Impact of Ultrasonication Treatment on Resistant Starch (RS) Content and Characteristics of Sago Starch

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Abstract

Ultrasonication is a nonthermal technique widely used in food science and technology. Sago starch of three different varieties (*Iwamuluk, Iwayuluk,* and *Iwasnan*) were subjected to ultrasonication (US) of 42 kHz at 30^{o}C and 50^{o}C for 15 minutes and 45 minutes. The US untreated and treated samples were analyzed for resistant starch (RS) content, pasting and thermal properties. Starch granules were characterized by light microscopy and scanning electron microscopy. The results indicated that under US treatment, the RS content significantly increased from 1.08-1.56% (db) to 17.66–31.96% (db). *Iwayuluk* consistently produces high content of RS compared to the varieties of *Iwamuluk* and *Iwasnan*. Ultrasonic treatment induced cracks and pores in starch granules without any loose of maltese cross properties. The pasting properties of US treated were comparable with those of US untreated sago starch. This study provides insights into the future direction on the benefit of ultrasonication treatment for the modification of sago starch functional properties.

Key words: Resistant Starch, Sago, Ultrasonication

Maltodextrin from Sago Starch at Different Hydrolysis Times

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Abstract

One product that can be produced from sago starch is maltodextrin. Maltodextrin is widely used in the food and beverage industries causing the need for maltodextrin to increase every year, then it is necessary to have this study. The aim of this research was to determine the characteristics of maltodextrin from spineless sago starch type at different hydrolysis times. The study was designed using a completely randomized design. The main raw material in this study was spineless sago starch. The enzymes used were Liquozyme Supra 4.5X with different hydrolysis times, that was A = 15 minutes; B = 25 minutes; C = 35 minutes with the concentration of enzyme being 0,015 µl/g dry starch. Each treatment was repeated 2 times. The sago starch suspension of 20% was prepared in 200 ppm $CaCl_2$ solution and adjusted to pH 6. Hydrolysis was carried out at 80°C and stirred at 950 rpm. After that, the slurry was dried in a cabinet dryer at 50°C for 2 days (± 5% of water content). The size uniformity of dry maltodextrin was carried out using a 100 mesh sieve. The results showed that the brightness level of the maltodextrin color for the three treatments ranged from 79.86-80.66. Slight roughness on the starch granule's surface was found at all treatments, but X-ray diffraction patterns did not change from the native sago starch pattern. The viscosity ranged from 3826.0-5294.0, the breakdown ranged from 774.0-1839.0, set back ranged from 401.0-1844.0, the pasting temperature ranged from 76.15-76.50, and equivalent dextrose ranged from 2.14-3.13. The DE value in this study was very small, which due to not optimal work of the enzyme.

Key words: Hydrolysis time, Maltodextrin, Sago starch

Formulation of Sago Based Biscuit: Incorporation of Sea Cucumber (*Holothuria scabra*) Powder to Improve its Sensory and Nutritional Properties

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Abstract

A formulation of sago based biscuit was made by incorporating the powder of sea cucumber (*Holothuria scabra*) in its dough to improve its nutritional and functional characteristics. The fresh sea cucumber was firstly processed through smoking, drying, and grinding to make a powder. The dough of biscuits, then, was formulated by mixing that sea cucumber powder with other ingredients. The formulations of the biscuits dough applied were F0 (100% wheat) as a control, F1 (50% wheat, 40% sago, 10% sea cucumber), F2 (50% wheat, 35% sago, 15% sea cucumber), F3 (50% wheat, 30% sago, 20% sea cucumber), and F4 (50% wheat, 25% sago, 25% sea cucumber). The product obtained was then measured its sensory, nutritional , and morphological properties. The results showed that the formulation of F1 gave the best sensory characteristics. Meanwhile, protein, fat, minerals, and antioxidant activity were increased as the percentage of sea cucumber powder substitution was increased. The morphological appearance of the products indicated that sea cucumber powder was evenly mixed with other ingredients in the formulation. The inclusion of sea cucumber in the formulation of processed food products had improved the nutritional and functional values of the food, and it may improve its added value.

