**EFFECT OF NATURAL PRESERVATIVE’S TYPE ON ARENGA PINNATA SAP AND CONCENTRATION OF SODIUM TRIPOLYPHOSPHATE (STPP) TO THE QUALITY OF SUGAR PALM (*Arenga pinnata Merr)***

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***ABSTRACT***

*This research aims to know the effect caused by a type of natural preservative on Arenga pinnata sap and concentration of Sodium Tripolyphosphate (STPP) to the quality of palm sugar in order to produce a type of palm sugar with optimal quality. The experimental plan used in this research is Randomized Block Design of two factors. The first factors is a type of natural preservative on Arenga pinnata sap (P) consist of 3 levels (mangosteen peel powder, guava leaves powder, and clovers powder) and the second factors is concentration of STPP consist of 3 levels (0,02%, 0,05%, and 0,08%) with 3 replications. The chemical responses analyzed were content of water, ash content, reducing sugar, and total sugar content. The organoleptic responses are color, sweetness taste, aroma, and texture. This research shows that a type of natural preservative on Arenga pinnata sap affects on the content of water, reducing sugar, total sugar content, color, and sweetness taste of palm sugar. The concentration of STPP affects on the content of water, ash content, color, sweetness taste, and texture of palm sugar. Interaction between both factors affects on the ash content, reducing sugar, color, and the sweetness taste of palm sugar. the chosen treatment is p1s3 (a type of natural preservative on Arenga pinnata sap and concentration of STPP of 0,08%) with water content of 4,294%, ash content of 0,892%, reducing sugar content of 3,901%, and total gula content of 82,890%.*

*Keyword : Arenga pinnata sap, natural preservative powder, palm sugar, sodium tripolyphosphate.*

# **PLEMINARY**

* 1. **Background of Research**

Sugar is a generic term that is often defined for each carbohydrate used as a sweetener, but the food industry is usually used to express sucrose, sugar obtained from beet or cane (Buckle et al., 1987). Sugar is one of the nine basic needs of the community. At present, sugar is also a strategic commodity because it is consumed by the whole society.

Dependency needs and national sugar consumption, especially for crystal sugar is increasing from year to year. In 2014, the national sugar demand reached 5,700 million tons. To meet the needs of the sugar is pursued through the National Sugar Self-Sufficiency Program (Ministry of Agriculture, 2013). One type of sugar that is required by the general public is brown sugar. In 2013, the average consumption of brown sugar per capita per week reached 0,105 ounces (Ministry of Agriculture, 2013).

According to the Indonesian National Standard, brown sugar known as palm sugar. According to SNI 01-3743-1995, palm sugar is sugar produced from palm tree sap processing, that is Arenga pinnata (*Arenga pinata Merr*), coconut (*Cocos nucifera*), “siwalan” (*Borassus flabellifer L*), or other types of palms, and shape solid or powder/granules.

Most of the brown sugar is found in the local market is quite varied, especially in terms of appearance and physical properties, namely color, ash content, and violence. In appearance, brown sugar expected was brownish yellow to brown’s color, not too hard so easily when broken, not easy to melt on storage at room temperature, in a clean and an interesting appearance, and has a sweet taste (not acidic).

Factors that lead to diverse and low quality palm sugar on the market can be caused by several things, namely the low-tech process used, the variety and quality of raw materials and processing conditions inconsistent. The main raw material in the manufacturing of brown sugar is sugar palm sap. Palm sugar sap will largely determine the quality of palm sugar produced. Palm sugar sap is one food that is easily damaged because influenced by environmental conditions during tapping and transportation to mills. Damage to the sugar palm sap one of them caused by the fermentation process. Fermentation is caused by the activity of the enzyme invertasi generated by microbes that contaminate sap (Hamzah and Hasbullah, 1997 in Marsigit, 2005).

Production process of palm sugar is using simple and traditional technology. Conditions such as temperature regulation processing uncontrolled, long cooking is only based on estimates, and stirring inconsistent are several factors that can lead to the production of palm sugar to be very varied and tend to be of poor quality. In the end, it makes palm sugar industry is less well developed.

Less precise raw materials handling will complicate the preparation process and lead to failure of the product. Therefore, it is necessary to the process of preservation during storage sap, which during tapping until now will be processed into palm sugar. Natural preservative derived from plants can be used as alternative method of preservation of the sap. Natural preservatives that can be used as an alternative to extend the shelf life of which is the mangosteen peel, guava leaves, and clovers. They can be used as a preservative in the sap because it has antimicrobial and antioxidant activity (Naufalin et al, 2013).

The addition of sodium tripolyphosphate (STPP) in production processing of palm sugar can improve the quality of the color and texture of palm sugar. STPP is a food grade material which is commonly used in the food industry because it has some major chemical properties as a buffer and pH controller. STPP has a function that is more effective than other phosphate compounds to improve the quality of the final product. STPP able to add taste, texture, prevent rancidity, and improve the quality of the end product by binding nutrients dissolved in saline solution (Haloho et al, 2015).

* 1. **Identification of Problems**

Based on the above research background, then the problem can be identified as follows:

1. How does the type of natural preservatives on the sap of the quality of palm sugar?
2. How does the concentration of STPP on the quality of palm sugar?
3. How does the interaction of natural preservatives’s type in the sap and concentration of STPP on the quality of palm sugar?
   1. **Intent and Purpose of Research**

The intent of the proposal is to make efforts to improve the quality of palm sugar which has been produced traditionally.

The purpose of this research is to study the effect of natural preservatives’s type in the sap and concentration STPP on the quality of palm sugar so as to produce palm sugar with optimum quality.

* 1. **Benefit of Research**

The expected benefits of this research are: (1) to increase knowledge of researchers and society, (2) to provide information to the palm sugar’s producer on the action or preservation palm sap before it is processed into palm sugar, and (3) to obtain information regarding the effectiveness of the use of natural preservatives in maintaining the quality of the sap, and (4) to obtain information on the effectiveness of the addition of STPP to quality palm sugar.

