

Potency of Natural Sweetener: Brown Sugar

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Abstract: This research about the substitutes of sugar cane that have the characteristics of a natural, valuable health, and have many functions for the preservation of nature. Brown sugar is a sugar substitute derived from palm plants, such as *aren* (*Arenga pinnata* (Wurmb) Merrill), *kelapa* (*cocos nucifera*), *siwalan* (*Borassus flabellifer* L.). This research aims to investigate the potential of resource, social and economic of brown sugar as a natural sweetener that can substitute sugar cane. The study shows that the *aren trees* which is the raw material of brown sugar is available in abundance, especially in mainland Southeast Asia, has high adaptability, it also serves as a forestry crop. Furthermore, brown sugar business can be done by people with low education, and in all age groups but predominantly in the range of productive age. Brown sugar is a natural sweetener because of its natural raw materials and the way of processing so valuable health. Economically, brown sugar has proven to be a source of livelihood and feasible to be developed. The implication of this study is about information to explore the potential of resources, social, and economics of brown sugar as a natural sweetener internationally.

Key-Words: natural sweetener, brown sugar, potential, aren tree, sap, feasibility

1 Introduction

Sugar is a strategic commodity because it has used worldwide. Sugar is used as an additive in various foods and beverages consumed daily by the world community. [1] According to Dubai's Sugar Yearbook data 2007 shows that sugar consumption was the smallest in Sub-Saharan Africa, at 8 million tonnes of sugar or 15.2 kg in per capita terms, then comes North America at 11 million tonnes, Eastern Europe at around 13 million tonnes, the Middle East and North-Africa at around 15 million tonnes and Western Europe, at around 18 million tonnes. All these four regions show a per capita consumption of at least 32 kg or more. Both the Indian Subcontinent and Latin America are consuming around 27 million tonnes of sugar a year, but per capita consumption in the Indian Subcontinent was only 16.3 kg while in Latin America it was much greater at 47.2 kg.

Increase in sugar consumption also occurred in India and Indonesia. [2] said that India's sugar consumption has increased steadily. Per capita sugar consumption has steadily increased from 5.3 kg per annum in the early 1960's to around 18 kg per annum at 2011. Increased consumption of sugar cane in Indonesia occurred every year but is not followed by the increased of production. It is pointed out by the [3] that sugar cane industry in the Indonesia is not able to meet the needs of the national consumption of sugar cane. This situation is shown in the Table 1 below.

Table 1. Production, Consumption, and Import, 2005-2013

Year	Production (Ton)	Import (Ton)	Consumption (Ton)
2005	2,241,742	1,980,487	3,057,536
2006	2,307,027	1,405,942	3,760,000
2007	2,448,143	2,972,788	3,750,067
2008	2,668,429	983,944	3,508,000
2009	2,299,503	1,373,546	4,850,109
2010	2,214,489	2,300,089	4,289,000
2011	2,228,259	2,060,000	4,670,770
2012	2,591,687	2,350,000	5,200,000
2013	2,762,477	2,260,000	5,516,470

Source: [4]

Table 1 shown that production, imports, and consumption on an upward trend generally, despite the downturn in certain years. Average increase in consumption is much greater than the average increase in production as well as imports. Decrease in production occurred in two consecutive years in 2009 and 2010. The highest increase of production occurred in 2012. Decline in imports occurred 4 times. The biggest decline in imports occurred in

2008. While the consumption is drop in last occurred in 2010, and after that sugar consumption continues to rise. Thus, it required a solution to meet the needs of the sugar in addition to sugar imports that can reduce foreign exchange without being followed by public welfare.

All the data is about sugar cane or white sugar. The high sugar demand of world community cannot be met by the sugar producers sustainably basis due to the limited resources of sugar beet or sugar cane. Thus, recent years the fulfillment of sugar demands came from beet plants genetically modified in the same way as most of the corn, soybeans and cotton grown in the U.S. The other half comes from sugar cane, [5].

There is the phenomenon that there is a great need for sugar as a sweetener, but people want a low-calorie sweetener and healthy. It is suitable with [6] which said that sugar is a purified (refined) sugar cane or beet juice after all the vitamins, minerals, proteins, enzymes and other beneficial nutrients discharged. As a result, the sugar does not contain a variety of nutrients and fiber found in other, more complex carbohydrates such as grains, fruits, and vegetables.

