Effect of glucomannan and glucose syrup concentration on the characteristics of pineapple vinegar soft candy

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Abstract. Confectionery products are increasingly in demand among consumers. Soft candies, in particular, can offer health benefits when derived from natural sources such as fruits, vinegar, leaf herbs, and rhizomes. Therefore, this study aimed to develop a soft candy recipe enriched with pineapple vinegar and to evaluate its physicochemical properties—specifically texture, colour, gumminess, cohesiveness, chewiness, nutrient content, and antioxidants—as well as its sensory qualities. The methodology involved varying the concentrations of glucomannan and glucose syrup. A Complete Randomized Design (CRD) was used, with two factors: glucomannan at 0.44%, 0.83%, 1%, and 1.13%; and glucose syrup at 10%, 15%, 20%, and 25%. The results indicated that the optimal formulation for soft candy was achieved with a specific glucomannan concentration combined with 20% glucose syrup.

1 Introduction

Confectionery products are highly popular among consumers, with candy being a favorite. Candy is generally classified into two types: soft and hard candy. Soft candies, such as jelly and gummy candies, offer certain health benefits because they can be made from natural sources like fruits, vinegar, leaves, herbs, and rhizomes. Vinegar, for example, can be produced through microbial fermentation of grains, fruits such as strawberries, pineapples, oranges, apples, and mangoes, or from sugar and molasses. Fruit vinegars are natural products that are widely included in daily diets, especially in countries like the United States, Thailand, and Indonesia. They offer numerous health benefits, including preventing gastrointestinal infections, regulating lipid metabolism, reducing oxidative stress, and protecting the liver, owing to their antioxidant properties [1]. For instance, pineapple vinegar contains phenolic compounds that decrease slightly from 282.74 mg GAE/L on the first day to 245.31 mg GAE/L on the last day. Meanwhile, its antioxidant activity increases over the same period, from 143.76 µg TE/g to 189.52 µg TE/g, indicating enhanced antioxidant capacity during storage. The process of making gummy candies involves heating sugars and gelling agents to temperatures above 100°C. According to research, common gelling agents

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used in producing jelly candies include gelatin, glucomannan, pectin, carrageenan, guar gum, modified starches, and xanthan gum [2]. The common use of gelatin derived from pork bones has raised concerns about its halal compliance. As a result, there's a need for a more acceptable alternative gel-forming ingredient, such as glucomannan.In candy formulation, dextrose is included along with sugar sources like sucrose, glucose, and fructose syrups. Glucose syrup plays a key role by increasing the viscosity of soft candies. It also helps prevent crystallization during cooking. When heated to high temperatures, candy crystals don't start to form until the glucose syrup solution reaches about 75% saturation [3].

The purpose of this study was to develop a soft candy made with fruit vinegar, focusing specifically on pineapple vinegar. Additionally, the study aimed to evaluate the physicochemical characteristics and sensory qualities of the resulting soft candy.

2 Methodologhy

2.1 Material

The raw materials used in this study included glucomannan konjac (CV. Ikaria Group, Yogyakarta), carrageenan (PT. Gumindo Perkasa Industri, Jakarta), glucose syrup, pineapple vinegar (PT. Nutrifarm Indonesia, Tangerang), distilled water (aquadest), petroleum ether solution, 0.1 N HCl solution, concentrated H_2SO_4, phosphate buffer solution, 78% ethanol solution, 0.1 g celite, DPPH, and 80% methanol solution.

2.2 Soft candy processing

Initially, all soft candy formulations, as detailed in Table 1, were mixed until homogeneous. The mixture was then cooked at 80°C for 5 minutes. After cooking, it was poured into silicone molds measuring 3 cm by 3 cm. The molded candies were cooled at 4°C for 2 hours and subsequently dried in a dehydrator at 50°C for 19 hours.

Tabel 1. Formulations of soft candy

Ingredients (gr)	Treatments			
	P1	P2	P3	P4
Glucomannan	2.27	2.83	3.40	3.97
Carragenan	0.5	0.5	0.5	0.5
Glucose syrup	11	18	24	30
Pinneapple vinegar	25	25	25	25
Aquadest	74.73	67.17	60.60	54.03

2.3 Chemical properties

Observations included measurements of pH, sugar content (Brix), moisture content, fat content, protein content, carbohydrate content, ash content[4], and antioxidant activity [5].

2.4 Physical properties

The physical properties observed in the soft candy included color [6] and texture [7].

2.5 Organoleptic properties

An organoleptic test was conducted using hedonic and hedonic quality assessments with 25 panelists [11].

2.6 Data analysis

The analysis was carried out using SPSS 22 software. One Way ANOVA was applied at a 95% confidence level. with significant differences marked by a p-value < 0.05. Differences between treatment means were further analyzed using Duncan's New Multiple Range Test. All treatment were measured with 5 replications.

