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Research Article
Characteristics of "Kolang-kaling" (Sugar Palm Fruit Jam) with Added Natural Colorants

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Abstract

Background: Sugar palm fruit contains galactomannan which has the potential to be used as raw material for making jam. In this study, natural colorants from Asian melastome fruit, Java plum fruit rind and Mangosteen fruit rind were added to sugar palm fruit pulp for making jam. **Materials and Methods:** This study used an experimental design with 3 natural colorants where each colorant had 4 treatments of 6, 8, 10 or 12%. **Results:** The addition of different natural colorants had a significant effect on the characteristics of sugar palm fruit jam. Chemical analysis of the jam with the addition of Asian melastome fruit juice, Java plum rind and Mangosteen fruit rind was as follows: Moisture content (21.81-30.56, 31.82-38.43 and 15.30-26.18%), water activity (0.59-0.67, 0.62-0.80 and 0.63-0.73), total dissolved solids (50.00-67.50, 57.5-62.33 and 63.33-72.17%), ash content (0.02-0.11, 0.23-1.57, 0.075-0.087%), pH value (3.43-3.45, 3.12-3.61 and 3.31-3.35), total sugar (18.03-35.67, 22.40-50.36 and 47.75-53.23%), dietary fiber (7.10-8.89, 7.37-8.38 and 3.80-8.34%) and crude fiber (4.05-4.41, 1.53-2.85 and 1.24-2.66%). **Conclusion:** The addition of Asian melastome fruit juice, Java plum rind and Mangosteen fruit rind had a significant effect on the characteristics of sugar palm fruit jam. All of the jams made from natural colorants were considered acceptable by panelists.

Key words: Sugar palm fruit jam, Kolang-kaling, natural colorant, organoleptic test, crude fiber, dietary fiber, characteristics

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Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

There are sugar palm plantations spread throughout Indonesia. As such, there is high production of sugar palm fruit but it is only processed for food and drink used on certain days, such as during Ramadan. Fresh sugar palm fruit is perishable and within a period of 1 week, it will begin to smell acidic and feel slimy.

Several studies have shown that sugar palm fruit contains a substance that has the potential to be used as food ingredients. Torio *et al.*[1] showed that sugar palm fruit contains of 90.23-92.28% water, 1.42-3.11% protein, 3.42-4.09% carbohydrates, 1.59-2.50% crude fiber, 0.27-0.67% fat and 0.12-0.30% ash[1]. Carbohydrates in sugar palm fruit consists of galactomannan and the ratio of mannose and galactose (M/G) increases with maturity, ranging from 2:1 to 5:1.

The ratio of mannose and galactose ranges from 1.8:1 in *Ipomea muricata*, up to 50:1 in *Phytelephas macrocarpa*[2] and 2.4:1 in *Cassia grandis* seeds[3]. The best solubility is at a ratio of 1:1. Galactomannan is a hydrocolloids which can bind water, so it is often used as an agent for viscosity[2]. The solubility of galactomannan in the mesquite[4] nut is 15.84 g of water g^{-1}.

MATERIALS AND METHODS

Materials: The main material used in this study was sugar palm fruit (*Arenga pinnata* Merr.) obtained from traditional markets and natural colorants from Asian melastome (*Melastoma malabathricum* L.) fruit, Java plum (*Syzigium cumini* L.) fruit rind and Mangosteen (*Garcinia mangostana* L.) fruit rind. These natural colorant materials were obtained from regions around Padang city.

Design: This study used a experimental design of 3 factors (Asian melastome fruit, Java plum rind and Mangosteen rind) as natural colorants. Data was analyzed statistically using analysis of variance (ANOVA) and Duncan's New Multiple Range Test (DNMRT) at a 5% significance level. The concentrations were set as follows: 6, 8, 10 and 12%.

Production of sugar palm fruit pulp: Sugar palm fruit was sorted and washed with water. Sugar palm fruit was blanched at a temperature of <80°C for 5 min. Then, the mixture was condensed (1×1 cm) and blended with the addition of water (1:5). Sugar palm fruit pulp was obtained from this process.