Key words: Antioxidant, Biscuits, Scanning electron micrograph, Sea cucumber, Sensory properties

Diversity of Medicinal Plants in the Sago area of Siberut National Park, West Sumatra

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Abstract

Medicinal plants can be found in various types of habitats including in sago stands in Siberut National Park. The purpose of this research is to identify and describe the diversity of plant species in sago stands and their use by the Mentawai indigenous people. Research activities were carried out from January to March 2022 in Siberut National Park using the methods of vegetation analysis, interviews, and field observations. The results showed that there were 193 plant species from 64 families found under sago stands. The composition of plant species under sago stands in Sakaladhat sub-village consists of 107 plant species from 51 families with an H' of 3.05. In the sago stands in Ukra sub-village, 140 species from 55 families were found with an H' of 3.14. The Community Similarity Index between sago stands in Sakaladhat sub-village and Ukra sub-village is 43.72%. As many as 60 species from 31 families have been used by the community as medicine for 13 groups of diseases. The most widely used plant species came from the Cyperaceae family (11.66%), herb habitus (63%), leaf parts (68.97%), internal use (50%), digestive tract disease group (26.67%), processed by grating then brewing (60.37%), as a single drug (84%), and used only when sick (97.30%). Knowledge about the use of medicinal plants is obtained by the community through dreams and passed down from generation to generation.

Key words: Diversity, Local Knowledge, Medicinal Plants, Sago Stands

Analysis of Sago *(Metroxylon sagu* Rottb.*)* Supply Chain in West Sulawesi, Indonesia

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Abstract
Sago palm is a potential starch producing plant and capable of providing economic benefits to the local community. However, its utilization is still very limited, hence an optimal supply chain management is expected to be able to control the availability of sago starch and other processed sago products, so that it is more effective and sustainable. This study aims to analyze three flows in the supply chain, namely information flow, product flow and financial flow. This research was conducted from June to December 2022 at a sago starch production center in Polewali Mandar Regency, namely Independent Agricultural and Rural Training Center (P4S) of Cahaya Duta Palili. The samples in this study were purposively selected, which were 30 sago farmers, 8 workers at P4S Cahaya Duta Palili, an owner of Sabar Jaya Rempah (SJR) Shop and 10 consumers. The analytical method used is mix method by using data analysis techniques, namely qualitative descriptive analysis and marketing margins. The results showed that P4S has the highest profit margin, with a cost of Rp 250,000, and P4S can make a profit of Rp 2,700,000 per production. The product and financial flows have been running well and effectively, but the flow of information to supply chain actors, between farmers and P4S has not running efficiently. This is due to a lack of communication and information between the two of them. Farmers do not know when P4S needs raw materials which can hinder the flow of product, financial and information in each supply chain.

Key words: Financial Flow, Information Flow, Product Flow, Sago Starch, Supply Chain Management

Small Scale Mechanical Processing of Sago in District Momi Waren, Manokwari Regency, West Papua Province

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Abstract

Small scale processing of sago both mechanically and semi-mechanically are now common practicing by sago farmer in West Papua and Papua Province. The objective of this research was to apply small scale mechanical sago processing equipment in order to transform the traditional processing method to mechanical one. In this research the sago processing machinery have been employed were cylinder type sago rasping machine and sago starch extraction machine, both were made in workshop of Agricultural Technology Faculty, University of Papua Manokwari. The performance of employed processing machinery in District Momi Waren were evaluated in terms of rasping capacity, extraction capacity, starch rendement, extraction capacity, fuel consumption and starch left in sago pith waste. Results showed that sago farmer in District of Momi Waran can operate the sago processing machineries easily without any difficulties. The performance of the machines were (a) rasping capacity 650 kg/hour, (b) extraction capacity 315 kg/hour, (c) starch rendement 20.17%, (d) starch losses in sago pith waste 2.5% and (e) fuel consumption for rasping and extraction machine were 1.4 litre/hour and 1.23 litre/hour respectively.