* 1. **Frame Work**

Good palm sugar is palm sugar that meet the quality requirements set by the Indonesian National Standard. According to SNI 01-3743-1995, in terms of a good state of palm sugar is palm sugar that has a shape, flavor, and aroma are normal and brownish yellow color to brown. SNI required in palm sugar has a moisture content of 10.0% w / w, ash content of 2.0% w / w, a reducing sugar content of 10.0% w / w, the amount of sugar as sucrose amounting to 77% w / w and part insoluble in water at 1.0% w / w. In addition, palm sugar is also expected to have properties not easily melted in storage at room temperature and not too hard so easy to be broken.

Manap (1995) in Naufalin et al (2012) states that one of the determinants of the quality of coconut sugar is its color. Palm sugar colors are determined by the pH of sap. Coconut sugar is made from the sap with a pH of 6 or less will produce palm sugar with brown color yellowish. Sap with a pH of about 7 will produce coconut sugar with a dark brown. Naufalin et al (2013) in his research stating that the more provision of natural preservatives in the sap will cause the color of palm sugar becomes increasingly brown because the higher pH of the sap.

Coconut sugar has a distinctive sweet taste because it contains several types of carbohydrate compounds such as sucrose, fructose, and maltose. Coconut sugar also has a slightly sour taste due to the content of organic acids, and has a caramel flavor because of the caramelization reaction on carbohydrates during cooking (Sukardi, 2010). The use of natural preservatives to maintain the quality so that the sap of sugar produced is not sour. This caused a natural preservative containing bioactive compounds that can inhibit the fermentation of the sap resulting from enzymatic and microbial activity (Naufalin et al, 2013).

Good palm sugar have the compact’s texture and structure, and not too hard so easily broken and gave the impression of soft (Sukardi, 2010). Naufalin et al (2013) in his study stated that the treatment of mangosteen peel with a concentration of 4.5% produces sugar approached very hard. That is because the higher the concentration of the use of natural preservatives will be able to maintain the pH of sap so the resulting of palm sugar have the hard texture.

According to Baharudin et al. (2007), ash content in sugar is strongly influenced by the mineral content of the sap as well as in the manufacturing process. Based on the research results Naufalin et al (2013), the use of natural preservatives mangosteen peel and clove with a concentration of 4.5% respectively 2.0% and 1.92% so it is still within the SNI. The ash content in the palm sugar with the addition of natural preservatives is still lower when compared with coconut sugar processed coconut sap plus the preservative sodium metabisulphite which amounted to 3.21%.

The higher the concentration of natural preservatives are added to the palm sugar, total sugar increased. This is due to the high concentration of natural preservatives can maintain total sugar in palm sap. The higher the concentration of natural preservatives, total dissolved solids also increased. This is due to antimicrobial compounds in a preservative to prevent the hydrolysis of glucose and sucrose degradation in palm sugar into simpler compounds, because sugar is a source of energy for the growth of microorganisms (Cowan, 1999, in Soritua, 2015).

The addition of STPP in production process of coconut sugar aim to improve the quality of the color and texture of coconut sugar. The higher the addition of STPP would be leading to higher brightness values produced coconut sugar (Haloho et al, 2015). STPP has properties as a buffer so as to maintain the pH of the sap. pH sap will greatly affect the color of palm sugar produced.

According to research by Haloho et al (2015), CaO and STPP is added to the coconut sugar production will be linked to each other, where the lime will react with the phosphate derived from STPP and form a precipitate calcium phosphate. The compounds are crystalline and more stable against interference from outside such as heating. This causes the interaction between the two will affect the texture of coconut sugar.

Sap with the addition of natural preservatives mangosteen peel produce sap with pH higher than the sap without the addition of natural preservatives after being stored for 4 hours and 8 hours. This is presumably because the mangosteen peel has high antimicrobial activity. Sap with the addition of natural preservatives mangosteen peel produce a pH of 6.3 (Naufalin et al, 2012). The addition of STPP is able to maintain the pH of sap that has been formed. The addition of STPP also aims to enhance the color, capture the dirt, and reduce levels of free water so that the water that might be utilized by microbes to grow slightly. If microbial growth can be inhibited, which formed reducing sugar levels will also decrease (Haloho et al, 2015).

* 1. **Hypothesis**

Based on the framework above, it can be arranged hypothesis is as follows:

1. Suspected types of natural preservatives in the sap affects the quality of palm sugar.
2. Suspected concentration of STPP affects the quality of palm sugar.
3. Suspected interaction between the type of natural preservatives in the sap and the concentration of STPP affect the quality of palm sugar.
   1. **Place and Time of Research**

The research was conducted in the Desa Wargasaluyu Kecamatan Gununghalu Kabupaten Bandung Barat and Laboratory of the University of Pasundan Bandung from July 2016 to November 2016.

**II. MATERIALS, TOOLS, AND METHOD OF RESEARCH**

**2.1. Materials and Tools of Research**

**2.1.1. Materials of Research**

Materials used in the production process of palm sugar is palm sap that obtained from the Desa Wargasaluyu Kecamatan Gununghalu Kabupaten Bandung Barat, sodium tripolyphosphat (Na5P3O10), mangosteen peel, guava leaves, and clovers.  
Materials used for the analysis of total microbes are sampled sap, mangosteen peel powder, guava leaves powder, clovers powder, sterile water, yeast glucose agar and nutrient agar. The materials used for the analysis of water content (distillation method) is a sample of palm sugar, boiling stones, and a solution of toluene. The materials used for the analysis of the ash content (gravimetric method) samples palm sugar and ethanol 70%. The materials used for the analysis of reducing sugar and total sugar content (Luff Schoorl method) is a sample of palm sugar, distilled water, 1 N Na-thiosulfate, a solution of Luff Schoorl, H2SO4 6 N, KI, starch, HCL 9.5 N, indicators PP, NaOH 30%, and starch.

