

Effects of addition of Sodium Benzoate of the Physicochemical Characteristic of Watermelon rind (*Citrullus lanatus*)

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Abstract

Watermelon rind is a food product that utilize wasted albedo waste. Generally, jam is gel or semi-dense so it has short shelf life. To make the jam more imperishable in storage, preservatives can be added in manufactured progress, one of the preservatives that can be used is sodium benzoate. This research aims to determine the effects of the addition of sodium benzoate on the physicochemical characteristics of watermelon rind jam. The results reveals that the formula of watermelon rind jam with the addition of sodium benzoate has physicochemical content that not much different apart from the one that isn't added by sodium benzoate. The characteristics that were significantly different were only in viscosity, the jam with the addition of sodium benzoate (6400 cP) was greater than the jam without the addition of sodium benzoate (2900 cP). The selected formula will be tested by organoleptic (hedonic quality) with texture, taste, and aroma attributes with the results that the jam formula was well received by 30 panelists. The quality of watermelon rind jam is identified by color aspect with average score of 5.10 with good category that has brownish yellow color, by texture with average score of 5.10 with good category that has soft and fibrous textured, and by the taste with average score of 5,20 with good category that has sweet acidity taste.

Keywords: Watermelon rinds, sensorics analysis

INTRODUCTION

Watermelon (*Citrullus vulgaris*, Schard) is one of the most popular fruits because it tastes sweet and contains a lot of water (Hani et al, 2014). Base on the data by Badan Pusat Statistik (BPS,2019) Indonesian watermelon production in 2019 is 15,783.3 ton with the composition of watermelon rind being 30% of the wight of the fruit so that the waste dispose around 4,735.6 ton in a year. Generally, only the flesh of the watermelon is used for consumption, while the skin of the watermelon is considered as a waste. Watermelon skin that is thick, fleshy and white is called albedo (Siskawardani et al, 2018).

The amount of watermelon rind wasted is because many people doesn't aware that it has many valuable substances such as vitamin A and minerals (Ca, Fe, and Phosphorus) needed by the body (Romdhane et al, 2017). In addition, watermelon rinds contain many citrulline substances (Soteriou et al, 2014) and pectin (Petkowicz and Vriesmann, 2016). Citrulline is a non-essential amino acid that is beneficial for health including, increasing of immunity system and improving blood circulation (Odewunmi et al, 2015). The content of pectin a watermelon rind is

quite large ranging, 21.03 % so, it has potential as a thickening agent, emulsifier, and gelling agent in the food, medicine and cosmetic industries (Jumde, et al, 2015).

The active substances in watermelon rinds supports its utilization into a food product such as jam. Jam is a fruit preservation product used by cooking pulverized fresh fruit, canned fruit, or frozen fruit mixed with sugar or without water addition (Islam et al, 2019). Jams are generally gel or semi-solid so, they have a short shelf life. In order for jams to last longer, it is necessary to study methods to extend their shelf life. One of the alternatives is the addition of preservatives such as sodium benzoate. This research aims to determine the effects of adding sodium benzoate to the physical and chemical properties of watermelon rind jam. This research consisted of three stages, the manufactured progress of watermelon rind jam with and without sodium benzoate, physicochemical analysis of the jam, and jam sensory analysis.

MATERIALS AND METHODS

Materials and Instrumentations

The material used in this research were distilled water, Nitric acid (HNO₃) merk KgaA, Standard solution Ca 1000 ppm (CertiPUR Merk KgaA), Natrium benzoate merk KgaA and watermelon rind. Glass Tools, Flame-AAS type Shimadzu AA 2000, Hollow cathode lamp Ca, Oven, Desiccator, Analytical balance and pH meter merk , spektrofotometer UV-Vis merk shimadzu Viscometer Brookfield and refraktometer brix merk

Procedure

Manufacturing of watermelon rind jam

Watermelon rind jams are manufactured by two treatments, one is without adding of sodium benzoate (A), and the other is with the addition of sodium benzoate (B). inner part of watermelon rind is rinsed and thinly sliced then mashed with a blender until soft. After that, put it in the pot and boil it until the water completely evaporates for approximately 10 minutes (while stirred continuously with temperature about 80°C). Then add sugar as much as 55% of fruit weight. While it is continuously stirring add little by little citric acid, then turn off the heat and cool it down. After it's warm, put it in the sterilized bottle. Table 1 shows the formulation of watermelon rind jam,

Table 1. Formulation of Watermelon Rind Jam

| Ingredients (g) | Ingredients percentage of total ingredients (%) | |
|-----------------|---|-------|
| | Jam A | Jam B |
| Watermelon Rind | 64.33 | 64.33 |
| Sugar | 35.38 | 35.38 |
| Citric Acid | 0.26 | 0.26 |
| Sodium Benzoate | - | 0.03 |

Physicochemical Analysis of Watermelon Rind Jam

Prior to the physicochemical and sensory analysis, homogeneity tests was first performed on the sample so that the homogeneous sample was obtained. Homogenized samples (A and B) were place in each ten polyethene bags, and water content analysis was performed two times. Different test (tested F) criteria are performed for homogeneity sample with Counted $F < \text{Table F}$, water content analysis was performed using the SNI Methode SNI 01-2891-1992.

