The Effectiveness Test of Application Anthocyanin’s Extract in Fruit Jam from Several Local Biodiversities

Elfi Anis Saati, Hilwa Heidir, Moch. Wachid, Sri Winarsih, Abd. Haris, and Nurhakim

The quality of fruit jam was determined by various factors, namely sugar concentration, pectin, and type of extract pigments as a colorant. The study is to investigate the effectiveness of several anthocyanins on quality of papaya jam. It was conducted using a randomized block design and then was arranged with two factors. The first factor is the anthocyanin with different sources from several local biodiversities such as control (without pigment), canna flower, grape and skins dragon fruit. The second factor is using sugar content which is 40%, 50%, and 60%. Pigment extract was added to papaya jam and then was made using water and citric acid. The results of the study indicate that there is significantly increased in the quality products/papaya fruit jam, which is to reduce water content, increase pectin levels, vitamin C and the color of jam products as well as levels of preference. The best treatment is papaya jam with canna flower anthocyanin pigment and 60% sugar addition, which contained lower water content, pectin content 3.2%, vitamin C 0.21%, reducing sugar 7.46%, pH value 3.9, brightness level (L) 30.57, redness level (a+) 2.77, and taste rating 1.

INTRODUCTION

Papaya is easily damaged by the influence of mechanical, chemical, microbiological and biological treatments while its shelf life can be extended by processing into jams. Food and drug administration (FDA) survey results from 2002-2005 have found violations in the use of food dyes on second rank (11.31%). Moreover, the Ministry of Health of Indonesia in 2012 revealed that the use of synthetic food dyes continually can cause damage to the liver.

The uses of pigment as a source of natural dyes do not give adverse effects on health. Natural dyes that have the potential to be extracted to give like anthocyanin, which is red, purple and blue pigments found in plants, are widely distributed in plants [1]. The water-soluble pigments usually found in flowers, fruits, and leaves of plants. These pigments can be applied as alternative natural dyes in industrial products, such as food, cosmetics, and pharmaceuticals [2]. In accordance with the findings of Wu et al. in 2009 [3] that the natural coloring product has excellent stability and can be used in various applications including beverages, foods, drugs, dietary supplements, cosmetics, handicrafts and fodder [3].

The results of previous studies, exploration of some local biological materials have found including canna flower petals and Probolinggo grapes that contain anthocyanin pigments with high yields and good potential as natural dyes. Red dragon fruit skin contains pectin which can maximize the formation of gel texture and can be used as natural dyes [4]. Therefore this study aims to test the effectiveness of anthocyanin pigments as well as the addition of sugar to the quality of papaya jam.

EXPERIMENTAL

General

The experimental design used in this study was a Randomized Block Design arranged as factorial, consisting of two factors. Factor I was the addition of anthocyanin concentration (2 wt.%) from different sources. Factor II was the addition of sugar to papaya jam. Factor I consisted of control (without anthocyanin), red canna flower pigment, Probolinggo...
grapes, and dragon fruit skin. The addition of different glucose levels (40%, 50%, and 60%) for Factor II, in order to obtain 12 treatments, where each treatment was repeated three times. The results were analyzed using statistical analysis (analysis of Duncan’s Median Range Test).

Thai Papaya as a raw material obtained from local farmers at Bululawang, Malang. Papaya jam processing was done about 3 days after harvest with the maturity level of 75-80%. Another materials used in research were red canna flower petals (Canna indica L.), Probolingo grape (Vitis vinifera), red dragon fruit skin (Hylocereus costaricensis), commercial sugar or sucrose (white), citric acid, distilled water, commercial pectin, and chemicals material for analysis such as silver nitrate (AgNO₃), sodium bicarbonate (NaHCO₃), 1% starch, iodine 0.01 N, sodium hydroxide (NaOH), hydrochloric acid (HCl), calcium chloride (CaCl₂), acetic acid (CH₃COOH), and Luffschool solution.

**Anthocyanin Extraction Procedure**

Materials were weighed, crushed in a blender and added with distilled water and solvent acid (citric acid 10% b/v). The mixture was kept for 24 hrs in cold temperature. Subsequently centrifuged for 10 mins (speed 4000 rpm) to separate the filtrate and the residue was filtered using Whatman no. 41 paper. The obtained filtrate was evaporated using a rotary vacuum evaporator at 50 °C. 1/5 of its original volume. Extracts that contain anthocyanin has a low level of toxicity [5]. The previous studies which explored the biological material found that the petals of canna flower and Probolingo grapes contain anthocyanin pigments with the highest yield and potential as a natural dye. The skin of dragon fruit has a red pectin content that maximizes the formation of gel texture and can be used as natural dyes [4,6,7].

