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Chemical Composition Of Modified And Fortified Sago Starch (*Metroxylonsp*) From Northern Maluku

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Abstract

This study aims to find out the chemical composition of modified and fortified sago starch by encapsulated phytoplankton extract. This study used a simple complete random design with 4 treatments (S_0, S_1, S_2 dan S_3) repeated three times resulting in total 12 experimental units. The treatments consisted of sago starch without modification and fortification (S0), sago starch with heat moisture treatment (HMT) (S1), sago starch fortified with 7% of phytoplankton extract flour 1 (S2), and sago starch fortified with 7% of phytoplankton extract flour 2 (S3). The study procedures included the following steps: production of modified sago starch and continued with fortified sago starch production. Each of treatment was analyzed for its chemical compositions that included water content, ash content, protein, fat, crude fibre, carbohydrate, starch, amylose, amylopectin and color.

Study findings indicated that the chemical compositions of the sago starch are: water level 13.51-17.37% (significant), protein 0.11-0.27% (significant),fat 0.65-0.87 % (significant), crude fibre 0.39-1.45% (significant), carbohydrate 81.07-83 % (significant), starch 70.25-72.61% (significant), amylose 23.95-26.59 % (significant)and amylopectin 43.69-48.4 % (significant).

Keywords: fortification, chemical composition, modification, sago starch

INTRODUCTION

The food availability crisis in Indonesia can be a serious threat if not addressed by taking preventive measures and providing solutions. The dependency on certain primary food commodities has been a cause of the difficulty in overcoming the food availability crisis. One of the attempts to address the food availability shortage is

diversification of primary foods as energy sources for society. Indigenous primary foods as carbohydrate sources can be found in many regions in Indonesia. Consumption of local foods and their traditional processing have been in place for centuries in many areas in Indonesia. This situation is highly potential for research and development of food diversification based on local primary foods. This will facilitate the follow-up of study findings by socializing them to society, that the society acceptance to the new product tends to be easy.

Sago plant (*Metroxylon*sp.) is one of the very potential local foods in Indonesia. Indonesia has the largest sago area in the world, about 1.128 million ha or 51.3% of 2.201 million ha of worldwide sago area[5]. From total sago area of about 1.128 million ha, about 90% of the number or 1.015 million ha are found in Papua, Maluku and Northern Maluku provinces[6]. In addition to sago, Northern Maluku is also known as skipjack tuna and sugar palm producer. According to data from Agricultural and Farming Office of Northern Maluku, the area of sugar plam in Northern Maluku is 1689 ha with total production of 1,018 tons per year.

Given the sago potency in Northern Maluku, an appropriate technology is necessary to process the local carbohydrate sources such as sago into flour that have higher nutritional content through modification and fortification of the local sago starch in Northern Maluku. Modification of starch can be performed physically or chemically. Physical modification can be made by heat treatment, shear stress (with friction in a plate), freezing in liquid nitrogen, radiation, and others [4]. Sagar [11] studied the physical modification of corn starch using radiation, whereas Ska and Tomasik [13] modified the potatoes starch by freezing the starch in liquid nitrogen. Fortification of sago starch is made to improve the nutritional value sago starch, in this case protein. The used protein is derived from encapsulated phytoplankton extract [16].

The modified and fortified sago starch is expected to be food preparation that have better nutritional value compared to sago starch without modification and fortification. The produced sago starch will be used as raw material in analogue rice production with sago as its basic composition. This study aims to find out the chemical compositions of modified and fortified sago starch.

METHODS

Materials used in this study consisted of sago and maltodextrin-encapsulated protein, phytoplankton 1 extract flour and dextrin-encapsulated protein, phytoplankton extract flour 2, and materials for chemical analysis.

Equipment used in this study consisted of equipment to make HMT-modified sago flour including scale, oven, grinder, pan, and mesh 100.

