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The quality of red guava (*Psidium guajava* L.) gummy candies with variation additions of pineapple peel extract paste (*Ananas comoscus* L. Merr) as a gelling agent

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Abstract

Gummy candies is a semi wet-food from fruit or vegetable juices and has the characteristic elasticity and transparency by using a commercial gelling agent. The commercial gelling agent is expensive. Since pineapple peel has not been used widely although it has pectin it could have the potential to act as a gelling agent. In this research, red guava gummies were added with various pineapple peel extract paste. The research was to determine the quality of red guava gummy candies with variation additions of pineapple peel extract paste based on chemical, physical, microbiological, and sensory parameters. Pineapple peel was used to improve the handling of pineapple waste and extend the shelf life of red guava. The research used a random design, in which the pineapple peel extract paste had variation additions of pineapple peel extract paste of 0 g (K), 10 g (A), 14 g (B) and 18 g (C). The parameters tested in this research include chemical, physical, microbiological, and sensory. The best addition of pineapple peel extract paste was 18 g (C) with a quality gummy candies moisture content of 17.87%, ash content of 0.48%, reducing sugar of 17.08%, pH of 2.5; gumminess of 335.31 gF, chewiness of 1344.67 gmm, hardness of 388.61 g and microbiological according to SNI gummy candies (SNI 3547-2-2008) standards.

1. Introduction

Gummy candies is one of the semi-wet food with a characteristic of elastic and transparent appearance. Generally, gummy candies is made from fruit or vegetable juices (Hidayati and Pereira, 2018). Gummy candies is cooked until 75% dissolved solids and they can be combined with materials that have the potential to increase the selling value of raw materials and the quality of gummy candies (Basuki *et al*., 2014). Gelatin is usually used as a gelling agent, but this ingredient is expensive. As an alternative, pineapple peel can be processed into jam as a by-product. However, this material has not been widely utilized. Therefore, the utilization of a by-product of pineapple with high pectin could be the solution to this problem.

Red guava is used for flavouring gummy candies since the taste is familiar to Indonesian. The increasing demand for gummy candies requires new innovations to improve the quality of gummy candies by adding a gelling agent. Pectin is a gelling agent that consists of a 70% galacturonic acid unit (Mellinas *et al*., 2020).

Pineapples grow well in tropical areas like Indonesia and the processing has been well developed. Because of that, it results in abundant pineapple peel as a waste (Mulyadi *et al*., 2015). Pineapple peel is one of the fruits that have moderate pectin content with a content of 7.05% (Nadir *et al*., 2019). This research was conducted by utilizing red guava fruit and pineapple peel in the form of paste. The purpose of this research was to determine the quality of red guava gummy candies with variation additions of pineapple peel extract paste based on chemical, physical, microbiological, and sensory parameters.

2. Materials and methods

2.1 Preparation of guava fruit juice

A total of 500 g of guava fruit was sorted, peeled, and then washed. The guava fruit was cut into several pieces and put into a juicer. Then, the juice was poured into a container.

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2.2 Preparation of pineapple peel powder

Ripe pineapple peel was washed with water. The pineapple peel was dried in an oven at 55°C for 24 hrs and then mashed with a grinder. The pineapple peel powder was sieved with a 60-mesh sieve.

2.3 Preparation of pineapple peel extract paste

A total of 10 g of pineapple peel powder were mixed with 5% citric acid and then stirred until completely dissolved (Nadir *et al*., 2019). The solution was concentrated in a rotary evaporator at 70°C.

2.4 Chemical analysis of raw material

The red guava juice was subjected to chemical analysis which includes moisture content (Sembiring and Sinaga, 2003), ash content (Latuperissa *et al*., 2019), reducing sugar (Dewi *et al*., 2005), pectin content (Arimpi and Pandia, 2019).