Production of Asian melastome fruit juice: Asian melastome fruit was sorted, peeled and blended with the addition of water (3:1). Then, it was filtered using a 40 mesh sieve. Asian melastome fruit juice was obtained from this process.

Production of Java plum rind juice: The rind was separated from the fruit and blended with the addition of water 1:1. Then, it was filtered using a 40 mesh sieve. Java plum rind juice was obtained.

Production of Mangosteen rind juice: The Mangosteen rind used in this study was the thin and hard part of the layer outer of the Mangosteen fruit. Rind was separated from the fruit and washed with flowing water. The Mangosteen rind was blanched at a temperature of <75°C for 5 min and blended with the addition of water 3:1. Then, it was filtered using a 40 mesh sieve. Mangosteen rind juice was obtained.

Production of sugar palm fruit jam: The jams were made by adding sugar[5] in amounts of 55 U section^{-1}.

Analysis: Moisture content (gravimetric method), water activity (a_w-meter), total dissolved solid (refractophotometry), ash content (gravimetric method), pH, total sugar (spectrophotometry), crude fiber (gravimetric method) and dietary fiber were measured.

RESULTS AND DISCUSSION

Raw materials: Raw materials used included fresh and clean white sugar palm fruit, purple Asian melastome fruit, Java plum rind of a blackish purple color and the red rind of Mangosteen. The analysis of raw materials is shown in Table 1.

Based on Table 1, the moisture content was 96.46%. This value was higher than the value reported by Torio *et al.*[1] of 92.09%. This difference was possibly due to the addition of water (1:5) in the production of the sugar palm fruit pulp, which increased the moisture content of the pulp. The pH value of the pulp was 3.42. According to Fachruddin[6] pH has an effect on gel formation. Ash content of the pulp was 0.29%, consistent with the value reported by Torio *et al.*[1]. Calcium content was 0.227%. According to Duke[7] the calcium content of sugar palm fruit is 21 mg/100 g of material.

The dietary fiber content of sugar palm fruit pulp was 2.085% and crude fiber was 1.59%. Dietary fiber represents a group of indigestible polysaccharides present in foods. Crude fiber represents the fiber group belonging to dietary fiber and

represents residue of food that has been treated with acid and boiled alkali[8]. According to Torio *et al.*[1], sugar palm fruit contains hydrocolloid compounds such as galactomannan. Galactomannan is a reserve polysaccharide found in several types of plants and produces high viscosity in food materials, such as in gum. In this study, most dietary fiber consisted of glactomannan.

Analysis of the Asian melastome fruit, Java plum rind and Mangosteen rind fruit juice included measuring crude fiber content and dietary fiber and total dissolved solid; analysis of raw material was also performed to study the characteristics of the fruit juice used to make the sugar palm fruit jam. The characteristics of fruit juice could affect the quality of the resulting jam. The results of these analyses are shown in Table 2.

Organoleptic test: Organoleptic tests determine the quality and consumer acceptance of a product and demonstrate the level of panelist acceptance of jams based on color, aroma, texture and flavor. In this study, these tests were conducted by 30 panelists. Organoleptic tests were performed using a hedonic test with a scale of 1-5 as follows: 1: Dislike, 2: Rather dislike, 3: Normal, 4: Rather like and 5: Like. Results from the organoleptic tests are shown in Table 3.

Table 1: Chemical analysis of sugar palm fruit pulp

Variables (%)	Mean±SD
Moisture content	96.470±0.11
pH	3.420±0.04
Ash content	0.310±0.04
Dietary fiber	2.085±0.01
Crude fiber	1.590±0.02
Calcium	0.230±0.01

Table 2: Asian melastome fruit juice, Java plum rind and Mangosteen rind

	Fruit extract (Mean±SD)		
Variables (%)	Asian melastome	Java plum rind	Mangosteen rind
Dietary fiber	6.52±0.18	2.38±0.05	4.51±0.12
Crude fiber	0.89±0.04	1.89±0.02	2.86±0.26

Color: Color is one of the attributes that is essential in providing an assessment of materials and food products. The process of mixing can be characterized by a prevalent and even color[9]. Based on the results of organoleptic tests shown in Table 3, the addition of Asian melastome fruit juice, Java plum rind and Mangosteen rind had a statistically significant effect on the color of sugar palm fruit jam.