**2.1.2. Tools of Research**

The tools used in the productions process of palm sugar is a tube, plastic cans, plastic containers, filters, cookers, frying pans, thermometers, and palm sugar mold.  
The tools used in the production process of a natural preservative is tunnel dryer, a tray, a knife, blender, sieve machines, and pH meters.  
The tools used for the analysis of total microbial is a plastic container, erlenmeyer, test tubes, bowls, a pipette and beaker. The tools used for the analysis of water content (distillation method) is a digital balance, pumpkin distillates, and a condenser. The tools used for the analysis of the ash content is digital balance, eksikator, furnaces, and the cup. The tools used for analysis of reducing sugar and total sugar content (Luff Schoorl method) is a digital balance, measuring cup, flask, pipette measure, spray bottles, funnels, erlenmeyer, burette, clamps, and the stand.

**2.2. Method of Research**

**2.2.1. Research Phase I (Preparation of Natural Preservative Powder)**

Various types of natural preservatives (mangosteen peel, guava leaves, and clovers) is dried using a tunnel dryer with a temperature of 500C for 20 hours, then crushed into powder and sieved using a sieving machine 60 mesh. Each natural preservative powder is subsequently mixed with palm sap for total microbial analysis.

**2.2.2. Research Phase II (Determination of Concentration of Natural Preservative)**

The second phase aims to determine the concentration of natural preservative powder to be used in the production process of palm sugar. The main raw material palm sap beforehand filtered to separate it from impurities that may be contained as sand, fiber, or bagasse. The second phase is done by giving each type of natural preservative powder (mangosteen peel, guava leaves, and clove) on the palm sap with a neutral pH (6.5). The concentration of natural preservatives are added at 1.5% and 4.5% (w / v) of 1.5 grams and 4.5 grams of powder in 1 liter of sap. Selected treatment of each type of natural preservative obtained by chemical responses include the pH of the juice after 8 hours of storage was measured using a pH meter.

**2.2.3.Research Phase III (Production Process of Palm Sugar)**

The third phase aimed to determine the type of natural preservatives and the addition of STPP concentrations used in the production process of palm sugar. Variables observed palm sugar is a chemical quality (moisture content, ash content, reducing sugar and total sugar content) and sensory quality (color, aroma, flavor, and texture) (Naufalin et al, 2013).

**2.3. Research Design**

**2.3.1. Research Treatment**

The design of treatment in this research consisted of two factors, namely the use of various types of natural preservative (P) and the concentration of STPP (S).

* + - 1. The first factor is the type of natural preservatives (P) on the juice consists of three levels, namely:

p1 = mangosteen peel

p2 = guava leaves

p3 = clovers

* + - 1. The second factor is the concentration of STPP (S) consists of three levels, namely:

s1 = 0,02%

s2 = 0,05%

s3 = 0,08%

**2.3.2.Experimental Design**

The experimental design used in this study using a randomized block design (RBD) with three replications thus obtained 27 treatments. Model experimental design to be used can be seen in Table 1.  
Table 1. Randomized Block Design

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Type of Natural Preserva-tive  (p) | Concentrati-on of STPP (s) | Replication Block | | |
| I | II | III |
| p1  (mango-steen peel powder) | s1 (0,02 %) | p1  s1 | p1  s1 | p1  s1 |
| s2 (0,05 %) | p1  s2 | p1  s2 | p1  s2 |
| s3 (0,08 %) | p1  s3 | p1  s3 | p1  s3 |
| p2  (guava leaves powder) | s1 (0,02 %) | p2  s1 | p2  s1 | p2  s1 |
| s2 (0,05 %) | p2  s2 | p2  s2 | p2  s2 |
| s3 (0,08 %) | p2  s3 | p2  s3 | p2  s3 |
| p3  (clovers powder) | s1 (0,02 %) | p3  s1 | p3  s1 | p3  s1 |
| s2 (0,05 %) | p3  s2 | p3  s2 | p3  s2 |
| s3 (0,08 %) | p3  s3 | p3  s3 | p3  s3 |

**2.3.3. Analysis Draft**

The analysis draft was conducted to determine the effect of treatment due to the response observed, compiled in Table Analysis of Variance (ANOVA) to obtain conclusions about the effect of the treatment. The data obtained from phase III studies are normal then made analysis of variance (ANOVA) for a randomized block design.

### **2.3.4. Draft Response**

Draft responses used in this study is divided into two, namely:

1. Chemical Response

Chemical response conducted on samples of the first phase of research, namely:

1. Analysis of Total Microba (Fardiaz, 1992)

Chemical response conducted on samples of the second phase of research, namely:

1. Measurement of pH (SNI 01-2323-2000)

Chemical response conducted on samples of the first phase of research, namely:

1. Analysis of water content in destilation method (Sudarmadji, 2010)
2. Analysis of ash content in gravimetric method (AOAC, 2005)
3. Analysis reducing sugar in Luff Schoorl method (SNI 01-2892-1992)
4. Analysis total sugar in Luff Schoorl method (SNI 01-2892-1992)
5. Organoleptic Response

Organoleptic test of palm sugar products carried out by 30 panelists with parameters that are used include color, aroma, flavor, and texture. The criteria used in the assessment of this organoleptic test are shown in the table below. The test results are collected and entered into the form filling, then the data is processed statistically. Table 2. Criteria of Hedonic Scale (Soekarto, 1985)

|  |  |
| --- | --- |
| **Hedonic Scale** | **Numeric Scale** |
| Profound like | 7 |
| Really like | 6 |
| Like | 5 |
| A bit like | 4 |
| A bit dislike | 3 |
| Dislike | 2 |
| Really dislike | 1 |

## **2.4 Research Procedure**

### **2.4.1. Procedure of Research Phase I (Preparation of Natural Preservative Powder)**

The procedure first phase of research on the process of making palm sugar are as follows:

1. Trimming natural preservatives (mangosteen peel, guava leaves, and clovers).
2. Washing a natural preservative.
3. Cutting a natural preservative.
4. Preparation of natural preservative in the tray.
5. Drying natural preservative at a temperature of 500C for 20 hours.
6. Milling natural preservative use the blender.
7. Sieved using a sieving machine size of 60 mesh.
8. The mixing / dilution with palm juice with a ratio of 0.15 grams of powdered natural preservative dissolved in 100 mL palm sap.
9. Analysis of total microbes.