**Papaya Jam Making Procedures**

Papaya flesh was crushed without water until it becomes soft. Papaya porridge was weighed as much as 100 g and boiled for 10 mins long. The sugar was added according to treatment as Factor II (40%, 50%, and 60%). Commercial pectin 0.75 wt.% was added at the 8th mins and then continue until all 10 mins were done. Butter was derived from appropriate fire and added to anthocyanin. The mixture was mixed until homogeneous. After all homogeneous, and the jam was packed in a sterile cup.

**RESULTS AND DISCUSSION**

**Analysis of Raw Materials**

Table 1 shows that the highest sugar content was in grapes (28.46%), followed by dragon fruit in 13-18% range, canna petals 15.42% and the lowest total sugar was papaya with 13.08%. The presence of total sugar content in the raw materials or sources shows indication of glycone as anthocyanin compounds. Glycine is one of pigment anthocyanin characters that consists of aglycone (as anthocyanins) and glycone as sugar compounds bound or glycoside bond [5,8,9]. Black grapes pectin content was 4.25%, followed with red dragon fruit skin 15.70% and papaya fruit flesh with 1.34%. Materials pectin content helps to maximize the existence of gel that formed in papaya and improve the spearing [10].

**Table 1. The result of raw material sources anthocyanin pigments and Thai papaya chemical analysis**

<table>
<thead>
<tr>
<th>Chemical Analysis</th>
<th>Red Canna</th>
<th>Grape</th>
<th>Red Dragon Fruit Skin</th>
<th>Thai Papaya</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water content (%)</td>
<td>85.36</td>
<td>88.35</td>
<td>83.50</td>
<td>90.54</td>
</tr>
<tr>
<td>Sugar total (%)</td>
<td>15.42</td>
<td>28.46</td>
<td>13.18</td>
<td>13.08 [11]</td>
</tr>
<tr>
<td>Vitamin C (mg/100g)</td>
<td>0.67</td>
<td>0.97</td>
<td>8.0-8.9</td>
<td>330.00</td>
</tr>
<tr>
<td>Reducing sugar (%)</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>2.42</td>
</tr>
<tr>
<td>pH</td>
<td>-</td>
<td>-</td>
<td>4.65</td>
<td></td>
</tr>
</tbody>
</table>

**Table 2. The result of papaya jam content of water, pectin, vitamin C due to the addition of anthocyanin and sugar content**

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Water (%)</th>
<th>Pectin (%)</th>
<th>Vitamin C (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control (without pigment)</td>
<td>44.57 a</td>
<td>1.79 a</td>
<td>0.21 a</td>
</tr>
<tr>
<td>Red canna</td>
<td>57.59 d</td>
<td>3.13 d</td>
<td>0.24 bc</td>
</tr>
<tr>
<td>Grape</td>
<td>55.63 bc</td>
<td>2.54 b</td>
<td>0.24 bc</td>
</tr>
<tr>
<td>Red dragon Fruit Skin</td>
<td>55.82 b</td>
<td>2.86 c</td>
<td>0.25 d</td>
</tr>
<tr>
<td>Level sugar 40%</td>
<td>20.32 c</td>
<td>0.09 c</td>
<td></td>
</tr>
<tr>
<td>Level sugar 50%</td>
<td>12.40 b</td>
<td>ns</td>
<td>0.08 b</td>
</tr>
<tr>
<td>Level sugar 60%</td>
<td>15.68 a</td>
<td>ns</td>
<td>0.06 a</td>
</tr>
</tbody>
</table>

**Color Intensity**

The color intensity of papaya pulp indicates the presence of carotenoid pigments that give the appearance of a yellowish red color or orange. This papaya pulp has color intensity 37.9 for brightness (L), 10.27 for redness (a+), and 11.57 for yellowish (b+). Orange-red pigment caused by carotenoid that soluble in oil. Ripe papaya is superior in terms of beta-carotene (276 microgram/ 100 g) [10]. Moreover, the absorbance values were found to be 0.585, 0.367 and 0.449 (at λ of 510-540 with 100 times dilution) for the anthocyanin’s extracts from canna flower, grapes, and dragon fruit skin, respectively. Previous research result from Saati, et al. in 2014 [5] indicates that red canna flower anthocyanin types were pelargonidin 3-glucoside, cyanidin 3-glucoside. Meanwhile, it was malvidin 3-glucoside in Probolingo grape and cyanidin 3-glucoside 5-glucoside in red dragon fruit skin. The results of various materials color intensity can be seen in Table 3.