The resulting color was bright red, dark red, mauve and dark purple. Improved color was due to the difference in concentration of the fruit juice added; the greater amount of fruit juice added, the darker the red color of the jam.

Aroma: A smell assessment of odors from a food product is more complex than taste. A delicious food is indicated by aroma as shown by the food industry that considers these tests a quick way to determine ratings of preference[10].

Based on the results of the organoleptic tests shown in Table 3, the addition of Asian melastome fruit juice, the Java plum rind and Mangosteen rind did not significantly effect the aroma of the jam. The aroma of sugar palm fruit jam with the addition of Asian melastome fruit extract, Java plum rind and Mangosteen rind was accepted by the panelists.

Table 3: Average value of organoleptic test of sugar palm fruit jam

Organoleptic tests	Color	Aroma	Texture	Flavor
Sugar palm fruit jam with Asian melastome as colorant (%)				
6	3.27^{a}	3.30	3.23^{a}	3.70^{a}
8	3.10^{a}	3.27	3.53^{a}	3.60^{a}
10	4.10^{b}	3.43	3.57^{a}	4.03^{a}
12	4.40^{b}	3.60	4.03^{b}	4.30^{b}
p-value	0.00	0.244	0.003	0.003
Sugar palm fruit jam with Java plum as colorant (%)				
6	3.5^{a}	3.5	4.0^{a}	3.7^{a}
8	4.0^{b}	3.6	3.9^{ab}	3.8^{ab}
10	3.8^{ab}	3.8	4.2^{ab}	4.0^{ab}
12	4.5^{c}	3.8	4.3^{b}	4.1^{b}
p-value	0.00	0.356	0.073	0.067
Sugar palm fruit jam with Mangosteen rind as colorant (%)				
6	3.43^{a}	3.43	3.70^{b}	3.96^{ab}
8	4.50^{c}	3.53	4.00^{b}	4.26^{b}
10	3.50^{a}	3.36	3.36^{a}	3.83^{a}
12	3.96^{b}	3.63	3.80^{b}	4.03^{ab}
p-value	0.00	0.28	0.00	0.06

Values are Mean±SD, means in the same column with different superscript letters differ significantly ($p<0.05$) by Duncan's New Multiple Range Test (DNMRT)

Texture: Based on the results of the organoleptic tests shown in Table 3, the addition of Asian melastome fruit juice, Java plum rind and Mangosteen rind had a significant effect on the texture of the sugar palm fruit jam. Sugar palm fruit jam with the addition of Asian melastome fruit juice, Java plum rind and Mangosteen rind had a semi-solid and slightly sticky texture. The process of producing a jam is affected by the balance between sugar, pectin and acid[5]. In the production of sugar palm fruit jam with the addition of Mangosteen rind juice, the texture of the jam was also affected by galactomannan contained in the sugar palm fruit. According to Prajapati *et al.*[2], galactomannan can produce a gel in a suitable solvent and also serves as swelling agent to form a high viscosity on material that is not too dry. Galactomannan is also capable of forming a gel at higher temperatures because it has a strong and stable properties of water binding so it is widely used in various industries, such as textile, food, study, petroleum, mining, explosives and pharmaceuticals to increase viscosity, water binding and stability. This characteristic of galactomannan affected the texture of sugar palm fruit jam with the addition of Asian melastome fruit extract, Java plum rind and Mangosteen rind.

