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Influence of Types of Fatty Materials and Addition of Sugar Concentration on Fruit Leather Quality from Dragon Fruit Albedo (Hylocereus polyrhizus)

Dina Mardhatilah¹, Ida Bagus Banyuro Partha¹, Herra Hartati¹
¹Department of Agricultural Product Technology, Institute of Agriculture STIPER, Yogyakarta, Jl. Nangka II maguwoharjo, Sleman Yogyakarta, Indonesia
Email: dinamardhatilah@yahoo.com; idabagusbp@gmail.com

Abstract. In this study, the production of fruit leather from dragon fruit skin albedo was conducted in order to investigate the effect of stabilizer types and ratio of dragon fruit skin albedo with sugar concentration on the quality of fruit leather from dragon fruit skin albedo. The research was conducted using Complete Randomized Block Design (CRBD) with two factors. First factor was the addition of stabilizer ingredients with 3 variants, which are gum arabic, pectin, and gelatine, with concentration 0.2% for each. Second factor was the ratio of dragon fruit skin albedo and sugar concentration added with 3 ratios, which are 70%:30%, 60%:40%, and 50%:50%. Results of the research showed that the addition of stabilizer ingredients affected the water content, pH, total acid, total sugar content, and fiber content, and also influenced the colour, texture, aroma, and flavour preferences of fruit leather. There was interaction between stabilizer type and ratio of dragon fruit skin albedo and sugar concentration added on the water content, total sugar content, fiber content, and the colour, aroma, and flavour preferences of fruit leather. From the mean of hedonic test, pectin as stabilizer ingredient type with ratio of dragon fruit skin albedo and sugar concentration 70%:30% generated the best fruit leather with the mean of water content 26.86% wb, pH 3.64, total acid 7.69% db, total sugar content 48.86% db, and fiber content 1.75% db.

1. Introduction

Dragon fruit (Hylocereus polyrhizus) was introduced in Indonesia in 90s decade and started to be consumed in early 2000s which was imported from Thailand. Dragon fruit weighs only 400-500 g/piece, consists of 30-35% skin and 65-70% flesh. Generally, people only consume the flesh. However, research showed that dragon fruit skin contains active compounds, which are pentacyclic triepene taraxast 20-ene 3-aol and taraxast 12.20 (30)-dien 3-aol, which are very good for health. In addition, it also contains betalain which functions as antioxidant and natural food colouring.

Dragon fruit skin has bigger potency than the flesh. From the production number of dragon fruit every year, 2,000-2,343 tons of dragon fruit skin end as waste. Until today dragon fruit skin has not widely used. In this modern era, people want everything instantly, including for their health. Therefore, we tried to process red dragon fruit skin waste become an instant, health, and easily-consumed product, in the form of fruit leather. Fruit leather is a kind of food which is made from minced and dried fruit flesh, and has final shape as dry thin sheets.

There is a problem in the making of fruit leather, which is about the mechanism of gel formation of fruit leather from dragon fruit skin albedo. This gel formation is affected by the addition of sugar, pectin, and acid. The more sugar added, the more water stays in fruit leather.
structure. The addition of filler ingredients such as gum arab, pectin, and gelatine will affect fruit leather texture. Therefore, the most appropriate filler ingredient and ratio of sugar and dragon fruit skin albedo used to produce the desired fruit leather texture should be determined.

According to the previous research which used stabilizer ingredients gelatine 1% and gum arab 3%, gelatine 1% performed better. In this research, we would like to add gum arab, pectin, and gelatine as filler ingredients with concentration 0.2% for each, and ratio of sugar and dragon fruit skin albedo 7:3, 6:4, and 5:5. Based on the background of this research, this research aims to: 1) know the effect of filler ingredients to the quality of fruit leather from dragon fruit skin albedo, 2) know the most appropriate number of sugar added to produce fruit leather from dragon fruit skin albedo.

2. Methods
The research was conducted in the laboratory of Faculty of Agricultural Technology, Institute of Agriculture STIPER Yogyakarta which included activities of leaf fruit production from albedo leather as well as performed some analytical tests.

The experimental design used in this study was a complete randomized block design (CRBD) consisting of two treatment factors.
1. Factor type of filler consists of 3 treatments, i.e.:
   • A1: Arab Gum 0.2%
   • A2: Pectin 0.2%
   • A3: Agar 0.2%

2. Comparison factor of albedo dragon fruit skin and sugar concentration consists of 3 treatments, i.e.:
   • B1: 7: 3
   • B2: 6: 4
   • B3: 5: 5

Replication was performed 2 times as block, so that it was obtained 3x3x2 = 18 experimental units. The data obtained from the research was analyzed with its diversity at 5% level of significance and to determine the difference between treatments Duncan multiple test (JBD) at 5% level of significance was performed.

