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The Analysis Production and Chemical Composition Flour of Sagu Baruk Palm (*Arenga microcarpha* Becc) According to Variation of Altitudes above Sea Level

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***Abstract* – Sagu baruk palm is a source of local food Sangihe island communities from generation to generation, the plant is an endemic and produces carbohydrates as the local staple food to the citizen in Sangihe Island. The aim of this study was to analyze the production of the sago, to analyze its chemical composition and nutrient content of sagu baruk palm at different altitudes.**

The research was conducted from March 2014 to May 2014 at "Gunung" Village, Tabukan Tengah, district of Sangihe. The village is laid from the coast to the top of the hill with an altitude of ±600 meters above sea level (m asl). The data analysis techniques in this research were descriptive analyses, and F test ANOVA.

The results showed that the production of Sagu Baruk Palm, based on three different altitudes, for the stem length of 9.7-11m and stem diameter of 14.3-15.7cm were obtained 44-44.3kg wet sago flour and the sago flour to palm stem ratio from 21.3% to 22.3%, statistically it was only stem weight and pith weight that were significantly influenced by the altitudes. The heaviest stem weight was obtained at the bottom position, while the heaviest pith weight was obtained at the top position, and for the largest ratio of sago flour to palm stem was obtained at the top position. The chemical compositions were significantly different in the levels of protein, calcium, iron, magnesium, and pH at the three altitudes.

***Keywords* – Production, Chemical Composition, Local Food, Sagu Baruk Palm.**

I. Introduction

Sagu Baruk Palm is a kind of sago plant that grows on dry land encountered in Sangihe Distric Island which is spread out in all fifteen districts with total area of 398.5 ha with total production of 713.14 t/year (Dinas Pertanian, Perkebunan, Peternakan dan Kehutanan, Kabupaten Kepulauan Sangihe, 2009)[1]. Sago palm can grow in land from 1 m of the seashore up to 600 m above sea level. The stem may reach a diameter of 14-25 cm and between 6-16 m in height (at mature stage). Noli and Allorerung (2001)[2] proposed that this plant belongs to the Palmae family and the genus of Metroxylon since it contains starch and is able to form a cluster. However, because the flower structure is similar to Arenga *palmga pinnata* Merr (Nurmayulis *et al.,* 2011)[3], Sagu Baruk Palm is classified into the genus of Arenga (Pusat Penelitian dan Pengembangan Perkebunan Bogor, 2005)[4]. Sagu baruk palm has root systems which can with stand the layer of soil, so the palm can suppress soil erosion and minimize surface runoff. Sagu baruk palm has a number of sago leaflets on each leaf that ranges between 50-60 with varying sizes of 42-72 cm long and 4-7.2 cm wide (Barri *et al*, 2001)[5], sagu baruk palm can grow and reproduce on steep land (60^0 -70^0) (Barri *et al*, 2001)[5]. Sagu baruk palm according to its ownership considered as privately owned natural resources, which is only found in the Sangihe Island (as an endemic plant) that its existence needs to be maintained or conserved (Mogea, 2002)[6]. Act no. 32 Year 2009 Chapter 1 Article 18 (Sekretariat Negara RI, 2009)[7] explained that natural resources conservation is the management of natural resources to ensure the wise utilization and the continuing availability by keeping maintaining and improving both quality and diversity.

Sagu baruk palm is the source of staple food for 88.33% population in Sangihe Island (Dinas Pertanian, Perkebunan, Peternakan dan Kehutanan, Kabupaten Kepulauan Sangihe, 1980)[8]. According to Noli *et al.* (2001)[2] production of sagu baruk palm/stem is around 13-15 kg/stem, while according to (Dinas Pertanian Rakyat Propinsi Dati I Sulut, 1980)[8] it may reach 25-30kg/stem. Sago flour can be used either directly as food or processed in industry such as the ingredient of cakes, noodles (Rostiwati, 1988)[9], and artificial syrup (Balai Riset dan Standardisasi Industri Manado, 2006)[10]. Moreover, sago flour can also be used as raw material for manufacturing biodegradable plastic, ethanol and other biofuel industries (Samad, 2002)[11]. Sagu Baruk stems are strong enough to be used as construction material (concrete reinforcement material) and potential to be developed as furniture. Sago waste residue can be used as animal feed and potential for cultivating mushrooms. When the pulp is recycled in the soil, it can be used as fertilizer.