3 Results

Results of analysis of variance ANOVA of all treatments showed significant on the chemical characteristics (P<0.05) of sof candy such as moisture content. ash content. protein content. fat content, carbohydrate content, sugar content, and antioxidant activity (see on **Table 2**).

Table 2. Chemical Properties of soft candy

Chemical Properties (%)	**Treatments**			
	P1	P2	P3	P4
Moisture content	19.32 ± 1.041^{c}	18.67 ± 0.888^{c}	16.96 ± 0.637^{b}	15.71 ± 0.745^{a}
Ash Content	1.38 ± 0.038^{a}	1.42 ± 0.080^{a}	1.73 ± 0.035^{b}	1.86 ± 0.018^{c}
Protein Content	0.17 ± 0.010^{a}	0.25 ± 0.008^{b}	0.28 ± 0.004^{c}	0.30 ± 0.026^{d}
Fat content	0.18 ± 0.011^{a}	0.21 ± 0.011^{b}	0.24 ± 0.008^{c}	0.27 ± 0.010^{d}
Carbohydrate content	78.45 ± 1.044^{a}	79.11 ± 0.952^{a}	81.12 ± 0.593^{b}	82.28 ± 0.769^{c}
pH	4.12 ± 0.298	4.23 ± 0.244	3.97 ± 0.254	3.91 ± 0.117
Sugar content (^{o}brix)	17.76 ± 0.461^{a}	18.30 ± 0.815^{a}	21.94 ± 1.461^{b}	22.96 ± 0.492^{b}
Antioxidant activity	54.40 ± 0.244^{a}	56.58 ± 0.228^{b}	58.58 ± 0.228^{c}	57.78 ± 0.240^{d}

Results of the analysis of variance or ANOVA of all treatments showed significant (P< 0.05) on physical characteristics of texture (gumminess, and chewiness) and colour (yellowness b*) can see on Table 3.

Table 3. Physical properties of Soft Candy

Physical Properties	Treatments			
	P1	P2	P3	P4
Colour intensity				
L	56.260 ± 4.19	53.423 ± 3.43	54.186 ± 2.74	56.793 ± 2.20
a*	6.30 ± 2.72	7.19 ± 2.35	7.69 ± 1.44	5.55 ± 1.17
b*	37.131 ± 2.11^{ab}	38.401 ± 1.08^{ab}	38.929 ± 1.84^{b}	36.399 ± 1.34^{a}
Texture				$0. \pm 3.43$
Hardness	11.74 ± 0.71^{a}	11.97 ± 0.57^{a}	13.80 ± 0.74^{b}	13.90 ± 0.54^{b}
Cohesiveness	0.86 ± 0.10	0.89 ± 0.12	0.90 ± 0.38	0.94 ± 0.93
Springiness	0.89 ± 0.06	0.91 ± 0.08	0.93 ± 0.11	0.97 ± 0.10
Gumminess	10.10 ± 1.13^{a}	10.72 ± 1.81^{ab}	12.49 ± 0.63^{bc}	13.12 ± 1.63^{c}
Chewiness	9.06 ± 1.49^{a}	9.81 ± 2.00^{ab}	11.64 ± 1.89^{bc}	12.66 ± 1.37^{c}

Results of the analysis of variance or ANOVA of soft candy is significant on colour, and taste hedonic test result (see on Table 4).

Table 4. Hedonic Test Result of Soft candy

Treatment	Colour	Aroma	Taste	Texture
P1	3.44 $\pm$0.87^{a}	3.48 $\pm$0.65	3.04 $\pm$0.61^{a}	3.60 $\pm$0.81
P2	3.64 $\pm$0.75^{ab}	3.64 $\pm$0.56	3.56 $\pm$0.58^{b}	3.72 $\pm$0.67
P3	4.08 $\pm$0.70^{b}	3.60 $\pm$0.70	3.96 $\pm$0.67^{c}	3.88 $\pm$0.97
P4	4.04 $\pm$0.88^{b}	3.52 $\pm$0.82	4.08 $\pm$0.57^{c}	3.67 $\pm$0.82

Results of the analysis of variance or ANOVA of quality hedonic test such as taste are significantly (see on Table 5).

