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WATER QUALITY IN TEST PONDS: APPLICATION OF SAGO PULP-BASED CATFISH FEED IN UDAPI HILIR VILLAGE, MANOKWARI, WEST PAPUA

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ABSTRACT

Research on water quality in test ponds based on the influence of the application of sago-based catfish food has been carried out in Udapi Hilir Village, Manokwari Regency. The effect of sago pulp composition was carried out on variations of rice bran: fish meal: sago pulp was 1:1:0.5, 1:1:1, 1:1:1,5, and rice bran: the fish meal was 1:1. This research explains the water quality of test ponds using physical and chemical parameter monitoring methods. The results of this study contain several chemical and physical parameters that exceed the quality standard threshold. The results of the proximate analysis showed that adding sago pulp provided a chemical value of the feed that was still following the recommended standards. The results of water quality tests carried out for 4 weeks showed an increase in TDS levels, without draining the test pool during the research. The average Nitrate (NO_3^-) has increased but is still below the quality standard of 10 mg/L. Nitrate (NO_3^-) concentrations are rising in all ponds for all treatments. Nitrate levels impact fish growth because they can lower water oxygen levels. Overall, the application of sago pulp as a raw material for catfish feed results in pond water quality that is still within the pond water quality standards so it has the potential as an alternative feed raw material.

Keywords: Sago Waste, Catfish, The Pond Water Quality.

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INTRODUCTION

Sago pulp as a by-product of sago processing activities in the Manokwari area of West Papua Province needs to be continuously explored to provide added value to the waste while at the same time increasing the welfare of catfish farmers. According to the results of a preliminary analysis of nutritional content by the Laboratory of Feed Science and Technology, Bogor Agricultural University in 2013, sago pulp has a relatively high nutrient content in the form of carbohydrates, so it has the potential to be used as a source of animal feed.[1] After most of the starch has been removed from the rasped pith of the sago palm, a cheap, plentiful fibrous residue known as "hampers" is still present.[2] Composition of sago is as follows where starch is 65.7%, crude fiber 14.8%, and crude protein 1%.[3] Some of the requirements for good materials to be given are that they meet high nutritional content (protein, fat, carbohydrates, vitamins, and minerals), are non-toxic, easy to obtain, easy to process, and not as a staple food for humans.[4] Sago pulp, a byproduct of processing sago, is a staple diet for locals and should be strongly considered for use as an alternative raw material in fish feed production to maximize local potential. The ratio of sago pulp to flour, produced from sago processing waste, is high and roughly 6:1. Additionally, according to the suggestions for processing sago pith, 18.5% starch and 81.5% pulp will be produced.[5] The sago potential in Manokwari Regency, particularly in the Waren Momi District, is spread out among each village and spans 11.94% to 25.37%. This has an effect on the household income of sago farmers as a whole, which is 74.58% when sago starch is used.[6] Sago hampas is a possible substrate for microbial conversion via solid substrate fermentation into value-added products like enzymes, in addition to its reuse as an organic fertilizer and supplement for animal feed.[2] In this study sago hampas is referred to as sago dregs or sago pulp. Fungi that can produce cellulose enzymes include the genus Trichoderma, Aspergillus, and Penicillium. This genus can decompose cellulose by producing cellulose complex enzymes.[7] It is known that EM4 is a mixed culture containing

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fermenting bacteria of the genus Lactobacillus, phosphate solubilizing bacteria, Actinomycetes, photosynthetic bacteria, fermenting fungi, and yeasts. The combination of microorganisms, which includes both fermenting and synthetic (integrating) microorganisms, ferments organic matter to produce sugars, alcohols, and amino acids.[8] The residents of Udapi Hilir Village, Prafi District, Manokwari Regency, West Papua Province, are interested in fresh fish farming as a sort of economic activity. This is brought on by enabling elements such as an abundance of water reserves, both from groundwater sources and with the availability of water from the village irrigation system, which has long been used as a source of water and local villagers' rice fields. Due to great fish durability in challenging water conditions, catfish farming is the preferred method of fish farming in this town.[9] The community now has a high demand for catfish, which is concerned with the nutritional value of this protein-rich fish and will also stimulate areas of marketing and breeding. Cultivation conditions show the influence of social environmental conditions on diet, growth parameters, and behavior of C. *gariepinus*.[10] In aquaculture, feeding has a significant role in determining output costs and water quality.[11] In this study, the water quality of the test pond was studied, which was given fish feed made from sago pulp with various compositions. it is expected to increase the economic value of sago pulp which was originally worth waste and can be an alternative substituent material for feed raw materials by utilizing the potential of the local community.