Key words: Extraction capacity, Mechanical processing, Rasping capacity, Sago processing, Small scale

Genetic Diversity of Sago (*Metroxylon* spp.) in Lingga District, Kepulauan Riau, Indonesia

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Abstract
Indonesia has not been able to meet the food needs of its people. This can be seen from the import activity of several food commodities such as wheat, sugar, and rice. Sago starch can be used as a substitute for wheat flour for making bread and biscuits and can be used as a substitute for cane sugar. Sago (*Metroxylon* spp.) is a potential commodity as an alternative food with high productivity, which is around 20-40 tons of dry starch/ha per year. Food security based on the strength of local resources will reduce dependence on imported commodities or products to create food self-sufficiency. The sago area in the world is 6,279,637 million hectares and Indonesia has 85% of the world's sago area or around 5,579,637 million hectares. This study aims to obtain information on the diversity of sago species through genetic analysis of various sago accessions in Lingga District. The genetic analysis method used is RAPD (Random Amplified Polymorphic DNA) analysis. Based on the results of the dendrogram analysis, sago samples can be grouped into three major groups at a Kf value of 54%. Group I consisted of 4 samples and 2 large groups at a Kf value of 45%. Group II consisted of 10 samples and 1 large group at a Kf value of 70%. Group III 10 samples have a Kf value above 70%. In these groups, there is visible genetic variation in sago plants in Lingga Regency which comes from differences in the growing environment, cross-pollination, and crosses between close relatives and different types of sago.

Key words: Genetic resemblance, RAPD, Riau

Genetic Relationship of Sago (*Metroxylon* spp.) in West Siberut and North Siberut, Mentawai Islands Regency, West Sumatra

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Abstract

Sago plants have long spread in Indonesia and are thought to originate from the Maluku and Papua regions. In several areas in Indonesia besides Maluku, Irian Jaya, and Aceh, sago is used as a staple food for the Mentawai Islands in West Sumatra. The diversity of sago plant species in Indonesia is still largely unknown. Differences in the diversity of sago plants based on morphological and genetic characteristics were observed directly through measurements (quantitative) and visual observations (qualitative). This study aims to determine the genetic relationship of various sago accessions found in West Siberut and North Siberut Districts, Mentawai Islands Regency, West Sumatra. Genetic characters were observed using the *Random Amplified Polymorphic* DNA (RAPD) method. There were six sago accessions observed in the two sub-districts of West Siberut and North Siberut, namely the *Saikoat, Limu, Betaet, Ukra, Sirilanggai*, and *Sibeotcun* accessions, all of which included non-thorny sago species. Based on genetic character analysis (RAPD), there is a fairly close diversity of the six sago accessions, with similarity coefficient values ranging from 61% to 77%. The *Ukra* accession has the most distant similarity coefficient with the other accessions, namely 61%. Based on the analysis of genetic characters from a total of 24 samples taken from the Mentawai Islands Regency, 11 samples that had a similarity coefficient value above 77% were samples that were still in the same area, but 13 samples had a similarity coefficient value of around 63%-77% despite being in a different area. Differences in the similarity coefficients can occur due to different accessions or crossings or due to differences in their living environment.

Key words: Character, Diversity, Genetics, RAPD, Sago accession

Genetic Relationship of Sago (*Metroxylon* spp.) Based on RAPD Analysis: A Case of Mamuju District, West Sulawesi Province, Indonesia

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Abstract
Sago (*Metroxylon* spp.) is an original plant from Indonesia, and about 85% of the world's sago is grown in Indonesia. Sago has a high potential, especially as a salvation plant. The research aims to identify sago accession based on genetic characteristics in Mamuju District and the sago relationship in West Sulawesi Province using RAPD method. Three accessions of sago were observed based on local names in Mamuju District, i.e. 2 types of non spiny, *Kasimpo* and *Kapas*, and 1 type spiny *Ruwi*. The genetic relationship of these accessions is known from the number of polymorphic bands in DNA. The bands are converted into binary data by comparing the presence or absence of bands belonging to selected samples from sago accessions. West Sulawesi Province consists of 6 districts, and sago sampling was collected in each of these 6 districts. Specifically, we collected 10 sago samples from Mamuju District, as well as 8 samples from Majene District and Polewali Mandar District. Moreover, 3 sago samples were taken from Donggala District, Central Sulawesi Province. The total sago samples used were 47. The genetic distance based on RAPD analysis of sago accessions in West Sulawesi Province was not too far, Kf value <80%. Uniqueness of gene expression was found in these accessions, and it is possible that there is a distant genetic relationship on spiny sago accessions, as well as non spiny sago accessions. However, there is a close genetic relationship between spiny sago and non spiny sago. Thus, the local accessions based on morphological characteristics of sago should be explored further using RAPD analysis to determine genetic closeness.