Flavor: Taste or flavor is one food assessment to be combined with other senses, namely taste, smell and touch. The flavors perceived in foodstuffs give the impression of sweet, bitter, sour and salty[10]. The expected flavor of the jam made in this study was a sweet taste. According to Winarno[9], flavor can be affected by several factors, including chemical, temperature, concentration and interaction with other flavor components. Flavor compounds in the product provide stimulation to the senses. The presence of glucose, sucrose, starch and others can improve flavor in foodstuffs.

Based on the results of the organoleptic tests shown in Table 3, the addition of Asian melastome fruit extract, Java plum rind and Mangosteen rind had a significant effect on the flavor of sugar palm fruit jam.

Moisture content: The result of moisture content analysis is shown in Table 4. The addition of Asian melastome fruit juice, Java plum rind and Mangosteen rind had a significant effect ($\alpha<0.05$) on the moisture content of sugar palm fruit jam. Of the three factors, moisture content was highest in treatment D (addition of 12% fruit extract), while moisture content was lowest in treatment A (addition of 6% fruit extract); the greater the concentration of fruit juice added, the greater the moisture content of the jam. Increasing concentrations of Mangosteen rind juice affected the moisture content of the produced jam.

Table 4: Moisture content of sugar palm fruit

Added (%)	Asian melastome	Java plum rind	Mangosteen rind
6	21.81±0.36^a	31.82±0.06^a	15.30±0.24^a
8	26.74±0.43^b	36.54±0.07^b	21.44±0.38^b
10	28.78±0.12^c	36.86±0.09^b	25.58±0.23^c
12	30.56±0.86^d	38.43±0.09^c	26.18±0.359^d
p-value	0.000	0.00	0.00

Values are Mean±SD, means in the same column with different superscript letters differ significantly ($p<0.05$) by Duncan's New Multiple Range Test (DNMRT)

Table 5: Water activity of sugar palm fruit jam

Added (%)	Asian melastome	Java plum rind	Mangosteen rind
6	0.59±0.004^a	0.79±0.003^a	0.63±0.002^a
8	0.64±0.00^b	0.80±0.001^b	0.70±0.002^b
10	0.66±0.00^c	0.78±0.005^b	0.72±0.001^c
12	0.67±0.00^d	0.62±0.002^c	0.73±0.002^c
p-value	0.00	0.00	0.00

Values are Mean±SD, means in the same column with different superscript letters differ significantly ($p<0.05$) by Duncan's New Multiple Range Test (DNMRT)

In the study by Siddiqui *et al.*[11], sapodilla jam had a moisture content of 35.1-41%, whereas Ashaye and Adeleke[12] reported that rosella jam had a moisture content ranging from 31.23-33.36%. Differences in moisture content in jams are due to the different characteristics of raw materials or other additives used to produce the jam.

Water activity (aw): The results of water activity can be seen in Table 5. The addition of Asian melastome fruit juice, Java plum rind and Mangosteen rind had a significant effect ($\alpha<0.05$) on the water activity of sugar palm fruit jam. The highest aw was found in treatment D (addition of 12% fruit extract), while lowest was found in treatment of A (addition of 6% fruit juice), the greater the concentration of fruit juice added to sugar palm fruit jam, the greater the aw value of the jam.

Water activity (aw) is a natural characteristic of aqueous solutions. Water activity values are obtained from the ratio between water vapor pressure at a certain relative humidity with pure water vapor pressure[13]. Water activity values obtained in the sugar palm fruit jam did not differ from values in the kiwi fruit jam as reported by Garcıa-Martınez *et al.*[14], the aw value of kiwi jam was 0.763. A low aw value is affected by addition of sugar in making jam. Sugar is hygroscopic due to its ability to form hydrogen bonds with water. The presence of hydrogen bonds between water and sugar lower the amount of free water and reduce aw so that water can not be used for microbial growth[8].