EXPERIMENTAL

Material and Methods

Sago pulp was obtained from Manokwari, West Papua, Indonesia. The catfish seeds come from a hatchery in the village of Udapi Hilir, and are five to seven cm in size. Commercial fish pellets are used as a control and given alternately to the feeding of pelleted pellets consisting of sago pulp, rice bran, fish meal, and EM4. The pool used is made of tarpaulin with type A12 size 2x1x1 of 4 pieces with 100 fish in each.

Preparation of Sago Pulp

The process of making sago dregs begins with the process of making sago dregs fermented with EM4, including first drying the sago dregs to reduce the water content by 12%. After drying, the sago pulp is steamed for 60 minutes at 60°C. The steamed sago pulp is incubated at 22°C for 1-4 days to get the fermented product. After that, it is baked in the oven at 70°C until dry and ground and then sieved to get sago pulp flour.

Experimental Diets

Variation of sago pulp in fish feed ingredients is made with a composition of 1:1:0.5, 1:1:1, 1:1:1.5 for rice bran: fish meal: sago pulp, and without sago pulp, namely 1:1 for rice brand: fish meal. Based on the results of the chemical analysis, the feed is then selected which contains ingredients according to catfish feed standards. The composition is determined as a feed test material in the test pond.

Fish and Feeding Management

Fish were artificially fed once daily at 7:00 am and commercially fed at 5:00 pm until full during the feeding experiment, and feed intake was recorded. During the feeding experiment, the test pond water was analyzed for water quality once a week.

Detection Method

Proximate testing of feed ingredients was carried out in 2 repetitions based on product quality testing standards, including moisture content, ash content, total protein, fat, crude fiber, and carbohydrates by difference based on AOAC 2005. Analysis of the water quality of the test pond using the HACH method. HACH Methods are equivalent to USEPA-approved methods. Even though minor modifications exist, the USEPA has reviewed and accepted certain procedures for reporting purposes.

RESULTS AND DISCUSSION

Preparation of Sago Pulp

The fermentation process carried out on sago pulp begins the stages of preparing sago pulp as raw material for fish feed. The basic idea behind fermentation is that it uses microbes to break down difficult-to-digest substances like cellulose and hemicellulose into simple carbohydrates. It is intended that the fermentation's outcomes will improve the feed ingredients' quality so they can be combined to make fish feed and facilitate fish growth. This is due to a decrease in the crude fiber content in sago pulp due to the fermentation step by probiotics so that the digestibility of fish will increase.[12,13] Three hydrolytic enzymes are thought to make up the cellulase system in fungi: exo-1, 4-β-D-glucanase (cellobiohydrolase), which hydrolyzes cellobiose from either the non-reducing or the reducing end, typically from the crystalline parts of cellulose, and β-glucosidase (cellobiase), which releases glucose from cellobiose and short chain cellooligosaccharides.[14–16] Despite not acting directly on cellulose, β-glucosidase is nevertheless regarded as a part of the cellulase system because it completes the hydrolysis of the substance. The cellulose's glycosidic linkages are converted to glucose by the cellulase enzyme (where cellulose is a polymer with its monomer, cellobiose, which is a combination of two glucose units). The results of the proximate analysis of feed made from variations in the composition of sago pulp are presented in Table-1.

