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Ratio of Filled Fruit and Rendement of Flour Produced from Nypa (*Nypa fruticans* Wurmb) Fruit

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ABSTRACT

The large number of nypa (*Nypa fruticans* Wurmb) fruit bunches that are carried away by the river indicates that this fruit has not been fully utilized by the community. This study aimed to measure the ratio of filled nypa fruit and determine the rendement of flour from ripe and filled nypa fruit. Ten ripe fruit bunches from 5 clumps were taken from Bunipah Village, Kandangan Lama Village, and Kuala Tambangan Village, Tanah Laut Regency, Indonesia respectively. The fruits were removed from the bunch, sorted according to content, and counted. After the filled fruits were halved, each endosperm was removed from the shell and weighed. The endosperm was then grated. The result was dried through exposure to sunlight for 3 days and pounded. The resulting flour was filtered, dried again through exposure to sunlight for 2 days, and weighed. Main data from the series of steps were the number of filled fruits as well as empty fruits each bunch, the weight of endosperm, and the weight of flour obtained. The normality of the data was tested by the Liliefors test and homogeneity by the Bartlett test. Diversity was analyzed by randomized block design (3 treatments, 3 replications). The ratio of filled fruit referred as the ratio of the number of filled fruits to the total number of fruits on the bunch, while the rendement of flour referred as the ratio of the weight of flour produced to the weight of processed endosperm. The ratio of filled fruits in Bunipah Village (75.83%) and Kandangan Lama Village (75.46%) were higher than in Kuala Tambangan Village (28.55%). The rendement of nypa fruit flour from the highest to the lowest came from Kandangan Lama Village (30.71%), Bunipah Village (30.27%), and Kuala Tambangan Village (25.57%). This rendement was obtained through grating.

Keywords*: filled fruit, Nypa fruticans, rendement, bunch, flour*

INTRODUCTION

Nypa (*Nypa fruticans* Wurmb) is a monotypic plant species belonging to Arecaceae that inhabits mangrove, a transitional area between saltwater and freshwater areas. This plant thrives around river estuaries and along the coast of Kalimantan Selatan Province, the smallest province on the island of Kalimantan or Indonesian Borneo.

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The nypa community not only functions ecologically as a habitat for animals, such as birds (Erflemeijer *et al*., 1991; Reynaldo *et al*., 2011), proboscis monkeys (Soendjoto *et al*., 2014), and invertebrates (Emoyoma *et al*., 2020), as well as protects riverbanks or coastlines from abrasion (Fithria *et al*., 2018) and floods or strong currents (Aquino, 2019), but also has economic potential. The leaves are processed to be used as roofs for livestock houses. Sap is the raw material for brown sugar, candy, and flavored teas (Wan Zaki *et al*.,

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2013), healthy food or drinks (Sukairi *et al*., 2018; Tai *et al*., 2019; Yusoff *et al*., 2015), and bioenergy (Irawan *et al*., 2016; Tsuji *et al*., 2011). Fruit is a part of the plant which is relatively abundant, both in the dry season and the rainy season. However, the fruit is not used at all or has not been used proportionally, especially by the people who live around the area. The fruit is even left to be wasted, drowned, or carried away by water currents towards the sea. This fact shows that the nypa is still considered a wild plant.

The endosperm (the meat of or edible part of nypa fruit) is a raw material for refreshing drinks (Suparto *et al*., 2019), jam (Afrizal & Pato, 2017), and flour for foodstuffs (Subiandono *et al*., 2011). The fruit fiber has potential in medicine (Dalming *et al*., 2018). The outer part of the fruit, namely endocarp (shell), mesocarp (fibrous husk), and exocarp (outer layer), is an alternative energy source (Mulyadi *et al*., 2013; Radam *et al*., 2018) or has the potential as a raw material for the particle board industry (Rosidah *et al*., 2019). In particular, nypa fruit is used according to the level of maturity. Fruit with a young maturity level is used as a mixture of fruit ice (a type of palm fruit) or sweets which are then packaged in bottles (Soendjoto & Sutiya, 2009). Fruit with an old maturity level is processed into flour for extenders or as a substitute for wheat flour in the particle board industry (Rosidah *et al*., 2019; Sari *et al*., 2008).