The pineapple peel extract paste was tested for moisture content (Sembiring and Sinaga, 2003), ash content (Latuperissa *et al*., 2019), and reducing sugar (Dewi *et al*., 2005), pH (Suryani *et al*., 2017), pectin equivalent weight and methoxyl content (Latuperissa *et al*., 2019), galacturonic acid content and the degree of esterification (Akhmalludin and Kurniawan, 2011).

2.5 Gummy candies making

The ingredient used to make gummy candies is 20 mL of red guava juice, 20 mL of high fructose syrup, 80 mL of water, 60 g of sugar, and pineapple peel extract paste (10, 14, 18 g) for the treated sample. The control sample is without pineapple peel extract paste. All the ingredients were then heated at 80°C and stirred for about 40 min until it thicked. Then 0.5 g of citric acid was added before turning off the heat (Table 1).

The thick dough of gummy candies is poured into moulds and cooled at room temperature (20-25°C) for 1 hr. The dough was stored at 5°C for 24 hrs and then it was stored at room temperature (20-25°C) for 1 hr.

2.6 Quality test of gummy candies

Gummy candies quality analysis includes chemical moisture content (Sembiring and Sinaga, 2003), ash content (Latuperissa *et al*., 2019), reducing sugar (Dewi *et al*., 2005), physical analysis (chewiness, gumminess and hardness) with the texture profile analyzer method (Untoro *et al*., 2012) and colour with chromameter (Wisesa and Widjanarko, 2014), total plate count (Jamhari, 2018) and yeast and mould count (Prastyowati *et al*., 2014).

Sensory analysis was performed with the hedonic test or predilection test. The panellists were thirty people comprising fifteen men and fifteen women, who like gummy candies. The parameters tested were colour, flavour, taste, and texture. The result of the test is based on rank with a scale of 1 to 4: (1) dislike, (2) slightly like, (3) like, and (4) mostly like.

2.7 Statistical analysis

The analysis used was Analysis of Variance (ANOVA) using the SPSS version 15 program to determine whether there was a significant difference between treatments. If there is a significant difference, then the data analysis will be continued by Duncan's Multiple Range Test (DMRT) with a 95% confidence level. However, if there is no difference, the DMRT test is not performed.

3. Results and discussion

3.1 Chemical analysis of red guava juice and pineapple peel extract paste

Red guava fruit is a perishable commodity. As the consequence, it can only be stored for a few days at room temperature with minimal handling. As a result of the pineapple manufacturing process such as jam and

Table 1. Gummy candies formulation

Ingredient	Additions of pineapple peel extract paste			
	0 g (K)	10 g (A)	14 g (B)	18 g (C)
Solid				
Sugar	60 g	60 g	60 g	60 g
Pineapple peel extract paste	0	10 g	14 g	18 g
Citric acid	0.5 g	0	0	0
Gelatin	18 g	14 g	14 g	14 g
Total Solids	78.5g	84 g	88 g	92 g
Liquid				
Red guava juice	20 mL	20 mL	20 mL	20 mL
High-Fructose Corn Syrup	20 mL	20 mL	20 mL	20 mL
Water	80 mL	80 mL	80 mL	80 mL
Total Liquid	140 mL	140 mL	140 mL	140 mL

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Table 2. Chemical analysis of red guava

Parameter	Yield	Literature	Sources
Pectin content	0.63±0.04%	0.5-1.8%	Dilla (2011)
Moisture content	92.61 ±1.64%	78.4-88.4%	Chiveu *et al.* (2019)
Ash content	0.89±0.06%	1.59%	Ferdaus *et al.* (2020)
Reducing sugar	4.51±0.63%	4%	Salunkhe and Kadam (2004)

Table 3. Chemical analysis of pineapple peel extract paste.