**2.4.2. Procedure of Research Phase II (Determination of Concentration of Natural Preservative)**

The second phase of reserach procedure are as follows :

1. Preparations of main raw materials.
2. Measurement of sap’s pH.
3. Weighing mangosteen peel powder, guava leaves powder, and clovers powder, 1.5 grams and 4.5 grams.
4. Mixing of any type of natural preservative powder (natural preservative added concentration of 1.5% and 4.5% (w/v) of 1.5 grams and 4.5 grams of powder) with 1 liter of sap.
5. Measurement of pH sap with a mixture of natural preservative.

**2.4.3. Procedure of Research Phase III (Production Process of Palm Sugar)**

The third phase of research procedure are as follows:

1. Preparation of main raw materials.
2. Natural preservatives with concentration that derived from phase II is mixed into palm sap and stir until homogeneous.
3. Screening. On arrival at the processing facility, palm sap is then filtered using a sieve to separate the powder deposition natural preservative.
4. Mixing II. Palm sap then through the process of mixing II with a STPP which have different concentrations (0.02%; 0.05%; 0.08%).
5. Cooking palm sap with each treatment at a temperature of 1000C until it reaches the end point (becomes extremely viscous) for 1.5 hours.
6. Cooling by means of stirring, stirring until the temperature reaches 600C for 20 minutes.
7. Molding the palm sugar.
8. Hedonic test of palm sugar products carried out by 30 panelists with parameters that are used include color, aroma, flavor, and texture.
9. Chemical analysis of palm sugar products conducted on the analysis of water content, ash content, reducing sugar and total sugar content.

**III. RESULT AND DISCUSSION**

**3.1. Result of Research Phase I**

The first phase was made by mixing each powder natural preservative with sap and then analyzed to determine the total microbiological microbes contained therein. Analysis of total microbes using YGA media (yeast glucose agar) with a 24-hour incubation period.

Table 3. Results of a Phase I study (Total Microbial Analysis)

|  |  |
| --- | --- |
| **Sample** | **Total Microba** |
| Palm sap | 197 x 102 CFU/ml |
| Palm sap + mangosteen peel powder | 40 x 102 CFU/ml |
| Palm sap + guava leaves powder | 43 x 102 CFU/ml |
| Palm sap + clovers powder | 100 x 102 CFU/ml |

Table 3 shows that the addition of natural preservatives powder in the sap is able to prevent the growth of *Saccharomyces cereviceae* in damaging the freshness of sap. Mangosteen peel powder has the highest effectiveness in preventing damage due to contamination of sap *Saccharomyces cereviceae* compared with guava leaves powder and clovers powder.

Arenga pinnata sap contains a water content of 88.40%; 10.27% sugar content; protein content of 0.41%; fat content 0.17%; ash content of 0.38%, and organic acids such as citric acid, tartaric acid, malic acid, succinic acid, lactic acid, fumaric acid, and the piroglutamat acid (Eka 2008 in Haryanti, 2012). Sufficient nutrition full of sap is a very suitable medium for microbial growth.

A fairly high sugar content of palm sap causing damage during storage. Palm sap shelf life of only up to 4 hours of completed intercepts that must be processed palm sap to prevent damage (Haryanti et al., 2012). According Judoamidjojo et al. (1992), the process begins with the sap damage sucrose inversion process, then the fermentation process and ends with the oxidation process produces acetic acid. Reactions that occur are:

1. C12H22O11 + H2O → C6H12O6 + C6H12O6

In this reaction inversion occurs when the sap is slightly acidic.

1. 2C6H12O6 → 4CO2 + 4C2H5OH

In this reaction the fermentation process.

1. 4C2H5OH + 4O2 →4CH3COOH + 4H2O

In this reaction the oxidation process occurs.

Fermentation of sugar in the sap into alcohol due to the growth of yeast *Saccharomyces cerevisiae* that can come from the air, tapping a tube, or of other contaminants that pollute during tapping palm sap and palm sap distribution to a treatment site (Mulyawanti, 2011). The addition of natural preservatives in the sap powder can inhibit the fermentation reaction.

Clovers contain saponins, tannins, alkaloids, glycosides and flavonoids which act as antimicrobial (Ferdinanti, 2001). The results showed that the mangosteen peel contains alkaloids, saponins, triterpenoids, tannins, phenolics, flavonoids, glycosides, and steroids. Guava leaves contain active compounds such as tannins, triterpenoids, saponins, eugenol, and flavonoids (Soritua, 2015).

Saponins, tannins and flavonoids are compounds in plants that have antibacterial activity. Saponin is an active substance which can increase the permeability of the cell membrane, causing hemolysis, if saponin interact with microbial cells, the microbes will rupture or lysis. Flavonoids are a group of phenolic compounds have a tendency to bind the protein so that it will interfere with the metabolic processes of microbes. Tannins in low concentrations to inhibit the growth of microbes (Soritua, 2015).

**3.2. Result of Research Phase III**

The second phase is done by mixing the respective natural preservative powder and sap with a concentration of 1.5% and 4.5% (w / v), 1.5 grams and 4.5 grams of powder in 1 liter natural preservative palm sap. Determining the best concentration of each powder natural preservative is done by analyzing the pH value.

Figure 1. Results of a Phase II study (Determination of Concentration Powder Natural Preservative)

Figure 1 shows that the pH value of the highest palm sap for each natural preservative powder was obtained at a concentration of 4.5%. The greatest inhibition of the rate of pH decrease is owned by palm juice with the addition of mangosteen peel powder. According Sumanti et al, (2004) in Soritua, (2015), a natural preservative that skin mangosteen, guava leaves, and clove leaves contain alkaloids, flavonoids and triterpenoids which act as antimicrobial so as to inhibit the rate of decrease in pH.

