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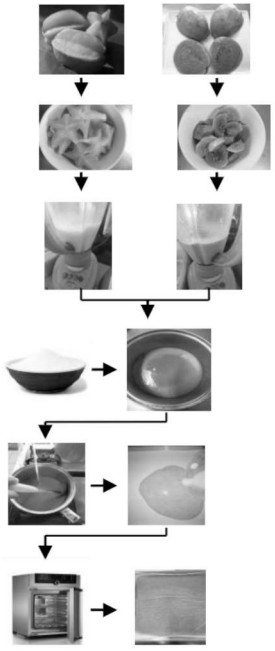
CHARACTERISTIC OF DEWA STARFRUIT-RED GUAVA FRUIT LEATHER DUE TO THE ADDITION OF GUM ARABIC

Graphical abstract



Abstract

Fruit leather is one of the processed fruit products, shaped similar to thin sheets that can be rolled, textured plastic, with specific consistency flavour. One of the suitable fruit that can be processed to fruit leather is starfruit and red guava. The aim of this research was to study the characteristics of Dewa starfruit-red guava fruit leather due to the addition of different concentration of gu Arabic (0%, 0.5%, 1%, 2%, and 2.5%). The analysis method used was analysis of variance (ANOVA) at α = 0.05. The result showed that the addition of gum arabic give significant effect of tensile strength, water content, ash content, vitamin C content, and ph value, but the addition of gum arabic did not significantly effect of crude fiber content, water activity content, total bacteria, and total yeast and mold. From the sensory properties, the addition of gum arabic give significantly effect of color and texture. Based on physicochemical and sensory properties, fruit leather that produces the best quality is fruit leather with the addition of 0.5% gum arabic with tensile strength value 437.38 gf water content 0f 7.38%, ash content 2.02%, vitamin C content 77.08%, crude fiber content 1.85%, ph value 4.22, water activity value 0.48 , total bacteria < 2.5 CFU/g, total yeast and mold < 1 CFU/g with golden yellow color, slightly strong starfruit aroma, strong starfruit flavor, and elastic fruit leather texture.

Keywords: fruit leather, dewa starfruit, red guava, gum arabic, physicochemical and sensory properties

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1.0 INTRODUCTION

Fruit leather is a fruit preserved product that develop quickly in many countries around the world [1] that are eaten as candy or snacks [2]. Fruit leather is manufactured by dehydrating a fruit puree into a thin sheet that can be rolled with a thickness of 2 - 3 mm, contain of 10-20% water, has a plastic texture, and has a specific consistency and flavor according to the kind of fruits are used [1].

In Indonesia, fruit leather is not popular, but some studies have been conducted on processed fruit leather from various kinds of fruit, such as apple fruit leather [2], guava fruit leather [3], papaya guava fruit leather [4], and many more. Currently in Indonesia, fruit leather is not popular. Therefore, the Dewa starfruit fruit leather will be made, due to it is one of the best starfruit varieties in Indonesia and the world, icon of Depok and it is the base resources of Depok [5]. In addition, the manufacture of Dewa starfruit fruit leather is expected to be the alternative for souvenirs of Depok City. The fruit used is Dewa starfruit quality C, due to it is not optimally use, while usually for producing juice and dodol, and is not sold in fresh because of its small size, which is ± 150 g / fruit. However, in terms of taste and aroma, starfruit

quality C has the same taste and aroma as starfruit quality A and quality B. In order to improve the quality of Dewa Starfruit fruit leather, it is formulated with red guava which is also spread in Depok. According to her research [6], red guava is rich of vitamin C, with 64.69 mg / 100 g of material, has a higher pectin than starfruit, as much as 4.1%. [7] [8]. In red guava, carotenoids are also found which have antioxidant activity for protect the body from many types of cancer. In the production of fruit leather, hydrocolloids are needed to help gel formation. One of the hydrocolloids that is widely used is gum arabic. Gum arabic can improve the flexibility of the fruit leather better compared to the stabilizer types of maltodextrin, citric slow pectin, and CMC, and it is the best hydrocolloid used to preserve leather's physico-chemical quality [9]. Therefore, it will be researched the fruit leather with gum arabic as a gel-forming material.