There is an alternative sugar. It is call low calorie sweeteners that its ingredients many times sweeter than sugar (sucrose). Examples include acesulfame-K, aspartame, saccharin, stevia and sucralose which are between 150 and 600 times sweeter than sucrose, and neotame which is between 7,000 and 13,000 times sweeter. Low calorie sweeteners are a valuable and safe tool for providing consumers with the opportunity to choose foods and beverages with different calorie levels [7]. According to [7] that in Europe and around the world, low calorie sweeteners, like other food additives, undergo a rigorous assessment process.

Sugar consumers turn to other sources of natural sweetener for health issues. Commodities are booming natural sweetener is stevia. Lately, many people complain about the aftertaste of stevia, and it doesn't melt or cook like sugar does [8]. Therefore, many people in the natural health community have been turning to agave nectar, a low-glycemic sugar made from the bulbous roots of agave plants. [8] continued that agave plants has also been embroiled in controversy about whether it is truly "natural" or even low glycemic.

Next, [9] said that the emphasis on the consumption of natural foods has resulted in the use of palm sugar concentrate as an alternative sweetener. There is brown sugar as the substitute of sugar cane. Brown sugar is a natural sweetener

derived from the sap of palm plants, like *aren* (*Arenga pinnata* (Wurmb) Merrill), *kelapa* (*cocos nucivera*), *siwalan* (*Borassus flabellifer* L). Productivity of sap from the *aren* (*Arenga pinnata* (Wurmb) Merrill) was the highest among the sap of *kelapa* (*cocos nucivera*), *siwalan* (*Borassus flabellifer* L). Thus, the study of the natural sweetener will be focused on brown sugar derived from *aren* (*Arenga pinnata* (Wurmb) Merrill).

2 Research Background

The aims of this research was to investigate the potential of resource, social and economic of brown sugar as a natural sweetener that can substitute sugar cane. Conceptual framework to achieve the research aims was shown on Figure 1.

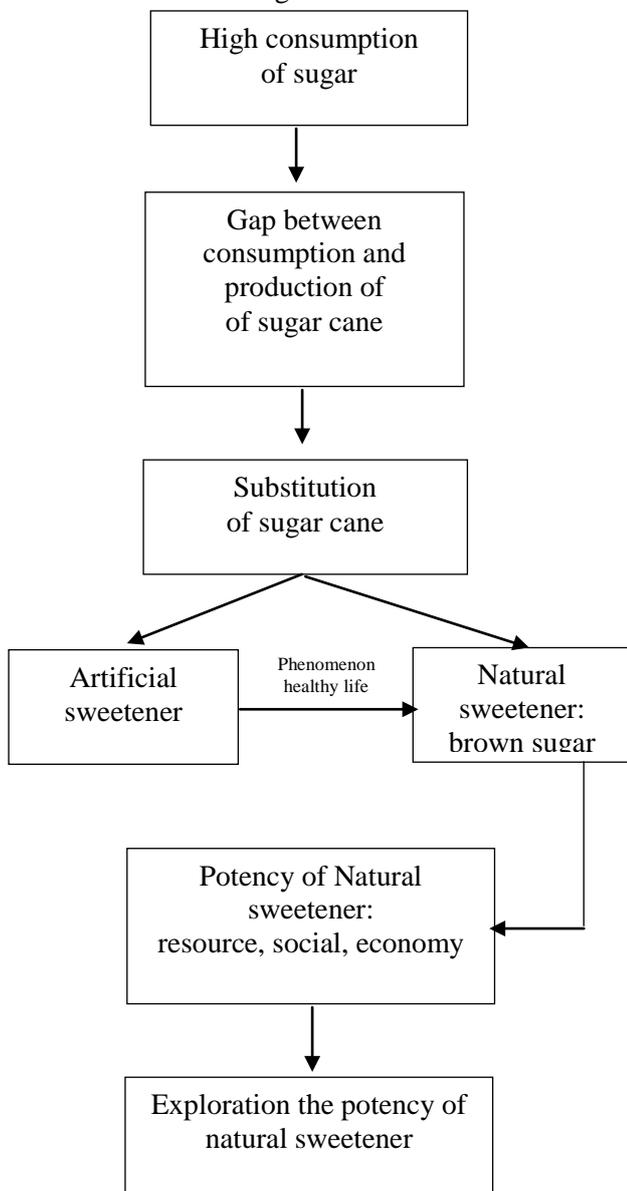


Fig.1 Research Conceptual Framework

Figure 1 illustrates the connection between the problem about high consumption of sugar cane as sweetener for daily food and beverage and the effort to finding and explore its substitute that have valuable health and big potency in resource, social, and economic. It could be explained that there was a phenomenon of consumers want about natural sweetener.