According Sulistyaningrum et al (2015), the higher the concentration of natural preservative that is added to the sap, the lower the rate of decrease in pH. This is because the content of bioactive compounds contained in them has increased so power becomes greater inhibition. The content of bioactive compounds found in natural preservative powder will prevent microbial activity so that the fermentation reaction can be inhibited.

The results showed that the storage time of 8 hours, pH palm juice is not added natural preservative powder decreased the most dramatically. One of the requirements for the production process of palm sugar is sap should have a pH ranging from 6 to 7.5. At a pH of less than 6, the sap can not harden even when heated and thickens. Increasing the organic acid content of palm juice visible from the increase in total acid and pH decrease (Mulyawanti, 2011). In the study conducted, although the sap has been added powder preservative, but the downward trend persists pH. On this basis, it is for the production process of palm sugar should have the sap to the appropriate pH above reference.

The results of research phase II showed that the addition of a natural preservative powder with a concentration of 4.5% gives a pH downward trend in smaller ones. Therefore, the concentration of 4.5% have been selected for use in phase III.

**3.3. Result of Research Phase III**

### Research phase III aimed to determine the type of natural preservatives that concentration obtained from research phase II and a concentration of STPP in making palm sugar and then analyzed the chemical and organoleptic. In research phase III, palm sap is used for the production process of palm sugar has a pH value ranging from 6.7 to 7.8.

### **3.3.1 Chemical Response**

#### 3.3.1.1. Water Content

#### The results of ANAVA showed that the type of natural preservative and concentration STPP affect the water content of palm sugar, but their interaction does not affect the water content of palm sugar. The influence of the type of natural preservative and concentration STPP to water content of palm sugar can be seen in Table 4 and 5.

Table 4. Effect of Natural Preservatives ‘s Type to the Water Content (%) of Palm Sugar

|  |  |  |
| --- | --- | --- |
| **Type of Natural Preservative** | **Average of Water Content (%)** | **Taraf Nyata 5%** |
| p1 (mangosteen peel powder) | 5,977 | a |
| p3 (clovers leaves powder) | 6,463 | a |
| p2 (guava leaves powder) | 6,577 | b |

Description: The average value is marked by the same letter show no significant difference in the level of 5% according to Duncan test.  
Table 5. Effect of Concentration of STPP to the Water Content (%) of Palm Sugar.

|  |  |  |
| --- | --- | --- |
| **Concentration of STPP** | **Average of Water Content (%)** | **Taraf Nyata 5%** |
| s3 (0,08%) | 4,642 | a |
| s2 (0,05%) | 6,337 | b |
| s1 (0,02%) | 7,842 | c |

Description: The average value is marked by the same letter show no significant difference in the level of 5% according to Duncan test.

SNI 01-3743-1995 states that the maximum limit of the water content contained in the palm sugar is 10% w / w. This shows that palm sugar produced has an average value of moisture content that meet SNI. The water content of a food greatly affects the texture and shelf, due to microbial activity will be further hampered by the increasingly low levels of water.  
Duncan test results in Table 4 show that the natural preservative powder mangosteen peel produce palm sugar with the average value of the lowest water content.

Duncan test results in Table 5 shows that the concentration of 0.08% STPP produce palm sugar with the average value of the lowest water content. The higher the concentration of the addition of STPP then lower the water content of palm sugar produced.

The addition of mangosteen peel powder, guava leaves powder, and clove leaves powder effective in inhibiting the breakdown of sap to produce palm sugar with the water content according to the standard. This is due of the mangosteen peel, guava leaves and clove leaves contain essential oils that can help prevent damage to the juice due to microbial activity. Winarno and Sundari (1996) in Naufalin (2013) also found the essential oils in the leaves of guava suspected to be antimicrobial. Essential oils can inhibit the growth or kill microbes by disrupting the formation process of the membrane and cell wall so that the membrane and the cell wall is formed is not perfect or even not formed.

Inhibition of microbial growth in palm sap can block the fall in pH in the palm sap. Palm sap with good pH (6 to 7.5) will produce optimal sugar. The higher the pH palm sugar will get low water content produced palm sugar. Low water levels along the optimal pH caused a decrease in reducing sugar palm sap results from sucrose inversion process (Zuliana et al., 2016).

Once the process of tapping, sap easily damaged. The process begins sap damage by the hydrolysis of sucrose into glucose and fructose. After that, the fermentation process that produces ethanol and ends with the oxidation process produces acetic acid and water (Dachlan, 1984 in Sihombing, 2014). The process of hydrolysis of sucrose caused by microbial activity groups, namely the yeast *Saccharomyces cerevisiae*. The addition of natural preservatives powder in the sap could inhibit microbial activity so that the sap damage can be avoided. This has led to low water levels in the final product palm sugar.

Sucrose will be hydrolyzed to glucose and fructose when experiencing warming. If the sucrose has been hydrolyzed during the cooking process brown sugar, water contained levels could rise further as glucose and fructose are hygroscopic. The addition of STPP can prevent the hydrolysis process. According Haloho et al. (2015), STPP is able to absorb, bind, and hold free water so as to reduce the water content in food products.

3.3.1.2 Ash Content

Results of ANAVA showed that the concentration of STPP and the interaction between the type of natural preservative and concentration STPP affect the ash content of palm sugar, but the type of natural preservative does not affect the ash content of palm sugar. The influence of the concentration of STPP and the interaction between the type of natural preservative and the concentration of the ash content STPP palm sugar can be seen in Table 6.

Table 6. Effect of Interaction of Natural Preservatives’s type and concentration of STPP to the Ash Content (%) of Palm Sugar.

|  |  |  |  |
| --- | --- | --- | --- |
| **Type of Natural Preserva-tive** | **Concentration of STPP** | | |
| **s1 (0,02%)** | **s2 (0,05%)** | **s3 (0,08%)** |
| **p1 (mango-steen peel powder)** | B | A | A |
| 0,941 | 0,868 | 0,892 |
| c | a | b |
| **p2 (guava leaves powder)** | A | B | B |
| 0,907 | 0,909 | 0,919 |
| a | a | a |
| **p3 (clovers leaves powder)** | A | B | B |
| 0,914 | 0,902 | 0,932 |
| a | a | b |

Description: The average treatment marked readable lowercase and uppercase horizontally to read the vertical direction, a different letter stating significant difference according to Duncan test at 5% level.