2.0 METHODOLOGY

The process of making Dewa starfruit and red guava fruit leather refers to the research results of her researcg [1], and their research [10] where it starts with the process of making puree and making fruit leather.

2.1 Producing Starfruit Puree

The starfruits used were the combination of ripe and half-ripe starfruit with the ratio of 2 : 1. Moreover, starfruits were washed by clean water and then blanched at 80°C for 15 minutes. Then, the blanched starfruits were cut into small pieces with size of ± 2 x 2 cm, then crushed with Turbo blender with speed of 1 for 2 minutes (modification [1] and [10].

2.2 Producing Red Guava Puree

The red guava fruits used were the combination of ripe and half-ripe red guava with a ratio of 2 : 1. Moreover, the red guava fruits were washed by clean water and then blanched at 80°C for 15 minutes. The blanched red guava fruits were cut into small pieces with a size of ± 2 x 2 cm, then crushed with Turbo blender with speed of 1 for 2 minutes with the ratio of fruit and water 1 : 1. After that, filter the puree of red guava.

2.3 Producing Fruit Leather

Starfruit puree and red guava puree were combined based on the formulation. In this research, there were five formulations. In each formulation, there were 83% starfruit puree, 9% red guava puree, 8% sorbitol, 0.05% citric acid, and gum arabic with different concentrations in each formulation, namely 0%, 0.5%, 1%, 2%, and 2.5% (Based on the results of previous research). Then the mixture was stirred manually until all the ingredients were mixed and heated at 70°C for 2 minutes. After the mixture was cooked, it was poured as much as 400 ml into the alumunium tray of 29.5 cm x 20.5 cm x 1 cm which has been lined with baking paper. Next, put it in the cabinet dryer, then dried it at 50 °C for 24 hours. The flow chart of the producing of Dewa starfruit-red guava fruit leather can be seen in Figure 1.

2.4 Fruit Leather Analysis

The quality of Dewa starfruit-red guava fruit leather was determined based on physical, chemical, microbiological, and sensory properties. The physical properties of the fruit leather analyzed was tensile strength values [11]. The chemical properties of the fruit leather being analyzed included water content [12], ash content [13], vitamin C content [12], crude fiber content [14], pH value [14], and water activity value [15]. The microbiological properties of the fruit leather being analyzed included total bacteria [16] and total yeast and mold [17], and the sensory properties of the fruit leather being analyzed included the hedonic test [18] and hedonic quality test [18] for the parameters of color, aroma, flavor, and texture.

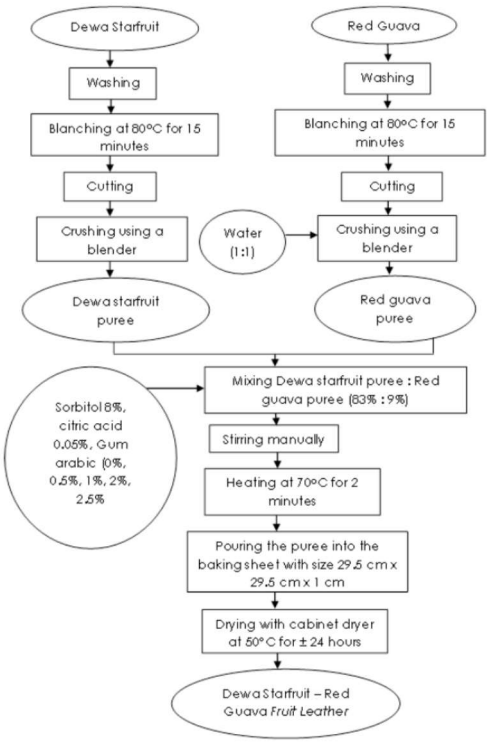

Figure 1 The flow chart of the making of Dewa starfruit-red guava fruit leather (modification [1])

2.5 Data Analysis Technique

The analysis technique used was a single factor analysis of variance (ANOVA) with three replicates. The differences among the mean values were determined by Duncan's multiple range tests with 95% confident interval.

