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Physicochemical Characteristic of Sago Hampas and Sago Wastewater in Luwu Regency

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Abstract. A study was carried out to determine the physicochemical characteristics of sago hampas and sago wastewater from sago processing mill in Luwu Regency. The sago hampas was used is the residue of sago starch filtration of unrefined raw fiber. The sago wastewater was taken from processing mill are discharged into river. The points of sago wastewater sampling were undertaken in three different points, namely first wastewater (A1), the last wastewater (A2), and water that has been discharged into the river (A3). The sago hampas and sago wastewater processing mill was obtained by Spectrofotometric, Atomic Adsorption Spectroscopy, and analytical methods. The sago hampas content was found at C-Organic 33.01%; N-total 1.66%; C/N ratio 20; P_2O_5 0.04%, and minerals which are Calsium 27716 ppm, Magnesium 4247 ppm, and Sulfur 743 ppm. COD concentration sago from wastewater was found at A3 point which is 177.3985 mg/l; N-total 0.1%; Phospor 0.01 ppm; Kalium 10.46 ppm; Magnesium 5.84 ppm; and Calsium 0.62 ppm. The high content of organic materials and minerals in sago hampas and sago wastewater needs to be processed before discharging it into the river. The results of this study indicate that sago waste can be used as a feedstock biogas production.

Keywords: **sago hampas; sago wastewater; sago processing mill; physicochemical characteristics**

1 Introduction

Indonesia poses approximately 1.2 million ha of sago plantation producing around 8.4-13.6 million tons of sago annually. Of this number, Papua owns about 90% of the sago area. In Indonesia, the majority of sago plants are found in Papua, West Papua, Maluku, North Sulawesi, Central Sulawesi, Southeast Sulawesi, South Sulawesi, South Kalimantan, West Kalimantan, Jambi, West Sumatra, and Riau [1]. In South Sulawesi, especially in Tana Luwu (Luwu District, Palopo City, Luwu Utara Regency, and East Luwu Regency), sago becomes the main source of food and income for the local community.

Sago becomes the main food for the local community in some areas in Indonesia as it contains high nutrient and calorie sources thus it may replace the use of rice. Each sago stalk produces about 200 kg of sago flour per year. Sago is one of the best carbohydrate-producing plants which contain 84.7 gram carbohydrate in every 100 gram of sago starch. The comparison of calories counted 100 gram for some common starch sources such as corns, cassavas, sweet potatoes and sago are 361, 195, 143, and 353 respectively [2].

Up to now, the processing of sago remains limited to produce sago flour for basic food needs, such as kapurung, papeda, or sinonggi. Furthermore, sago flour processing is also limited for making traditional snacks (bagea, ongol-ongol, cendol), sago pearl, roasted sago (dange, sago rangi), and dried sago starch or dried sago flour [3]. Despite the utilization of sago as main food, as alternative energy source and as the source of liquid sugar for industrial purposes, other potentials use of sago are including as raw materials for organic pesticides, medicines, and plywood [4].

Sago flour can be produced from the extraction of sago stalks. Currently, the process of sago starch extraction is carried out by either traditional or modern ways (manufacturing) and is executed by local groups and small-scale plants manufactures. Technically, local groups are carried out by individual farmers where sago trees are harvested and processed simultaneously in one place or land to help out the lifting of extremely heavy sago stalks. Small-scale sago manufacturing is performed by a group of people by collecting sliced-sago stalks. This group collects and purchases sago stems

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from landless farmers who directly utilize their sago trees [5].

The cycle of sago processing produces solid and waste water including bark of sago, fibrous sago residue (hampas), and waste water. It is about 26% of sago bark and 14% of sago hampas counted of the total weight of the sago block [6]. In fact, sago waste remains having about 65.7% of dissolved starch while water waste still contains organic materials such as starch and cellulose [7]. In addition to dissolved organic materials, this waste water also contains inorganic compounds such as sand and mud that are difficult to decompose by microorganisms.

The waste generated in sago starch extraction still contains high organic materials, therefore it is necessary to do the processing prior discharging it. Several existing research show the potential use of sago hampas and waste water as adsorbent [6, 8, 9, 10, 11]; as foodstuff and animal food [5], bioethanol [12], sago waste water as an alternative energy source [13, 14, 15]. Unfortunately, there is lack of research data regarding the conversion of sago hampas into biogas. This study aimed to investigate the viability of biogas conversion using Sago waste by initially detecting the physicochemical characteristic of sago hampas and wastewater.

2 Material and methods

2.1 Material

Research samples were taken at the location of the sago processing plant located in Telluwanua District, Luwu Regency, South Sulawesi. Site selection is based on the intensity of the small-scale manufactures in producing sago and waste water disposal location directly to the river. The sample used is the rough fiber-shaped sago resulted from sago starch filtration whereas sago waste water is water discharged after sago starch washing process. Sago waste water was collected at three different points, namely first-washing waste water (A1), second-washing waste water (A2), and waste water discharged into main water (A3). Samples of sago hampas were collected and stored in a sealed plastic container. Each waste-water sample was collected in a clean and dark bottle container. Temperature and pH were measured directly in the field.