3. Result and Discussions
3.1 Water Content
From Table 1, it can be seen that each treatment showed significant effect to the water content of fruit leather. Fruit leather with gum arab filler addition had the highest water content (mean 28.3% wb). This can be caused by the ability of gum arab to bind a big amount of water compared to pectin and gelatine (agar-agar) filler (1), therefore gum arab has higher water content.

| Type of filler     | Water content (%) | pH  | Total acid (mg/g) | Total sugar content (%) | Fiber content (%) |
|--------------------|-------------------|-----|-------------------|-------------------------|------------------|
| A1 (Gum arab 0.2%) | 28.272a           | 3.605 | 8.870a            | 45.656c                 | 1.585a           |
| A2 (Pectin 0.2%)  | 24.813b           | 3.650b | 7.482b            | 52.637c                 | 1.875b           |
| A3 (Gelatine 0.2%)| 21.303c           | 3.997c | 5.318c            | 58.503c                 | 2.148c           |
| Sugar concentration|                  |      |                   |                         |                  |
| B1 (7:3)          | 25.510a           | 3.723 | 7.308a            | 49.748c                 | 1.865            |
| B2 (6:4)          | 24.814c           | 3.763 | 7.147c            | 52.991c                 | 1.831            |
| B3 (5:5)          | 24.063d           | 3.765 | 7.216d            | 54.057d                 | 1.910            |

Note: mean which is followed by the same letter in each column of filler or sugar concentration shows no significant difference based on Duncan's Multiple Range Test 5%.
From Table 1, we can also see that the addition of sugar concentration in 5:5 ratio resulted the lowest mean (24.063% wb). Sucrose belongs to disaccharide because it is consisted of glucose and fructose molecules. Binding between two molecules of monosaccharide is called glycosidic bond. This generally happens between C atom no. 1 with C atom no. 4 by releasing 1 mol of water. By the increasing of sucrose content, the releasing of water content from the glycosidic bond was increased as well (2). From Table 1, it can also be seen that the higher sugar concentration added, the lower the water content. Therefore, the higher sugar concentration added, the longer the shelf life. Otherwise, the higher ratio of the dragonfruit (*Hylocereus polyrhizus*) peel caused the increasing of the water content of fruit leather. Dragon fruit peel has higher water content than the flesh. The water content of dragonfruit peel is 94.05%, while the water content of dragonfruit flesh is 84.8% (3). Therefore, the treatment of ratio between the albedo of dragonfruit (*Hylocereus polyrhizus*) peel and sugar concentration added showed a significant effect to the water content of fruit leather. Water content of fruit leather from dragon fruit (*Hylocereus polyrhizus*) peel albedo was 16.19% - 32.98% wb. that was in accordance to the standard, which is 45% wb (National Standardization Agency, 1992).

**Table 2. Result of hedonic test of fruit leather (score).**

| Type of filler | Preferences |
|---------------|-------------|
| A1 (Gum arab 0.2%) | | |
| A2 (Pectin 0.2%) | | |
| A3 (Gelatine 0.2%) | | |
| B1 (7:3) | | |
| B2 (6:4) | | |
| B3 (5:5) | | |

**Sugar concentration**

| Sugar concentration | Colour | Texture | Aroma | Flavour |
|---------------------|--------|---------|-------|---------|
| B1 (7:3)            | 3.775  | 3.433a  | 3.158 | 3.783b |
| B2 (6:4)            | 3.725b | 3.308c  | 3.150 | 3.693de |
| B3 (5:5)            | 3.530  | 3.233c  | 3.117 | 3.525c |

Note: for hedonic test: score 3 = neutral; score 4 = prefer

a) Mean which is followed by the same letter in the same column shows no significant differences based on Duncan’s Multiple Range Test 5%.

**Table 3. Mean of hedonic test of fruit leather (score).**

| Treatments | Colour | Texture | Aroma | Flavour | Mean of Preferences |
|------------|--------|---------|-------|---------|--------------------|
| A1B1       | 3.33   | 3.38    | 3.175b| 3.23    | 3.28               |
| A1B2       | 3.68   | 3.40    | 3.45ab| 3.55    | 3.52               |
| A1B3       | 3.55   | 3.45    | 3.35ab| 3.45    | 3.45               |
| A2B1       | 4.35   | 4.30    | 2.66ab| 4.30a   | 3.89               |
| A2B2       | 3.95   | 4.05    | 2.675| 3.95   | 3.66               |
| A2B3       | 3.73   | 3.75    | 3.1bdef| 3.73    | 3.57               |
| A3B1       | 3.65   | 2.63    | 3.7a  | 3.83bc  | 3.45               |
| A3B2       | 3.55   | 2.48    | 3.325abcd| 3.58cde| 3.23               |
| A3B3       | 3.33   | 2.50    | 2.9def| 3.40def| 3.03               |

a. Mean which is followed by the same letter in the same column shows no significant differences based on Duncan’s Multiple Range Test 5%.
b. For hedonic test: score 3 = neutral; score 4 = prefer
3.2 Potential Hydrogen (pH)

