphodiester," *Trop. J. Pharm. Res.*, vol. 13, no. 9, pp. 1393–1400, 2014, doi:10.4314/tjpr.v13i9.3.
[26] E. Valencia and M. Goretti Marianti Purwanto, "Artificial Rice as an Alternative Functional Food to Support Food Diversification Program," *KnE Life Sci.*, vol. 2020, pp. 177–186, 2020, doi:10.18502/kls.v5i2.6449.
[27] BPS, *Statistik Indonesia 2011*. 2011.
[28] T. Farzana, M. J. Abedin, A. T. M. Abdullah, and A. H. Reaz, "Exploring the impact of pumpkin and sweet potato enrichment on the nutritional profile and antioxidant capacity of noodles," *J. Agric. Food Res.*, vol. 14, no. October, p. 100849, 2023, doi:10.1016/j.jafr.2023.100849.
[29] N. Phomkaivon, V. Surojanametakul, P. Satmalee, N. Poolperm, and N. Dangpium, "Thai Purple Sweet Potato Flours: Characteristic and Application on Puffed Starch-Based Snacks," *J. Agric. Sci.*, vol. 10, no. 11, p. 171, 2018, doi: 10.5539/jas.v10n11p171.
[30] S. C. Ubbor, V. C. Ezeocha, J. N. Okoli, O. E. Agwo, O. A. Olaoye, and I. E. Agbai, "Evaluation of Biscuits Produced from Wheat (Triticum aestivum), Tiger Nut (Cyperus esculentus) and Orange Fleshed Sweet Potato (Ipomea batatas) FLOURS," *FUDMA J. Sci.*, vol. 6, no. 4, pp. 254–261, Sep. 2022, doi: 10.33003/fjs-2022-0604-1072.
[31] D. Puspitasari, E. Noerhartati, M. Revitriani, F. S. Rejeki, and E. R. Wedowati, "The concentration of sago flour to taro-mung bean composite flour on the quality of non-gluten biscuits," *IOP Conf. Ser. Earth Environ. Sci.*, vol. 733, no. 1, 2021, doi: 10.1088/1755-1315/733/1/012076.
[32] M. N. Azkia, S. B. Wahjuningsih, and C. H. Wibowo, "The nutritional and functional properties of noodles prepared from sorghum, mung bean and sago flours," *Food Res.*, vol. 5, no. s2, pp. 65–69, 2020, doi:10.26656/fr.2017.5(S2).002.
[33] S. B. Wahjuningsih, Haslina, N. Nazir, M. N. Azkia, and A. Triputranto, "Characteristic of Mocaf Noodles with Sago Flour Substitution (Metroxylon sago) and Addition of Latoh (Caulerpa lentillifera)," *Int. J. Adv. Sci. Eng. Inf. Technol.*, vol. 13, no. 2, pp. 417–422, 2023, doi: 10.18517/ijaseit.13.2.18205.
[34] C. Litaay, A. Indriati, and N. K. I. Mayasti, "Fortification of sago noodles with fish meal skipjack tuna (Katsuwonus pelamis)," *Food Sci. Technol.*, vol. 42, pp. 1–7, 2022, doi: 10.1590/fst.46720.
[35] Sumarto, Suparmi, and A. Hidayati, "Utilization of Biang Fish (Ilisha elongata) as an Enrichment Material for Sago Noodles Nutrient Value," *IOP Conf. Ser. Earth Environ. Sci.*, vol. 1118, no. 1, pp. 8397–8402, 2022, doi: 10.1088/1755-1315/1118/1/012033.
[36] S. Kusumasari and V. Y. Pamela, "Sensory evaluation of synbiotic yoghurt with Banten taro flour as prebiotic," *IOP Conf. Ser. Earth Environ. Sci.*, vol. 383, no. 1, 2019, doi: 10.1088/1755-1315/383/1/012044.
[37] D. Fajriaty, B. Setiawan, T. Sinaga, and A. Sulaeman, "High-fibre Analog Rice Made from Beneng Taro Flour," *J. Gizi dan Diet. Indones. (Indonesian J. Nutr. Diet.*, vol. 10, no. 3, p. 125, 2022, doi:10.21927/ijnd.2022.10(3).125-131.
[38] M. Nugraheni, S. Purwanti, and P. Ekawatiningsih, "Nutrient and sensory analysis of analog rice made with arrowroot (Maranta arundinaceae) flour, germinated red kidney bean (phaseolus vulgaris l) flour, germinated white sorghum flour, and sago starch," *Food Res.*, vol. 4, no. 6, pp. 2241–2246, 2020, doi: 10.26656/fr.2017.4(6).269.
[39] M. Salama, T. Mu, and H. Sun, "Influence of sweet potato flour on the microstructure and nutritional quality of gluten-free fresh noodles," *Int. J. Food Sci. Technol.*, vol. 56, no. 8, pp. 3938–3947, 2021, doi:10.1111/ijfs.15010.
[40] S. B. Wahjuningsih, Y. Marsono, D. Praseptiangga, and B. Haryanto, "Resistant Starch Content and Glycaemic Index of Sago (Metroxylon spp.) Starch and Red Bean (Phaseolus vulgaris) Based Analogue Rice," *Pakistan J. Nutr.*, vol. 15, no. 7, pp. 667–672, 2016.