2.2 Methods

The content of minerals namely Potassium, Magnesium, Calcium in sago waste and wastewater were measured using Atomic Adsorption Spectroscopy, while Sulfur and P_2O_5 sago hampas and Phosphor from waste minerals in waste water were measured by Spectrophotometry. The content of N-total, C-total, C/N ratio and COD in wastewater were measured using Analytical Method. Data obtained in this research was analyzed descriptively in tables.

3 Results and Discussion

3.1 Physicochemical characteristics of sago wastewater

Temperature - Methane gas producing-bacteria requires a certain temperature to work properly. High temperature can produce good biogas however the temperature should not exceed the room temperature for bacteria to work optimally. Sago wastewater temperature ranges from 28.5-29^{0}C, this strongly supports the optimum temperature for biogas production, which is 28-30^{0}C [16].

Degree of acidity (pH) – The acidity is a crucial factor in anaerobic processes in biogas production. The optimum acidity level for bacterial work ranges at pH between 6.8-7.8 [17]. The level of sago wastewater equilibrium status for all three points is 6 approaching neutral pH. This is likely due to the limitation amount of organic materials in the first washing process discharging into the river.

Table 1. Physicochemical characteristics of sago wastewater

Parameter	Sample*		
	A1	A2	A3
Temperature (^{0}C)	28.5	28.7	29
pH	6	6	6
COD (mg/l)	98.92	109.36	177.40
Total Nitrogen (%)	0.01	0.01	0.01
Phosfor (ppm)	0.12	0.02	0.01
Kalium (ppm)	50.71	32.33	10.46
Magnesium (ppm)	7.94	7.91	5.84
Calsium (ppm)	2.62	1.15	0.62

*Average of triplicate

The content of COD - COD content indicates that sago wastewater still contains high organic materials. The content of COD in sago wastewater has not exceeed the quality standard based on Kep.MENLH No. 5/2014 Annex V concerning the Quality Standards of Waste Water for Tapioca Business and/or Industry Activities, ie 300 mg/l. The content of COD in sago wastewater increases at the point of A3. Therefore, sago wastewater needs to be managed before being discharged into the environment. Sago wastewater treatment with anaerobic fermentation can decrease the COD content of sago wastewater because bacteria will utilize the organic material as nutrients and convert it to methane gas. The lower the COD sample value, the higher the methane gas produced [18].

Mineral content - The presence of minerals is required to ensure the nutritional needs for bacterial growth. High mineral content in the material can cause toxins and affect bacterial growth in the gas production process. The results shows that the mineral content in the sago waste water is under the concentration of inhibitor agents, namely: Nitrogen 0.01 mg/l; Calcium 2500 - 5000 ppm; Magnesium 1000 - 1500 ppm; and Potassium 2500-4500 ppm [19], therefore the existence of these minerals functions as nutrients in methane gas production

3.2 Physicochemical characteristics of sago hampas

Nitrogen and Carbon Content - Biogas production is determined by the presence of organic contents in the material. Nitrogen content in sago hampas plays a role in the formation of amino acids. High level of Nitrogen will diminish Carbon early and stop the fermentation process, increases the amount of ammonia formation and inhibits the action of anaerobic bacteria (inhibitors). High level of carbon can cause early Nitrogen depletion that leads to slow fermentation process and low gas production.

C/N Ratio - Biogas production is determined by the sample organic content based on the ratio Carbon and Nitrogen content. The C/N ratio obtained from the low sago hampas that affects the action of anaerobic bacteria in fermentation process. The optimal C/N ratio for the growth of anaerobic bacteria in the fermentation process is 25/1 [20, 21]. To produce an optimal C/N ratio, sago hampas can be mixed with other organic materials that have an high C/N ratio.

Table 2. Physicochemical characteristics of sago hampas

Parameter	Value
Total Nitrogen (%)	1.66
P_2O_5 (%)	0.04
C-Organic (%)	33.01
C/N Ratio	20
Calsium (ppm)	27716
Magnesium (ppm)	4247
Sulfur (ppm)	743

The content of minerals - Minerals contained in organic materials can affect the work of anaerobic bacteria in the anaerobic process. Small concentration of Calcium, Magnesium, and Sulfur minerals can stimulate bacterial growth while high concentrations can have toxic effect and inhibit bacterial growth. The average mineral concentrations that can inhibit bacterial growth are Calcium 2500 - 5000 ppm; Magnesium 1000 - 1500 ppm; and Sulfur 5000 ppm [19]. Mineral content in sago hampas exceeds the toxic levels of mineral inhibitors. One potential factor that can lead to high concentration of minerals in the sago hampas is the process of washing sago pith using groundwater containing minerals as well as repeated filtration. This process can dissolve the minerals in the sago pith and diminish along with the waste.

4 Conclusion

Sago wastewater and sago hampas was produced from sago processing can be used as a feedstock for biogas production. The results of physicochemical characteristic may indicate that the sago hampas and sago wastewater still require pretreatment to find optimally conditions for anaerobic bacteria in biogas production. The results of this study are used to reduce sago hampas and sago wastewater from the sago processing using environmentally methods, in Luwu Regency.

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