Total dissolved solids: The result of total dissolved solids is shown in Table 6. The addition of Asian melastome fruit juice, the Java plum rind and Mangosteen rind had a significant

Table 6: Total dissolved solids of sugar palm fruit jam

Added (%)	Asian melastome	Java plum rind	Mangosteen rind
6	50.00±0.00[a]	57.50±2.18	63.33±2.89[a]
8	60.00±2.50[b]	58.67±3.21	63.33±2.89[a]
10	61.67±5.21[bc]	58.83±2.47	68.67±1.89[b]
12	67.50± 2.50[c]	62.33±2.57	72.17±2.56[b]
p-value	0.001	0.23	0.007

Values are Mean±SD, means in the same column with different superscript letters differ significantly (p<0.05) by Duncan's New Multiple Range Test (DNMRT)

Table 7: Ash content of sugar palm fruit jam

Added (%)	Asian melastome	Java plum rind	Mangosteen rind
6	0.11±0.12	0.23±0.24[a]	0.087±0.006
8	0.04±0.00	0.51±0.35[b]	0.081±0.009
10	0.04±0.01	0.98±0.18[a]	0.084±0.003
12	0.02±0.00	1.57±0.30[a]	0.075±0.007
p-value	0.44	0.14	0.03

Values are Mean±SD, means in the same column with different superscript letters differ significantly (p<0.05) by Duncan's New Multiple Range Test (DNMRT)

Table 8: pH value of sugar palm fruit jam

Added (%)	Asian melastome	Java plum rind	Mangosteen rind
6	3.45±0.01	3.61±0.06	3.35±0.025
8	3.43±0.02	3.30±0.04	3.31±0.027
10	3.43±0.19	3.15±0.07	3.33±0.015
12	3.45±0.24	3.12±0.02	3.33±0.025
p-value	0.25	0.21	0.28

Values are Mean±SD, means in the same column with different superscript letters differ significantly (p<0.05) by Duncan's New Multiple Range Test (DNMRT)

effect (α<0.05) on total dissolved solids in the sugar palm fruit jam. The highest total dissolved solids was found in treatment D (addition of 12% fruit juice), while the lowest total dissolved solids was found in treatment A (6% fruit juice added), the greater concentration of fruit juice added, the greater the total dissolved solids of the jam.

Total dissolved solids is one of the parameters required for jam as the amount of total dissolved solids jam products state whether the product meets the standards based on BSN[15]. According to BSN[15] total dissolved solids must be at least 65%. Guichard *et al.*[16] reported that the total dissolved solids in strawberry jam is 60%, while the total solids of coconut jam based on previous study conducted by Sindumathi and Amutha[17] is 68.5%. Total solids in jam can be affected by various factors.

Ash content: The results of ash content are shown in Table 7. The addition of Asian melastome fruit juice and Mangosteen rind had no significant effect (α<0.05) on ash content of the sugar palm fruit jam. The higher the concentration of Mangosteen rind juice added, the lower the ash content tended to be; however, the decrease in ash content did not by much in each treatment. The results of analysis of variance showed that the addition of Java plum rind had a significant effect on ash content of sugar palm fruit jam.

Ash is an organic residue from the combustion or oxidation of organic components of food. Ash content indicates the mineral content contained in materials and the purity and cleanliness of the materials produced. Most foodstuffs contain 96% of organic substances and water and the rest consists of mineral elements[18]. Pavlova *et al.*[19] reported that raspberry and peach jam contain ash content of 0.29 and 0.22%, respectively. Muresan *et al.*[20] reported that banana jam-based and ginger jams contain 0.57% ash. Differences ash content contained in every jam can be affected by differences in the characteristics of the raw materials and additives used.

pH value: The results of pH values are shown in Table 8. The pH value of jam with the addition of Asian melastome fruit juice and Mangosteen rind tended to be stable but the jam with Java plum rind juice decreased at each concentration, possible due the Java plum rind juice that is slightly more acidic than the Asian melastome fruit juice and Mangosteen rind. Swami *et al.*[21] showed that Java plum contained some organic acids.

According to Fachruddin[6] the measurement of pH in the jam is important because pH value affects the texture, flavor and color of the resulting product. In this study, researchers used citric acid to control the pH so as to provide appropriate acid conditions in the jams. The acidity level is very important in the formation of jam, since the jam gel will not form if the acidity is too low but high acidity can also cause jams to become watery. In making jams, we used fruit with low acidity levels; acidity can be controlled by the addition of acid sources, such as citric acid or lemon[22].