It was suitable with [10] who said that artificial sweeteners are regulated by the Food and Drug Administration (FDA) as food additives. Next, he said that all of artificial sweetener must be reviewed and approved by the FDA before being made available for sale. There was consumers want to use many artificial sweetener that did not require FDA approval before sale or consume. Natural sweetener (brown sugar) could be solution of that wants. Besides that, brown sugar is not refined or bleached so it retains its nutrients.

3 Research Methodology

Qualitative and quantitative methods were be used in this research. Potency in resource, and social of brown sugar were be investigated by qualitative method. The data were be collect by study of literature. Require data in this case were distribution and characteristic of *Aren* (*Arenga Pinnata* (Wurmb) Merrill), sap productivity, and its adaptability, demographic of brown sugar producer, and their habit in processing brown sugar.

Potency in economics of brown sugar were be investigated by quantitative method, namely R/C ratio analysis. R/C ratio shows feasible or not brown sugar business.

$$R/C \text{ ratio} = \frac{R}{C}$$

Where R is revenue of palm farmer from brown sugar business, and C is total production cost (fixed and variable cost). Brown sugar business is feasible if R/C ratio > 1, and it is not feasible if SR/C ratio < 1. The result of R/C ratio will be compare with previous studies in order to obtain generalization about economic feasibility of brown sugar business.

4 Problem Solution

Study of potential of brown sugar as natural sweetener alternative translated in some aspect into the following:

4. 1 Resource potency

Discussion about the resource potency of brown sugar include the assessment distribution of *aren tree* in the world with their advantages and

disadvantages as the main source of raw material (sap) on the manufacture of brown sugar. In this case the content of the natural nutrient in the sap and the brown sugar was examined also.

The raw material of brown sugar is derived from the sap of palm plants, such as *aren* (*Arenga pinnata* (Wurmb) Merrill), *kelapa* (*cocos nucifera*), *siwalan* (*Borassus flabellifer* L.). Among the types of palm plant, *aren* (*Arenga pinnata* (Wurmb) Merrill) produce abundant sap. Average sap of *aren* 10-15 liters per tree per day [11]. The other study by [12] said that the average production of sap was highest was produced by *aren* in 10 to 20 years as much 20.83 liters per tree per day while *aren* in 21 to 30 years only produce 7.95 liters per tree per day. Compare with other palm plant, namely; according to [13] that the sap production of *siwalan* (*Borassus flabellifer* L.) 5-6 liters per tree per day, and [14] said that the sap production of *kelapa* (*cocos nucifera*), 3-5 liters per tree per day.

Aren grows naturally in the tropical regions. Spread of *aren* region cover: Southeast Asia to Papua east part, Jepang (Ryukyu Island), Vietnam (Annam) dan east Himalaya [15]. Native to Southeast Asia (Bangladesh, Brunei, Cambodia, India, Indonesia, Laos, Malaysia, Myanmar, Papua New Guinea, Philippines, Singapore, Sri Lanka, Thailand, Vietnam), occurring in tropical rainforest and dry forest [16].



Fig. 2. Distribution of native countries of *aren*

Source: [16]

The map above shows countries where the species has been planted. But, it did not mean the species could not be planted in other countries than those depicted.

Aren has a different name (local name) in each country, namely : Indonesian (*aren*, *ejow*, *gomuti*, *kaong*); Thai (*tao*, *chok*, *kaong*); Vietnamese (*doasc*, *busng* *basng*); Burmese (*taung-ong*); Lao (Sino-Tibetan) (*taw tad*); English (*arenga* palm,

sugar palm, sagwine); French (*palmier areng*, *palmier à sucre*); German (*Zuckerpalm*); Italian (*palma dello zucchero*, *palma arenga*); Spanish (*palma azucarera*), Holand suiker palm) ([16].

In southern Thailand, *aren* is widely grown in Petchaburi and Songkhla Provinces [9]. [17] said that in Indonesia, there are 14 province from 34 province that have the abundance of *aren tree*. It is showed in Table 2.

Table 2. Palm planted area in Indonesia, 2002

No	Province	<i>Aren tree</i> area (Ha)
1	Moluccas	1,000
2	South Kalimantan	1,442
3	Banten	1,448
4	Bengkulu	1,748
5	West Sumatra	1,830
6	North Moluccas	2,000
7	Southeast Sulawesi	3,070
8	Central Java	3,078
9	Nangro Aceh Darussalam	4,081
10	North Sumatera	4,357
11	North Sulawesi	6,000
12	South Sulawesi	7,293
13	Papuan	10,000
14	West Java	13,135
Total		60,482

Source : [17]

Table 2 shows that West Java as the highest *aren tree* area, while the Southeast Sulawesi has the fifth largest area plantation among the fourteen provinces in 2002 (3,070 Ha). However, there has not been definite data about *aren tree* area until now. This is because *aren* has not been cultivated specifically but only grows wildly.