3.0 RESULT AND DISCUSSION

The quality of the Dewa starfruit-red guava fruit leather includes physical quality, namely tensile strength test, chemical quality, namely water content, ash content, crude fiber content, vitamin C content, pH, water activity value (aw), microbiological quality, namely the total bacteria test and mold-yeast test, and also the organoleptic quality, namely the hedonic test and the hedonic quality for the parameters of color, aroma, texture, and flavor. The results of the *fruit leather* quality test are presented in Table 1 and Table 2.

3.1 Tensile Strength Value

The tensile strength value of the Dewa starfruit-red guava fruit leather shown in Table 1 ranged from 294.12 to 553.75 gf. Table 1 shows that the tensile strength value increased as the gum arabic concentration was higher. The ANOVA results showed that the addition of different gum arabic concentrations had a significantly different effect ($p < 0.05$) on the tensile strength value of the fruit leather. Tensile strength is calculated based on the force required to stretch the fruit leather until it breaks [11].

Table 1 Physicochemical and microbiological characteristics of Dewa starfruit - red guava fruit leather

Quality Parameters	Gum arabic concentration				
	0%	0.5%	1%	2%	2.5%
Tensile strength value (gf)	294.12±29.35^{a}	437.38±75.10^{ab}	465.60±71.82^{b}	467.90±93.72^{b}	553.75±80.27^{b}
Water content (%)	7.63 ± 0.44^{a}	7.38 ± 0.43^{a}	7.62 ± 0.29^{a}	7.17 ± 0.22^{ab}	6.63 ± 0.31^{b}
Ash content (%)	1.88 ± 0.13^{a}	2.02 ± 0.02^{b}	2.07 ± 0.01^{bc}	2.14 ± 0.01^{cd}	2.18 ± 0.01^{d}
Crude fiber content (%)	1.78 ± 0.09	1.85 ± 0.10	2.09 ± 0.32	2.11 ± 0.41	2.32 ± 0.17
Vitamin C content (mg/100g)	76.91 ± 1.19^{a}	77.08 ± 1.22^{a}	77.61 ± 2.35^{a}	82.96 ± 0.25^{b}	86.53 ± 0.53^{c}
pH content	4.16 ± 0.05^{a}	4.22 ± 0.03^{ab}	4.23 ± 0.04^{b}	4.25 ± 0.02^{bc}	4.31 ± 0.03^{c}
Water activity content	0.49 ± 0.03	0.48 ± 0.02	0.46 ± 0.02	0.46 ± 0.03	0.44 ± 0.00
Total bacteria (CFU/g)	<2.5	<2.5	<2.5	<2.5	<2.5
Total yeast and mold (CFU/g)	<1	<1	<1	<1	<1

Notes : Values with different superscript letters are significantly ($p < 0.05$) different

In this research, gum arabic as a gel-forming material. Gel formation is a process of the cross-linking of polymer chains form a continuous three-dimensional network capable of trapping liquids, forming a rigid and sturdy texture [19], making it difficult to break caused it required a large amount of energy to break the bond. Ref [20] also stated that a denser fruit leather structure will require more energy to break down the fruit leather into a state of 'ready to swallow. Thus, the higher the concentration of gum arabic, the tensile strength value of the Dewa starfruit-red guava fruit leather increased. This is in accordance with her statement [1] in her research on banana fruit leather which stated that the addition of gum arabic concentration can increase the tensile strength of the banana fruit leather. Fruit leather which has high tensile strength has better resistance to tensile forces so that it is not easily broken and torn [21].

One of the characteristics of fruit leather is that it has an elastic texture. Hydrocolloids are important in maintaining desired texture of fruit leathers. They have been used as gelling or thickening agents capable of binding water molecules, thereby enhancing the desired textural properties of foodstuffs [22]. Ref [23] studied that hardness and gumminess of date-tamarind leather increased with an increase in hydrocolloid concentration.