In the industrial world, the content of materials that can be produced from the processing technology of a material (hereinafter referred to as rendement) needs to be recorded. Data on rendement is useful in economic calculations, especially if the rendement is from materials of different origin (such as the place of acquisition). On the other hand, material processing involving technology also generates waste. Waste needs to be worked out to be zero so that the environmental balance is not disturbed.

This study aimed to measure the ratio of filled fruit in nypa bunches and to determine the rendement of flour produced from processing ripe and filled fruits. The results are not only to enrich science but also serve as a benchmark for the community to use palm fruit sustainably for food security or industrial needs.

MATERIALS AND METHOD

Nypa fruit samples were taken from three locations in Tanah Laut Regency, South Kalimantan Province which have mangrove forests with abundant nypa plants. The first location was Bunipah Village (BP) which located in Aluh-aluh District, the second location was Kandangan Lama Village (KL) of Panyipatan District, and the third location was Kuala Tambangan Village (KT) of Takisung District.

At each location, 10 bunches of ripe fruits were sampled from 5 clumps. Visually, ripe fruit skin color is dark brown. Nypa fruits were removed from their bunch (Figure 1-a), sorted according to the presence or absence of endosperm. Filled fruit is a fruit that has endosperm and its structure is tight and heavy, while empty fruit does not have endosperm and its structure is flat and light. (Figure 2). Either filled fruits or empty fruits were counted. After halving the filled fruit (Figure 3), the endosperm was removed from the shell (Figure 1.b) and weighed using an analytical balance (Figure 1.c). The endosperm was then grated (Figure 1.d). The results were dried through exposure to sunlight for 3 days (Figure 1.e) and pounded (Figure 1.f). The pounded flour was sieved (Figure 1.g) with a 45-mesh sieve, dried through exposure to sunlight for 2 days (Figure

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1.h), and weighed (Figure 1.i). From this series of steps, the data obtained were the number of filled fruits as well as empty ones per bunch, the weight of pulp, and the weight of flour obtained.

Figure 1. The steps of processing the nypa endosperm into flour.

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Filled fruits Empty fruits

Figure 2. Visual displays of filled and empty fruits

The normality of the data was tested by the Liliefors test and homogeneity by the Bartlett test. The treatment effect was determined based on the comparison of F_{count} with F_{table} at the 0.05 and 0.01 levels. Diversity was analyzed using a randomized block design (RBD) consisting of 3 treatments and 3 groups as replications. The general model for randomized block design is $Y_{ij} = \mu + i + j + E_{ij}$ (Steel & Torrie, 1995). In this case, Y_{ij} = the observed value of the experimental unit which received the i-th treatment and the j-th repetition group; μ = common mean; i = effect of i-th treatment i; j = the effect of the j-th repetition group; E_{ij} = effect of experimental error on treatment i and group j repetitions. The coefficient of diversity (CD) expressed in percent is calculated by the formula: $CD = \frac{\sqrt{MSE}}{\bar{Y}} x\, 100\%$. In this case, MSE = middle square of error and $\bar{Y}$ = mean of all observations. If there were differences in influence, further tests were carried out with the Duncans Multiple Range Test (DMRT). The ratio of filled fruits is the ratio of the number of filled fruits to the number of all fruits in the bunch. The rendement of flour is the ratio of the weight of flour produced to the weight of the endosperm that is processed.