Key words: Genetic closeness, RAPD method, Sago accession

Sago (*Metroxylon sagu* Rottb.) Agroforestry Based on Morphological Characters, Physical Environment and Productivity in Siberut National Park, Indonesia

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Abstract

Sago is the highest starch-producing plant with a carbohydrate content of 94 g per 100 g of starch. The potential of sago can overcome the problem of national food shortages and reduce people's dependence on rice. Sago areas in Indonesia are spread across 5 major islands such as Papua, Sulawesi, Kalimantan, Java and Sumatra. Siberut National Park, located on the island of Siberut, West Sumatra, has one of the sago swamp forest ecosystems in it. Agroforestry is one way to maintain food sovereignty and forest management by taking into account forestry and agricultural aspects. The purposes of the study was to analyze morphological characters, the physical environment, and the productivity of sago to obtain a sustainable sago agroforestry design in the Siberut National Park area. The methods used were observation and vegetation analysis. The physical environment of the sago habitat was divided into two categories of land, moist land, and wetlands. Morphological characteristics of sago (size, shape and total) were superior in North Siberut District. However, there are several morphologies that are not affected by the physical environment of the canopy, the surface of the bark and the shape of the tips of the leaf tillers. Sago is ready to harvested, generally has a stem height of 8 - 10 m. Sago productivity in North Siberut and West Siberut sub-districts produced 16,88 tons/ha and 14,69 tons/ha. The availability of sago productivity on Siberut Island from conditions in natural forest is 20,448.16 tons, while to meet the food needs of all people living on Siberut Island it is 7,400.56 tons/year for 40,551 people. So the remaining availability of sago productivity is 13,047.61 tons/year. Comparison of the results of the remaining availability of sago productivity in natural forests with agroforestry systems is 1: 156. This comparison provides an opportunity if an agroforestry system can be applied from sago conditions in natural forests and is able to improve people's welfare from potential natural resources other than sago. Recommended sago-based agroforestry design uses a spacing of 10 x 10 m which produces an ideal sago stand of around 100 trees/ha/year. Supporting plants for agroforestry include food, medicine, manau rattan as well as beekeeping, and fish. Sago agroforestry activities consist of preparing seeds, planting, weeding for pest and disease control, and harvesting. Activities for medicinal plants and other food include planting, stitching, weeding, fertilizing, thinning, pruning and harvesting. The community will get other income from the types of plants and livestock developed on agroforestry land.

Key words: Agroforestry, Morphological characters, Physical environment, Productivity

Soil Carbon Stock Comparison of Sago Palm Plantation and Monoculture Crop Around Converted Wetland in Southern Thailand

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Abstract

Converting wetlands to monoculture crops affects the amount of carbon sequestration in soil. This study aimed to quantify and compare the soil carbon stock (SOC) between sago palm and other monoculture crops, namely, oil palm, rubber, and rice, which were converted from natural wetlands around the Khuan Khreng peat swamp. Forty-two soil samples were collected at a 30-cm layer from the agricultural areas using random-sampling non-destructive techniques. Bulk density and organic carbon were determined by the core method and Walkley and Black. Soil carbon stocks were calculated using measured carbon content and the corresponding soil bulk densities. The results showed that the average soil carbon stock of sago palm, oil palm, rubber, and rice were 3.44, 0.76, 0.64, and 1.23 t C ha^{-1}, respectively. The sago palm had the highest average of soil carbon stock compared to the monoculture crop areas. This study provides relevant information on the carbon storage capabilities of the four land-use types in the converted wetland. Effective planning and management of agricultural land must take into account the soil carbon storage capacity to develop a sustainable solution for preserving carbon pools in wetlands to mitigate the effects of climate change.

Key words: Ecosystem Services, Oil Palm, Paddy Filed, Peatland, Rubber

Knowledge Co-Production Practices in Nurturing Local Innovators for Promoting Conservation and Use of Sago Palm (*Metroxylon Sagu*) and its Product

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Abstract

The global food supply is in a "tight market". The chain of disruptions caused by the COVID-19 pandemic, extreme weather events, and the Russian invasion of Ukraine in 2022 has led to severe shortages in the agri-food chain, resulting in higher consumer prices, especially in the EU. As the war continues, plantings in Ukraine are down 35 % to 40 %, meaning that one of the world's major exporters will produce far less again this year. Like other countries in the world, Indonesia was also affected and suddenly the interest in the Sago palm as starch producing plant has increased considerably. Attempts are being made to harvest the crop from natural stands and promotion of utilization has been started.

