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The Improvement of roduction Tecnique on Agroindustry *Canna edulis* STARCH

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ABSTRACT

Study of *Canna edulis* starch production technology improvement is needed to produce high quality processed product. Three level of number washing treatment (2 times, 3 times, and 4 times) and duration of precipitation (1 hour, 2 hours, and 3 hours) were applied following in a randomized complete block design with 3 replicates. Result indicated that the best result was obtained from 3 times washing treatment and 3 hours precipitation. The quality of starch, water content, strach content, amylosa content, ash content, and white score were 13.14 %, 81.93 %, 38.34 %, 0.75 %, 72,4 respectively. A financial analysis for the establisment of small scale starch industry is also reported.
Keywords: *Canna edulis*, starch, production, agroindustry

INTRODUCTION

The human effort to develop local food has a strategic value. It is due to the availability of local foods will prevent starvation in society. Therefore, food security needs to be developed based on local resources because it will give more value for food diversification product. Food security research activities directed to support the efforts of all stakeholders in fulfilling the needs of foods, nutritious, safety, appropriate, taste, belief, and affordable purchasing power. During the 15th ASEAN Summit held in Thailand in October 2009, food security and pandemic diseases were all brought to the spotlight. Regional leaders have pledged to strengthen regional cooperation to enhance food security on both production and distribution fronts and reaffirmed their collective efforts to enhance regional capabilities in surveillance, preparedness and response to pandemic diseases [1].

Food diversification can be done with the substitution of rice flour by tubers. *Canna edulis* as one of the local food sources becomes one alternative in food diversification which can be processed into products [2]. This product has several advantages, such as, has a high saving power, in making easy, practical, and easy to serve.

One alternative of food diversification is using tubers as raw material, one of which is *Canna edulis*. Moreover, *Canna edulis* starch as raw material of several products (vermicelli noodles, cookies, crackers) is expected to reduce dependence on wheat flour and rice. *Canna edulis* starch is the extract of *Canna edulis*. *Canna edulis* starch can be used as raw materials of *cendol*, porridge, and biscuits. Based on the research of Dwiyitno and Rufaidah [3], *Canna edulis* starch can also substitute tapioca starch in the production of fish nuggets. In addition, *Canna edulis* starch has been used to fulfill the needed of food in society, especially in rural areas to improve food security and nutrition. One of area that produce Canna edulis tuber in Malang regency is Tawangsari, Ngabat, and Madingrejo, District Pujon. In Tawangsari, *Canna edulis*production increases 12.5% per year. In 2006, the production of *Canna edulis* is 500 tons in two harvests time. Then, local community processes *Canna edulis* tube into starch, with the production capacity of ± 50 tons per year. The advantages of *Canna edulis* starch that produced by Tawangsari community is the organic nature, which start from planting into processing, it does not use (drugs) chemistry substances.

Study of *Canna edulis* starch production technology improvement is needed to produce high quality processed product. Furthermore, techno-economic data analysis is needed for the development of it into industrial scale, so it is expected obtain comprehensive results. This effort is expected to be able to increase the social value and value added of *Canna edulis*. It is also expected to develop into industrial scale, so it can become an alternative supply of local foods instead of rice and flour as well as helping communities facing food insecurity problems in the future.

The problem that is faced now is *Canna edulis* starch has brown color so it will reduce the appearance value if it is processed into different product compared to flour. This is due to *Canna edulis* tube has fibre and high phenols enzyme so easily become browning. One solution that can be done to improve the colour of the *Canna edulis* starch is a soaking *Canna edulis* starch in the water for several time, then repeating washing, followed by soaking in sodium Meta bisulphide.

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MATERIALS AND METHODS

Improvement of Processing Technology of *Canna edulis* starch

A. Determination of Optimal Condition of *Canna edulis* starch Production

This stage is research laboratory stage about production process from *Canna edulis* tube into starch. The production flowchart is based on Utomo and Antarlina [4] that already modified with production process in Malang regency is Tawangsari. Research design using randomized complete block design, with 3 replicates.

- Factor 1: The numbers of washing the starch were 2 times, 3 times and 4 times.
- Factor 2: Duration of the precipitation were 1 hour, 2 hours and 3 hours

Canna edulis starch is produced and tested physically and chemically to determine their quality, include starch content, moisture content, amylase contents, ash content and white score [5].