Parameter	Yield	Literature	Sources
Moisture content	67.36±0.38%	63.31-85.52%	Leonard *et al.* (2019)
Ash content	0.67±0.10%	2.5%	Nadir *et al.* (2019)
Reducing sugar	0.36±0.01%	1.68-2.04%	Siti Roha *et al.* (2013)
pH	2.88±0.01	3.63	Campos *et al.* (2020)
Pectin content	0.91±0.01%	0.1%	Ukiwe and Alinnor (2011)
Galacturonic acid	65.67±0.86%	35.30-44.78%	Rodsamran and Sothornvit (2019)
Equivalent weight	540.01±2.02 mg	640.15-1073.46 mg	Rodsamran and Sothornvit (2019)
Degree of esterification	27.03±0.71%	26.92-35.69%	Rodsamran and Sothornvit (2019)
Methoxyl content	5.59±0.11%	5.24-6.12%	Rodsamran and Sothornvit (2019)

candies, a large amount of peel waste will be generated. Therefore, it is necessary to utilize the ingredients in the pineapple peel to improve its economic value. The pectin content of pineapple peel is extracted with citric acid 5% as the solvent (Nadir *et al*., 2019). The chemical analysis result of the red guava and pineapple peel extract paste are tabulated in Table 2 and Table 3, respectively.

3.2 Chemical analysis of red guava gummy candies with variation additions of pineapple peel extract pastes as gelling agent

3.2.1 Moisture content

The moisture content of red guava gummy candies with variation additions of pineapple peel extract paste were 17.87 – 18.91% (Table 4). Based on the quality standard of the Indonesian National Standard Agency (2008), the moisture content maximum is 20%. The different moisture content levels were due to the addition of the solid content from 0 g, 10 g, 14 g, and 18 g. As a result, the moisture contents got lower because of the higher level of solid contents. The increase of solidities will reduce the dampness of content in the product (Guyot *et al*., 2002).

Table 4. The moisture content of red guava gummy candies with variation additions of pineapple peel extract paste

Additions of pineapple peel extract paste	Moisture content (%)
0 g (K)	18.91±0.06[a]
10 g (A)	18.48±0.11[b]
14 g (B)	18.10±0.05[c]
18 g (C)	17.87±0.08[d]

Values are presented as mean±standard deviation. Values with different superscripts are statistically significantly different at 95% confidence level.

3.2.2 Ash content

The gummy candies ash content with variation of the pineapple peel extract paste were 0.38 – 0.48% (Table 5). Based on the quality standard of the Indonesian National Standard Agency (2008), the maximum ash content is 3%. The ash content of red guava gummy candies with the addition of pineapple peel extract paste showed that the higher the addition of pineapple peel extract paste, the higher the ash content obtained. Red guava gummy candies with the addition of 18 g (C) pineapple paste produced a higher ash content than gummy candies products with low pineapple paste of 0 g (K), 10 g (A), and 14 g (B).

Table 5. The ash of content red guava gummy candies with variation additions of pineapple peel extract paste

Additions of pineapple peel extract paste	Ash content (%)
0 g (K)	0.38±0.01[a]
10 g (A)	0.41± 0.01[b]
14 g (B)	0.45±0.01[c]
18 g (C)	0.48±0.04[d]

Values are presented as mean±standard deviation. Values with different superscripts are statistically significantly different at 95% confidence level.

The addition of pineapple peel extract paste increased the ash content on red guava gummy candies. The control sample without the addition of pineapple peel extract paste had only the ash content of 0.89% (Table 2). The results of the chemical analysis can be seen in Table 3, where the ash content of pineapple peel extract paste is 0.67%. In addition, pineapple peel contains 8.3 mg of calcium, 6.46 mg of zinc, 25.52 mg of iron and 5.32 mg of manganese (Romelle *et al*., 2018).

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3.2.3 Reducing sugar

The result analysis of reducing sugar of gummy candies with variation additions of pineapple peel extract paste ranged from 16.98-17.08% (Table 6). Based on the quality standard of the Indonesian National Standard Agency (2008), the maximum level of reducing sugar is 25%. There was no significant difference in the results of this reducing sugar test since the result of the test was only 0.36%. Based on the research by Minggi and Hari (2018), the higher added sugar content increases the concentration of reducing sugar in the material.