Table-1: Results of Feed Proximate Analysis

Composition	Rice bran: fish meal: sago pulp				Sago pulp
	A 1:1:-	B 1:1:0.5	C 1:1:1	D 1:1:1.5	
Moisture, % by weigth	6.65	4.58	4.65	12.36	45.92
Total ash (wet basis), % by weight	12.86	14.17	12.09	11.3	6.72
Protein (N x 6.25) (wet basis), % by weight	30.63	19.97	21.75	20.93	1.45
Crude fiber (wet basis), % by weight	26.63	24.62	30.86	28.31	6.45
Fat (wet basis), % by weight	10.27	9.78	8.59	7.51	0.12
Carbohydrate by difference (wet basis), % by weight	54.88	61.28	61.52	55.43	45.92

The water content of sago pulp used in this research is 45.92%, this content is relatively lower than the report from Abd-Aziz, which is 59.1%.[3] The observed ash content was in the range as previously reported, namely 4% [3], 8% [17] and 10.66%.[18] In this research, the measured protein level of 1.45% had a value similar to that previously reported by Abd-Aziz, but slightly lower than that reported by Simanuhuruk and Sirait.[3,18] The value of crude fiber in this research has a value of 6.45%, which is lower than previously reported results, namely 14.8%. According to a previous report, the sago frond fiber component from South Kalimantan contained a water-soluble extractive of 16.41%; lignin of 18.25%; cellulose of 35.53%; and hemicellulose of 27.12%.[19] Based on previous reports on the fat value of sago pulp, which is 2.71%, this figure is higher than the results of this research, which is 0.12%[18] and is more similar to the results of other reports which state that the fat content in sago pulp is not detected.[3] Carbohydrate by difference in this research is 45.92%. According to the National Research Council (US) Subcommittee the value of the carbohydrate content of a food given in the composition table is usually known as carbohydrates with a difference, i.e., the residual weight after subtracting amounts of water, fat, proteins, and ash found by analysis; this moiety includes fiber, starches, sugars, and small amounts of other organic compounds.[20,21]
The water content in the four samples with variations in pellet composition showed that the synthetic feed had a value of less than 14%. According to the Indonesian National Standard (SNI) the maximum moisture content of the pellets is 14% (Directorate of Production Development, 1997).[22] Feed ingredients with a moisture content of <14% have a longer shelf-life and durability compared to their fresh state, at a higher moisture content. Although it is included in the nutritional category of feed, moisture is frequently excluded from it. Animals can use the moisture content of feed items, which is present in all feed ingredients. As fish live in water, and as livestock have free access to water, the form of the water does not matter as much to them as it does to animals that do not have a consistent source of water. The only issue with moisture in catfish meals is that it shouldn't be more than 12% to avoid mold. Typically, commercial catfish meals have a moisture content of 9–10%.[23] The water content of the pellet samples meets the standards, making sago pulp a potential choice for pellet raw materials. Ash content is correlated with the amount of inorganic matter (minerals), therefore if inorganic matter (ash) declines, it is assumed that the amount of organic matter, which contains significant amounts of nutrients like protein, fat, carbs, and vitamins, will rise. The ash component in the proximate analysis does not provide an important food value, the ash content in the