Total sugar: The total sugar content in sugar palm fruit jam was increased by the addition of Asian melastome fruit juice and decreased by the addition of Java plum rind juice and Mangosteen rind juice. Total sugar content in sugar palm fruit jam with the addition of Asian melastome fruit juice ranged between 18.03-35.67%, while the jam with the addition of Java plum rind juice ranged between 22.40-50.36% and the jam with the addition of Mangosteen rind juice ranged from 47.75-53.23%. The results of this analysis is shown in Table 9. The characteristics of raw materials affected the total sugar content in sugar palm fruit jam that was produced. Increased levels of total sugars resulted from more Asian melastome fruit juice added, while it decreased when Java plum rind juice and Mangosteen rind juice were added.

Sugar is a chemical compound that includes carbohydrates with a sweet taste that are soluble in water and easily digested in the body as an energy source. Sugar is

Table 9: Total sugar of sugar palm fruit jam

Added (%)	Asian melastome	Java plum rind	Mangosteen rind
6	35.67±2.00[a]	50.36±5.26[a]	53.23±3.700[b]
8	28.94±1.61[b]	46.09±1.38[a]	49.26±1.078[a]
10	24.99±1.24[c]	27.39±0.02[b]	49.06±0.393[a]
12	18.03±1.55[d]	22.40±2.88[b]	47.75±1.424[a]
p-value	0.00	0.00	0.05

Values are Mean±SD, means in the same column with different superscript letters differ significantly (p<0.05) by Duncan's New Multiple Range Test (DNMRT)

Table 10: Dietary fiber off sugar palm fruit jam

Added (%)	Asian melastome	Java plum rind	Mangosteen rind
6	7.10±0.01[c]	8.22±0.07[c]	8.34±0.07[d]
8	5.84±0.09[a]	8.38±0.09[d]	6.76±0.16[c]
10	6.78±0.06[b]	7.79±0.12[b]	3.80±0.09[a]
12	8.89±0.05[d]	7.37±0.01[a]	4.79±0.02[b]
p-value	0.00	0.00	0.00

Values are Mean±SD, means in the same column with different superscript letters differ significantly (p<0.05) by Duncan's New Multiple Range Test (DNMRT)

Table 11: Crude fiber of sugar palm fruit jam

	Fruit extract (Mean±SD)		
Added (%)	Asian melastome	Java plum rind	Mangosteen rind
6	4.41±0.33	1.53±0.34[a]	1.24±0.173[a]
8	4.16±2.77	2.10±0.14[b]	2.22±0.183[b]
10	4.40±0.36	2.38±0.09[b]	2.33±0.162[b]
12	4.05±0.77	2.85±0.14[c]	2.66±0.155[c]
p-value	0.99	0	0

Values are Mean±SD, means in the same column with different superscript letters differ significantly (p<0.05) by Duncan's New Multiple Range Test (DNMRT)

contained in various forms, including sucrose, fructose, glucose and dextrose. Sugar used in the manufacturing of jam is sucrose. Sugar is added to obtain the texture, appearance and flavor and acts as a preservative. The high consistency of sugar solution can prevent the growth of bacteria, yeasts and molds[6]. In the making of jam, the composition ratio between sugar, acid and fruit pulp should be balanced because if too much sugar is added, the jam will crystallize but too little sugar will produce a jam that is too liquid. Sugar can bind water in food so that the aw declines and cannot be used by microorganisms to grow.

Dietary fiber: The results of dietary fiber are shown in Table 10. The addition of Asian melastome fruit juice, Java plum rind and Mangosteen rind had a significant effect on dietary fiber; the higher the concentration of fruit juice added, the lower the dietary fiber level. Decreased levels of dietary fiber in sugar palm fruit jam presumably occurs during the process of jam-making. Trisnawati *et al.*[23] showed that drying processes affect the levels of dietary fiber in pumpkin flour.