Sago palm growing areas already has started to be visited by local scientists, as well as by scientists from Japan, the United Kingdom, and the Netherlands since the 1970s. An abundance of knowledge has been accumulated on agronomy, taxonomy, distribution and diversity, ecology and natural condition, breeding, and at the other end recently various sago based food and product has been explored. However, communities in sago-growing areas are still left behind. They are losing their interest and pride in the importance of this local food due to the economic value of the plant and competition for land and utilization. It is important and absolutely necessary to embrace the local community and make them the main actor in sago development.

This research is implemented using transdisciplinary approach as a series of knowledge co-production to nurturing local community innovators. Knowledge co-production will include interdisciplinary researchers and non-researchers, local community and broad stakeholders to share knowledge and discuss the plan and action. This research is started with discussion with staff of agriculture services office and farmers, and we agreed to find out the supply chain of sago starch, followed by interviews to the sago processing group, continue with FGD to analysis the result of interview, then continued with research on value chain. The local community also agreed to learn how to produce sago seedlings. Training is conducted both for seedling and marketing strategy. Each step designed carefully in order to find practical solution by sharing knowledge but also to get scientific data.

This paper elaborates on the steps and strategy of co-production of research done since 2021 and concluded the effectivity in bringing a bunch of solutions and necessary action for multilevel stakeholders for promoting both conservation and utilization of sago palm and its product.

Key words: Co-production, Indonesia, Local innovator, Sago palm, Transdisciplinary research

Development of Sustainable Sago Plantation on Peatland Towards Commercial Level

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Abstract

Indonesia has the largest peatlands, up to 18.3 million hectares spread out in Sumatra, Kalimantan, and Papua, while only around 6.06 million hectares had the potential to be used as agricultural land. In Presidential Decree No. 32 of 1990 and Law no. 21 of 1992, peat areas thickness >3 m which located in the upper coarse of rivers or swamps were designated as conservation areas which can be useful as water preservation, flood preventive, and ecosystem protection, whereas in Presidential Instruction No. 10 of 2011, updated in August 2019, which states the exception of business permits in the 'Moratorium' of peat areas with a food security program including the management of cultivation of plants that produce rice, sugarcane, corn, sago and soybeans. The sago palm *(Metroxylon sagu* Rottb.) is an Indonesia's native plant with potential source of starch production which can thrive in marginal lands such as swamps and peat. Sago plants in Indonesia mostly grow as natural stands and some are cultivated traditionally in secondary forest areas, peatlands, and swamps. Cultivation of sago plants has not been optimally carried out because of the less information regarding effective cultivation methods. One of the examples is that, sago plantation which was the commercial cultivation with a planting distance system of 8 m x 8 m in Meranti Islands Regency, produced low percentage of the final dry factory starch product around 13-14%, because of the minimum maintenance and the various condition of plant access within a block or location. It was not significantly different from dry starch produced by traditional cultivation system. Starch productivity can be increased by changing the pattern of traditional cultivation practices into intensive cultivation practices. This cultivation system is supported by Good Agronomy Practice which should be applied to sago plantations, including effective fertilization using both nano-fertilization technology in the seedling phase and the use of microbes in sago clumps to increase growth rate and starch content, good mechanisms for high percentage of successful seedling, focusing on specific accessions with high starch potential, arrangement of sucker in clumps to ensure that all stems can be harvested in regular period and management transportation for immediate harvest process. The existence of Good Agronomy Practice could increase potential productivity by up to 5-6%. However, this activity should be carried out routinely with periodic monitoring and evaluation, as well as a system improvement mechanism to get the right sago cultivation technique.

Key words: Good Agronomy Practice, Marginal, Productivity, Starch.