feed ingredients is only important for determining nitrogen-free extracts calculations. The ash content regulated in the SNI for catfish feed for the enlargement category is 13%. Nitrogen-free extracts contain polysaccharides, trisaccharides, disaccharides, and monosaccharides especially starch which dissolves easily in acid and alkaline solutions in the analysis of crude fiber and has high digestibility. Protein content in food ingredients is all nitrogen-containing bonds (N), both true protein and nitrogen-containing substances but not protein. For example, urea. The determination of the total N number is said to represent the amount of protein to be searched for. The protein content resulting from the Kjeldahl method of protein content analysis is thus often referred to as the crude protein content. The protein content regulated in the SNI for catfish feed for the enlargement category is 28%. It was also recommended by previous researchers to use a 28% protein feed with protein supplied mainly from high-quality oilseed meal.[23] Giving animals too much protein is bad because it costs money and makes them work harder to excrete the extra nitrogen, which has a bad effect on the water's quality. Consequently, catfish meals should be balanced in terms of protein and energy, with enough energy coming from sources other than protein (i.e., starch and fat). The results of the proximate analysis showed that the tested feed had a protein content range of 19-21%, which was still within the recommended levels, namely the ratio of rice bran: fish meal: sago pulp of 1:1:0.5, 1:1:0.5, 1:1:1, and 1:1:1. Only the use of non-sago dregs does not meet these recommendations. Since catfish can produce carbs from lipids and proteins, like other animals, they don't need to eat any carbohydrates. Nevertheless, catfish meals naturally contain a sizable quantity of starch-rich grain or grain byproducts. A normal catfish meal comprises an additional 37% crude fiber and 35–40% or more digestible carbs.[23] The entire test sample shows conformity to the recommended value, which is around 24-30%. Lipids (fats and oils) are a rich source of energy that is very easily digested. Lipids not only offer energy but also necessary fatty acids (EFA), which are needed in the diet because animals are unable to produce them on their own. Lipid in catfish commercial feed ingredients is 5-6%, as well as the recommendation from SNI, which is at least 8%.[23] The fat content shown in the feed informs that by giving sago pulp there is a decrease in fat content. This is due to the increase in the percent composition of sago pulp which also reduces the composition of other feed raw materials, namely bran and fish meal. It can be concluded that the fat contained in these feed ingredients comes from both types of raw materials. Among the most prevalent organic compounds in nature, carbohydrates are a class of substances that also include sugars, starches, celluloses, and other closely related substances. In the proximate analysis, what includes carbohydrates is extract material without nitrogen (Nitrogen-free extracts). Nitrogen-free extracts are a carbohydrate component that is easily digested and is a good source of energy for livestock. The Nitrogen-free extract value is obtained from 100% of the material minus the percentage of ash, crude fiber, fat, and crude protein. The range of extract ingredients without nitrogen in the four feed samples was 54-61%. This result is relatively higher than the figure reported by Robinson and Li, which is 35-40%.[23] To maintain a proper life for cultivated fish, water quality or a living medium for fish is fully taken into account in aquaculture. Water plays a very vital role as a living medium for fish. The results of testing water samples in the first, second, third, and fourth weeks are presented in Table-2, Table-3, Table-4, and Table-5, respectively.

Table-2: Water quality analysis in the first week

No.	Parameter	Ratio of rice bran: fish meal: sago pulp				Quality standards based on PP No.82 -2021 (Class II)	SNI 6484.4:2014
		A (1:1:-)	B (1:1:0.5)	C (1:1:1)	D (1:1:1.5)		
Physic							
1	Temperature, °C	27-28	27-28	27-28	27-28	Dev 3 The difference with the air temperature	25-30

						above the water surface	
2	Total Dissolved Solids/TDS, mg/L	114	128	152	284	1000	-
Organic chemistry							
1	pH	6.57	6.60	6.55	7.92	6-9	6.5-8
2	Dissolved oxygen/DO, mg/L	3.8	4.1	4.8	0.2	4 (minimal)	Minimal 3
3	Ammonia, mg/L	0.5	0.1	0.4	0.1	0.2	Maximal 0.1
4	Nitrate (NO_3^-), mg/L	0.5	0.5	0.6	21.5	10	-
5	Phospate (PO_4^{3-}), mg/L	0.14	0.16	0.17	3.44	0.2	-

Table-3: Water quality analysis of the test pool water quality in the second week

No.	Parameter	Ratio of rice bran: fish meal: sago pulp				Quality standards based on PP No.82 -2001 (Class II)	SNI 6484.4:2014
		A (1:1:-)	B (1:1:0.5)	C (1:1:1)	D (1:1:1.5)		
Physic							
1	Temperature, °C	27-28	27-28	27-28	27-28	Dev 3 The difference with the air temperature above the water surface	25-30
2	Total Dissolved Solids/TDS, mg/L	254	271	301	305	1000	-
Organic chemistry							
1	pH	6.35	6.66	7.73	7.6	6-9	6.5-8
2	Dissolved oxygen/DO, mg/L	3.0	2.3	1.5	2.7	4 (minimal)	Minimal 3
3	Ammonia, mg/L	1.1	1.3	0.2	5.0	0,2	Maximal 0.1
4	Nitrate (NO_3^-), mg/L	1.5	2.5	3.0	2.0	10	-
5	Phospate (PO_4^{3-}), mg/L	0.95	1.6	4.81	5.03	0.2	-