The watermelon rind jam that was made was subjected to physical analysis that contains Brix degree, viscosity, spreading force, and syneresis. Chemical properties have pH level, water content, ash content, protein, fat and carbohydrate content (Using the method of AOAC).

An effectivity test was conducted to determine the selected treatment by mass adding on each of the used parameter. (Nurhayati et al, 2020). The parameter used for weighting test is pH level, water content, syneresis, and spreading force. The selected value is the highest results value from the sum of all parameter values with the normal parameters. Then the jam with the chosen treatment is used for the sensory test.

Sensory Analysis of Watermelon Rind Jam

Sensory analysis was carried out on the selected jam with hedonic quality assessment (preferred quality) on a scale of 1-7 includes taste, aroma, and texture parameters, using 30 panellists.

RESULTS AND DISCUSSION

Manufacturing of watermelon rind jam

Jam is a half-wet food product that is traditionally produce, so it has a soft and elastic texture. According to Ho et al (2020), the proportion to make jam is 45% part of fruit weight and 55% part of water, thus it contains a minimum total dissolved solid of 65% in the final product. The watermelon rind jam produced in this research has soft and fibrous texture, unique scent of a watermelon rind and a consistency of a semi-gel. The ineration between sugar, acid and pectin contained in watermelon rind, affects the consistency of the gel in the product (Vibhakara and Bawa, 2012). Figure 1 shows the appearance of watermelon rind jam.

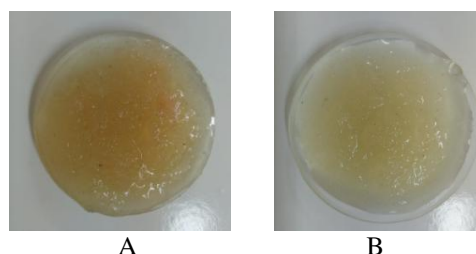


Figure 1. Jam A and Jam B

The colour of the product is slightly brown/ brownish yellow. The colour in Jam B looks clearer compared with jam A. It is because the addition of benzoic acid will inhibit the browning process when cooking. According to Islam et al (2019), benzoic acid is a strong reagent thus it functions as an antioxidant that protects another substance from oxidation so, it prevents discolouration to brown. The addition of sodium benzoate also binds copper ions which are the active sites of the enzyme so that the activity of the inhibited polyphenol oxidized. (Santoso, 2006).

The watermelon used in this research is fresh so the results will have a good quality. The affecting factor in the production process is pectin, sugar, and acid. The addition of citric acid also serves as a catalyst for the hydrolysis of sucrose

and also a clarify agent for the resulting gel (Beatrice and Fasogbon, 2013). The addition of sugar functions in the formation of texture, appearance and flavour of the jam. Due to the heat and acidic conditions, sucrose will be hydrolyzed into glucose and fructose. Pectin acts in the formation of gel (consistency) of jam. According to Yapo and Koffi (2014), the pectin content in the watermelon rind is 6.24% and is classified in low metoxy pectin. The heating process aims to homogenize the mixture of fruit, sugar, pectin and gel texture is formed due to the evaporation of water. The addition of citric acid and pectin will inhibit the browning reaction (He and Luo, 2007).

Physicochemical Analysis Jam

Homogeneity test Sample

The homogeneity test sample is performed by analyzing water content to ensure that the content in each part of the sample is identical and does not contain a confounding mix (Martóñez-costa & Brines, 2000). Table 2 shows the results of homogeneity test. From the results, it is known that the score of counted $F < \text{Table } F_{\alpha} = 5\%$ as big as 3.02. From both effects can be declared that the sample is homogeneous.

Table 2. Homogeneity Test of Watermelon Rind

| Subject | Water Content (%) | |
|-------------|-------------------|--------|
| | Jam A | Jam B |
| 1 | 46.99 | 46.82 |
| 2 | 46.97 | 46.81 |
| 3 | 46.90 | 46.99 |
| 4 | 46.89 | 46.97 |
| 5 | 46.86 | 46.90 |
| 6 | 46.74 | 46.89 |
| 7 | 46.80 | 46.86 |
| 8 | 46.76 | 46.74 |
| 9 | 46.96 | 46.80 |
| 10 | 46.58 | 46.76 |
| Mean | 46.84 | 46.85 |
| MSB | 0.015 | 0.003 |
| MSW | 0.007 | 0.0026 |
| F calculate | 2.14 | 1.05 |

Acceptance Conditions: Counted $F < \text{Table } F (3.02)$

The addition of 0.03% of sodium benzoate was used in this study, with the results appearing that the addition of sodium benzoate had a significant effect on the observed physicochemical analysis. This is an accordance with Wardhani (2019). that the addition of pure sodium benzoate at a concentration of 0.05% have significant affect on the taste, and aroma of fruit juice. Teble 3 shows the results of the effects of the addition of sodium benzoate.