B. Techno-Economic Studies of Agroindustry *Canna edulis* Starch

From the result of the study about the improvement of *Canna edulis* starch production technology to obtain optimal results, then the next stage is the techno-economic studies of agroindustry *Canna edulis* starch. The scope of this study was limited to financial analysis, financial parameters, namely: Payback period, Net Present Value, Internal Rate of Return, and Profitability Index [6]

RESULTS AND DISCUSSION

Canna edulis Starch Quality

1. Moisture content

Moisture content of *Canna edulis* starch is the most important factor that must be considered because it affects its storage life. *Canna edulis* starch has hygroscopic characteristic that easily absorb water, so the high moisture content will increase the damage level and decrease its storage life.

The result of analysis of variant, it shows that the number of washing and duration of precipitation were significantly different (p = 0.01) to moisture content (p = 0.01), however the interaction was not significantly different.

Table 1 The effect of number of washing to moisture content

Number of washing	Mean (%)
4 times	7.56 a
3 times	13.31 b
2 times	14.43 c
	LSD 5 % = 0.3993

Note : Mean followed by the same letter are not significanly different (p=0.05)

Moisture content range of *Canna edulis* starch is from 7.56% to14.43%. Compared to SNI that tapioca as a reference, moisture content of *Canna edulis* starch from the research is still below the maximum limit from SNI, which is 15%. Table 1 show that differences in the number of washing treatment will cause the difference of water content. In addition, the level of starch in the material also influences moisture content. Sjoqvist and Gatenholm [7] have shown that the water content of amylopectin starch extradites has a significant effect on their expansion capacity during microwave foaming and stability towards shrinkage after treatment. The largest expansion is achieved when extradites are conditioned at 33% and 54% RH, which corresponds to moisture contents of 11.2% and 13.4%, respectively. It is because the starch does not dissolve in water. Hence, the more washing treatment will reduce fibre content and increase starch content. As a result the moisture content will decrease.

Table 2 the effect of duration of precipitation to water content on *Canna edulis* starch

Duration of Precipitation	Mean (%)
1 hour	12.31 b
2 hours	11.34 a
3 hours	11.65 a
	LSD 5 % = 0.3993

Note : Mean followed by the same letter are not significanly different (p=0.05)

From Table 2, it can be seen that the lowest moisture content obtained at the 2 hours precipitation, which is 11.34%. This is assumed that the longer precipitation, the number of precipitated starch will increase. Therefore, more water will dry out in drying process and *Canna edulis* starch moisture content will be lower. For yam flour

the best treatment using curing time of 12 hours in 50°C. The characteristics of that yams flour are: moisture content 6.30% [8].

2. Starch content

The result of analysis of variant, it shows that the number of washing was significantly different (p = 0.01), however the duration of precipitation and the interaction were not significantly different.

Table 3 The effect of number of washing on *Canna edulis* starch content

Number of washing	Mean (%)
2 times	78.64 a
3 times	81.93 b
4 times	83.11 c
LSD 5 % = 0,069	

Note : Mean followed by the same letter are not significanly different (p=0,05)

Hence, the more washing treatment will reduce fibre content and increase starch content. As a result the moisture content will decrease. It can be seen in Table 3, that the more often washing treatment, the higher starch levels. The lowest starch level is obtained by 2 times water washing treatment (78.64%). Moreover, the highest starch content is obtained by 4 times water washing treatment (83.11%), this result higher than starch *Canna edulis* from Xingyi Guizhou [9]. It is because the starch does not dissolve in water. Therefore, the more washing treatment will reduce fibre content and increase starch content.

3. Amylose content

Amylose is a polysaccharide, a polymer that composed of glucose as its monomer. Each monomer is connected with a 1.6-glycosidic bond. Amylose is not branched polymers that become the component of starch, together with Amylopectin. Amylopectin is a polysaccharide that is composed of α-glucose monomers. Amylopectin is a bigger molecule and easy to find since become one of the two main component of starch, together with amylose. Although amylopectin is composed from the same monomer, it is different with amylose, which can determine from its physical characteristics [10].

The result of analysis of variant, it shows that the number of washing treatment, duration of precipitation, and the interaction were significantly different (p = 0.01) to amylase content.