Breadth distribution of *aren tree* was caused its height adaptability. [18], [19], [20] said that *aren tree* has well adapts to a variety of agro climate, ranging from lowlands to 1,400m. [21] also reported that the sugar plant often grows from sea level to an altitude of 1,300 m above sea level. But this plant is more like a place with a height of 500-1,200 m [22] and when cultivated in places with an altitude of 500-700 m above sea level will give satisfactory results [21]. Soil conditions are adequate nest or excess water can pass, such as loose soil, volcanic soil on the slopes, and the soil is sandy land around the banks of the river is ideal for growing sugar. The best environmental temperature 25⁰C with an average annual rainfall of 1,200 mm on average.

In addition, to the excellence of its adaptation power so as to ensure the availability of raw material for brown sugar on a large scale, *aren* also

has a very good conservation benefits. [19] said that *aren* has a high tolerance in a mixed cropping pattern including the fast growing woody plants as well as have a lot of roots and dense canopy is suitable to be developed as well on marginal lands that are mostly poor farmers. In addition, [23] said that the *aren tree* produce biomass above-ground and in the soil that are very large so it plays an important role in the CO₂ cycle.

In line with what was said by [15] about some advantage of *aren tree*, namely: a) it has high adaptability to various soil and agro climate condition, even though no intensively cultivation. b) it has high hydrological function (relatively fast growing and has dense root and crown) making it suitable for plant conservation, c) it has high tolerance in mixed cropping pattern including timber plants. It is reported to by [24] that Sugar palms constitute an important resource at the local level that has a great potential as a component in agro-forestry systems.

Another advantage is that the *aren tree* can thrive even without fertilization. This as the result of research by [25] where the non-fertilizer application gave a better net benefit than the three fertilizer formulations for the sugar palm growth. Therefore, [25] recommend that the sugar palm be planted in community forests in northern Thailand using plenty of water, with a propertillage practice, and without costly fertilizer. This condition is also supporting the naturalness of brown sugar made from sap of *aren tree* (sugar plant).

One of the indicators of brown sugar is a natural sweetener for raw materials derived from palm plants that grow naturally without artificial fertilizer and pesticide free. No pest and diseases have been reported [26]. Next, [26] said that brown sugar does not use artificial colorants and aroma enhancer.

Palm sugar is a nutrient-rich, low-glycemic crystalline sweetener that looks, tastes, dissolves and melts almost exactly like sugar, but it's completely natural and unrefined. has a far superior taste [8].

Actually brown sugar has been known and used by some countries since some years ago. This is shown by the variation of the local names which vary by country and even in some regions within a country. Indonesia, Malaysia, Philippines, Thailand, India, Brazil, Mexico, and Venezuela has developed to produce palm sugar. There is some local name of brown sugar in some country [27] as follow: Indonesian: *gula kelapa*, *gula aren*, *gula merah*, *gula Jawa*; Malaysia: *gula anau*, *gula Melaka* (coconut palm), *gula kabung* (arenga pinnata

palm/sugar palm); Philippines: *Pakaskas*; Thailand: *nam tan pip* (น้ำตาลปีบ; pronounced [ná:m.tā:n.pí:p]) or *nam tan puek* (น้ำตาลปีก; pronounced [ná:m.tā:n.pùk]); Vietnam: *đường thốt nốt*; Sri Lanka: jaggery, *kitul-hakuru*, *tal-hakuru*, *pol pani*; Laos: *nam tan pip* (ນ້ຳຕານປິບ; pronounced [nâm.tà:n.píp]); Bangladesh/Bengal: *gur* (cane sugar), *taal patali* (solid palm sugar), *khejur gur* (date palm sugar); Cambodia: *ស្ករត្នោត* (*skor tnot*); Burma: jaggery, *htanyet* (pronounced: [tʰəŋeʔ]); Telugu: *nalla bellam*, *thaati bellam* (Palm Jaggery); India disebut *kerala*, *karippati* atau *karipotti*, Kannada: *bella*.

[17] also reported that brown sugar is produced by country who has tropic climate, namely China, Thailand, Vietnam, India, Korea Selatan, Bolivia, Brazil, and Indonesia Indonesia as one of develop country that produce brown sugar have big potency as exporter country of brown sugar. Develop country as a producer country as well as a potential market of brown sugar. It is suitable with [28] who said that emerging markets have become an important economic pole, and rising interest in investment opportunities in these markets has spread among investors.