This study used a simple complete random design with four treatments (S_0, S_1, S_2 and S_3) repeated 3 times each resulting total 12 units of treatment. The treatments included unmodified and unfortified sago flour (S0), HMT-modified sago flour (S1), sago flour modified with phytoplankton extract flour 1 (S2), and sago flour fortified with phytoplankton extract flour 2 (S3). The procedures included the making of modified sago starch and continued with the making of fortified sago starch. Each of the

treatments was analyzed for its water, ash, protein, fat, amylose, and amylopectin content and its color.
The obtained data were tabulated by Ms-Excel and analyzed. When there was a difference, analysis was continued with least significance different at level of 5%.

The Making of Heat Moisture Treatment (HMT)-Modified Sago Starch
The used heat moisture treatment technique referred to Adebowale et.al. [1]. Sago flour was analyzed for tis water content at first. Modification of sago starch by HMT technique was as follow: 200 grams of starch were adjustred for its water content up to 28% by spraying distilled water. The volume of the sprayed distilled water was determined based on mass balance calculation.
The wet starch that had reached 28% of water content was put into closed pan and stirred. Starch was kept aside in a refrigerator overnight for water content uniformity. The pan with wet starch was heated in the oven at 110ºC. Heating time was differentiated into three treatments: 2, 4, and 6 hours. Starch was stirred every 2 hours to evenly distribute the heat. After cooling down, the modified starch was dried for 4 hours at 50ºC. The HMT-modified starch was then used to make rice analogue.

The Making of Fortified Sago Starch
Fortified sago starch was made by adding 7% of maltodextrin-encapsulated protein / phytoplankton extract flour 1 in treatment S2, and adding 7% of dextrin-encapsulated protein / phytoplankton extract flour 2 at treatment S3.

RESULTS AND DISCUSSION
Chemical analysis and color analysis results are presented in Table 1. This table indicates significant differences except for ash content analysis results.

Table 1. Chemical and Color Analysis of Sago Starch

Analysis Type	Analysis Results			
	S0	S1	S2	S3
Chemical Analysis				
Water Content (%)	15,80^{b}	17,27^{c}	13,82^{a}	13,66^{a}
Ash (%)	1,56	0,79	4,85	0,87
Protein (%)	0,12^{a}	0,24^{c}	0,24^{c}	0,16^{b}
Fat (%)	0,80^{b}	0,84^{b}	0,80^{a}	0,67^{b}
Crude Fiber (%)	0,63^{b}	0,44^{a}	0,71^{b}	1,42^{c}
Carbohydrate (%)	81,73^{b}	80,86^{a}	84,30^{c}	84,64^{d}
Starch / Amylum	72,16^{b}	72,69^{b}	71,66^{ab}	70,33^{a}
Amylose	23,97^{a}	24,22^{b}	25,36^{c}	26,57^{d}
Amylopectin	48,20^{c}	47,21^{bc}	46,30^{b}	43,75^{a}
Color Analisis				
ColorL	81,47	80,58	82,17	81,56
Colora	0,88	1,25	0,75	0,64
Colorb	7,17	7,41	7,20	6,86

Note: Subscript notation followed by same letter is considered not significantly different at least significant different test α 0.01

Water content analysis results indicated that the HMT-modified sago starch still had high water content, indicating that in treatment S1 further drying was needed. The high water content makes the products damaged easily due to fungi or fleas attack. Flour water content was influenced by the treatment received and storage duration and condition. Water content in materials can be used to determine the storage duration of materials. The lower the water content, the longer the duration time will be.

Ash content analysis results in all treatments indicated no significant difference. Majority of the food materials, namely about 96% consists of organic substances and water. The others consist of mineral elements. Minerals in food are usually determined by ashing or incineration. Ash content is inorganic substance derived from incineration of an organic substance. Ash content relates to minerals of a material. Majority of the food materials consist of organic substances and water, the others consist of mineral elements usually called inorganic substances or ash content. In incineration process, organic substances are burned but its inorganic substances are not burned. The higher the ash content the more its mineral content. Minerals found in a substance consist of organic salt such as malate acid, oxalate, acetate, pectate and inorganic salt such as phosphate, carbonate, cloride, sulphate, and nitrate. In treatment S2 (fortified sago with maltodextrine-encapsulated phytoplankton extract flour), the sago flour had the highest ash content, indicating that the added phytoplankton extract contributed to increased mineral content in sago starch (S2).