Ethnobotany of Sago in the Malay Community in Lingga Regency, Riau Islands, Indonesia

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Abstract

Sago (*Metroxylon* spp.) is a palm species found in Southeast Asia, particularly in Indonesia, Papua New Guinea, Malaysia, and the Philippines. Sago can grow in natural conditions or can be cultivated in underutilized wetlands and peat swamps. Lingga Regency, with a sago plantation area of 3,449 ha and a total sago plantation production of 2,618 tons/year, is one of the areas with sago potential. The purpose of this research is to determine how the Malay community in Lingga Regency, Riau Islands, utilize sago. The study was carried out in six sago-producing villages in the Lingga Regency: Panggak Laut, Nerekeh, Musai, Pekaka, Keton, and Teluk. Data was gathered through interviews with sago farmers and field observations. According to the study's findings, the Lingga Malay community has been using sago for a variety of purposes since the time of the Linga Sultanate. The main sago product used by the Lingga Malay community is pith, which is used to make starch. The Lingga Malay community produces three types of sago starch: dirty sago (quality II), clean sago (quality I), and dry sago. The Lingga Malay community's sago products are typically marketed in Lingga as well as other areas such as Cirebon, Jambi, Tanjungpinang, and Malaysia. Aside from the pith, the community also uses the leaves as roofing, the bark (*guyung*) as garden fences and firewood, sago fronds as the wall of the cage, the sago shoots (*umbut*) as vegetables, the sago pulp (*serampin*) as animal feed and organic fertilizer, and the sago waste (*bidat*) as animal feed. Currently, the community depends on sago that grows naturally on sago forest lands plantedduring Sultan Lingga's reign. As a result, efforts must be made to rejuvenate natural sago forests and convert them into sago plantation forests.

Key words: Local knowledge, Malay community, Sago palm, Traditional Usage

Ethnobotany of Sago (*Metroxylon sagu* Rottb.) in Mentawai Community, Siberut National Park, Mentgawai Islands District, Indonesia

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Abstract
The study of ethnobotany is a science that studies traditional community knowledge of the diversity of plants around it and the utilization of these plants. The Mentawai community have used sago plants as a staple food since their ancestors, both for staple food, roofing, and traditional marriages. This study aimed to describe the ethnobotany of sago (*Metroxylon sagu* Rottb.) and to compare the use of several other communities in Indonesia. When the data was collected, the method of snowball sampling technique was adopted. The people in Mentawai community utilize some parts of sago, and they use 4 out of 9 parts, which are leaves, bark, stem(pith) and roots. These communities have not utilized sago optimally, compared to other Indonesian communities.

Key words: Ethnobotany, Mentawai, *Metroxylon sagu*, Snowball sampling

Agronomic Prospects for New Sago Palm Cultivation by farmers: Time to Harvest and Associated Cultivation Management

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Abstract

In supporting long-term research survey on the growth of sago palm, a 2 ha sago planting experimental plot was established in Pengkajoang Village, one of the traditional sago-producing community centers in South Sulawesi. A total of 157 selected sago suckers were transplanted from 10 to 22 September 2012 with a spacing of 10 m. After that, data such as the number of leaves, the number of leaflet on the lowest leaf, length of leaf, length of rachis, length of longest leaflets, the width of widest leaflets, and the number of leaf scars on the trunk was counted.

This research found that stable leaf growth occurred when about 8 leaves emerged after transplanting, and more stable growth was observed after the trunk formation stage began. In addition, removing the lower leaf sheath increased the diameter of the trunk as a treatment before the trunk emerged. At this stage, the rachis length was about 3 m and the roots developed by penetrating the lowermost leaf sheath. The size of the leaves gradually increased and the rachis length grew from 3 m to around 7 m at the beginning of the trunk formation stage. The growth of the sago palm in this experimental plot was faster than farmer's expectation. After about 10 years from transplanting, individual sago palms began to show the characteristics of being ready to harvest.

Since a trunk length growth was 1 m per year, the future annual yield can be predicted by examining the frequency distribution for every 1 m trunk length. We plan to conduct a frequency distribution survey for each trunk length shortly, and will make an empirical prediction of yield. The summarized results of cultivation management and land productivity prediction through the identification of the growth characteristics of sago palm will discussed at SAGO 2023.

Key words: Cultivation management, Growth characteristics, Trunk formation, Prediction of yield.