**Table 3. The result of papaya jam color intensity due to the addition of anthocyanin and sugar Content**

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Brightness (L)</th>
<th>Redness (a+)</th>
<th>Yellowish (b+)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control (without pigment)</td>
<td>31.16 b</td>
<td>1.69 a</td>
<td>0.27 b</td>
</tr>
<tr>
<td>Red canna</td>
<td>30.81 a</td>
<td>2.88 d</td>
<td>-0.26 a</td>
</tr>
<tr>
<td>Grape</td>
<td>31.51 c</td>
<td>2.32 c</td>
<td>0.28 bc</td>
</tr>
<tr>
<td>Red dragon fruit skin</td>
<td>31.84 d</td>
<td>2.02 b</td>
<td>0.37 d</td>
</tr>
<tr>
<td>Level sugar 40%</td>
<td>10.55 c</td>
<td>0.79 c</td>
<td>0.12 b</td>
</tr>
<tr>
<td>Level sugar 50%</td>
<td>10.50 b</td>
<td>0.77 b</td>
<td>0.12 bc</td>
</tr>
<tr>
<td>Level sugar 60%</td>
<td>10.28 a</td>
<td>0.67 a</td>
<td>-0.08 a</td>
</tr>
</tbody>
</table>

Based on the variant analysis, there was no interaction between the addition of anthocyanin and sugar content to the color intensity of papaya jam analysis (including brightness, redness, and yellowish), but separately they were two significant factors. The L level based on Table 2 was due to the addition of anthocyanin pigments. The highest L value was the one with red dragon fruit skin (31.84), followed by grape and control (31.51 and 31.16 in sequence), and the lowest was papaya jam with

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canna flower (30.81). Papaya jam with lower L score means that the product has a solid red. On the other hands, it indicates that canna flower anthocyanin pigment is more stable than grape and red dragon fruit skin. Canna flower contains the most anthocyanin (0.91%), then followed by grape (0.15%) and red dragon fruit skin with 0.02% [5,7].

In Table 3, it can be seen that the highest water content and pectin, prepared from papaya jam using canna flower pigment extract, which is as much as 57.59% and 3.13%. The level of vitamin C in papaya jam showed a relatively similar value between the addition of canna flower extract and dragon fruit or grape skin, which is 0.24-0.25%. The pectin content in black grapes is 4.25%, in red dragon fruit skin is 15.70% and in papaya fruit is 1.34%, had were decreased after being papaya jam (Table 3). This is due to degradation at high-temperature heating during processing. The lowest pectin level in the control papaya jam (without anthocyanin) was 1.79%. The level of pectin was increased with the addition of anthocyanin, which is 3.13% (canna flower), 2.54% (black grapes), and red dragon fruit skin 2.87%. This is due to the anthocyanin extract taken from flower petals, fruit, and fruit skin. According to Muryanti [11], rosella petals contain 3.19% pectin, 4.25% grapes [12] and red dragon fruit skin 15.70% [13], and Campoli fruit as much as 0.91% [14]. Gel formation was influenced by various factors, namely sugar, pectin concentration, type of pectin, pH, and temperature. It can form faster with lower temperatures and increased sugar concentration [15]. The observation of the pH of papaya jam, the highest value on jam without the addition of anthocyanin (control) was equal to 5.63, followed by jam grape anthocyanin addition of 4.02, dragon fruit skin 3.96 and the lowest with the addition of Canna flower anthocyanin was equal to 3.94. The amount of vitamin C content in papaya jam is influenced by the high levels of anthocyanin and the pH value of the extract. In conditions of acidic media, it will slow down the oxidation process of vitamin C [16]. The presence of anthocyanin pigments suppresses the loss of vitamin C in the material because it is an antioxidant [17]. Non-water carriers such as anthocyanin pigments can actually increase the stability of Vitamin C jam papaya. These results, in accordance with the results of the research of You et al. [18], which observed the stability of Vitamin C glycerin containing carrageenan as its carrier.

