Comparative Study on the Properties of Various Commercial Sago Starches and Examination of Gluten-Free Pasta Using Sago Starch

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Abstract

It is well known that property differences in sago starch can arise due to such factors as sago variety, production area, cultivation environment, and purity level. With this in mind, the objective of this research was to compare a total of nine types of sago starch, including sago starches sold in Indonesia and sago starches imported to Japan from Indonesia. A focus was also put on gluten-free, which is receiving much attention nowadays, and the development of gluten-free pasta made with sago starches imported to Japan was attempted. Nine varieties of sago starch produced in Indonesia were used in the property comparison of various commercial sago starches. Their viscosities at a starch concentration of 7.5%, and the physical properties of starch gels kept at 5℃ for two hours, were compared. For production of the gluten-free pasta using sago starch, first a gel with 18% starch concentration was made using 15g sago starch and 80g distilled water heated in a saucepan. Then, 40g of the gel, 54g of corn flour, 1g of xanthan gum, and 2g of olive oil were kneaded together, and pasta dough was prepared. With the aim of suppressing retrogradation, 3%, 5%, and 7%, of the sago starch was substituted with two types of modified starch (hydroxypropylated tapioca starch (HP), and acetylated distarch phosphate and enzyme-treated starch (APE)). Creep meter (breaking strength test) and sensory evaluation tests were used for analysis. Results obtained were: 1) The nine Indonesian sago starches showed remarkable differences in quality, in their viscosities, and in the physical properties of their gels. 2) Non-cooked pasta substituted with modified starch (HP and APE), showed a tendency to be softer than pasta made with sago starch, but after boiling, the hardness of the pastas was similar. 3) 15 minutes after boiling, the hardness of the sago pasta roughly doubled. However, when 5%, or 7%, of the sago starch was replaced with the two types of modified starch, a tendency for the increase in hardness to be suppressed was seen, meaning, retrogradation suppression could be confirmed.

Key words: Gluten-free pasta, Modified starch, Physical properties, Sago starch, Viscosity

Application of Sago Starch in Karukan (Japanese Rice Flour Steamed Cake)

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Abstract

When rice flour used for karukan preparation was substituted with other starches, differences were observed in the expansion of karukan. In this paper, rice flour was substituted for sago starch, which is expected to improve the utilization and palatability of karukan, and the results were compared with those of karukan made with other starches.

Reference karukan was prepared in a food processor using Yamatoimo (Japanese yam: produced in Chiba, Japan in 2022), rice flour (Tomizawa Shouten), white sugar, and distilled water. Sago, corn, wheat, potato, sweet potato, and cassava were used as starch substitutes for rice flour. Moistures were determined by heat drying method under the atmospheric pressure and viscosities were measured for the crushed Japanese yam by the instrument of Toki Sangyo (Cone-plate viscometer TV-22). Specific volume and texture measurements were performed on the karukan by Yamaden (Creep meter RE2- 3305B). Sensory evaluation was conducted using a 7-point grading system to evaluate relative strengths and preference.

Karukan with 100% substitution of sago starch for rice flour was significantly lower preference than the reference in the sensory evaluation. On the other hand, the karukan with 50% sago starch substituted for rice flour did not differ significantly from the reference in terms of all the determined value. Though in terms of preference, the appearance and color items were significantly lower, there were no significant differences in the good texture, taste, hardness, and elasticity items. Therefore, the starch replacement ratio was decided to 50% in subsequent experiments. The physical properties of the karukan prepared showed that all starches tended to have higher values for hardness than the reference, while cassava starch had the same value as the reference for adhesiveness, and the other starches had smaller values. The appearance and color of the karukan substituted with sago and cassava starches were lower in the sensory evaluation preferences. This may be due to the light grayish color of sago starch product, while the cassava starch product showed lower swelling, resulting in a gelatinous product with less foams. In the overall evaluation, cassava starch was significantly less preferred than the reference, corn and sweet potato starches. However, sago starch showed no significant differences from the other starches. While some panels liked the distinctive light pink color of sago starch karukan, others said it tasted a little astringent. This suggests that improving the taste of sago starch would improve the preference of sago starch karukan.

Key words: Karukan, Physical properties, Sago starch, Sensory evaluation, Specific volume

The Possibility of Sago Starch as a Healthy Food

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Abstract

Metroxylon Sagu is a type of palm that produces sago. Sago is a local delicacy native to Indonesia, specifically from Sumatera to Papua. For the most part, the potential of sago has yet to be fully explored. Eighty percent of the world's sago forests are located in Indonesia. Sago are environmentally friendly plants, which are naturally nurtured. The sago tree is the highest producers of starch in the world, producing 20-25 tons/ha/year. The sago tree is also known as a resilient tree. Sago palms are resistant to extreme weather changes and are one of the biggest contributors to slowing down global warming. This is due to its high CO2 absorption rate.