Table 5. Quality Hedonic Test Result of Soft candy

Treatments	Colour	Aroma	Taste	Texture
P1	4.08 $\pm$0.57	3.68 $\pm$0.85	2.82 $\pm$0.54^{a}	3.76 $\pm$0.87
P2	4.20 $\pm$0.64	3.68 $\pm$0.69	3.52 $\pm$0.51^{b}	3.80 $\pm$0.76
P3	4.04 $\pm$0.84	3.68 $\pm$0.85	3.96 $\pm$0.53^{c}	3.88 $\pm$0.97
P4	3.96 $\pm$1.02	3.72 $\pm$0.84	4.04 $\pm$0.61^{c}	3.64 $\pm$0.86

4 Discussion

4.1 Physicochemical of soft candy

Table 2. The analysis shows the contents of moisture, ash, protein, fat, sugar, pH, and carbohydrate across various soft candy treatments, indicating ranges of 15. 71% to 19. 32% for moisture, 1. 38% to 1. 86% for ash, 0. 17% to 0. 30% for protein, 0. 18% to 0. 27% for fat, 17. 76% to 22. 96% for sugar, 4. 23 to 3. 91 for pH, and 79. 2% to 80. 8% for carbohydrates, respectively. The moisture, ash, pH, and sugar levels of soft candy from all treatments met the standards set by SNI 3547-2-2008, which requires that moisture, ash, and sugar content should not exceed 20%, 3%, 4. 78%, and 25%, respectively. The increase in glucomannan concentration led to a reduction in the water content of the soft candy. The cause may be attributed to glucomannan's ability to tightly bind water within the soft candy polymer. It is known that konjac glucomannan can attract and hold water due to its hydroxyl groups. According to [8], increasing the concentration of konjac glucomannan leads to a reduction in the moisture content of soft candy made from gelatin. This effect is due to synergistic interactions that might reduce the ability to bind water. On the contrary, the rising ash content results in an increase in the ash content of soft candy. This may occur due to the presence of glucomannan, which contains 43 mg of calcium and 33 mg of potassium. A high glucose syrup raises the sugar levels, which aligns with the findings of research by [13], indicating that adding a low concentration of sugar to jelly candy results in a reduced overall sugar content. Table 2. The antioxidant activity of soft candy infused with pineapple vinegar ranges between 54. 50% and 57. 78%, which is derived from the acetic acid present in the pineapple vinegar. The presence of glucomannan and glucose syrup can help maintain the

antioxidant properties in soft candy. It was indicated that incorporating thickeners can preserve antioxidant compounds more efficiently since the film's matrix can create a double helix structure that acts as a shield against heat and oxygen during cooking and storage [9].

Table 3. The average L* value (indicating lightness) of soft candy made from pineapple vinegar varies between 53. 42 and 56. 79, the a* value (reflecting redness) ranges from 5. 55 to 6. 30, and the b* value (representing yellowness) falls between 36. 39 and 38. 92. The lightness value is below [10] due to a high amount of agar and glucose syrup, which leads to faster caramelization (browning) and Maillard reactions during the cooking process. The measurements for hardness, gumminess, and chewiness of pineapple vinegar soft candy range from 11. 74 to 13. 90 N for hardness, from 10. 10 to 13. 12 for gumminess, and from 9. 06 to 12. 66 for chewiness. This information, as indicated by [11], shows that the gelation process minimizes the force required on the probe when evaluating the texture of the soft candy. The difficulty in forming a gel from glucomannan is due to the presence of acetyl groups, which hinder the interaction between the glucomannan chains. Nevertheless, konjac undergoes gelation when heated to 85°C in alkaline conditions, resulting in decreased pressure on the probe during the texture testing of soft candies, as indicated by [16]. As the concentration of glucomannan increases, the softness, cohesiveness, springiness, and gumminess of the candy also increase. In a similar study, [12] found that a high chewiness value indicates that more effort is needed while chewing soft candy for it to be prepared for swallowing. A high gumminess value makes the gel cling to the teeth, making it difficult to chew and swallow.

4.2 Sensory properties of soft candy

Table 4. shows average hedonic colour results of all treatments scale from 3.44 (slightly like) to 4.08 (like), taste 3.04 (slightly dislike) – 4.08 (like), texture from 3.60 (slightly like) to 3.88 (like). Aroma from 3.48 (slightly like) to 3.64 (slightly like). Table 5 shows the average results of the hedonic quality of colour between 3.96 (slightly yellow) to 4.20 (yellow), texture between 3,64 (chewiness) to 3,88 (chewiness), aroma scale from 3.68 (quite typical of pinneapple vinegar) to 3.72 (quite typical of pinneapple vinegar), taste between 2,82 (slightly sweetness) to 4,04 (sweetness). [13] stated that colour and aroma of soft candy is more influenced by the natural color of fruit extract and browning process. All Treatment of Soft candy enriched pinneapple vinegar can see on Fig 1.

Fig. 1. All Treatment of Soft candy enriched pinneapple vinegar

5 Conclusion

A combination of 1% and glucomannan concentration and 20%glucose syrup was the most preferred formula to produce soft candy with the best characteristics in terms of low moisture content, pH, ash, fat, antioxidant, and protein content, and slightly low hardness, gumminess, and chewiness.

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