Addition of sugar levels of 40%, 50%, and 60% showed decreasing levels of vitamin C, namely 90 mg/100 g, 80 mg/100 g and 60 mg/100 g. This is due to the nature of vitamin C and sugar which are both easily dissolved in the water fraction. Addition of the proportion of sucrose with high concentration caused the water fraction to increase so that vitamin C levels undergo dilution. According to Pertiyi's report (2014) [19], the greater the proportion of sucrose added, the higher vitamin C to be degraded.

According to Table 3, the highest L score was papaya with 40% sugar (10.55), followed by 50% sugar (10.50) and 60% sugar (10.28). The L value of papaya jam decreased as sugar content increased. This is because the sugar will be browning (caramelization) due to the heating process while making the jam, same with another polyphenol [23]. Compatible with its L, the highest a+ score for papaya jam was canna flower with 2.88, followed with grape (2.32) and dragon fruit skin (2.02) and the lowest a+ was papaya jam without anthocyanin extract (1.69). The high a+ score for canna flower was supported by its low pH analysis result (3.94) that improves anthocyanin stability.

According to Rein [20], anthocyanin pigment is more stable at low pH range which is between 1-4 and it will give red color as its physical characteristic. Papaya jam with 40% sugar has the highest a+ score (0.79), followed by sugar 50% and 60% (0.77 and 0.67). Papaya jam a+ score will decrease along with the addition of sugar. It was because the more sugar added to jam, its increase papaya jam pH. The existence of glucose, fructose, and ascorbic acid can accelerate anthocyanin degradation at the same time [21].

Papaya jam with the highest b+ score was dragon fruit skin addition (0.367), followed by control (0.267), grape (0.278), and the lowest was canna flower with -0.26 that produce more bluish color (purplish red). It was affected by anthocyanin content which canna flower has the highest anthocyanin contents [5]. Papaya jam with 40% and 50% sugar have the same b+ score (0.122), meanwhile, papaya jam with 60% sugar content has the lowest score (-0.081) that produce bluish color. The addition of sugar causes changes in anthocyanins structure, and the sign (-) indicates bluish/purplish red physical appearance.

### Papaya Jam Organoleptic Analysis (Taste, Appearance, and Aroma)

Table 4 shows the papaya jam organoleptic analysis with an evaluation of addition of anthocyanin and sugar content. It showed that papaya jam with the highest preference score was 60% sugar addition and canna flower anthocyanin pigment and the lowest was 50% sugar without extract pigment. Sugar and pigment provide acceptable flavor combination for costumes. Papaya jam sweet and sour flavor came from citric acid 10% that has been used [22]. The citric acid amount has a significant effect on panelist acceptance.

<table>
<thead>
<tr>
<th>Treatment (Papaya Jam)</th>
<th>Taste</th>
<th>Appearance</th>
<th>Aroma</th>
</tr>
</thead>
<tbody>
<tr>
<td>Without anthocyanin and 40% sugar</td>
<td>-0.60</td>
<td>-1.29</td>
<td>-0.83</td>
</tr>
<tr>
<td>Canna flower anthocyanin and 40% sugar</td>
<td>-0.35</td>
<td>1.21</td>
<td>-0.44</td>
</tr>
<tr>
<td>Grape anthocyanin and 40% sugar</td>
<td>-0.15</td>
<td>-0.31</td>
<td>0.11</td>
</tr>
<tr>
<td>Dragon fruit skin anthocyanin and 40% sugar</td>
<td>-0.04</td>
<td>-0.73</td>
<td>-0.25</td>
</tr>
<tr>
<td>Without anthocyanin and 50% sugar</td>
<td>-0.65</td>
<td>-0.97</td>
<td>-0.82</td>
</tr>
<tr>
<td>Canna flower anthocyanin and 50% sugar</td>
<td>0.10</td>
<td>0.93</td>
<td>0.14</td>
</tr>
<tr>
<td>Grape anthocyanin and 50% sugar</td>
<td>0.31</td>
<td>-0.19</td>
<td>0.63</td>
</tr>
<tr>
<td>Dragon fruit skin anthocyanin and 50% sugar</td>
<td>-0.11</td>
<td>-0.46</td>
<td>-0.13</td>
</tr>
<tr>
<td>Without anthocyanin and 60% sugar</td>
<td>-0.54</td>
<td>0.14</td>
<td>-0.68</td>
</tr>
<tr>
<td>Canna flower anthocyanin and 60% sugar</td>
<td>0.96</td>
<td>1.06</td>
<td>0.96</td>
</tr>
<tr>
<td>Grape anthocyanin and 60% sugar</td>
<td>0.65</td>
<td>0.41</td>
<td>0.85</td>
</tr>
<tr>
<td>Dragon fruit skin anthocyanin and 60% sugar</td>
<td>0.43</td>
<td>0.21</td>
<td>0.67</td>
</tr>
</tbody>
</table>