Table 3. The Effect of The Addition of Sodium Benzoate into the Observed Parameters

| Analysis | Test Results | |
|-------------------|--------------|-------------------|
| | Jam A | Jam B (+benzoate) |
| pH level | 3.45 | 3.66 |
| Total Dissolve | 67 | 68 |
| Solids (°Brix) | | |
| Viscosity (cP) | 2900 | 6400 |
| Spreading | 6.9 | 6.2 |
| Force(cm) | | |
| Syneresis | 5.70 | 5.92 |
| Water Content (%) | 46.80 | 46.67 |
| Ash Content (%) | 0.27 | 0.31 |
| Protein (%) | 0.0050 | 0.0034 |
| Fat (%) | 1.03 | 1.06 |
| Carbohydrate (%) | 0.71 | 0.56 |

pH Level

The pH level in the product is acidic (pH value of less than 7). According to Kastner and Einhorn (2012), the optimum state of gel formation in a jam is less than 3.5. If its too acidic, syneresis will occur, it's a condition where the water from the gel will be released, and the viscosity of the jam will decrease, and even gel is not formed at all. The higher the pH level then the acidity of the product will decline and vice versa. The addition of sodium benzoate can lower the pH level. pH level is one of the factors used to control microbial growth in food product. The inhibition of bacterial and yeast growth was performed by adding sodium benzoate. The more sodium benzoate is added, the more effective it is for the microbial inhibition. The use of sodium benzoate salt is more effective because it is more soluble than in the form of benzoic acid. The maximum limit of sodium benzoate in soft drinks is 600 mg/kg (BSN, 1995).

Total Dissolved Solids

The total dissolved solids in the produce are above 65%; this is in accordance with the SNI 3746 (2008) standard regarding fruit jams with a total dissolved solids value of at least 65%. The addition of sodium benzoate can inhibit the decrease in total solids value. This happened because as the addition of sodium benzoate, the growth of microorganisms will be inhibited so that the number of microorganisms that can ferment sucrose will be low the value of dissolved solids will decrease (Estiasih et al, 2015).

Viscosity

The addition of sodium benzoate in this research will increase the viscosity in watermelon rind jams. It is suspected that benzoate salt's action is based on the permeability of the microbial cell membrane to undissociated acid molecules. The

contents of the microbial cell always have neutral pH level. If the microbial cell becomes acidic or alkaline, there will be disturbances in the cell organs so that metabolism is hampered and eventually the cell dies. The cell membrane is only permeable to undissociated acid molecules. So, to get high effectiveness, these acids should be used in an acidic environment. Hence, it is suspected that the pineapple peel syrup drinks have a neutral to alkaline pH level, so the pineapple peel syrup drinks will be affected, which causes the viscosity to increase. The viscosity of the jams is also affected by the addition of sugar because sugar can absorb water so that the apt development becomes slower and the gelatinization temperature is higher.

Spreading Force

Spreading force in both jams generate values that are not much different. Adding sugar as much as 55% into the jam formula will cause the spreading force to be more delicate, because sugar is easily soluble in water. According to Hambali (2004), adding sugar more than 75% will result in poor spreading force.

Syneresis

Syneresis is a process that causes the formation of exudate (liquid) on the surface of the gel as a result of the pressure that occurs on the water that is between polysaccharide chains which result in the release of water drops on the surface material. The results of the analysis of syneresis value on both jams were not much different. The liquid that appeared on the surface of the gel during and after the syneresis process is not pure water but may be alkaline or acidic depending on the gel composition.

Water Content

The results indicate that water content in both formulae is not different. The Heating process didn't affect the water content of the jam because with the high-level water content of the watermelon rind, the water content of the resulting jam is also high. The water content in the fresh watermelon rind is high, it is as significant as 94%, and decrease after it becomes to jam to 46,80 for the jams without any addition of sodium benzoate, and it becomes 46,67% for the jam with the addition of sodium benzoate. This happens due to the evaporation process during cooking and the binding of water by sugar to reduce free water. Condition high acidic environment there is an imbalance of H⁺ ions with free carboxyl groups, thus affecting the stability of the bond between pectin and water. This imbalance of H⁺ ions happens due to H⁺ ions will

reduce the negative charge of the pectin molecule so that more water will evaporate and the water content will decrease.