This great natural resource would bring more benefits if it is managed well with the best technology. Thus, two local Bangka citizens were inspired to innovate and started a modern and sustainable sago industry in PT Bangka Asindo Agri (BAA). PT BAA applies the concept of an Integrated Green Sago Industry with Zero Discharge and Waste to Value. This is a sustainable concept because it applies closed-system water management, supported by the green energy derived from waste (biogas and methane capture), and utilizes waste for animal feed. The sustainable concept above is applied by PT BAA with reference to several SDGs and has succeeded in fulfilling these responsibilities.

Nowadays, a new term has emerged in the global community, the "Diabesity Pandemic" or diabetes pandemic. (Widi, Shilvina. *Indonesia has the Highest Number of Type 1 Diabetes Patients in ASEAN by 2022.*) Indonesia has the highest number of type one diabetes in Southeast Asia. Based on the International Diabetes Federation (IDF) report, the number of people with this type of diabetes in the country reached 41,813 people in 2022.This figure raises concerns because people with diabetes are in the age range of 20-59 years, which means almost all age groups are afflicted with the disease. This indirectly illustrates that there is a lack of knowledge

about foods with low Glycemic Index (GI). The GI made sources of carbohydrate more “marketable” in the pandemic of “DIABESITY”.

Sago is a source of carbohydrate with low GI levels and is applicable for various types of food. The natural sago is processed with modern technology in collaboration with the Bangka Sago Forest Community, which supplies quality sago pith to PT. BAA. PT. BAA processes the sago with high technology and food-grade hygiene. Sago is a healthy food that is naturally gluten-free, low-GI, high- resistant, and processed without bleaching, preservatives, or GMOs. Sago starch is multifunctional and multipurpose. It can substitute rice, wheat, corn, and other sources of carbohydrate in a variety of ways. It can also produce various types, shapes, and flavors of healthy processed foods with the potential to reduce the use of rice and wheat.

SagoMee, the world's first instant noodles made with Sago, is an innovative and useful product derived from the true sago palm by PT. BAA. It is healthy for the intestines and may help the body in growing probiotic bacteria with its low GI. In conclusion, Indonesian Sago can be an alternative food source for a better world.

Spheroid Echinate Symmetric Phytolith Assemblage in Sago Palm (*Metroxylon sagu* Rottb.) Leaflet

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Abstract

The Arecaceae family of plants accumulate a substantial amount of silicon, which helps to mitigate the harmful effects of stress caused by heavy metals, salts, and drought. This also leads to the formation of phytoliths in all parts of the palm. In this study, phytoliths from several palm leaflets were compared. In order to determine the relative abundance of phytoliths, microscope observation was conducted on slides containing 250 phytoliths each. The samples were subjected to incineration at 550°C, ultrasonic treatment, 0.1 mol/L HCl treatment, and distilled water washing. Sago palm phytoliths were identified as spheroid echinate symmetric structures with a diameter of 5-10 µm (28%), 10-15 µm (49%), and 15-20 µm (20%). These phytoliths were relatively larger than those of other palm species such as *Phoenix roebelenii*, *Phoenix canariensis*, and *Pritchardia* spp. The phytolith asseblages of sago palm were also distinguished by their symmetrical spheroidal shape and sharp spines. *Corypha umbraculifera* and *Butia yatai* contained high percentages of spheroid echinate phytoliths (10 to 15%), and low percentages of conical phytoliths. However, conical phytoliths with and without echinate surface texture were observed in *Corypha umbraculifera*, *Butia yatai*, *Dypsis lutescens*, *Caryota maxima*, *Areca catechu*, *Cocos nucifera*, *Chamaedorea elegans* and *Hyphorbe verschafeltii*, for which there could be multiple explanations. We have proposed a schematic phylogenetic tree for Arecaceae based on the description of their phytoliths, using the results of this study.