SNI 01-3743-1995 states that the maximum limit of ash content in the palm sugar is 2% w / w. Palm sugar produced has an average value of ash content meets the standards. It showed that all treatments have good efficacy in producing palm sugar with ash content according to the standard.

Duncan test results in Table 6 indicate that the type of natural preservatives do not provide significant effect on the ash content of palm sugar. Based on the results of the study, the type of natural preservatives mangosteen peel powder to produce sugar with low ash content. The addition of STPP with a concentration of 0.08% to produce palm sugar with high ash content. In general, the higher the concentration of STPP, the higher ash content of sugar produced.

Type of natural preservatives do not affect the ash content of palm sugar allegedly due to low ash content contained in each type of powder preservative. The addition of mangosteen peel powder as preservatives to produce palm sugar with an average ash content low of 0.90%. It corresponds to the ash content of mangosteen peel powder which is the lowest compared to the other preservative powder, which is 2%, guava leaf powder at 2.23%, and clove leaf powder amounted to 3%.

The addition of natural preservatives powder causes an increase in the mineral content of the sap. Screening is less than perfect roomie will also lead to increased levels of ash from palm sugar. According Bacharuddin et al. (2007), ash content in sugar is strongly influenced by the mineral content as well as in the manufacturing process. Mineral content in the sap began to diminish and be replaced by water during storage, so even when the sugar is stored.

STPP is a salt that does not dissolve in water, the sediment will be contained in palm sugar and will be counted as the ash content. This resulted in higher concentrations of STPP is added, the higher the ash content of the resulting palm sugar (Haloho et al, 2015).

The ash content and composition depending on the type of material and the way pengabuannya. Increased levels of ash palm sugar due to an increased number of anorganic mineral compounds in the product. Mineral contained in a given material are two kinds of salt, namely organic and inorganic. Eg organic salts are salts of malic acid, oxalate, acetate, and pektat. Inorganic salts among others in the form of phosphate salts, carbonates, chlorides, sulfates, and nitrates (Zuliana et al., 2016). Increased levels of ash palm sugar is affected by the presence of phosphate compounds on STPP. Allegedly, the more the addition of STPP the higher the ash content contained.

* + - 1. Reducing Sugar Content

The results of ANAVA showed that the type of natural preservative as well as the interaction between the type of natural preservative and concentration STPP effect on reducing sugar palm sugar, but does not affect the concentration STPP ash palm sugar. The influence of the type of natural preservatives and natural preservatives interaction between the type and concentration of STPP towards reducing sugar palm sugar can be seen in Table 7.

SNI 01-3743-1995 states that the maximum limit on the reduction sugar palm sugar is 10% w / w. Palm sugar produced has reduced sugar levels that meet SNI. It showed that all treatments have good efficacy in producing palm sugar with a reducing sugar according to the standard.

Table 7. Effect of Interaction between Natural Preservatives’s type and concentration of STPP to the reducing sugar content (%) of Palm Sugar.

|  |  |  |  |
| --- | --- | --- | --- |
| **Type of Natural Preservative** | **Concentration of STPP** | | |
| **s1 (0,02%)** | **s2 (0,005%)** | **s3 (0,08%)** |
| **p1 (mangosteen peel powder)** | A | A | A |
| 4,284 | 4,308 | 3,901 |
| b | b | a |
| **p2 (guava leaves powder)** | C | C | C |
| 7,044 | 7,250 | 7,658 |
| a | b | c |
| **p3 (clovers leaves powder)** | B | B | B |
| 6,733 | 6,482 | 6,192 |
| c | b | a |

Description: The average treatment marked readable lowercase and uppercase horizontally to read the vertical direction, a different letter stating significant difference according to Duncan test at 5% level.

Based on the results of the study, the type of preservative powder mangosteen peel produce sugar with reducing sugar lows. The addition of STPP with a concentration of 0.08% to produce palm sugar with reducing sugar lows. In general, the higher the concentration of STPP will get low reducing sugar produced from palm sugar.

Natural preservative powder is effective in inhibiting the fermentation process palm sap. Fermentation is hampered because of the content of bioactive compounds from any type of natural preservative powder that can inhibit microbial activity. Hamzah and Hasbullah (1997) in Marsigit (2005) states that the fermentation of sap caused by the activity of the enzyme invertase produced by Saccharomyces cerevisiae that helps the process of hydrolysis of sucrose to reducing sugars in the sap. The addition of natural preservatives powders cause hydrolysis of sucrose can be inhibited so that a decrease in pH of the juice can be greatly minimized.

Inhibition of hydrolysis of sucrose in sugar palm sap will cause low reducing sugar content in palm sugar produced. Low levels of reducing sugars in palm sugar due to the optimal pH maintained palm sap. Palm sap optimum pH caused by the addition of powdered natural preservative that could inhibit microbial activity on palm juice. Microbial activity in palm sugar can cause the formation of acid resulting in a decrease in pH. Sucrose inversion reaction is influenced by the nature of the acid, the temperature of the environment, environmental hygiene, and the presence of the enzyme invertase. Invert sugar or reduced sugar crystals can not form because glucose and fructose have a high enough solubility (Zuliana et al., 2016).

The lower the levels of reducing sugars increases the quality of palm sugar which will also affect the level of hardness, color, and taste of sugar. Palm sap with high sugar content reduction will produce a soft palm sugar. This is because the reducing sugar is hygroscopic so that the resulting brown sugar becomes hard.

The addition of STPP in making brown sugar aim to reduce levels of free water so that water may be used by microbes for growth becomes a bit. Thus, microbial growth can be inhibited and lower levels of reducing sugars formed. STPP also has a role as a pH controller that aims to maintain the pH of sap that has been formed (Haloho et al, 2015).