Table-4: Water quality analysis of the test pool water quality in the third week

No.	Parameter	Ratio of rice bran: fish meal: sago pulp				Quality standards based on PP No.82 -2001 (Class II)	SNI 6484.4:2014
		A (1:1:-)	B (1:1:0.5)	C (1:1:1)	D (1:1:1.5)		

Physic							
1	Temperature, °C	27-28	27-28	27-28	27-28	Dev 3 The difference with the air temperature above the water surface	25-30
2	Total Dissolved Solids/TDS, mg/L	319	319	321	384	1000	-
Organic chemistry							
1	pH	7.52	7.34	7.33	6.43	6-9	6.5-8
2	Dissolved oxygen/DO, mg/L	0.1	2.6	0.6	3.4	4 (minimal)	Minimal 3
3	Ammonia, mg/L	5.0	1,35	0.1	1.4	0,2	Maximal 0.1
4	Nitrate (NO_3^-), mg/L	4.90	3.0	3.0	3.0	10	-
5	Phospate (PO_4^{3-}), mg/L	40.0	45.0	46.3	50.3	0.2	-

Table-5: Water quality analysis of the test pool water quality in the forth week

No.	Parameter	Ratio of rice bran: fish meal: sago pulp				Quality standards based on PP No.82 -2001 (Class II)	SNI 6484.4:2014
		A (1:1:-)	B (1:1:0.5)	C (1:1:1)	D (1:1:1.5)		
Physic							
1	Temperature, °C	27-28	27-28	27-28	27-28	Dev 3 The difference with the air temperature above the water surface	25-30
2	Total Dissolved Solids/TDS, mg/L	398	431	480	572	1000	-
Organic chemistry							
1	pH	7.13	7.33	7.48	6.93	6-9	6.5-8
2	Dissolved oxygen/DO, mg/L	1.9	3.2	2.7	1.7	4 (minimal)	Minimal 3
3	Ammonia, mg/L	13.7	13.6	12.6	12.0	0.2	Maximal 0.1
4	Nitrate (NO_3^-), mg/L	3.0	2.0	2.0	3.0	10	-
5	Phospate (PO_4^{3-}), mg/L	31.4	31.4	38.1	39.5	0.2	-

Figure-1 shows the results of water quality tests conducted for 4 weeks showed increasing levels of TDS, which caused DO levels to increase that was shown clearly in Fig.-2. The process of dewatering the test ponds A, B, C, and D was not carried out, causing high levels of DS. The average Nitrate (NO_3^-) has increased but is still below the quality standard of 10 mg/L. Figure-5 shows increasing levels of Nitrate (NO_3^-) in ponds A, B, C , and D, although not toxic, nitrate levels affect fish growth, because high nitrates can reduce oxygen levels in the water. The less dissolved oxygen in the water, the greater the potential for fish death. Ammonia and Phosphate(PO_4^{3-}) levels are shown in (Fig.-4 and 6) in test ponds A, B, C, and D showed an increase from the first week to the fourth week, this was caused by an increase in leftover feed and metabolite waste so that the water quality became low and caused a decrease DO levels in the pond.

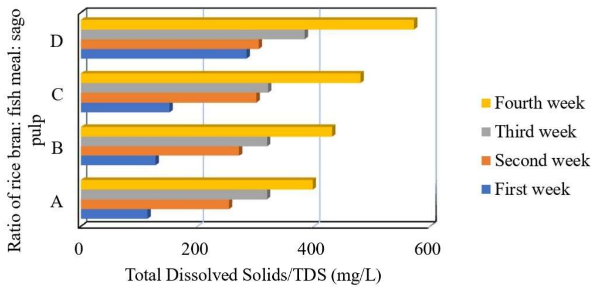

Fig.-1: The Results of the Analysis of the TDS Test of Pond Water Based on Variations in the Ratio of Components of Feed Raw Materials