Table 1 describes that the treatment of filler type addition showed significant differences in pH of fruit leather. The pH of fruit leather added by gum arab filler was the lowest compared to pectin and gelatine, which the mean was 3.605. This was because gum arab contains more H\(^+\) ion than pectin and gelatine, therefore the acidity was increased/pH was decreased. According to Saputera (4), the lower the pH/the higher the acidity, the more H\(^+\) in the solution. pH of fruit leather added by gelatine was the highest with the mean 3.997. This was because the lower the acidity of solution, the higher the pH. The addition of gelatine concentration increased the concentration of hydroxide (OH\(^-\)) ion that made pH low (5). Analytical results of the pH of fruit leather from dragonfruit (*Hylocereus polyrhizus*) peel albedo was in accordance with the standard of jam’s pH, which is 3.5-4.5 (6).

3.3 Total Acid

Based on Table 1, the treatment of filler addition showed significant effect to the total acid of fruit leather. Total acid of fruit leather with gum arab filler was the highest, which the mean was 8.870%. This was related to pH analysis in Table 1 that shows that gum arab had the lowest pH. The lower pH, the higher the acidity. Furthermore, gum arab is a hydrocolloid that has ability to form gel so it can protect acid and another components from oxidative damage (2), therefore the higher the concentration of gum arab, the stronger its binding to protect acid from damage during drying process, so that the total acid of fruit leather will be higher.

Total acid of fruit leather with pectin filler follows, which the mean was 7.482%. Pectin has ability to bind sugar, water, and soluble solid (such as acid). Moreover, pectin itself is an acid, and acid can hydrolize sugar become acid. The increasing of acid in food can be caused by decomposition of glucose to acid (7). Those caused fruit leather with pectin filler had higher total acid than gelatine filler.

3.4 Total Sugar Content

From Table 1, we can see that each treatment showed the significant effect to the total sugar content of fruit leather. Total sugar content of fruit leather with gelatine filler was the highest, which the mean was 58.503%, because gelatine is a carbohydrate with high molecular weight that fills seaweed’s cell wall. Total carbohydrate of gelatine “Swallow” product is 5.92% per 7 gram (Swallow Gelatine, 2010). Therefore, total sugar content of gelatine was higher than gum arab and pectin.

From Table 1, it is known that ratio of dragonfruit (*Hylocereus polyrhizus*) peel albedo and sugar concentration added showed significant differences to total sugar content of fruit leather. The highest total sugar content was in 5:5 ratio with the mean 54.057%. The more sugar concentration added, the higher the total sugar content.

3.5 Fiber Content

From Table 1, it can be seen that each treatment showed the significant differences to the fiber content of fruit leather. Fiber content of fruit leather with gelatine filler was the highest with the mean 2.148%, because gelatine has high fiber content. Gelatine is a polysaccharide component of seaweed which included to soluble fiber (8). Soluble fiber content in the combination of gelatine addition treatment was higher than gum arab and pectin because gelatine has higher solubility (9). Gelatine “Swallow” product has fiber content 5.88% per 7 gram (Swallow Gelatine, 2010). Therefore, the addition of gelatine filler resulted the higher fiber content than gum arab and pectin. Furthermore, interaction between filler type with various ratio of dragonfruit (*Hylocereus polyrhizus*) peel albedo and sugar concentration added showed significant differences effect to fiber content of fruit leather, shown in Table 1. This was because dragonfruit peel has high fiber content, approximately 46.7% (10). Therefore, the more the dragonfruit (*Hylocereus polyrhizus*) peel albedo, the more fiber content of fruit leather.
3.6 Hedonic test of fruit leather

3.6.1 Colour preferences

From Table 2, it is known that each treatment showed significant effect to the preference of fruit leather colour. Fruit leather colour with pectin had the highest score, 4.01. This was because the addition of pectin forms a clear/transparent gel (11). Table 2 shows that fruit leather colour with ratio of dragon fruit (*Hylocereus polyrhizus*) peel albedo and sugar concentration added 7:3 tend to be more preferred than the others. This was because the more the mixture of dragonfruit (*Hylocereus polyrhizus*) peel albedo formed the brighter red colour of fruit leather. According to Handayani and Rahmawati (12), extract of red dragonfruit peel contains 26.4587 ppm of antocyanine. Antocyanine is a red colour pigment that can be used as natural food colouring to substitute synthetic colouring which is more safe to health (13). Meanwhile, fruit leather colour with ratio of dragon fruit (*Hylocereus polyrhizus*) peel albedo and sugar concentration added 6:4 and 5:5 formed more brownish colour as the effect of caramelization of sugar, as pointed out by Anonymous (14). Meanwhile, the desired colour of fruit leather is the bright one.