Brown sugar was a widely used health food in ancient India. Even now in many Indian villages it is being widely used. This is especially significant for women's health [29]. Next, [29] reported that traditionally that brown sugar has lots of medicinal qualities. It is widely used in Indian medical sciences like Siddha and Ayurveda. It is known to be effective against cold and lung related ailments.

Brown sugar potential as a sugar substitute is not only caused by the same function as a sweetener, but also because of the nature, unique flavor and aroma, as well as its nutritional content.

Compared to white sugar, brown sugar content has calcium, phosphorus, and iron higher, also contains thiamine and riboflavin [30]. It is showed by Table 3.

Table 3. Comparison of macro and micro minerals in brown sugar and white sugar

Mineral	Brown Sugar	White Sugar
Micro Mineral mg/L (ppm) in dry matter		
Manganese (Mn)	1.30	0.00
Baron (B)	0.30	0.00
Zinc (Zn)	21.90	1.20
Iron (Fe)	2.30	1.20
Copper (Cu)	2.30	0.60
Macro Mineral mg/L (ppm) in dry matter		
Nitrogen (N)	2.02	0.00
Phosphorus (P)	790.00	0.70
Potassium (K)	10.30	25.00
Calcium (K)	60.00	60.00

Magnesium (Mg)	290.00	10.00
Sodium (Na)	450.00	10.00
Chlorin (Cl)	4.70	100.00
Sulfur (S)	260.00	20.00

Source: [30]

Other health benefits of brown sugar has been reported by [31] that smaller calories contained in a palm sugar than white sugar. Palm sugar or brown sugar has a glycemic index value that is lower by 35 while the white sugar glycemic index of 58. Brown sugar still have the main benefit such environmentally friendly. It is because brown sugar is made from palm sap that free from pesticide.

[32] Also reported about comparison between palm sugar and white sugar. It is shown on Table 4. Table 4. Comparison Palm Sugar with Sugar Cane

No	Palm sugar	Sugar Cane
1	Free from Chemicals, bleaches, preservatives and GMO	Bleached using harmful chemicals and bleaches, the traces of which are very much present in the Sugar
2	Highly Nutritious, contains about 24 nutrients including Vitamins, Minerals and Protein	Contains hardly any nutrients
3	All nutrients are natural and not fortified or artificially added	Contains hardly any nutrients
4	Contains Vitamin B12, which is very rare to find in Plant Sources. Consumption of 15 gms of Palmyra Palm Sugar daily takes care of daily Vitamin B12 requirement of an adult	Contains hardly any nutrients
5	Traditionally in India women are suggested to consume palm sugar as a first thing after giving birth to a child and immediately after Puberty, because of its high nutritional content	Contains hardly any nutrients
6	Contains Low Glycemic Index. The Glycemic index is only 40. Replacing cane sugar with palm sugar is a big step for diabetics, heart patients, cancer patients and obese people. Normal people by replacing Palm Sugar with white sugar, the risk of diabetics, obesity and heart ailments are reduced.	Contains High Glycemic Index. The GI of cane sugar is more than 92. This makes it harmful for Diabetic patients, heart patients, cancer patients and Obese people.
7	Safe for infants to have Palm Sugar as it is free from chemicals and bleaches	Because of presence of harmful chemical, unsafe for infants to consume

8	Consumption of Palm sugar does not make children hyperactive	Consumption of cane sugar makes children hyperactive
9	Palm sugar is certified Organic	Most of the cane sugars available in the market are not organic
No	Palm sugar	Sugar Cane
10	Palm sugar is free from flocculent, surfactants, viscosity modifiers	The process of making cane sugar crystals includes these process
11	Adds unique exotic flavor apart from sweetening the dish.	Merely sweetens the dish
12	Contains medicinal properties. Used in many Ayurveda medicines and in varieties of indigenous medicines of India. By itself it is considered as a medicine for cough cold and breath related problems	Does not known to have any medicinal properties
13	Palm trees are dry land flora. They consume very less water. Consuming Palm Sugar is ecofriendly way of living. An acre used for Palmyra tree cultivation can give more than one and half times of Palm Sugar yield than that of cane sugar. In today's population pressure over land this is very significant	Sugar cane consumes lots of water. To get 1 kg of cane sugar, the water consumed is much higher than that of Palm Sugar
14	Palm sugar consumption brings in equality in economy as this supports unprivileged palm tree tappers life. Since palm sugar comes with minimal processing, the proportion of money spent on processing is less and proportion paid to the farmers is more	Proportion of money which goes to palm tree tappers out of every sale price paid by the customer is high than that of cane sugar. Large share of the money paid by the end customer goes to big sugar mill owners and to meet out huge processing expenditure.
15	Palm Sugar is the Traditional staple sweetener of India. This is the cause of health of Indians for many centuries.	Introduced and popularized to Indians by the British. Cane Sugar is one of the cause of current health problems of majority of Indians through prolific Diabetes, Anemia and Malnutrition