3.2 Water content

The water content of the Dewa starfruit-red guava fruit leather shown in Table 1 ranged from 7.63 to 6.63 percent. Table 1 shows that the water content of fruit leather relatively decreased as the gum arabic concentration was higher. The ANOVA result showed that the addition of gum arabic with different concentrations had significant effect ($p < 0.05$) on the water content in fruit leather.

Gum arabic is a hydrocolloid which used as a gel-forming material. Presence of a large number of hydroxyl (-OH) groups in hydrocolloid markedly increases their affinity for binding water molecules rendering them hydrophilic compounds. Gel formation is the phenomenon involving the association or cross-linking of the polymer chains to form a three dimensional network that traps or immobilises the water within it to form a rigid structure that is resistant to flow [24]. Therefore the amount of free water and adsorbed water in the fruit leather decrease. The higher the gum arabic concentration, the water absorption was higher too, so the water content in the fruit leather decreases. Lower water content in fruit leather would be advantageous because it would be difficult for microorganisms to live and it may extend the shelf life. Ref [25] showed that a water content of leather below 15% prevents microbial growth. Overall, the water content of the dewa starfruit-red guava fruit leather still met the criteria of SNI 1718-1996, which states that the maximum water content of dried sweet fruit is 25% [26].

3.3 Ash Content

The ash content of the Dewa starfruit-red guava fruit leather ranged from 1.88 to 2.18 percent. Table 1 shows that the ash content of fruit leather increased as the gum arabic concentration was higher. The ANOVA results showed that the addition of gum arabic with different concentrations had a significant effect ($p < 0.05$) on the ash content of the fruit leather.

The difference in the ash content of the fruit leather is due to the presence of several minerals in gum arabic, namely 0.17% of calcium, 3.90% of magnesium, 0.00004% of iron, 0.0004% of sodium, and 2.07% of potassium. Ref [27] also said that there were several minerals in gum arabic, namely calcium, magnesium, iron, sodium, phosphorus, potassium, and non detectable traces of Pb, Co, Cu, Zn, Ni, Cd, Cr, and Mn. So that the addition of gum arabic can increase the ash content of the fruit leather. The difference in ash content is possibly due to the different locations where gum arabic grows. The gum arabic used in this research is gum arabic that grows in Sudan, while the gum arabic used in the their research [27] is gum arabic that grows in Ethiopia. Thus producing a different mineral content.

3.4 Crude Fiber Content

The crude fiber content of the Dewa starfruit-red guava fruit leather ranged from 1.78 to 2.32 percent. Table 1 shows that the crude fiber content of the fruit leather increase as the gum arabic concentration was higher. The ANOVA results showed that the addition of different concentrations of gum arabic did not have a significant effect ($p > 0.05$) on the crude fiber content of the fruit leather.

The increase in crude fiber content of the fruit leather was due to the soluble and insoluble dietary fiber content in gum arabic. There were 76.20 mg of soluble dietary fiber and 13 mg of insoluble dietary fiber in 150 g of gum arabic, which means that the concentration of gum arabic can increase the fiber content of fruit leather. This is in line with their research [28] that addition of gum arabic can increased the amount of dietary fiber, caused there were 78.099% dietary fiber in gum arabic. The difference in crude fiber content is possibly due to the different variants of gum arabic used. The gum arabic used in this research is a variant of the senegal gum arabic, while the gum arabic used in their research [28] is a variant of the kerensis gum arabic. So that it produces different crude fiber content.

According to the Regulation of the Minister of Health of the Republic of Indonesia Number 28 of 2019, concerning the Recommended Nutritional Adequacy Rate (RDA) for the Indonesian people, the recommended amount of fiber per person per day ranges from 11-23 g for the age group of infants and children, 22-37 g for the male 10-80 years old group, and 20-32 g for the 10-80 year old female age group. The crude fiber content of Dewa-red guava fruit leather ranges from 1.78% - 2.32%. So it can be said that 1 roll of fruit leather as much as 2 grams can meet the nutritional adequacy rate of fiber of 0.2 - 0.5% for the category of infants and children, 0.14-0.23% for the male age group 10-80 years old, and 0.16-0.25% for the female age group 10-80 years old.