Figure 1: Fruit Leather from dragon fruit albedo.

3.6.2 Texture preferences

Table 2 shows that the addition of filler treatment showed a significant effect. However, various ratio of dragon fruit (*Hylocereus polyrhizus*) peel albedo and sugar concentration added indicated no significant effect to the texture preferences of fruit leather. Fruit leather texture with pectin filler had the highest score, which was 4.03. This was because pectin has thickening and adhesive characteristic, where it contains polysaccharide, i.e. selulose, hemiselulose, pectin, and lignin that can strengthen the texture. According to Winarno (2), pectin is a mixture of complex polysaccharide (cellulose, hemicellulose, pectin, and lignin) that can be found in fruits and vegetables as gel former, adhesive, binder, and texture former. Table 2 also shows that fruit leather texture with ratio of dragon fruit (*Hylocereus polyrhizus*) peel albedo and sugar concentration added 7:3 tend to be more preferred than the others. This was because the mixture of dragon fruit (*Hylocereus polyrhizus*) peel albedo was higher than the others so it produced the better texture. Meanwhile, fruit leather texture with ratio of dragon fruit (*Hylocereus polyrhizus*) peel albedo and sugar concentration added 6:4 and 5:5 formed mushy texture. The more the mixture content of dragonfruit (*Hylocereus polyrhizus*) peel albedo, the higher the hedonic score of fruit leather texture. Texture, in the terms of hardness and tenderness level, is related to water content. Foods with higher water content is more tender than foods with the lower one (15).

3.6.3 Aroma preferences

Table 2 shows that there was no significant effect to aroma preferences of fruit leather for gum arab and gelatine filler, however for pectin there was a significant effect. This was because gum arab and gelatine have more scent than pectin, therefore gum arab and gelatine addition to fruit leather gives more preferred aroma to consumer. Table 2 also shows that fruit leather aroma
with ratio of dragon fruit (\textit{Hylocereus polyrhizus}) peel albedo and sugar concentration added was not significantly different. This was because addition with the same sugar concentration makes caramelization aroma smelled by panellist not significantly different (16).

3.6.4 Flavour preferences

Table 2 shows that each treatment showed significant effect to the flavour preferences of fruit leather. Fruit leather flavour with pectin filler had the highest score 3.99. This was because pectin originated from fruits and vegetables gives specific flavour to food. That appropriates to Picconena et al. (17), the increasing of hydrocolloid amount in food matrixevidently can increase thickness of the product where with pectin addition flavour perception comes from the pectin itself that comes from fruits or vegetables. From Table 2, it is also known that flavour of fruit leather with ratio of dragon fruit (\textit{Hylocereus polyrhizus}) peel albedo and sugar concentration added 7:3 was more preferred than other treatments. This was because it had more dragon fruit (\textit{Hylocereus polyrhizus}) peel albedo mixture than others so it gave stronger flavour. In addition, flavour was affected by interaction with other flavour components, such as addition of sugar and citric acid (2). From hedonic test mean data in Table 3 it can be concluded that fruit leather with pectin filler and ratio of dragon fruit (\textit{Hylocereus polyrhizus}) peel albedo and sugar concentration added 7:3 had the highest score, both from preferences and quality parameter. It was followed by pectin filler with ratio of dragon fruit (\textit{Hylocereus polyrhizus}) peel albedo and sugar concentration 6:4 in second place, while in the third place was pectin filler with ratio of dragon fruit (\textit{Hylocereus polyrhizus}) peel albedo and sugar concentration 5:5. Table 3 shows that three most preferred fruit leathers by panellist either from preferences or their quality parameter was fruit leather with pectin filler. Pectin filler with ratio of dragon fruit (\textit{Hylocereus polyrhizus}) peel albedo and sugar concentration added 7:3 had water content 26.825%, pH 3.635, total acid 7.691%, total sugar content 48.864%, and fiber content 1.746%.

4. Conclusions

In conclusion, the best type of stabilizer was pectin, followed by gum arab and gelatine. Type of filler showed significant difference on the quality of fruit leather from dragonfruit (\textit{Hylocereus polyrhizus}) peel albedo. The most appropriate sugar concentration added in the production of fruit leather from dragon fruit (\textit{Hylocereus polyrhizus}) peel albedo was at ratio 7:3.

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