Source: [32]

However [33] said that brown sugar processing is still traditional business and only done by a household, in contrast to the processing of sugar cane. It is produced by large-scale industries. Brown sugar processing business in Southeast Sulawesi Province in Indonesia is generally characterized by a very simple technology and rely solely on family

labour or even just doing one or two people. Supply of brown sugar fluctuates widely in these conditions.

The fluctuating of brown sugar supply can weaken the Southeast Sulawesi potential market of brown sugar. Meanwhile, the certainty supply is requirement for good trade of brown sugar mainly for export purpose. Understanding of risk analysis is also important in this case. This is as proposed by [34] that is not everyone knows the inherent risks involved in investing or how to strike a correct balance between risk taking and making a profit. Next [35] said that Business risk is fundamental to the long term success of a company and the achievement of its goals.

4. 2 Social potency

Discussion about the social potency of brown sugar include the assessment of the social aspect of the brown sugar processing. These include: how to acquire knowledge about the processing of brown sugar, and the characteristics (age, education) of brown sugar producer.

Many social activities became a cultural community around brown sugar producers. Knowledge about creating and managing of brown sugar business are not obtained through a training or special education. Knowledge in managing brown sugar business is obtained based on personal experience and participate in helping a neighbor or family relatives. There is some of brown sugar producer who obtain their knowledge from generation to generation in his family.

That is one of the social potential of brown sugar. Easily transmitted knowledge of brown sugar processing based on emotional relationship between one to another person. It could be used to expand the spread of brown sugar business in many *aren tree* center.

Brown sugar business became source of livelihood for many people in the central areas of the *aren tree*. Thus the characteristics of brown sugar producer needs to be studied as one of the potential development of brown sugar business.

Brown sugar processing business consist of two types of activities, namely tapping and cocking the sap. These activities are still carried out without involving labor rent (labor outside the family). This is because a very small scale of business.

Brown sugar producers only tap between 1 until 5 *aren trees*. Small number of workers as well because they can maximize their energy in that business. This is because their average age in the range of productive age. It is shown in Table 5.

Table 5 showed the characteristic of brown sugar producers by age in the South East Sulawesi, contained in three districts, namely Kolaka, Bombana, and Muna. Table 5 showed that there is no old less than 15 years of brown sugar producer, and only 30% at most of brown sugar producer over the age of 55 years.

Table 5. Characteristic of brown sugar producers by age in the South East Sulawesi, 2014

No	Lokasi	Umur					
		Produktif (15 - 54 Tahun)		Non produktif (>55 Tahun)		Total	
		Σ (orang)	%	Σ (orang)	%	Σ (orang)	%
1	Kolaka	113.00	77.40	33.00	22.60	146.00	100.00
2	Bombana	140.00	70.00	60.00	30.00	200.00	100.00
3	Muna	13.00	65.00	7.00	35.00	20.00	100.00

Source: [36]

The research by [37] also showed the dominance of people on productive age range who produce brown sugar. It is shown in Table 6.

Table 6. Characteristic of brown sugar producers by age in the Rejang Lebong District Bengkulu Province, 2013

Old (year)	Quantity (%)
25-40	40.69
41 – 55	45.36
55-80	13.95

Source: [37]

Brown sugar processing business is dominated by processing the productive age. This indicates that the business of processing of brown sugar can be used as a potential jobs for people in the productive age who do not have jobs. This case as well as a solution for unemployment in Indonesia. The number of unemployed in Indonesia 2014 at 7.15 million people or 5.70% of the total labor force in Indonesia [38].

The level of education is usually a requirement to get a job, but not in this this brown sugar business. It can be seen in Table 7.

Table 7. Characteristic of brown sugar producers by education in the South East Sulawesi, 2014

No	Formal education	Location (District)					
		Kolaka		Bombana		Muna	
		Σ (org)	%	Σ (org)	%	Σ (org)	%
1	No school	10.00	6.85	15.00	7.50	3.00	15.00
2	Elementary School (SD)	70.00	47.95	97.00	48.50	13.00	65.00
3	Junior High School (SMP)	58.00	39.73	63.00	31.50	4.00	20.00
4	Senior High School (SMA)	8.00	5.48	25.00	12.50	0.00	0.00
5	University	0.00	0.00	0.00	0.00	0.00	0.00
Total		146.00	100.00	200.00	100.00	20.00	100.00

Source: [36]

Table 7 showed the characteristic of brown sugar producers by education in the South East Sulawesi, (District of Kolaka, Bombana, dan Muna). Brown sugar business is done by those who have only 9 years of basic education (elementary school, middle), mostly. It can be explained that the no school certificate and no special skills required to run this business.