Ash

Ash content states the number of inorganic substances contained in a material. In the combustion process, will burn the organic substances, but the inorganic component will be left thus, the ash content can indicate the sum of the mineral compounds in a food product (Adejiji, 2017). According to Sutriyono (2016), the average outcome of ash content ranged between 0.21-0.44%. Mineral content of raw materials used with different geographical origin, the climatic conditions and the edaphic characteristics of the soils, causing the differences between the two jams. Fruits with a high pH level tend to have bigger amount of ash content causes hydrolysis of pectin from magnesium and calcium bond (Kalapathy dan Proctor 2001).

Protein, fat, and carbohydrates content

Protein, fat, and carbohydrates are the energy source that functions as energy substances for metabolism, growth temperature regulation and other physical activities. Carbohydrates act as a calori source, the fibrous source that plays a role in the digestive system, as well as a sweetener, thickener, and stabilizer for a food products. According to Rukmana (1994), the carbohydrate content in 100 grams of watermelon rind is 3.2% and decreases after it becomes a jam to 0.71% for the jam without any 0.56 for the jam with the addition of sodium benzoate. The decreasing of the carbohydrate content happens because the starch is heated. Hence the starch granules will swell, and gelatinization occurs. The dietary fibre contained in watermelon albedo when the heating process will be damaged so that the starch content (carbohydrates) will decrease.

Protein in products was so low it's 0.005% for the jams without the addition of sodium benzoate and 0.003 for the jam with the addition of sodium benzoate. Amino acids that are readily soluble in water and easily evaporate when heated are reduced due to the process of processing jam which is performed by boiling (Liur 2014).

Fats are a group of lipids soluble in the organic solvent, and insoluble in water solvents (Hidayat, 2008). Fat serves as a savoury taste and specific aroma and improves the texture of food ingredients. Fat in a jam with the addition of sodium benzoate is 1.06% and 1.03 % for the jam without any addition of sodium benzoate.

Nutritional adequacy score (AKG) determines that fat adequacy should meet between

20-30% of the needed total energy while protein needs should meet between 10-20% of total energy requirement. The protein and fat content in watermelon rind jam has not met the daily protein and fat requirement. Therefore it is recommended to add another raw material with other food ingredients for the jam.

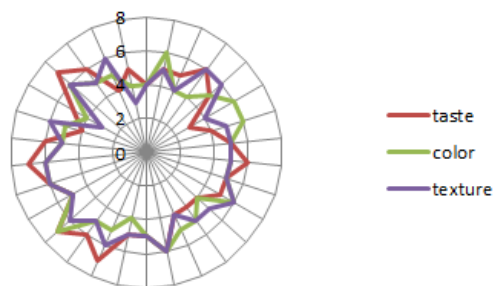
Effectiveness of giving weight to each parameter used some parameters (Nurhayati et al, 2020). The parameters used for the weighting test are pH level, water content, syneresis, and spreading force. The highest result value from the summary of all parameter scores with weight parameters is declared as the selected treatment. The effectiveness test of watermelon rind jams can be seen in Table 4.

Table 4. Test results of the effectiveness of watermelon rind jam

| Watermelon rind jam | Productivity score |
|--|--------------------|
| Without addition | 0.48 |
| With addition of sodium benzoate (0.05%) | 0.52 |

Sensory Analysis

The sensory test is carried out on jams with a high effectiveness value, namely jams with the addition of sodium benzoate. Jam with the selected treatment is used for the sensory test with hedonic quality assessment (preferred quality). The organoleptic test is performed based on three indicators, taste, colour, and texture, by score sheets using answers (like very much, very like, like, somewhat like, somewhat dislike, dislike, and dislike very much).



a. Colour

Colour plays essential role in the food industry so that it can arouse appetite. A brownish-yellow color is produced from the two jam formulas, due to the caramelization process during heating. In the acceptance test of the colour of watermelon rind jam, panelists favoured the brownish-yellow colour with an average score of 5.10.

b. Texture

The texture is a material property that can be felt by touch or taste. A good jam texture has a soft texture when spread and evenly

distributed. From the resulting research, it was obtained that the panelist favoured the thick texture with an average score of 5.10.

c. Taste

Taste is an important parameter in assessing food or beverage products. The resulting taste is sweet and slightly sour, which is favoured by panelists with an average score of 5.20.

CONCLUSIONS

The addition of sodium benzoate in the manufacture of watermelon rind jam significantly affects the viscosity, while on another physicochemical parameter didn't give any differences. Consumers can accept organoleptic analysis for watermelon rind jam with the addition sodium benzoate with average score of 5.10 for colour, taste, and texture attributes.

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