Improve The Process Flow By Utilizing Wet Sago Biomass To Increase The Productivity And Economics Of Sago Processing In Meranti, Riau

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Abstract

The Sago plant (*Metoxylon* sp.) for the community in the Regency of the Meranti Islands has an important role in the life and economy of its people. The prospect of developing the sago business in Meranti is still promising because the land used has only reached 43 % of the available land, and management can still be optimized. Sago processing that is currently operated is still running conventionally. That is, it only produces sago starch products. Its by-products in the form of waste from the pulp (*repu*) and skin (*uyung*) have not been optimally utilized. This study aims to optimize the processing of by-products into high-value products through improving sago management towards the concept of a zero waste industry in the Meranti Islands Regency, Riau Province.

The results of the research that has been carried out show that it is necessary to add a process flow to the processing so that the resulting sago pulp is not wet. The resulting dried sago pulp will expand its utilization. From supporting studies, the results of studies that have been carried out show that fermentation using Trichoderma can increase protein by 18 to 22 %. So that it can be used as a bioconversion product as an ingredient in the formulation of ruminant animal feed (cattle) and poultry (chicken) can reach 40% and 25%, respectively. With the potential of sago pulp, as much as 2,640,000 tons/year can meet the needs of 2,411 cows per year. Dried sago pulp to gain popularity as a raw ingredient for wood pellet combinations at a cost of Rp. 1200/kg. Sales of sago starch and dry repu or its derivatives provide the sago refinery with two sources of income. has the potential for a revenue boost of 30–70%. And at the same time can overcome pulp heaps that interfere with the environment.

Key words: By-Products, Economics, Feed, Integrated Sago, Meranti

The Potential of Sago Frond as Large-Scale Animal Feed

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Abstract

This is a review paper based on our experience in production of sago silage from mashed and fermented sago fronds with feeding trials tested on individually caged thirty (30) Malin sheep for a duration of three (3) months. The ever-increasing price of the global animal feedstock is an annual constraint to the livestock production industry, particularly to the smallholders. Hence, production of animal feed from locally available resources is the definitive solution to the incessant dependency on imported food and feed, and in our case it's the sago frond. The frond is continuously pruned over the long lifecycle (between 10 to 12 years) of the palm producing a massive stockpile of unutilized agro-wastes and serves as our raw material to produce animal feed for ruminants. The frond is of two components, the long slender leaves and the stout rachis in the middle. Leaves are removed and the rachis is pressed to extract the sap for use as the medium to culture our inoculant (named SaFLact) for the making of sago silage. The leaves and residual fibers from the rachis are pulverized and sprayed with SaFLact prior to packing into the silo bag. After 3 weeks of ensiling, sago frond silage (SFSil) served to the sheep exhibited competitive results against commercial feed on the growth performance (ADG) at 74.12 g/day and 97.67 g/day, respectively. On the other hand, the SFSil feeding regime shows better feed efficiency than commercial feed at 125.35 g/day and 81.48 g/day of RFI and 6.46 g/g and 12.93 g/g of FCR, respectively. Consequently, farmers can rear more livestock with SFSil compared to commercial fodder at the same amount of feed. Analyses of meat quality confirmed that meat from sheep fed with SFSil contain 55% less fat and 16% more protein compared to sheep fed with commercial fodder. Fat and protein content are 8.43% and 77.3% and 18.82% and 65%, for meat from sheep fed with SFSil and commercial fodder, respectively. Production of sago frond silage from growing sago palm not only provides an elegant solution to the shortage of feed supply but also offers novel opportunities to sago farmers to generate extra income while waiting for the sago palm to be harvestable.

Key words: Ensiling, Frond, SaFLact, Sago silage

Utilization of Palm Oil By-products for Sustainable Crop Production in Marginal Land

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Abstract

Indonesian Central Bureau of Statistics (BPS, 2021) reported that Indonesian crude palm oil (CPO) production in 2021 was 49,710,000 t year^{-1} which produced from 187,586,340 t bunch of fresh fruit. This CPO processing produced 33% organic by-products, equivalent to 45,499,000 tons. The current study purpose to evaluate the chemical properties and the potential uses of palm oil by-product as organic fertilizer for sustainable crop production in marginal land of Southeast Sulawesi. We collected two types of organic by-product from two industries of CPO: dust of empty bunch fruit (*Abu Tankos* or AT) and sludges (S), mixed with ratio of AT/S (w/w): 11/89 as formula F-11, 15/85 as formula F-15 and 22/78 as formula F-22. AT and S were mixed and fermented for 10 days and then were used for analysis of pH, organic C, Total N, C/N ratio, P2O5 and K2O content. The F-11, F-15 and F-22 were applied as organic fertilizer for rice cultivation in rainfed soil and rising of sago palm seedling in Biological Garden of Halu Oleo University. The results indicated that the increase in AT concentration was prominent in inducement of the rice production and growth of sago palm seedling.