Note: The same letter on the same column indicated insignificant result according to Duncan 5%

According to Table 4, the highest appearance score was papaya jam added by canna flower with 40%, 50%, and 60% sugar. The highest performance score in the sequence is papaya jam plus canna flowers with sugar 40%, 60%, and 50%, followed by papaya jam with 60% sugar and grapes as well as
dragon fruit skin pigments. It was followed by papaya jam with 60% sugar and grape also dragon fruit skin pigments. The results show that high sugar and pigment addition make jam color darker especially pigment from canna flower. Sugar addition and some glycoside from pigment extract on jam gave contribution for dark color (brown) due to caramelization process because of heat [23,24], while anthocyanin pigment gave red color on a jam. The combination of red and brown raised panelist interest. In addition, papaya jam appearance and color were supported by its gel form. Gel formed and maintained because of the addition of sugar and acid which make anthocyanin more stable. The gel would perfectly form with higher sugar content.

The highest aroma score was papaya jam with 40% sugar and canna flower anthocyanin while the lowest score was papaya jam with 40% sugar and no pigment added. It was because sugar and anthocyanin generated natural acidic aroma to papaya jam. As a result, it can combine with papaya aroma and unique caramel aroma from browning reaction make panelist more interested [23,6]. It proved that high sugar and anthocyanin addition improve papaya jam quality.

CONCLUSION
There was a significant interaction between the addition of anthocyanin pigments from various local biodiversity sources and sugar content on papaya jam quality. Anthocyanin addition and sugar content affected papaya jam water content, reducing sugar, pectin concentration, pH value, redness (a+) score, brightness (L) score, and topical power jam. Anthocyanin addition significantly affected papaya jam yellowish (b+) score. Meanwhile, sugar content significantly affected papaya jam water content, reducing sugar, vitamin C, (a+) score, (b+) score, (L) score, and papaya jam. The best treatment in this research was papaya jam with canna flower anthocyanin and 60% sugar (G3A1 or was deleted) which contain relatively low water content, 3.2% pectin, 0.21% vitamin C, 7.46 reducing sugar, 3.9 pH, 30.57 (L) score, 2.77 (a+) score. It also had high rank on taste, appearance, and aroma organoleptic analysis.

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REFERENCES

Abstrak
Kualitas selai pepaya ditentukan beberapa faktor yaitu konsentrasi gula, pektin dan tipe pigmen sebagai pewarna. Penelitian ini ialah untuk mengetahui efektivitas dari beberapa pigmen antosianin pada kualitas selai pepaya. Penelitian ini dilakukan dengan menggunakan Rancangan Acak Kelompok (RAK) dengan dua faktor. Faktor pertama adalah pigmen antosianin dengan perbedaan sumber seperti kontrol (tanpa pigmen), bunga canna, anggur, dan kulit buah naga merah). Faktor kedua adalah dengan konsentrasi gula yaitu 40%, 50%, dan 60%. Ekstrak pigmen ditambahkan pada selai pepaya, dan kemudian dibuat dengan menggunakan air dan asam sitrat. Hasil dari penelitian ini menunjukkan bahwa ada penambahan secara signifikan dalam kualitas produk/selai buah pepaya, yaitu menurunkan kadar air, meningkatkan kadar pektin, vitamin C dan warna dari produk selai serta tingkat kesukaan. Perlakuan terbaik dalam penelitian ini adalah selai buah pepaya dengan penambahan pigmen antosianin bunga canna dan penambahan gula 60% yaitu mengandung kadar air lebih rendah, kadar pektin 3,2%, vitamin C 0,21%, gula reduksi 7,46%, nilai pH 3,9, tingkat kecerahan (L) 30,57, tingkat kemerahan (a+) 2,77, dan ranking rasa 1.

Kata kunci: pigmen, antosianin, bahan lokal, selai pepaya