The addition of STPP also aims to prevent the hydrolysis of sucrose sugar during the cooking process. STPP has properties that are resistant to interference from outside such as heating. Additionally, STPP will accelerate the formation of sugar crystals by increasing the time of the unification of glucose and fructose to sucrose to form sugar crystals (Haloho et al, 2015).

* + - 1. Total Sugar Content

The results of ANAVA showed that the type of natural preservative effect on total sugar content of palm sugar, but the concentration of STPP and their interaction did not affect the total sugar content of sugar. The influence of the type of natural preservatives on levels of total sugar palm sugar can be seen in Table 8.  
Table 8. Effect of Natural Preservatives type to the Total sugar Content (%) of Palm sugar.

|  |  |  |
| --- | --- | --- |
| **Type of Natural Preservative** | **Average of Total Sugar Content (%)** | **Taraf Nyata 5%** |
| p1 (mangosteen peel powder) | 82,814 | a |
| p3 (clovers leaves powder) | 93,368 | b |
| p2 (guava leaves powder) | 93,543 | b |

Description: The average value is marked by the same letter show no significant difference in the level of 5% according to Duncan test.

SNI 01-3743-1995 states that the minimum total sugar content in the palm sugar is 77% w / w. Palm sugar produced has a total sugar content in accordance with SNI. It showed that all treatments have good efficacy in producing palm sugar with a total sugar content according to the standard. High levels of total sugars in the palm sugar because the sugar is measured not only reducing sugar sucrose alone but also counted in the measurement of total sugars.

Based on the results of the research, the type of preservative powder of guava leaves produce brown sugar with the highest total sugar content. The addition of STPP with a concentration of 0.08% to produce palm sugar with the highest total sugar content. In general, the higher the concentration of STPP the higher the total sugar content of sugar produced.

The content of the three types of bioactive compounds from natural preservative powder were equally effective in inhibiting the fermentation process so that the sap total sugar content in palm sugar produced is still high. This is due to a natural preservative mangosteen peel powder, powder of guava leaves, and clove leaf powder has bioactive compounds including tannins that can inhibit the breakdown of sap and maintain the pH of the sap.

According Marsigit (2005), the addition of natural preservatives that contain tannins can inhibit the activity of yeast, thereby reducing the hydrolysis of sucrose into glucose reduction. Palm juice with optimal pH containing reducing sugar is low. This causes the brown sugar produced is also still contain high sucrose. This is what makes high total sugar content in palm sugar produced.

**3.3.2. Organoleptic Response**

3.3.2.1. Color

The results of ANAVA showed that the type of natural preservative, the concentration of STPP and their interaction affect the color characteristics of palm sugar. The influence of the type of natural preservative, the concentration of STPP and its interaction with the color characteristics of palm sugar can be seen in Table 9.

According to SNI 01-3743-1995, palm sugar has a brownish yellow color to brown. Duncan test results in Table 9 show that the type of preservative powder leaf clovers produce palm sugar colors most preferred by panelist. STPP concentration of 0.08% produces brown sugar color most preferred by the panelists. In general, the higher the concentration the more chocolate the addition of STPP also the color of palm sugar produced.

Table 9. Effect of Interaction between Natural Preservatives type and concentration of STPP on Characteristics Color of Palm Sugar

|  |  |  |  |
| --- | --- | --- | --- |
| **Type of Natural Preservative** | **Concentration of STPP** | | |
| **s1 (0,02%)** | **s2 (0,05%)** | **s3 (0,08%)** |
| **p1 (mangosteen peel powder)** | A | A | B |
| 4,622 | 4,311 | 4,422 |
| c | a | b |
| **p2 (guava leaves powder)** | B | B | A |
| 4,900 | 4,722 | 4,244 |
| c | b | A |
| **p3 (clove leaves powder)** | C | C | A |
| 5,156 | 4,867 | 4,289 |
| c | b | a |

Description: The average treatment marked readable lowercase and uppercase horizontally to read the vertical direction, a different letter stating significant difference according to Duncan test at 5% level.

Manap (1995) in Naufalin et al (2012) states that one of determining the quality of sugar is its color. Palm sugar color is determined by the initial pH roomie. Palm sugar made from the sap with a pH of about 6 will produce sugar with a light brown color yellowish. Sap with a pH of about 7 will produce sugar with dark brown color darkening as increasing the pH of the juice.

Adding a natural preservative powder and STPP aims to maintain the pH of palm sap so that the fermentation that causes increased reducing sugar will affect the final product of the sugar palm mera. Haloho et al (2015) stated that the higher the reducing sugar palm sap, the more sucrose is inverted to glucose and fructose. The higher the content of reducing sugar and protein in the sap, the Maillard reaction occurs and the more colors produced palm sugar is getting dark. According Catrien et al (2008) in Naufalin et al (2013), the Maillard reaction takes place better in alkaline conditions. The higher the pH, the color of foodstuffs may become darker.

Sucrose degradation process followed by the formation of dark brown color. The higher the amount of decomposition of sucrose increasingly apparent color. Conditions will improve the sour sap sucrose inversion in the palm juice. Losses due to formation of invert sugar is causing the product to be wet, high water affinity, giving the effect of caramelization, causing a brownish color (Haloho et al, 2015).

The largest content of palm sugar is sucrose. According to Winarno (2004), the caramelization of sucrose will experience when exposed to high heat. Caramelization is one of the non-enzymatic browning reactions. During the process of heating and boiling the Maillard reaction will occur at a temperature of 1180C - 1210C for 30-45 minutes.  
Water in sucrose will continue to evaporate until it becomes molten or molten sucrose with continuous heating. Caramelization reaction is a reaction that occurs due to warming of sugar at a temperature above the melting point that will produce color changes to a dark color to brown (Tranggono and Sutardi, 1989).

3.3.2.2. Aroma

The results of ANAVA showed that the type of natural preservative, the concentration of STPP, and their interaction does not affect the characteristic scent of palm sugar. According to SNI 01-3743-1995, palm sugar has normal and typical aroma.