Table 6. The results of reducing sugar red guava gummy candies with variation additions of pineapple peel extract paste

Additions of pineapple peel extract paste	Reducing sugar (%)
0 g (K)	16.98±0.56[a]
10 g (A)	17.03±0.56[a]
14 g (B)	17.06±0.63[a]
18 g (C)	17.08±0.73[a]

Values are presented as mean±standard deviation. Values with different superscripts are statistically significantly different at 95% confidence level.

3.2.4 pH value

The pH value (Table 7) of red guava gummy candies with variation additions of pineapple peel extract paste were 2.50 to 3.51, and there was a difference among the treatments. The higher the addition of pineapple paste, the lower the pH value in gummy candies. This was due to the acidity of pineapple peel extract paste. The pineapple peel extract paste was extracted with citric acid and the result was an acidic paste with a pH value of 2.88.

Table 7. The pH of red guava gummy candies with variation additions of pineapple peel extract paste

Additions of pineapple peel extract paste	pH
0 g (K)	3.51±0.01[a]
10 g (A)	2.92±0.02[b]
14 g (B)	2.72±0.01[c]
18 g (C)	2.50±0.02[d]

Values are presented as mean±standard deviation. Values with different superscripts are statistically significantly different at 95% confidence level.

The more paste added to the gummy candies, the lower the pH value of the red guava gummy candies. The pineapple peel extract paste contains several organic acids are citric acid (20.24 g/100 g) and lactic acid (0.78-0.82/100 g) (Upadhyay et al., 2010). The addition of pineapple peel extract pastes in food products resulted in a low pH value of 2.5-4 (Dominiak, 2014) and gummy candies has a pH range of 2.38-3.45 (Agustin and Putri, 2014).

3.3 Physical analysis of red guava gummy candies with variation additions of pineapple peel extract pastes as gelling agent

3.3.1 Texture gumminess, chewiness, and hardness

The main parameters in texture analysis (Table 8) on gummy candies products are gumminess, chewiness, and hardness. Texture analysis of red guava gummy candies with variation additions of pineapple peel extract paste showed that the gumminess ranged from 314.37 gF to 474.13 gF, chewiness from 1111.18 to 1465.31 gmm, while hardness yields ranged from 297.91 to 414.16 g. As a comparison, commercial product gumminess ranged from 305.40 to 497.59 gF, chewiness from 1109.03 to 1502.72 gmm, and hardness ranged from 345.00 to 487.00 g. These results showed significant differences among the guava gummy candies added with pineapple peel extract paste with a ratio of 0 g, 10 g, 14 g, and 18 g. Texture parameters of gummy candies with the addition of pineapple peel extract paste (10 g, 14 g, 18 g) are close to the texture of commercial gummy candies (Table 8).

The addition of 18 g pineapple peel extract paste has the highest texture parameter in terms of gumminess, chewiness, and hardness among all treatments and it is close to the value of the commercial product. The pineapple peel extract paste used in making gummy candies contains pectin. The higher the concentration of pectin added, the greater the formation of hydrogen bonds with pectin causing the gel structure to be more stable and the gel strength to be stronger (Desai *et al*., 2018).

The results of the physical analysis of red guava gummy candies with the addition of pineapple peel extract paste parameters of gumminess, chewiness, and hardness have a value that is directly proportional. The higher the level of gumminess and hardness of the gummy candies, the higher the required chewiness. The chewable power (chewiness) is affected by the hardness value (hardness) and elasticity (gumminess). The higher the hardness and gumminess, the greater the energy required for chewing (Delgado and Bañón, 2015).