The research by [37] also showed the dominance of people on primary education who produce brown sugar. It is shown in Table 8.

Table 8. Characteristic of brown sugar producers by education in the Rejang Lebong District Bengkulu Province, 2013

Education level	Quantity (%)
Elementary School (SD)	30.25
Junior High School (SMP)	66.27
Senior High School (SMA)	3.48

Source: [37]

These data in accordance with [38] who reported that in February 2014, Unemployment Rate (TPT) for senior high school education in the highest position in the amount of 9.10 percent, followed by junior high school by 7.44 percent, while the TPT lowest for the primary education level down in the amount of 3.69 percent.

Brown sugar processing skills that have been mastered though by less educated population is a potential for the development of brown sugar business in terms of business scale, and it can more easily in the development of quality and product differentiation, also. It is because they have learned the basic skills in the business.

4.3 Economic potency

Economic potential is explored by analyzing the financial feasibility of the business of processing of brown sugar. Brown sugar business was done in traditional way at household industry. In this condition, *aren trees* was making use of the natural in the brown sugar business. Therefore many inputs that were not counted as costs however need to be assessed all costs incurred brown sugar producers for the existence and development of brown sugar business in the future.

The feasible was be showed by the value of R/C ratio. R is revenue and C is cost. Therefore we will describe about costs and revenue of brown sugar business, firstly. There are two kinds of cost namely fixed and variable cost. It were shown on Table 9 and 10 as below. Brown sugar processing was done every day, actually. It mean that fixed and variable cost expenses every day.

The following description of the use of some types of equipment in Table 9.

- Container was used to hold sap when tapping on a palm tree. There were two or three bunches that could be tapped and one jerry for one bunch.
- Bamboo ladder was used to help palm farmer to climb a palm tree for tapping. One of bamboo ladder for one palm tree.

Table 9. Fixed costs (FC) of brown sugar business

No	Equipment	Depreciation cost (\$/month)	%
1	Container	0.07	4.26
2	Bamboo ladder	0.36	21.32
3	Machete	0.09	5.33
4	Skillet	0.36	21.32
5	Kitchen	0.71	42.64
6	Brown sugar mold	0.06	3.84
7	Spoon stirrer	0.02	1.28
Total		1.68	100.00

Source: primary data

- Machete was used to slice as thin as possible so that the bunch can spend a lot sap.
- Skillet was used to cook the sap until thickened and ready to be molded into brown sugar.
- Kitchen was a special kitchen for brown sugar processing. This were outdoor or in the plantation.
- Brown sugar mold was used to print saps that has been cooked and thickened.
- Spoon stirrer was used to stir the sap while cooking process so as not to scorch.

Table 9 showed various kinds of fixed cost of brown sugar business that came from the use of all the equipment for one tree in a month. One *aren trees* could produce minimal 10 liters and maximal 50 liters of sap, but average produce 30 liters of sap per day, where 1 kg of brown sugar was produced from 4.4 liters of sap. Therefore, one palm tree produced 6.82 kg of brown sugar by price \$1.45 per kg.

Fixed cost was be accounted by depreciation cost. The biggest depreciation cost came from kitchen building (42.64%), while spoon stirrer was the smallest depreciation cost (1.28%). There were the same depreciation cost for bamboo leader and skillet, namely 21.32% from total depreciation cost.

Various kinds of variable cost less than fixed cost. There were four variable cost at Table 10 as bellow.

Table 10. Variable costs (VC) of brown sugar business

No	Equipment	Variable cost (\$/month)	%
1	Sap	78.26	27.44
2	Lime	0.43	0.15
3	Wood fire	43.48	15.24
4	Labor	163.04	57.16
Total		285.22	100.00

Source: primary data

Most farmers obtained palm sap from *aren tree* that grows wild in his plantation. Even so the sap should be counted as variable costs for development of brown sugar business in the future, and so for wood fire and labour. Lime purchased by brown sugar producers and used to inhibit the acidification process sap. This was the smallest variable cost.