RESULTS AND DISCUSSION

Ratio of Filled Fruits

The ratio of filled fruit originating from mature fruit bunches taken from BP and KL was higher than that taken from KT (Table 1). However, the ratio for the nypa fruit spread normally (Li_{max} = 0.2041; α = 0.05 or α = 0.01) and homogeneous ($\chi 2_{count}$ = 3.339; α = 0.05 or α = 0.01) (Table 2). The Duncan test showed that the treatment at BP was not significantly different from the treatment at KL. However, the treatment at these two locations was significantly different from the treatment at BP (Table 3).

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Table 1. The ratio of ripe and filled fruits taken from three locations

Nypa clumps	BP			KL			KT			NFF	
	NRB	NEF	NFF	NRB	NEF	NFF	NRB	NEF	NFF	All locations	Per location
RN-1	3	41	114	2	28	82	2	86	37	233	77.67
RN-2	2	34	89	2	28	80	2	97	24	193	64.33
RN-3	1	13	46	2	25	88	2	83	33	167	55.67
RN-4	2	19	79	3	43	120	2	68	37	236	78.67
RN-5	2	24	83	1	10	42	2	79	34	159	53.00
Total	10	131	411	10	134	412	10	413	165	988	329.33
∑ fruits per bunch	-	13.1	41.1	-	13.4	41.2	-	41.3	16.5	98.8	32.9
Filled fruit ratio (%)	-	-	75.83	-	-	75.46	-	-	28.55	-	-

Remark:
1. Location: BP = Bunipah Village, KL = Kandangan Lama Village, KT = Kuala Tambangan Village
2. Parameter: NRB = number of ripe bunches; NEF = number of empty fruits; NFF = number of filled fruits

Table 2. Analysis of the diversity of treatment effects on the ratio of filled fruit

Source of varians	Freedom degree	Total Square	Mean Square	F_{count}	F_{Table} 0.05	F_{Table} 0.01
Treatment	2	8,101.7333	4,050.8667	5.8119*	3.84	7.01
Error	8	5,576.0000	697.0000		4.46	8.65
Total	14	13,677.7333				

Note: tn = not significant; * = significant; KK = 40,08%

Table 3. Results of the Duncan Test between locations

Treatment	Mean Value	Difference Value	
		KL	BP
KL	82.400		
BP	82.200	0.20tb	
KT	33.000	49.40*	49.20*
	5%	48.76	51.26
	1%	66.12	69.13

Note: tb = not significant; * = significantly different

The ratio of filled fruit that were found is more in BP (75.83%) and KL (75.46%) than in KT (28.55%) were thought to be due to different substrate conditions. The fruit taken at BP and KL comes from nypa which grows on river banks where the substrate is muddy and is inundated by brackish water, while in KT comes from nypa which grows in inland areas relatively far from the river banks. Although it can be found from the riverbank to the last zone of mangroves inland (Sinaga *et al*., 2019), nypa likes a muddy substrate or muddy sand (Baleta & Casalamitao, 2016; Mukhlisi & Sidiyasa, 2014; Suryani, 2018) with salinity range 1–30 ‰ (Yuliana *et al*., 2019). On the banks of rivers like this, nypa absorbs nutrients that are always available or high enough. Nutrition is the main requirement in the formation of plant parts, especially leaves. Along with receiving full sunlight by nypa, the leaves can carry out photosynthesis properly and produce adequate carbohydrates in the formation of fruit pulp. In addition to fiber, minerals, and vitamin A, nypa endosperm is rich in carbohydrates (Osabor *et*

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al., 2008) whose levels range from 82.75% (Ulyarti *et al*., 2017) and 89.61% (Heriyanto *et al*., 2011). Unlike in Indonesia, the average carbohydrate content of ripe palm fruit in Malaysia Peninsular is 21.40% (Sum *et al*., 2013) and 51.08% in Nigeria (Osabor *et al*., 2008).