Aroma in palm sugar formed from the Maillard reaction and caramelization of the cooking process palm sugar. Caramelization contribute to the aroma as a brown color also produces compounds maltol and isomaltol which has strong caramel aroma and sweetness. Palm sugar has a distinctive aroma caused by the reaction of caramelization and content of organic acids (Tjahjaningsih, 1997).

3.3.2.3. Sweetness

The results of ANAVA showed that the type of natural preservative, the concentration of STPP and interactions affect the characteristic sweetness palm sugar. The influence of the type of natural preservative, the concentration of STPP and its interaction with the characteristic sweetness palm sugar can be seen in Table 10.

Table 10. Effect of Interaction between Natural Preservatives type and concentration of STPP to the Characteristic Sweetness of Palm Sugar.

|  |  |  |  |
| --- | --- | --- | --- |
| **Type of Natural Presrvative** | **Concentration of STPP** | | |
| **s1 (0,02%)** | **s2 (0,05%)** | **s3 (0,08%)** |
| **p1 (mangosteen peel powder)** | A | A | B |
| 4,522 | 4,589 | 4,256 |
| b | c | a |
| **p2 (guava leaves powder)** | B | B | A |
| 4,967 | 4,667 | 4,067 |
| c | b | a |
| **p3 (clovers leaves powder)** | C | C | C |
| 5,100 | 4,744 | 4,611 |
| c | b | a |

Description: The average treatment marked readable lowercase and uppercase horizontally to read the vertical direction, a different letter stating significant difference according to Duncan test at 5% level.

According to SNI 01-3743-1995, palm sugar flavor has normal and typical. Duncan test results in table 10 stated that the type of natural preservative powder leaf clovers produce palm sugar with a sweetness that most preferred by the panelists. The concentration of 0.02% STPP produce palm sugar with a sweet taste that is most preferred by the panelists. The higher the concentration of STPP cause a bitter taste in the palm sugar produced.

Palm sugar has a distinctive sweet taste. Sweet taste of palm sugar is resulting compound contains several types of carbohydrates such as sucrose, fructose, and maltose. Coconut sugar also has a slightly sour taste because of the content of organic acids, and has a caramel flavor because of the caramelization reaction on carbohydrates during cooking (Sukardi, 2010). The content of sucrose in the palm juice serves as a humectant, helps the formation of texture, gives flavor through browning reaction, and give a sweet taste (Afriananda, 2011).

Sugar from sap that has been fermented to cause the brown sugar has the aroma and taste that is slightly acidic. The sour taste derived from organic acids produced by microorganisms that cause acidity value into the lower palm juice. This acidity value also affects the amount of reducing sugar in the sugar so it will affect the final product palm sugar that will not be preferred by the panelists (Haloho et al, 2015).

3.3.2.4. Texture

Results of ANAVA showed that the concentration of STPP influence the characteristic texture of palm sugar, but the type of natural preservatives and their interaction does not affect the texture characteristics of palm sugar. The influence of the concentration of STPP against palm sugar textural characteristics are presented in Table 11.  
Table 11. Effect of concentration of STPP on Texture Characteristics Palm Sugar

|  |  |  |
| --- | --- | --- |
| **Concentration of STPP** | **Average Ratings** | **Taraf Nyata 5%** |
| s1 (0,02%) | 4,519 | a |
| s3 (0,08%) | 4,670 | b |
| s2 (0,05%) | 4,696 | b |

Description: The average value is marked by the same letter show no significant difference in the level of 5% according to Duncan test.

The concentration of 0.02% STPP produce palm sugar with the texture of the most preferred by the panelists. The higher the concentration of STPP allegedly produce palm sugar with increasingly harsh texture.

The addition of natural preservatives powder on palm sap can maintain the pH of palm sugar thus produced has a hard texture. Palm sugar has the texture and structure is compact and not too hard so easily broken and gave the impression of soft (Sukardi, 2010).

The addition of STPP in making palm sugar aim to improve the quality of texture and reduce levels of free water so that the water that might be utilized by microbes to grow slightly. The inhibited microbial growth can reduce levels of reducing sugars formed. The low reducing sugar will affect the level of violence of palm sugar. Palm sap with low sugar content reduction will produce palm sugar is getting louder. This is because the reducing sugar is hygroscopic. The higher the concentration of the addition of STPP in causing the harder anyway palm sugar produced.

**IV. CONCLUSIONS AND RECOMMENDATIONS**

**4.1. Conclusions**

Based on the research results, it can be concluded as follows:

1. Based on the results of Phase I note that the mangosteen peel powder, guava leaves powder, and clove leaves powder as a natural preservative has the ability to inhibit the growth of microorganisms that commonly undermine the freshness of sap (*Saccharomyces cerevisiae*).
2. Based on the results of phase II that concentration of 4.5% w / v for each type of powder preservative give the best result because it provides a downward trend in pH smaller.
3. Type natural preservatives in the sap (P) effect on water content, reducing sugar, total sugar content, and response organoleptic (color and sweet taste), but has no effect on ash content and response organoleptic (flavor and texture).
4. Concentration of STPP (S) effect on water content, ash content, and the response organoleptic (color, sweet flavor, and texture), but had no effect on reducing sugar, total sugar content, and organoleptic response aroma.
5. The interaction between the type of natural preservatives in the sap (P) and the concentration of STPP (S) effect on ash content, reducing sugar, and response organoleptic (color and sweet taste), but does not affect the water content, total sugar content, and response organoleptic (flavor and texture).
6. The treatments are selected based on chemical and organoleptic response is p1s3 (a natural preservative and concentration of mangosteen peel powder STPP 0.08%) with a water content of 4.294%, ash content of 0.892%, reducing sugar amounting to 3.901%, and the total sugar content of 82.890%.

**4.2. Recommendations**

Based on the research results, suggestions can be submitted are as follows:

1. Need to do research on proper storage methods for palm sugar products.
2. Need to do research on types of packaging products appropriately palm sugar.

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