The protein content in sago starch indicated a significantly different results in each treatment. Modified and fortified sago starch indicated increased protein content compared to sago without modification and fortification (S0).

Crude fiber is a part of food that cannot be hydrolyzed by digestive enzymes. The highest crude fiber level was found in sago starch fortified with phytoplankton extract flour (S3), namely 1.42 (b/b).

Carbohydrate, starch/amylum, amylose and amylopectin indicated significant different results. Carbohydrate value increased in fortified sago (S2 and S3). This increase was attributable to phytoplankton extract flour addition because the plankton extract flour was made from plankton extract encapsulation with maltodextrin (S2) and dextrin (S3). Maltodextrin and dextrin are the carbohydrates used as filter in encapsulation process. Therefore, the carbohydrate content in S2 and S3 treatments was higher compared to that in S0 and S1.

The highest starch/amylum content was found in modified sago flour (S1) (72.69% w/w). This was possibly due to modification process with HMT, where there was a breakdown of starch components into simpler elements by amylase enzymes. The same is true for amylose and amylopectin content after modification which tended to increase compared to before the modification. This was due to the fact that at same mol, the starch molecule weight after modification became higher than before modification. Increased amylose and amylopectin after modification was also observed in a study by Adebowale et.al. [2] and Singh [12].

Each type of starch has different characteristics and functional properties. Limited starch functional properties has limited the application of the starch for food products. The improvement of characteristics and functional properties of starch can be obtained by modifying the starch [8]. The modified starch is starch the have been modified for its original properties, the chemical and physical properties making it having the preferred characteristics [15]. The modification of starch can be performed with physical treatment, including by heating at certain water content level (hydrothermal or heat moisture treatment). Physical treatment to modify starch tends to be safer and more natural than chemical treatment [3]. According to Lorenz and Kulp [4], *heat moisture treatment* (HMT) is the process of heating starch at high temperature above the gelatinization temperature in a semi-dry condition, lower water content than the required for gelationization process to occur. The required water content for the HMT is 18-30% and the temperature is 100ºC. Purwani et.al. [10] modified sago starch with HMT at water content of 25% at temperature of 110ºC. Pukkahuta and Varavinit [9] modified sago starch with HMT at water content of 20% at temperatures of 100, 110, and 120ºC. Different water contents influence the extent of gelatinization temperature increase and decreased viscosity of starch paste [8]. Increased gelatinization temperature in HMT-modified sago starch indicates starch granule shape change [9]. According to Manuel [8], changes occurring in physical parameters of starch were caused by the presence of relationship between the following factors: (i) structural change in crystalline area and amorphous area in starch granule, and (ii) physical modification in starch granule surface during HMT process. Modification of starch with HMT technique can damage the granule shape of the starch resulting in holes on its surface. The heating process of starch and water presence during HMT make the amorphous area in starch inflated, and then pushing outward the crystalline area resulting in damage and melting of starch granule crystalline area and produce more heat stable granules.

The color value was indicated by L, a and b. L value is the parameter of light with score ranging from 0 (dark) to 100 (white). In this study, the L value of sago samples were above 90, the highest L value was 82.17 in treatment S2. The a value states the chromatic of mixed green-red, with +a value (positive) from 0 to +100 for red and –a (negative) from 0 to -80 for green color. The b value indicated the chromatic of mixed yellow-blue, with value +b (positive) from 0 to +70 for yellow and –b (negative) from 0 to -70 for blue color. The highest a and b value in this study was 1.25 and 7.41. This sago starch color will influence the color of the produced products. All sago starches in this study were made as a raw materials to make rice analogue.

CONCLUSION

The chemical composition of sago starch includes water content 13.51-17.37% (significant), ash content 0.73-1.67% (not significant), protein 0.11-0.27% (significant), fat 0.65-0.87% (significant), crude fiber 0.39-1.45% (significant), carbohydrate 81.07-83% (significant), starch 70-25-72.61% (significant), amylose 23.95-26.95% (significant) and amylopectin 43.69-48.41% (significant). The color of

the produced sago starch was stated with L value (80.58-82.17), a value (0.64-1.25) and b value (6.86-7.41).

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