Table 10 showed that labour cost was the highest variable cost. It could be explained that brown sugar processing needs a long time, about 10 hours. After ten hours of which brown sugar has been moulded, the work of a palm farmer was not finished, actually. He had to cook the sap that was tapped in the afternoon until the next morning with a small flame. It was done to prevent the sap became acid so it still can be mixed with morning sap and then processed into brown sugar. This continuous cooking process of sap resulting in high demand for fuel.

Base on all information above, now we can analysis feasibility of brown sugar business like Table 11 below.

Table 11. R/C ratio of brown sugar business

Brown sugar Production (kg)	Price (\$/kg)	FC (\$)	VC (\$)	TC (\$)	R (\$)	R/C
204.55	1.45	1.68	285.22	286.89	296.44	1.03

Source: primary data

Table 11 showed the difference between revenue (R) and cost (C), where $R > C$. Therefore the value of R/C ratio was bigger than one ($R/C \text{ ratio} > 1$). It mean that brown sugar business was feasible so it can exist and develop for the future business. However, the small value feasibility is not disputed by brown sugar producer because of the circulation of goods (brown sugar) is very fast. Brown sugar produced each day is always sold out, and even when there are orders for the next day.

The feasibility of very small numbers even close to one, which means the breakeven point ($R=C$). This happens because of the very large dependence against the nature of brown sugar producers in processing brown sugar. As a result, many production inputs were not counted as expenses so that they cannot take into account what the price per kg of brown sugar that they deserve or in other words, the price that can cover the expenses for

production inputs as well as providing a profit. In this condition, regardless of the price of brown sugar in the level of trader will still be accepted by the palm farmer. It was also caused by brown sugar business was still very small scale so that these businesses bear higher costs. This can be overcome by expanding the production scale so that the production cost becomes more efficient.

The feasibility can be improved by increasing the sap raw material acquisition to more than 30 liters per tree. This can be done by intensive cultivation of palm trees and improve the skills of tapping.

Some researchers have examined the business feasibility of brown sugar in various regions in Indonesia such as follow:

[39] showed R/C ratio = 1,12 for brown sugar business in the Dukuh Village, Ngadiluwih Sub District, Kediri District, East Java Province, [40] showed R/C ratio = 1,63 for brown sugar business in the Tuhaha Village, Saparua Sub District, Maluku Tengah District, Maluku Province, [41] showed R/C ratio = 3,06 for brown sugar business in the Mungka Sub District, Lima Puluh Koto Kota District, West Sumatera Province, [42] showed R/C ratio = 1,32 for brown sugar business in the Makian Village, Bacan Selatan Sub District, Halmahera Selatan Province, [43] showed R/C ratio = 1,56 and 1,65 respectively for the wet and dry seasons for brown sugar business in the Rejang Lebong District, Bengkulu Province, [44] showed R/C ratio = 1,5 for brown sugar business in the Bekoso Village, Pasir Belengkong Sub District, Paser District, East Kalimantan Province, [45] showed R/C ratio = 1.26 for brown sugar business in the Kulon Progo District, Yogyakarta Province, and [46] showed R/C ratio = 1.86 for brown sugar business in the Cikuya Village, Culamega Sub District, Tasikmalaya District, West Java Province, [47] showed R/C ratio = 2.12 for brown sugar business in the Tulo'a Village Bulango Utara Sub District, Bolango District, Gorontalo Province.

All of these studies indicate that the efforts of brown sugar processing in various regions in Indonesia is financially feasible. It shows the economic potential of brown sugar so that the business of processing of brown sugar can also be carried out in various regions in Indonesia and in other countries in Southeast Asia. This effort can also be scaled up so that it can supply more sweetener needs of the world community

5 Conclusion

This paper is a qualitative and quantitative analysis. Some things are studied in this paper is on the

various potentials of brown sugar as a natural sweetener in terms of resource, social, and economic potential.

First, potential resources in the form of a broad distribution of palm plant (*aren tree*) as a source of raw material sugar in mainland Southeast Asia, the high productivity of sap of plant palm, length of productive age, high adaptability to various climatic and soil conditions coupled with the additional benefits of plant conservation. Resource potential is also indicated by the naturalness of palm plants that are free of artificial fertilizers and pesticides, the excellence nutrient content of *aren* sap and brown sugar and the uniqueness aroma of brown sugar.

Second, social potential in the form of easily transfer skills to produce brown sugar through the emotional closeness of the relationship between the brown sugar producers. Social potential is also shown in the form of easily recognized and run of brown sugar business by people who only have primary education, so that the business as employment for the population in the productive age. And third, economic potential is indicated by the feasibility value of the brown sugar business.

The implication of this study is about information to explore the potential of resources, social, and economics of brown sugar as a natural sweetener internationally.

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