Key words: Marginal land, Organic fertilizer, Palm oil by-products, Rice, Sago

Utilization of Sago Palm Rachis to Woven Local Fishing Gear at Nakhon Si Thammarat Province, Thailand

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Abstract

This research studied the weaving of traditional fishing gear with sago rachis material of villagers at Inkeree sub-district, PhromKhiri District, Nakhon Si Thammarat province, Thailand. Sago rachises are utilized with remaining sago leaves by suturing the leaves to thatched roofs. Also, they are used to prepare the surface of the sago rachis for weaving fishing tools, such as eel baskets and large upright basket traps. When fishing gear is made, first the skin of sago rachis are peeled along the length and sharpened to be thin, and next they are trimmed so that they have different sizes of widths such as 1.54±0.11, 0.62± 0.08 and 0.34± 0.05cm. The baskets for eels are vase-shaped and 45 cm high and 25 cm in diameter at the widest part. The bottom of the baskets is funneled, and fish inlet is 10 cm deep and 5 cm wide and square-shaped. Coconut shells are used as a lid for the top eel baskets to prevent fish from being released while fishing. They place a specific habitat for eels and add bait to inside of the eel baskets. In the case of large upright basket traps, they are large vase-shaped fishing gear, which are more than 1 meter height with 30 cm in diameter and their bottoms are opened to be an entrance with rectangular 15 cm and 7.5 cm width. This large upright basket traps are used to catch fish by using fermented fish fillets with bran and broken rice balls to be put into the trap. However, popular local fishing gears are found to include gill net, cast net, bamboo fish trap, man hook, lying trap and seine net. Most common fishes harvested include many kinds of fish; swamp eel, striped snakehead, catfish, silver sharkminnow, climbing perch, snake skin gourami, bronze featherback, three spot gourami, red-cheek barb and san goby. The communities' value and utilization of fishery in sago palm swamp can be assessed through socio-economic indicators from fish use, such as fishing and the direct use of sago palm. The quality of water in the sago palm swamp which is suitable for aquatic life, consist of as follows; water temperature, pH, dissolved oxygen, conductivity, alkalinity, hardness, ammonia, nitrite, nitrate, and total phosphate. The average of these criteria were as follows; 28.10 ± 0.77 ^{o}C, 6.44 ± 0.57, 3.51 ± 0.63 mg/l, 180.23 ± 25.64 µs/cm, 61.14 ± 33.63 mg/l, 90.68 ± 11.38. mg/l, 0.12 ± 0.11mg/l, 0.06 ± 0.01mg/l, 0.10 ± 0.03 mg/l and 0.05 ± 0.05 mg/l, respectively.

Key words: Fishing gear, Sago palm swamp, Sago rachis

The effect of palm oil organo-waste and NPK fertilizers on growth of Manno sago seed

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Abstract

The purpose of this experiment was to examinate two formulas of palm oil organo-waste on growth of Manno sago seed by comparing with $NPK_{15-15-15}$ chemical fertilizer. Two formulas were F-11 and F-22, in which F-11 indicates ratio of sludge (S) and ash of empty fruit bunches (AEFB), (w/w) = 89:11 and F-22: ratio of S and AEFB (w/w) = 78:22. Both F-11 and F-22 was applied at rates of 7.0 and 14 g pot^{-1}, respectively, in comparison with $NPK_{15-15-15}$ at 1.0 and 1.5 g pot^{-1}. The fertilizers were mixed with 8.0 kg of air dry soil pot^{-1} before transplanting. Manno seeds of F-2 generation were grown in a sago garden in Andobeu Jaya Camp for 7 months after germination. Each treatment was conducted with 3 replications. The results indicated that both formula of palm oil organo-waste significantly increased P2O5 content in the soil, and promoted SPAD values, leaf frond number, leaflet and biomass dry matter production

Key words: Manno sago, NPK, Palm oil organo-waste