3.5 Vitamin C Content

The vitamin C content of Dewa starfruit-red guava fruit leather ranged from 76.91 to 86.53 mg / 100g. Table 1 shows that the vitamin C content of fruit leather increased as the gum arabic concentration was higher. The ANOVA results showed that the addition of gum arabic with different concentrations had a significant effect ($p < 0.05$) on the vitamin C content of the fruit leather. Gum arabic is a hydrocolloid to form a gel so it is able to protect vitamin C from oxidative damage [29]. Ref [30] also said that gum arabic also has the ability to inhibit oxidation and protect major components. Therefore, the higher the gum arabic concentration, vitamin C is protected from oxidative damage was higher too.

According to the Regulation of the Minister of Health of the Republic of Indonesia, concerning the recommended nutritional adequacy rate (RDA) for the Indonesian people, the recommended amount of vitamin C per person per day ranges from 40 - 45 mg for the age group of infants and children, 50 - 90 mg for the male age group, and 50-75 mg for the female age group [31]. Vitamin C content of Dewa starfruit-red guava fruit leather ranged from 76.91 to 86.53 mg / 100 g. So it can be stated that 1 roll of fruit leather as much as 2 g can met the nutritional adequate rate of vitamin C as much as 4% for the category of infants and children, 2-3% for the male age group 10-80 years old, and 2% for the female age group 10-80 years old.

3.6 pH Value

The pH value of the fruit leather ranged from 4.16 to 4.31. Table 1 shows that the pH value of fruit leather increased as the gum arabic concentration was higher. The ANOVA results showed that the addition of gum arabic with different concentrations had a significant effect ($p < 0.05$) on the pH value of the fruit leather. Gum arabic has the ability to bind water, and water has properties to bind organic acids. So that the higher the concentration of gum arabic, the more water is bound, and organic acids are bound by water [32]. Therefore, the measured amount of free organic acid is less. A low acid concentration can be indicated by a high pH value.

The pH value of the fruit leather ranged from 4.16 to 4.31 which indicated that this fruit leather is a acid food. Acid fod is defined as a food with a pH value of 4.60 or lower [33]. Lower pH in fruit leather would be advantageous because it would not be support growth of disease-causing bacteria. According to his research [34], gum arabic dissolves at acidic pH. Ref [35] states that gum arabic can reach a maximum viscosity at pH 3.9 -

4.9. This pH condition will help form the colloidal properties of the fruit leather solution, so that the fruit leather sheets can be formed properly.

3.7 Water Activity Value

The water activity value of fruit leather ranged from 0.44 to 0.49. Table 1 shows that the water activity value of fruit leather relatively decreased as the gum arabic concentration was higher too. The ANOVA results showed that the addition of gum arabic with different concentrations did not have a significant effect ($p > 0.05$) of the water activity (aw) value of fruit leather. Water activity is the amount of free water in food materials for the growth of microorganisms. The decrease of water activity value was associated with the decrease of water content, indicating the decrease amount of free water required for microorganism activity. The water evaporated during the drying process is included in the free water group which is not strongly bound [36].

The water activity can predict microorganisms will be potential sources of spoilage and infection. The water activity value on the fruit leather has low aw value compared to the aw value for bacterial, yeast, and mold growth requirements. For instance, pathogenic microorganisms can not grow at aw <0.86, yeast and moulds are more tolerant and usually no growth occurs at aw <0.62 [37]. The relatively small value of water activity, hamper the growth of bacteria, mold, and yeast in fruit leather products. However, with aw 0.44 to 0.49, the fruit leather is most stable with respect to lipid oxidation, non-enzymatic browning, and enzyme activity.

3.8 Total Bacteria Value

The total bacteria value of fruit leather indicates bacterial growth less than 2.5 CFU / g. According to the Bacteriological Analytical Manual [16], the conditions for the plates that can be counted are 25 to 250 colonies. However, based on the results shown in Table 1, the resulting bacterial colonies were less than 25, so the data obtained could not be analyzed by ANOVA.