Sagu baruk palm is not only used as a source of carbohydrates but it is also valuable for reforestation program (Mahmud dan Amrisal, 1991; Samad, 2002)[12,11]. Sago plant shows highly resistant to the drought. In the long dry season which other crops usually do not survive, the palm still can grow and productize. Sagu Baruk palm can grow naturally to form 5 to 6 seedlings every month (personal Communication with sagu baruk farmers, 2010). In cultivating the plant, farmers do not particularly apply a special treatment but just cleaning when they cut down sago trees from the cluster. Its economic value is one of the advantages of sagu baruk palm. Its ability which holds and distributes water into the soil as well as the ability to grow on dry land is highly reliable potential for utilizing sago palms as superior carbohydrate plants.

The purpose of this study were (1) to analyze the production and yield of sagu baruk palm, (2) to analyze the chemical composition and nutrient content of sagu flour.

II. Materials and Methods

The research was conducted from March 2014 to May 2014 at "Gunung" Village, Tabukan Tengah, Sangihe Island District. The materials of the experiments from mixed farm land with an altitude of ± 600 m asl. The tools used for this experiment were GPS, clinometers, set of sago processing devices. The altitude in this research was divided into 3 levels, namely high altitude (400-600 m asl), the medium altitude (200-400 m asl), and the low altitude (0-200 m asl) based on the type and soil physical properties as described. At each altitude three of sagu baruk palms were taken to be processed become sago flour. The method of this research was a survey with a purposive sampling method. Data analysis techniques included descriptive analysis, T test and F test (ANOVA) using SPSS 16.00.

The parameters observed were stem length, diameter, weight, pith weight, flour weight and ratio of sago flour to palm stem. Meanwhile, the chemical observed were proteins (Ghosh and Dill, 2009)[13], fats (Sanderrs,*et al,* 2011)[14], carbohydrates (Ferrier, 2002)[15], water, calcium, iron, magnesium, acidity, ash and energy (Wolmarans,*et al,* 2008)[16].

III. Results and Discussion

The Sagu Baruk Palm Production

The results of the experiment from three different locations are presented in Table 1. Stem length, diameter, flour weight and the sago flour to palm stem ratio from the three altitudes were not significantly different. However, the stem weight and pith weight showed a significant difference. This is probably due to differences in soil fertility level and timely harvest (Lay *et al*., 1998; Mahmud and Amrizal, 1991)[17,12]. The stem weight of the low altitude sagu was the highest among the other altitudes but this did not relate to the flour weight variable. This indicates that the yield of plant as shown by the flour was the most important component although they were taken from three different altitudes. Based on the data presented in Table 1, it is likely that palm productions from the three locations were not significantly different. The production from the plants between stem weight and pith weight would not show significant difference. It is concluded that the sagu baruk can be grown from seashore and land reaching the altitude of 600 m asl. . The result of sagu baruk flour production is shown in the Table 1.

Table 1: Comparison of sagu baruk palm production of the different altitudes

Variable	Altitudes		
	High	Medium	Low
Stem Length (m)	11.0 a	9.7 a	11.0 a
Stem Diameter (cm)	14.3 a	15.7 a	15.0 a
Stem Weight (kg)	199.0 b	196.7 a	205.0 c
Pith Weight (kg)	132.7 b	121.7 a	122.7 a
Flour Weight (kg)	44.3 a	42.0 a	44.0 a
Stem Rendemen (%)	22.3 a	21.3 a	21.5 a

Numbers followed by the same letter at the same line are not significantly differentat p = 0.05

Chemical Contents

The contents of protein, carbohydrates, water, ash and energy content of the sagu baruk palm flour from three different altitudes were not significantly different (Table 2). However, fat, calcium, iron, magnesium contents and the pH value were significantly different. The differences of the chemical contents from three different locations are due to the process of photosynthesis which finally produces carbohydrates and other components (Ferrier, 2002)[15]. The raw materials are inorganic component with the aid of sun light.