3.3.2 Colour

The colour of gummy candies control is bright yellow without the addition of pineapple peel extract paste, but with the addition of pineapple peel extract paste the colour of gummy candies changes to orange (Table 9). The high amount of pineapple paste added to the gummy candies resulted in a darker colour (Figure 1). The decrease in the brightness level of the gummy candies is due to the colour of the pineapple peel extract paste which is light yellowish brown (Gunawan, 2018). The dark colour of the pineapple peel extract paste

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Table 8. The texture of red guava gummy candies with variation additions of pineapple peel extract paste

Additions of pineapple peel extract paste	Gumminess (gF)	Chewiness (gmm)	Hardness (g)
0 g (K)	474.13±4.26^{a}	1465.31±3.74^{a}	414.16±4.07^{a}
10 g (A)	314.37±1.71^{d}	1111.18±1.66^{d}	297.91±0.96^{d}
14 g (B)	325.82±0.22^{c}	1233.73±4.98^{c}	360.11±1.35^{c}
18 g (C)	335.31±1.64^{b}	1344.67±0.32^{b}	388.61±5.16^{b}
Commercial Product A	497.59	1502.72	487.00
Commercial Product B	305.40	1109.03	345.00

Values are presented as mean±standard deviation. Values with different superscripts within the same column are statistically significantly different at 95% confidence level.

causes a decrease in the brightness of the resulting gummy candies.

Pigment carotenoids and xanthophyll on the pineapple peel extract paste can be used as a food colouring (Nugraheni, 2014). Carotenoid pigments produce yellow, orange, and red colours when they are added to the substance. The high content of carotenoids can change the result colour of products into a red or reddish colour (Winarno, 2002). The colour results of the guava juice gummy candies were not too dark because only the addition of paste higher than 18 g would affect the transparency of the gummy candies.

Table 9. The colour of red guava gummy candies with variation additions of pineapple peel extract paste

Additions of pineapple peel extract paste	Colour
0 g (K)	Bright yellow
10 g (A)	Orange
14 g (B)	Orange
18 g (C)	Orange

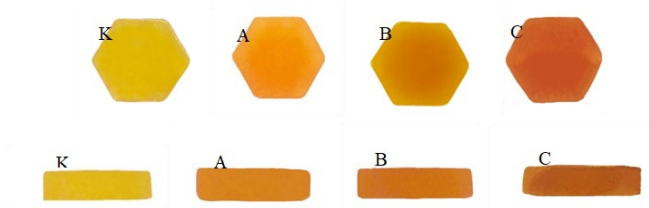

Figure 1. Results of the colour red guava gummy candies with variation additions of pineapple peel extract paste

3.4 Microbiological analysis of red guava gummy candies with variation additions of pineapple peel extract pastes as gelling agent

3.4.1 Total plate count

The total plate number of control gummy candies with variation additions of pineapple peel extract paste ranged from 1.34×10^{2} to 6.49×10^{2} CFU/g (Table 10). Based on the quality standard of the Indonesian National Standard Agency (2008), the total plate count maximum is 5×10^{4} CFU/g. There is a significant difference between treatments on the total plate count. The decrease in the total plate number can be caused by pineapple peel extract paste containing organic acids. Organic acids in pineapple peel extract paste are acetic acid, citric acid, and propionic acid (Andriani *et al*., 2013). Organic acids such as citric acid and acetic acid work well in reducing the growth of microorganisms (Desai *et al*., 2018)

The mechanism of organic acids in reducing the growth of microorganisms is in pH homeostasis inside and outside the cell. pH homeostasis is very important in cell growth and metabolism (Guan and Liu, 2020). High acid concentrations causes a decrease in intracellular pH and imbalanced pH homeostasis. This causes protein and DNA damage, and microorganisms are difficult to survive in acidic conditions (Wu *et al*., 2012).

Table 10. The total plate count of red guava gummy candies with variation additions of pineapple peel extract paste

Additions of pineapple peel extract paste	Total Plate Count (CFU/g)
0 g (K)	6.49×10^{2}±1.16^{a}
10 g (A)	3.90×10^{2}±0.74^{b}
14 g (B)	2.62×10^{2}±0.28^{c}
18 g (C)	1.34×10^{2}±0.18^{d}

Values are presented as mean±standard deviation. Values with different superscripts are statistically significantly different at 95% confidence level.