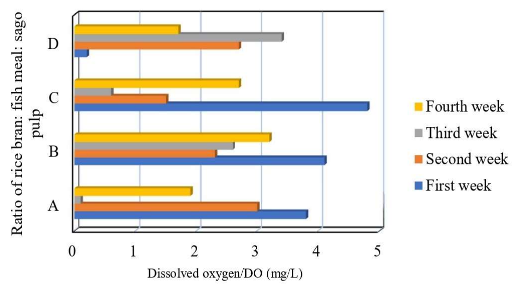

Fig.-2: The results of the analysis of the DO test of pond water based on variations in the ratio of components of feed raw materials

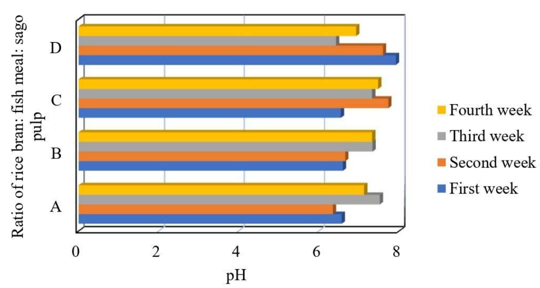

Fig.-3: The Results of the Analysis of pH Test of Pond Water Based on Variations in the Ratio of Components of Feed Raw Materials

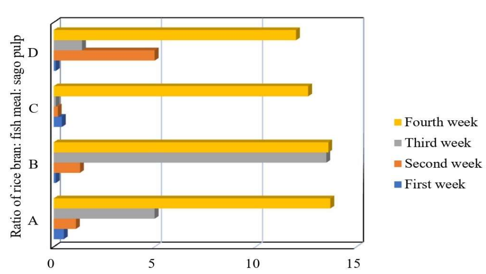

Fig.-4: The Results of the Analysis of the Ammonia Test of Pond Water Based on Variations in the Ratio of Components of Feed Raw Materials

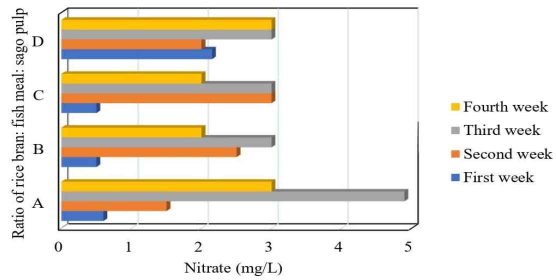

Fig.-5: The Results of the Analysis of the Nitrate Test of Pond Water Based on Variations in the Ratio of Components of Feed Raw Materials

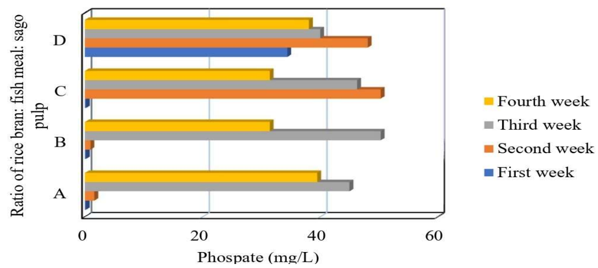

Fig.-6: The Results of the Analysis of the Phosphate Test of Pond Water Based on Variations in the Ratio of Components of Feed Raw Materials

The pH in test pools A, B, C, and D has increased, this is due to the high amount of TDS each week and the minimal amount of oxygen, which increases CO_2 levels in the water. High levels of CO_2 can increase the pH value (Fig.-3). Ammonia levels in the test pool decreased every week, this was caused by an increase in CO_2 which was indicated by a high pH during weekly monitoring. High pH >7 (Fig.-4).

CONCLUSION

This study concludes that the overall, pond water quality parameters were still within the pond water quality standards after the application of sago dregs as a raw material for catfish feed. This proves that sago dregs have the potential as an alternative feed raw material. This is also related to the proximate content of feed ingredients containing sago pulp which is proven to still provide results that are by commercial feed standards.

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CONFLICT OF INTERESTS

The authors declare that there is no conflict of interest.

CONTRIBUTION OF AUTHORS

All the authors contributed significantly to this manuscript, participated in reviewing/editing, and approved the final draft for publication. The research profile of the authors can be verified from their ORCID IDs, given below:

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