According to SNI 7388 : 2009 [38], the maximum standard limit for microbial contamination of dried fruit sweets for total bacteria is 1×10^5 colonies / g. Based on the total results of the fruit leather bacteria, it means that the total bacterial Dewa starfruit-red guava fruit leather still meets the standard of dried fruit sweets. The total value of bacteria obtained is relevant with the result of aw fruit leather value, which is less than 0.9, so that this condition hamper the growth of bacteria in the Dewa starfruit-red guava fruit leather product. Low water content and pH also can inhibit microbial growth and prolong shelf-life, which subsequently affected the consumer health [39].

Based on the research results, gum arabic has an effect in reducing the pH of the Dewa starfruit-red guava fruit leather, so that low pH conditions can inhibit the growth of microorganisms. This is in line with the effect of gum arabic in reducing the water content of the fruit leather, which shows the decreasing amount of free water required for microorganism activity.

3.9 Total Yeast and Mold Value

The total yeast and mold value of fruit leather indicates the growth of yeast and mold less than 1.0 CFU/g. According to the Bacteriological Analytical Manual [17], the requirements for the plates that can be counted are 10 to 150 colonies. However, based on the results shown in Table 1, the resulting yeast and mold colonies were less than 10, so the data obtained could not be analyzed by ANOVA.

According to SNI 7388 : 2009 [38], the maximum standard limit for microbial contamination of dried fruit sweets for total yeast and mold is 5×10^1 colony/g. Based on the results of the total yeast and mold, it can be stated that the total yeast and mold of Dewa starfruit-red guava fruit leather still met the standard of dried fruit sweets. The total value of yeast and mold obtained relevant with the aw value fruit leather that is produced, which is less than 0.6 will hamper the growth of yeast and mold in the products of Dewa starfruit-red guava fruit leather. These results were expected since fruit leathers had low pH and low water content. Thus this fruit leather was expected to have a stable shelf-life for several months. Similar results of microbial stability of fruit leather are also reported in guava papaya fruit leather, the growth of microorganism were also well within the safe limit for consumption till 4 months of storage period [40].

Based on the research results, gum arabic has an effect in reducing the pH of the Dewa starfruit-red guava fruit leather, so that low pH conditions can inhibit the growth of microorganisms. This is in line with the effect of gum arabic in reducing the water content of the fruit leather, which shows the decreasing amount of free water required for microorganism activity.

3.10 Sensory Test

The sensory test of the Dewa starfruit-red guava fruit leather includes the hedonic test and the hedonic quality for the parameters of color, aroma, texture, and flavor. The results of the fruit leather sensory test are presented in Table 2.

3.10.1 Color

Color, an important attribute in food products, can be assessed either by a sensory panel [41].The value of color quality on fruit leather ranged from 3.0 to 3.5 (golden yellow - orange) with acceptance value ranged from 3.7 - 3.8 (like). The ANOVA results showed that the addition of gum arabic with different concentrations had a significant effect ($p < 0.05$) on the color quality of the fruit leather.

Table 2 Sensory test of Dewa starfruit - red guava fruit leather

Concentration of gum arabic	Parameters	Attributes			
		Color	Aroma	Taste	Texture
0%	Score	3.0 ± 0.08[a]	2.5 ± 0.08	3.5 ± 0.03	3.5 ± 0.08[a]
	Acceptance	3.8 ± 0.06	3.6 ± 0.08	3.9 ± 0.03	3.6 ± 0.03[ab]
0.5%	Score	3.1 ± 0.06[ab]	2.7 ± 0.05	3.5 ± 0.08	3.6 ± 0.05[a]
	Acceptance	3.8 ± 0.12	3.6 ± 0.10	3.9 ± 0.09	3.6 ± 0.05[b]
1%	Score	3.3 ± 0.05[b]	2.7 ± 0.16	3.5 ± 0.10	3.7 ± 0.03[b]
	Acceptance	3.8 ± 0.06	3.6 ± 0.08	3.8 ± 0.03	3.8 ± 0.05[c]
2%	Score	3.5 ± 0.05[c]	2.7 ± 0.12	3.5 ± 0.03	2.6 ± 0.10[c]
	Acceptance	3.8 ± 0.06	3.6 ± 0.12	3.9 ± 0.05	3.7 ± 0.03[c]
2.5%	Score	3.5 ± 0.14[c]	2.8 ± 0.36	3.5 ± 0.08	2.7 ± 0.08[c]
	Acceptance	3.7 ± 0.06	3.6 ± 0.08	3.8 ± 0.03	3.5 ± 0.05[a]