On the other hand, the nutrient content that comes from growing places in the interior is relatively low. Such nutritional content limits the formation of leaves and, of course, the implementation of photosynthesis. As a result, it produces relatively few carbohydrates which are then stored as endosperm by only a few fruits. In other words, many fruits are empty. The large number of empty fruit gives room to the filled fruit for a relatively rounder shape. This is different from the nypa fruit from BP which is slightly more oval or even KL which has a more extreme tilt (Figure 3).

BP (Bunipah) KL (Kandangan Lama) KT (Kuala Tambangan)

Figure 3. Different shapes of nypa fruit from three locations

Rendement of Fruit Flour

The average rendement of flour processed from the endosperm of nypa fruits varied. This variation occurred from one location to another (Table 4). The rendement of KL was the highest (30.71%). The next rendement of flour is from BP with the amount of 30.27%. The rendements of flour from these two locations were significantly higher than the rendememt of flour from KT which was only 25.57%.

Table 4. Total filled fruits, endosperm weight, flour weight, and rendement of flour from the three locations

Rum-pun	BP (Bunipah Village)				KL (Kandangan Lama Village)				KT (Kuala Tambangan Village)			
	NFF	EW (g)	FW (g)	RF (%)	NFF	EW (g)	FW (g)	RF (%)	NFF	EW (g)	FW (g)	RF (%)
RN-1	114	10,680	3,334.20	31.22	82	7,380	2,671.00	36.19	37	3,465	955.42	27.57
RN-2	89	8,052	2,470.20	30.68	80	7,114	2,512.00	35.31	24	2,442	614.29	25.16
RN-3	46	3,956	1,148.20	29.02	88	8,049	2,789.00	34.65	33	3,021	758.83	25.12
RN-4	79	7,376	2,219.64	30.09	120	11,121	2,643.94	23.77	37	3,199	804.71	25.16
RN-5	83	7,301	2,139.90	29.31	42	3,864	908.99	23.52	34	3,091	757.67	24.51
Total	411	37,365	11,312.14	30.27	412	37,528	11,524.93	30.71	165	15,218	3,890.92	25.57
Average (g)	-	90.91	27.52	-	-	91.09	27.97	-	-	92.23	23.58	-

Notes:: NFF = the number of filled fruits ; EW = endosperm weight; FW = flour weight; RF = rendement of flour

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The cause of the low rendement of nypa fruit flour from KT was the age of the fruit that was too old. At this age, the fruit begins to dry out. Some of the pulp begins to harden and petrify. When grated, this part cannot be shredded at all, even though it is ground. This does not happen to the endosperm from BP and KL. Although visually classified as old, the endosperm is soft. There is little or no remaining endosperm that cannot be shredded.

Grating is a method or technique of changing the endosperm of the nypa fruit into small pieces, before finally being ground to become flour. In this study, grating was preferred over slicing because the rendement was higher. According to Nafidzah *et al*. (2018), the rendement of nypa fruit flour through the grating technique was 31.0%, while through the slicing technique was 30.1%.

Based on data from other research in Indonesia, variations in the rendement of nypa fruit flour even occur between certain provinces and other provinces. The average rendement of flour from the three sample locations in South Kalimantan Province was 28.85%, from Jambi 20.00% (Ulyarti *et al*., 2017), and from East Kalimantan 46.39% (Heriyanto *et al*., 2011).

CONCLUSION

Overall, the mean ratio of ripe and filled fruit in nypa bunches was 59.95% (range 28.55–75.83%). The ratios of ripe and filled-fruit sampled from BP (Bunipah Village) and KL (Kandangan Lama Village) were higher than that from KT (Kuala Tambangan Village). The average rendement of nypa endosperm flour from locations in South Kalimantan was 28.85% (range 25.57–30.71%). The highest to lowest rendement of flour obtained from nypa fruit was respectively, from KL, BP, and KT. The rendement was obtained by grating.

Research needs to be continued and one of the aims is to investigate more deeply the factors causing the differences in the amount of fruit-filled and the rendement of flour.

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