According to Kusnandar[8], dietary fiber is a component of vegetable food ingredients that cannot be digested. Components of dietary fiber include hemicellulose, cellulose, a pectat substance, gum and lignin. According to Elleuch *et al.*[24], dietary fiber consists of carbohydrates that cannot be digested like lignin, a kind of substance contained in plants and carbohydrate modification. Meyer[25] defined dietary fiber as an integral part of the foodstuffs consumed daily with the main source being plants, vegetables, cereals, fruits and nuts.

In sugar palm fruit, there is a substance known as galactomannan. According to Torio *et al.*[1], sugar palm fruit contains gum, which mostly consists of water-soluble polysaccharides in the type of galactomannan that has a main chain composed of residues (1→4) β-D-mannose and (1→6) α-D-galactose in a ratio of 2:1 (mannose:galactose). Galactomannan can produce a gel in a suitable solvent, serves as swelling agent and forms a high viscosity on material that is not too dry. Galactomannan is also capable of forming a gel at higher temperatures because it has strong and stable properties as water binding. It is widely used in various industries, such as textile, food, study, petroleum, mining, explosives and pharmaceuticals due to its viscosity, water-binding and stabilizing properties[2].

Galactomannan content in sugar palm fruit is expected to affect levels of dietary fiber in the resulting jam. Dietary fiber has many health benefits. According to Anderson *et al.*[26] consuming dietary fiber can reduce the risk of liver disease, stroke, hypertension, diabetes, obesity and gastrointestinal disorders.

Crude fiber: The result of crude fiber is shown in Table 11. The higher the addition of natural colorant, the higher the fiber content of the sugar palm fruit jam. The highest crude fiber content was found in the jam with the addition of Asian melastome fruit as natural colorant (4.42±0.33%) and the lowest was found in the jam with the addition of Mangosteen rind juice (1.24±0173%).

Crude fiber is a polysaccharide group that cannot be digested and is usually found in foodstuffs. The presence of fiber content in food increases water-holding capacity, oil absorption capacity, emulsification and can extend the shelf life of food products[24].

Crude fiber content in the sugar palm fruit jam produced was quite high, possible due to the content of coarse fiber derived from raw materials of the sugar palm fruit and various types of natural colorants between 1.90-3.30%.

CONCLUSION

Based on this study, the addition of Asian melastome fruit juice, Java plum rind and Mangosteen fruit rind had a

significant effect on the characteristics of sugar palm fruit jam. Sugar palm fruit jam with the addition of Asian melastome fruit as the natural colorant was most preferred (treatment D; 12% fruit juice added) as well as sugar palm fruit jam with the addition of Java plum rind as the natural colorant (treatment D; 12% fruit juice added) and sugar palm fruit jam with the addition of Mangosteen rind as the natural colorant was most preferred (treatment B; 8% fruit juice added). However, all of the jams made with all natural colorants at all concentration levels were considered acceptable by the panelists.

Chemical characteristics of the sugar palm fruit jam with the addition of 12% of Asian melastome fruit juice were as follows: 12% with a moisture content of 30.56%, water activity of (aw) 0.67, total dissolved solids of 67.50%, ash content of 0.02%, a pH value of 3.45, dietary fiber of 8.89% and total sugar of 18.03%. Chemical characteristics of sugar palm fruit jam with the addition of 12% Java plum rind juice were as follows: Moisture content of 32.60% water activity (aw) of 0.62, total dissolved solids of 62.33%, ash content of 1.57%, the value of pH 3.12, dietary fiber of 7.37% and total sugar of 22.40%. Chemical characteristics of sugar palm fruit jam with the addition of 12% Mangosteen rind juice were as follows: 8% moisture content of 26.18%, water activity (aw) of 0.73, total dissolved solids of 72.17%, ash content of 0.075%, pH value of 3.33, dietary fiber of 4.79% and total sugar of 47.75%.

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