Score description:
Quality (Score) : Color : 1 (light yellow) ; 2 (yellow) ; 3 (golden yellow) ; 4 (orange) ; 5 (red)
Starfruit Aroma : 1 (not very strong) ; 2 (not strong) ; 3 (slightly strong) ; 4 (strong) ; 5 (very strong)
Starfruit Taste : 1 (not very strong) ; 2 (not strong) ; 3 (slightly strong) ; 4 (strong) ; 5 (very strong)
Texture : 1 (very inelastic) ; 2 (not elastic) ; 3 (slightly elastic) ; 4 (elastic) ; 5 (very elastic)
Acceptance : 1 (very dislike) ; 2 (dislike) ; 3 (rather like) ; 4(like) ; 5 (very like)

The yellow color in fruit leather indicate presence β-cryptoxanthin which is color pigment in starfruit [42]. While the orange color in the fruit leather is the result of a combination of yellow pigments in star fruit and red pigments in red guava. According their research [43], red guava has carotenoid compounds, especially lycopene pigments of 6900 µg/100 g and *β*-carotene of 430 µg/100 g [44]. According to her research [45], the dehydration process can change the surface characteristics of food, as well as its color and reflectance. Chemical changes in pigments such as carotene and chlorophyll are produced by heat and oxidation that occurs during drying. In general, the longer the process and the higher the temperature, the greater the loss of the pigment.

Fruit leather with a concentration of 0% gum arabic has a golden yellow color, while the color of fruit leather with a concentration of 2.5% gum arabic tends to be reddish yellow (orange), which means it is darker than the color of the fruit leather without the addition of gum arabic. This is supported by his study [11] which states that the level of preference for panelists to the color of jackfruit fruit leather decline along with the higher concentration of gum arabic. The color change is caused by the Maillard reaction. The maillard reactions in fruit leather is possibly caused by the presence of proteins contained in gum arabic. Apart from the protein content, gum arabic also contains monosaccharide molecules which act as reducing sugars [11].

3.10.2 Aroma

The value of the aroma quality assessed from the Dewa starfruit-red guava fruit leather is the intensity of the starfruit aroma. Table 2 shows that the value of the fruit leather aroma ranged from 2.5 to 2.8 (rather strong), which indicated that the scent of starfruit from the fruit leather was rather strong, with a acceptance value is 3.6 (like). The ANOVA result showed that the addition of gum arabic with different concentrations did not have significant effect (a = 0.05) to the value of the aroma quality of fruit leather.

According to their reserach [46] [47], gum arabic is odorless when consumed by humans, so the addition of gum arabic did not affect the aroma of fruit leather. This is reinforced by his statement [48], that hydrocolloids do not contain volatile ingredients which can cause aroma and color to food ingredients. The value of aroma quality that is assessed from the Dewa starfruit-red guava fruit leather is the intensity of the starfruit aroma. According his research [49], there were fifty-six volatile components in starfruit identified (8.9 mg/kg), the main ones being butyl acetate, ethyl decanoic and hexadecanoic acid.