Table 4 The effect of number of washing and duration of precipitation to amylose content on *Canna edulis* starch

Number of washing	Duration of Precipitation	Mean (%)
2 times	1 hour	38.18 a
	2 hours	38.29 b
	3 hours	38.34 b
3 times	1 hour	38.69 c
	2 hours	39.16 d
	3 hours	39.20 d
4 times	1 hour	43.62 e
	2 hours	43.63 e
	3 hours	43.66 e
LSD 5 % = 0.053		

Note : Mean followed by the same letter are not significanly different (p=0,05)

From Table 4, it can be seen that average of amylose of *Canna edulis* starch has range from 38.18% - 43.66%. The highest amylose content is obtained from the combination 4 times washing treatment with 3 hours precipitation (43.66%). This result higher than Thitipraphunkul, *et al*. [11] research, they were reported that amylase content of *Canna edulis* from Japanese-green, Thai-green and Thai-purple cultivars ranged from 19 to 25%. If *Canna edulis* starch is used for crackers, or cookies, *Canna edulis* starch that has high amylose is needed. On the other hand, if *Canna edulis* starch is used for porridge (baby food), then *Canna edulis* starch that has high amyl pectin is needed.

Amylopectin is more difficult to precipitate compared to amylose, because of the differences in molecular weight. Thus, the more often washing treatment, duration of precipitation will increase the amylose starch content and vice versa.

4. Ash contents

The result of analysis of variant, it shows that the number of washing treatment and duration of precipitation were significantly different (p = 0.01) to ash content, however the interaction was not significantly different.

Table 5 the effect of number of washing treatment to ash content

Number of washing	Mean (%)
4 times	0.68 a
3 times	0.78 b
2 times	1.37 c
	LSD 5 % = 0,054

Note : Mean followed by the same letter are not significanly different (p=0,05)

From Table 5, it can be seen that the lowest ash content (0.68%) is given from 4 times washing treatment. This result higher than Thitipraphunkul, *et al.* [11] research, they were reported that ash content of *Canna edulis* from Japanese-green, Thai-green and Thai-purple cultivars ranged from 0.25 and 0.33%. The increasing number of washing treatment will increase the number of dissolved mineral in the water. Therefore, the ash contents will be lower.

Table 6 the effect of duration of precipitation to ash content

Duration of Precipitation	Mean (%)
3 hours	1.24 a
2 hours	1.25 a
1 hour	1.34 b
	LSD 5 % = 0.054

Note : Mean followed by the same letter are not significanly different (p=0.05)

From Table 6, it can be seen the lowest ash content (1.24%) is showed from the longest precipitation time (3 hours). This is due to the longer precipitation time, the fewer particles that come suspended in starch deposition. Therefore, the mineral levels are also lower.

5. White score

Canna edulis starch colour (white score) is one standard measure of starch quality and also affect consumer acceptance. White score of the product can be influenced by the type of materials used.

The result of analysis of variant, it shows that the number of washing treatment, duration of precipitation, and interaction were significantly different ($p = 0.01$) to white score of *Canna edulis* starch.

Table 7 The effect of number of washing and duration of precipitation to white score of *Canna edulis* starch

Number of washing	Duration of Precipitation	Mean
2 times	1 hour	62.57a
	2 hours	65.40b
	3 hours	65.53b
3 times	1 hour	65.57b
	2 hours	65.61b
	3 hours	65.63b
4 times	1 hour	72.47c
	2 hours	72.63c
	3 hours	72.73c
LSD 5 % = 0.335		

Note : Mean followed by the same letter are not significanly different (p=0.05)

From Table 7, it can be seen that the more often washing treatment and the longer precipitation, the colour will be better. The highest white score (72.73%) is obtained in 4 times water treatment and 3 hours duration of precipitation. This is due to the increasing number of washing treatment and the longer precipitation will increase the white score of *Canna edulis.* Besides, the white score of starch is also determined by its amylase content. Therefore, the more often washing treatment and the longer precipitation, the amylase content will be higher. This is resulted in whiter colour.

6. Techno-economic analysis Agroindustry *Canna edulis* Starch

Financial feasibility analysis for the development of *Canna edulis* starch agro-industry is using a 5-year analysis period. It shows that starch agroindustry is feasible (payback period = 1 year 0.5 months; Profitability Index = 3.99; NPV at 10% interest rate per annum = Rp. 148,374,540, -; IRR = 86.9%). Therefore, the growth of this industry should be supported since this industry is prospective.

CONCLUSION

The optimal condition to produce *Canna edulis* starch was obtained from 3 times washing treatment and 3 hours precipitation. The quality of starch, moisture content, strach content, amylosa content, ash content, and white score were 13.14 %, 81.93 %, 38.34 %, 0.75%, and 72.4 respectively. A financial analysis for the establisment of small scale starch industry was feasible (payback period = 1 year 0.5 months; Profitability Index = 3.99; NPV at 10% interest rate per annum = Rp. 148,374,540, -; IRR = 86.9%).

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