The microbial stability relies on the percentage and the type of organic acid. Citric acid (pH of 2.64) can prevent the growth of microorganisms at 18.03% and lactic acid (pH of 2.79) at 15.18%. Organic substances have a hydrophobic character that causes dissociation in cell membranes which later slows cell growth (Hassan *et al*., 2015).

3.4.2 Yeast and mould

Yeasts and mould count on control gummy candies with variation additions of pineapple peel extract paste were 0.08×10^{1} to 0.31×10^{1} CFU/g (Table 11). Based on the quality standard of the Indonesian National Standard Agency (2008), the yeasts and mould maximum is 10^{2} CFU/g. There is a significant difference between treatments on the yeasts and mould. The reason for the decrease in the number of yeasts and mould was due to the organic acids in pineapple peel.

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Table 11. The yeasts and mould of red guava gummy candies with variation additions of pineapple peel extract paste

Additions of pineapple peel extract paste	Yeast and mould (CFU/g)
0 g (K)	$0.31\times10^{1}\pm0.01^{a}$
10 g (A)	$0.22\times10^{1}\pm0.01^{b}$
14 g (B)	$0.15\times10^{1}\pm0.05^{c}$
18 g (C)	$0.08\times10^{1}\pm0.01^{d}$

Values are presented as mean±standard deviation. Values with different superscripts are statistically significantly different at 95% confidence level.

3.5 Sensory analysis red guava gummy candies with variation additions of pineapple peel extract pastes as gelling agent

The sensory analysis (Table 12) of red guava gummy candies with variation additions of pineapple peel extract paste revealed that the addition of 14 g (B) showed the highest average based on taste and texture parameters. Colour is one of the parameters in food that can be attractive to consumers. A product with an appealing visual will give high score to the consumer, and a product with a less appealing visual will cause decreasing consumer interest (Winarno, 2004). The addition of 10 g (A) pineapple peel extract paste showed the highest colour parameters with an average of 3.44 than the addition of 0 g (K), 14 g (B), and 18 g (C).

Table 12. The sensory analysis of red guava gummy candies with variation additions of pineapple peel extract paste

Additions of pineapple peel extract paste	Parameter				
	Colour	Aroma	Taste	Texture	Average
0 g (K)	2.83	3.00	2.06	2.33	2.55
10 g (A)	3.44	2.70	2.96	1.43	2.67
14 g (B)	2.13	2.16	3.30	3.30	2.72
18 g (C)	1.56	2.03	1.67	3.03	2.07

The aroma is one of the important parameters in food that can increase appetite (Winarno, 2002). The addition of 0 g (K) indicated the highest flavour parameters with an average of 3.00. The red guava flavour with 0 g (K) addition of pineapple peel extract paste resulted in a unique flavour of guava juice, but the addition of 10 g (A), 14 g (B), and 18 g (C) pastes created a more citric acid flavour that made the panellists less interested.

The unique taste of gummy candies is sweet and slightly sour (Malik, 2010). The addition of 14 g (B) pineapple peel extract paste showed the highest taste parameters with an average of 3.30. Gummy candies with the additions of 14 g (B) pineapple peel extract paste created a balance of sweet and sour taste. The addition of 18 g (C) pineapple peel extract paste was not preferred because of the sour taste.

The highest texture parameters is obtained with the addition of 14 g (B) pineapple peel extract paste and the parameter taste value is 3.30. Gummy candies with the additions of 14 g (B) pineapple peel extract paste has an acceptable elasticity level based on the panellists. High-quality gummies are chewy and easy to cut (Malik, 2010). Therefore, panellists chose the 14 g (B) as the best treatment. However, the C sample has the closest texture value to commercials.

4. Conclusion

The research showed 18 g (C) pineapple peel extract paste produced the best red guava gummy candies based on moisture content, ash content, reducing sugar, pH, texture, colour, and microbiological which include total plate count and yeasts and mould count according to Indonesian National Standard (SNI) Gummy candies (SNI 3547-2-2008) standards.

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