3.10.3 Taste

The value of the taste quality assessed from the Dewa starfruit-red guava fruit leather is the intensity of the starfruit taste. Table 2 shows that the value of the fruit leather taste is 3.5 (strong) which indicated that the taste of starfruit from the fruit leather was strong , with a acceptance value ranged from 3.8 to 3.9 (likes). The ANOVA results showed that the addition of gum arabic with different concentrations did not have a significant effect ($p > 0.05$) to the value of the taste quality of fruit leather. It caused of gum arabic has no taste, so the taste produced by the Dewa starfruit-red guava fruit leather is the original taste of starfruit. Similar results of their research that the addition of gum arabic did not affect the taste of the product [50].

3.10.4 Texture

The value of the texture quality assessed from the Dewa starfruit-red guava fruit leather is the intensity of the fruit leather elasticity. Table 2 shows that the value of the fruit leather texture ranged from 2.6 (slightly elastic) to 3.5 (elastic), with a acceptance value ranged from 3.5 to 3.8 (like). The ANOVA results showed that the addition of gum arabic with different concentrations had significant effect ($p <$

0.05) to the value of the texture quality of fruit leather.

Texture is an important parameter in determining the quality of the fruit leather. The texture produced by the fruit leather is influenced by the type and concentration of hydrocolloids [51] [52]. The texture parameter tested on the panelists is the level of elasticity of the fruit leather . The elasticity level of the fruit leather increased until the addition of 1% gum arabic, but decreased in the addition of 2% and 2.5% gum arabic. The decrease in the elasticity of the fruit leather possibly caused by the concentration of gum arabic that is too high.

In this research, gum arabic acts as a gelling agent. Gel formation is a process of cross-linking polymer chains to form a continuous three-dimensional network capable of trapping liquids, forming a rigid and sturdy texture [19]. This makes the fruit leather difficult to break because it requires a large amount of energy to break these cross-links. Thus the higher concentration of gum arabic, then the more water is bound by gum arabic, so that the amount of free water contained in the material decreases, as a result the fruit leather water content is lower. This causes a decrease in the level of elasticity of the fruit leather [53].

The decrease in the level of elasticity of the fruit leather was also caused by the increase in the tensile strength value along with the increasing concentration of gum arabic. This is relevant with his statement [54] in his study on jackfruit fruit leather which stated that the increasing the concentration of gum arabic, the resulting decreased water content of the fruit leather, which causes the texture of fruit leather tight and less elastic. The addition of gum arabic with a concentration that is too high will cause the texture of the fruit leather to get tough due to it has a dry texture making it difficult to chew. This statement is directly proportional to the water content of the Dewa starfruit-red guava fruit leather relative decline with the concentration of gum arabic. Ref [55] also stated that high water content will produce a soft texture indicated by a lower texture value. Therefore, there is optimum limit to the use of gum arabic to produce the wanted and acceptable texture of fruit leather.

4.0 CONCLUSION

1. The addition of gum arabic at different concentrations in the manufacture of Dewa starfruit-red guava fruit leather was significantly different at a = 0.05 on the parameters of tensile strength, water content, ash content, vitamin C content, pH value, hedonic quality value of color, hedonic value and hedonic quality value of texture. However, there is no significant effect on crude fiber content, water activity value, hedonic value of color, hedonic value and hedonic quality value of aroma, as well as hedonic value and quality hedonic value of flavor.
2. Fruit leather which produces the best quality is the fruit leather with the addition of 0.5% gum arabic with the parameters of the tensile strength value of 437.38 gf, water content of 7.38%, ash content of 2.02%, vitamin C content of 77.08 mg / 100 g, crude fiber content of 1.85, pH value of 4.22, water activity value of 0.48, total bacteria value of <2.5 CFU/g, total yeast and mold value of <1 CFU/g, with golden yellow color, slightly strong starfruit aroma, strong star fruit flavor, and elastic fruit leather texture. In addition, 1 roll of fruit leather as much as 2 grams can meet the nutritional adequacy rate of vitamin C by 4% for the infant and child category, 2-3% for the male age group 10-80 years, and 2% for the 10-80 years, and can meet the nutritional adequacy rate of fiber of 0.2 - 0.5% for the category of infants and children, 0.14-0.23% for the male age group 10-80 years, and 0.16-0.25% for the 10-80 year age group for women.