Key words: Arecaceae, Conical, Echinate, Phylogenetic tree, Spheroid

Antioxidant Polyphenols in Sago Starch Affected by Wet and Dry Extraction Processing

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Abstract
The color of polyphenol in starches reduces the overall product value. However, polyphenols possess many functional properties, e.g. anti-inflammatory, antioxidant, antimicrobial, anticancer, and antidiabetic. We have attempted to analyze polyphenols in various samples of starch derived from the Sago palm (*Metroxylon sagu* Rottb.), Buli palm (*Corypha elata* Roxb.), Taro (*Colocasia esculenta*), Potato (*Solanum tuberosum*), Sweet Potato (*Ipomoea batatas*) and Wheat (*Triticumaestivum*); from Malaysia, Indonesia, the Philippines and Japan, produced between 2000 and 2022, and stored at room temperature. Polyphenols were extracted via ethanol, using the Folin-Ciocalteu method outlined by the Ministry of Education, Culture, Sports, Science and Technology (2015). The polyphenol content in sago starches ranged from 55.0 mgGAE/kg (Kuching, Malaysia, wet extraction processing) to 3395.8 mgGAE/kg (Cebu, Philippines, dry extraction processing). In Cebu, dry extraction processing (a continuous process of slicing, drying and pounding) was traditionally used to extract starch from the sago pith (Toyota and Okazaki, 2003). Wet extraction processing of the pith causes an obvious loss in polyphenol content. The dry extraction process of sago starch should receive more attention as a potential source of antioxidants for human nutrition.

Key words: Dry extraction processing**,** Polyphenol, Sago starch, Wet extraction processing

Sago Starch as an Innovative Fermentation Aid for Tempeh Fungi (*Rhizopus oligosporus*)

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Abstract

Tempeh is a food made from soybeans fermented by the tempeh fungus *Rhizopus oligosporus*. Although it is familiar in Japan nowadays, its culinary tradition originated in Indonesia. In Japan, we can obtain *R.oligosporus* from a small group of companies who typically grow it using starch (2% concentration as a fermentation aid). For this study, *R.oligosporus* was cultured on samples of sago starches (2% concentrations as a fermentation aid) from Jayapura, Indonesia (sample A), Sarawak, Malaysia (sample B) and Cebu, Philippines (sample C). The inoculum strains of *R.oligosporus* were incubated at 30 °C for periods of 24 and 48 hours. Samples A and B were extracted using a wet extraction process, and sample C, using a dry extraction process (Paluga and Ragradio, 2016). Samples A and B displayed lower polyphenol concentrations than sample C. Large colonies of *R.oligosporus* were grown on culture plates. The *R.oligosporus* colonies on plate containing samples A and B were notably different from the colonies on the plate containing sample C. The use of *R.oligosporus* grown using sample C (2% concentration as a fermentation aid) in tempeh production resulted in improved consistency and higher quality than did the use of *R.oligosporus* grown using samples A or B. Further study is needed to perfect a methodology for high-quality tempeh production using sago starch as a fermentation aid.

Key words: Assimilation, Fermentation aid, *Rhizopus oligosporus*, Sago starch, Tempeh

Sensory Evaluation of Cookies Made from Sago (*Metroxylon sagu*) and its Mixture with Taro (*Colocasia esculenta*) Starch

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Abstract

We performed a sensory evaluation of sago cookies made from sago (*Metroxylon sagu*) and taro (*Colocasia esculenta*) starch. Cookies were made from sago starch and taro starch with different composition: 0% (control), 5% and 10% of taro starch was used instead of sago starch, which were named cookie A, B, and C, respectively. Cookies of 100% sago starch with different diameters or thicknesses were prepared as D and E, respectively. Cookies characteristics were evaluated by appearance, sweetness, hardness, crispness and comprehensive evaluation by the panelists recruited from the 10 university students of 20s. The appearance, sweetness, hardness and crispness were scored by the 10-point hedonic scale. Comprehensive evaluation was scored by the 9-point evaluation after Kawasome et al. (1971): “the most favorite” was given 9 point and “not like eating” was given 1 point. The difference between cookies for each score was tested by Fisher’s least significant difference method using Excel Statistics 2012 for Windows (SSRI Co., Ltd., Tokyo). Factors affecting comprehensive evaluation were examined by stepwise multiple regression analysis using Excel Statistics 2012 for Windows. We used the forward selection method for variable selection and chose 2 as the threshold for the F-value.

The score of appearance, sweetness, and comprehensive evaluation of cookie D was the highest, 7.4, 7.8, and 6.0, respectively. Comprehensive evaluation of cookie D was significantly higher than other cookies. The score of hardness, crispness of cookie C was the highest, 6.6 and 4.8. Hardness and crispness of cookie D were significantly less than those of cookie C. Standardized partial regression coefficient of sweetness was the highest except cookie D, which score of sweetness varied from 7 to 10.

Although sugar content was same for all cookies, score of sweetness was different for each cookies and was the most effective for comprehensive evaluation of sensory evaluation.

Key words: Cookies, Sago and taro starch, Sensory evaluation