The sagu baruk palm is probably classified as C-3 plants with high photosynthesis rates between 10–35 mg/dm^2/hour with high compensation points range from 30 to 70 ppm. The plant which grows from the coast to the mountain produces similar results in the carbohydrates, protein, water, ash, and energy contents. It is likely that the sagu baruk palm has high tolerance to temperatures (Lay *et al*.,1998)[17]. The temperature factors in relation to height will give an effect because the higher altitude has low temperature, but to the process of photosynthesis at low temperatures the energy used for respiration is also low. Therefore, the carbohydrates, protein, water, ash and energy as the results of photosynthesis activity were similar due to the different altitudes. In associated with metabolic processes, total proteins, fats and carbohydrates are the primary metabolic outcome, while terpenoids, steroids, flavonoids and alkaloids are the result of secondary metabolism. In the process of secondary metabolic, primary metabolism changed into metal ions and other products. The content of calcium, magnesium, iron can be affected by the topography of Sangihe Regency that is mostly composed of volcanic tuff rock, algomerat, andesite, diarit resulted from molten magma. Acidity of soil from the same kind of rock may be different due to the weathering process of litter at the study site land used is mixed farms. The result of chemical contents of sagu baruk flour is shown in the Table 2.

Table 2: Chemical contents of sagu baruk flour of the different altitudes

Variable	Altitudes		
	High	Medium	Low
Protein (%)	1.79 a	1.63 a	1.70 a
Fat (%)	1.39 a	1.24 ab	1.57 c
Carbohydrates (%)	55.43 a	55.83 a	55.18 a
Water (%)	40.62 a	41.48 a	40.04 a
Calcium (ppm)	67.13 a	90.36 b	127.07 c
Iron (ppm)	0.33 b	0.42 b	0.16 a
Magnesium (ppm)	11.88 b	9.34 a	11.58 b
pH	6.41 c	4.12 a	6.23 b
Ash (%)	0.18 a	0.18 a	0.21 a
Energy (cal)	241.39 a	241.00 a	253.11 a

Numbers followed by the same letter at the same line are not significantly differentat p = 0.05

The fat content from the three different altitudes was significant. The low altitude sagu yielded the highest fat content, 1.57%, followed by those from high and medium altitudes. Fats, proteins and carbohydrate are the primary metabolic outcome, the process of fats formation in palms in general depends on the age of the plants (Mahmud and Amrizal,1991)[12]. The age of sample palms used in the experimentation was not known precisely. However, the palms population in the medium altitude showed younger in their performances, than the sago product were lower from the other altitudes.

The calcium content of the trunk resulted from the low altitude was the highest (127.07 ppm), meanwhile the content of the high location was the lowest (67.13 ppm). This result is probably due to the leaching process from the top part of land and flow down to the lower land.

As shown by the calcium parameter, the content of iron in the trunk resulted from three different planting area was also significantly different. The content of iron of the high altitude was the highest (0.42 ppm), meanwhile the low altitude yield the lowest iron content, 0.16 ppm. The differences in iron content were perhaps affected by the environmental conditions (kind of rocks, the presence of soil surface) and also due to the root interception and competition of this element entering the plant tissue.

Three locations of growing sagu baruk palm also affected the different content of magnesium. The data showed in Table 2 listed that the high altitude had the highest magnesium content (11.88 ppm) followed by the low (11.58 ppm) and the medium (9.34 ppm). This condition was probably due to uneven rock composition as (aglomerat, lava, tuf volcanic, andesit) and the balance of nutrients and also due to the differences of minerals concentration entering the plant tissue (Uchida, 2000)[18]. The pH values of different levels of sagu baruk palms plantation were also significantly different. The soil of the high altitude results the highest pH value compared to that of the soil of the medium and the low altitude. The pH value of the soil of the high altitude was 6.41, while the values of pH of the low and medium altitude were 6.23 and 4.12 respectively. The differences in pH values were probably caused by the environmental situation (accumulation of litter, leaching, etc.)

In relation with the chemical content of the sagu flour, especially with the energy, the probability of the flour using for food supply is very likely. The energy content of each 100 g of sagu flour contains 253 calories, whereas for 100 g of rice will produce 360 calories. Therefore, the comparison of the calorie content of rice and sago baruk is 1:1.42. This means that consuming 100 g of rice would be equivalent to 142 g of sago baruk flour. Based on the result of this experiment, the consumption of sagu baruk flour as a food substitution for rice would be very beneficial. If the People of Sangihe Insland eats rice three times daily, one third of this meal can be replaced by eating processed sagu baruk flour.

IV. Conclusion

The production of sagu baruk palm from three different altitudes were quite similar, this plant can grow from low to high land. The use of sagu baruk flour as rice substitution for local people of Sangihe region especially for staple food is very likely. The Average production of sagu baruk starch at each location are as follows, at 508 m above sea level is 44.3 kg, at 330 m above sea level is 42.0 kg and at 44 m above sea level is 44.0 kg.

Suggestion

Based on this research, some suggestions are provided as follows:

For the Government in Sangihe district that Sagu Baruk Palm needs to be developed and preserved within the framework of the availability for local food sources. To consume the sagu baruk flour recommended that combined with foods that contain protein such as fish or meat.

References

[1] Laporan Tahunan Dinas Pertanian , Perkebunan, Peternakan Dan Kehutanan (DP3K) Kabupaten Kepulauan Sangihe.2009. p.25-30.
[2] Noli, B dan David,A. 2001. Survey Keragaman Tanaman Dan Ekosistem Habitat Sagu Baruk Di Kabupaten Sangihe Talaud.Laporan Akhir Kegiatan Penelitian Balai Penelitian Tanaman Kelapa Dan Palma Lain. pp.115.
[3] Nurmayulis, Susiyanti and Kartina. 2011. Growth of Arenga Palm(Arenga *palmga pinnata* (Wurmb) Merr) Explant With Benzil Amino Purine (BAP) Application. Agrivita, Journal of Agricutural Science, 33 (2): 142-145
[4] Pusat Penelitian dan Pengembangan Perkebunan Bogor.2005. Budidaya Dan Manfaat Sagu Batuk .Bulletin Palma..29:73-74.
[5] Barri, N dan D.Allorerung. 2001. Survey Keragaman Tanaman dan Ekosistem Habitat Tanaman Sagu baruk di Kabupaten Sangihe Talaud.Laporan akhir Kegiatan Penelitian Balai Penelitian Tanaman Kelapa dan Palma lain.pp115.
[6] Mogea, J.P. 2002. Preliminary study on the palm flora of the Lore Lindu National Park, Central Sulawesi, Indonesia. Biotropia 18: 1–20
[7] Sekretariat Negara RI.2009. Undang-Undang no 32 Tahun 2009 tentang Perlindungan dan Pengelolaan Lingkungan Hidup,pp 39.
[8] Dinas Pertanian Rakyat Propinsi Dati I Sulut .1980. Beberapa Penelitian Sagu baruk di Pulau Sangihe Besar, Kabupaten Sangihe Talaud, Bulletin Palma. 26:21-22
[9] Rostiwati, T. 1988. Teknik Penanaman Sagu, Pusat Penelitian dan pengembangan Hutan Bogor. Bulletin Palma.235:13-18.
[10] Balai Riset Dan Standardisasi Industri.Manado.2006. Pembuatan Sirup Glukosa Dari sagu Baruk Secara Enzimatis,93: 10-15.
[11] Samad, M.Y . 2002. Meningkatkan Produksi Industri Kecil Sagu Melalui Penerapan Teknologi Ekstraksi Semi Mekanis. Jurnal Sains dan Teknologi Indonesia Vol.4, No.5, hal. 11-17
[12] Mahmud,Z Dan Amrizal. 1991. Palma Sebagai Bahan Pangan,Pakan Dan Konservasi.Bulletin Balitka.14:112-114.
[13] Ghosh, K. and Dill, K.A.. 2009. Computing protein stabilities from their chain lengths. Proceedings of the National Academic of Science, USA. Jun 30, 2009;106(26):10649-106454. Epub 2009 June 17.
[14] Sanders, C.R. and Mittendorf. KF. 2011. Tolerance to Changes in Membrane Lipid Composition as a Selected Trait of Membrane Proteins. *Biochemistry*, 50 (37), pp 7858–7867. DOI: 10.1021/bi2011527
[15] Ferrier, R.J. 2002. The Carbohydrate Chemistry: Volume 33. Royal Society of Chemistry

[16] Wolmarans, D.N. P,, Buitendag, C.S. and De Jager, A. 2008. Energy and nutrient composition of South African wheat, wheat flour and bread. *Technical report to The Winter Cereal Trust of South Africa*. ISBN: 978-1-920014-54- Medical Research Council of South Africa

[17] Lay,A; D, Allorerung; Amrizal,dan M, Djafar. 1998. Pengolahan Sagu Berkelanjutan , Hasil-Hasil Penelitian Kelapa dan Palma Lain, Balitka Bulletin,29: 73-75.

[18] Uchida, R.S. 2000. Recommended plant tissue nutrient levels for some vegetable, fruit, and ornamental foliage and flowering plants in Hawaii. In: *Plant nutrient management in Hawaii's soils. College of Tropical Agriculture and Human Resources.* Silva, J.A. and Uchida, R.S. (eds),, University of Hawaii at Manoa. pp. 57–65.