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The effects of sweet potato (Ipomoea batatas L.) extract and stevia extract on the physicochemical characteristics of effervescent granules

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Abstract

This study aims to determine the effects of the ratio of sweet potato extract and stevia on the physicochemical characteristics of effervescent granules. This study uses the Factorial Randomized Group Design with three repetitions. The treatment design carried out in this study consists of one factor, namely, the comparison of sweet potato extract consisting of six levels, namely, (37.5:7.5), (35:9), (32.5:11.5), (30:14), (27.5:16.5), and (25:19). Responses in this study include chemical responses, namely, water content, pH value test, total sugar content, and anthocyanin content. Physical responses include dissolving time, hygroscopicity, color intensity, and scanning electron microscope. The comparison of sweet potato extract with stevia results showed an effect on effervescent granule characteristics, namely, total sugar content, dissolving time test, hygroscopicity level, and color intensity. This includes a moisture content of 2.56%, pH value of 3.45, total sugar content of 1.61%, and anthocyanin content of 21.19 mg/g. The best physical response results are dissolving time of 39.96 s, hygroscopicity level of 0.33%, and color intensity L* 49.46, color a* 16.55, and color b* -4.21.

Keywords: sweet potato; stevia; effervescent granules.

Practical Application: This article is relevant for use in the beverage and pharmaceutical industry, especially beverage, and pharmaceutical products with the addition of natural colorings and natural sweeteners as food additives that are safer for public consumption.

1 INTRODUCTION

People are nowadays increasingly aware of the importance of health, causing significant changes, one of which is diet, where people tend to prefer natural and healthy food (back to nature). People tend to favor consuming food or drinks as they tend to favor instant food, such as sweet potato extract and stevia (Salim et al., 1996).

Sweet potato (*Ipomoea batatas* L.) is one of the types of sweet potatoes found in Indonesia. Sweet potatoes' purple color is due to the presence of natural dyes called anthocyanins, which are a group of pigments that cause a reddish color, located in a water-soluble cell fluid (Salim et al., 1996).

Stevia is used as a sugar substitute due to the high consumption of sugar in Indonesia. The use of stevia as a sweetener has more economic value than sugar. Stevia does not affect blood sugar levels, is safe for diabetics, prevents tooth decay by inhibiting bacterial growth in the mouth, helps improve digestion, and relieves stomach pain (Lynatra et al., 2018).

Effervescent is defined as a dosage form of a mixture of acid and base, which will produce gas bubbles as a result of chemical reactions in the solution. The gas produced is generally carbon dioxide (CO_2). Examples of effervescent products on the market are Extra Joss®, Hemaviton Jreng®, Jess Cool®, CDR®, Protecal®, Supradyn®, and Vit up®. Effervescent sweet potato extract and stevia are made from the main raw materials and supporting raw materials; the main raw materials used are sweet potato extract and stevia. Drying method is used for extraction (Ansel, 2005). The process of extracting sweet potato powder using the drying method, namely, Rotary vacuum (vacuum dryer), is done using a drying machine where the material is dried at low pressure and temperature accompanied by suction of water vapor (vacuum) from the heating of the material. This is suitable for materials that are sensitive to high temperatures and the drying time is relatively faster. This machine is also equipped with paddles so that the dried material will rotate continuously, and the presence of these paddles helps in co-crystallization process (Parikh, 2015).

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2 MATERIALS AND METHODS

2.1 Materials

The materials used in the process of making effervescent granules of sweet potato powder extract with stevia are sweet potato, stevia sugar, citric acid, tartarate acid, and sodium bicarbonate obtained from e-commerce. The materials used in this study were distilled water, HCl solution, NaOH solution, pp indicator, Luff-Schoorl solution, KI powder, standard sodium thiosulfate solution, amylum solution, and methanol PA solution.

2.2 Preparation of sweet potato extract

Sweet potatoes were peeled and cut. Then, stevia sugar and other supporting materials were prepared. Viable sweet potatoes were sorted and selected to match the desired quality. The sorted sweet potatoes were washed to remove dirt. The sweet potato skin was peeled using a knife. The sweet potatoes were then sliced at a thickness of 0.5 cm and steamed at a temperature of 60–70°C for 10 min. The sweet potatoes were then dried in a drying machine, which was used as a cabinet dryer, at a temperature of 50°C, and the drying time was 10 h. Ultrasound was carried out by emptying the dried sweet potatoes into a beaker and then into an ultrasound bath machine at 55°C for 120 min. The sweet potatoes were then dissolved with a solvent in the form of distilled water at a ratio of 1:5. Filtering was carried out by filtering the extracted sweet potatoes using a filter paper, which removed the residues. During filtering, extracts that did not pass turned into a residue or pulp. Centrifugation was done to separate the supernatant from the sediment. Centrifugation was done at 5000 rpm for 10 min. The sweet potatoes were evaporated using a vacuum rotary evaporator at 50℃ for 10 min. The liquid sweet potato extract added to maltodextrin was dried using freeze drying in order to remove some of the water content at a temperature of -80℃ for 48 h, which resulted in dried sweet potato extract. Size reduction was done by emptying the dried sweet potato extract into a grinder to get powdered extract. Finally, raw materials were mixed with supporting ingredients, namely, sweet potato extract, stevia, sodium bicarbonate, tartaric acid, and citric acid.

3 RESULTS AND DISCUSSION

3.1 Moisture content

According to Table 1, taking into account the results of analysis of variance (ANOVA), the comparison of sweet potato extract with stevia affects the water content of the effervescent granules; hence, it is necessary to perform Duncan's test. The effects of the ratio of sweet potato extract to stevia on the physicochemical characteristics of effervescent granules are determined using Duncan's test.

Based on the results of Table 1, t_1 was 5.73%, t_2 was 5.38%, t_3 was 5.24%, t_4 was 3.78%, t_5 was 3.32%, and t_6 was 2.56%. This is due to the water content of each sweet potato extract being different and affects the product with a different ratio of extracts.. The lower the water content in the raw materials used, the lower the water content in the product.

Based on the results of testing the water content of effervescent granules, the average water content meets the requirements of the water content of an effervescent granule, which is < 5% (BPOM RI, 2014). While testing the water content, it was found that t_4, t_5, and t_6 met the requirements of good water content This was possible as the smaller the composition of sweet potato extract causes the product's water content to be lower and the more the composition of sweet potato extract causes the product's water content to increase.

3.2 pH analysis

Based on the results of Table 2, the pH for t_1 is 3.63, for t_2 4.27, for t_3 3.70, for t_4 4, for t_5 3.47, and for t_6 3.43. Based on the test results according to BPOM RI (2014), effervescent granules have a requirement of 6–7. By testing the pH value of each treatment, the results showed that t_1, t_2, t_3, t_4, t_5, and t_6 did not meet the requirements for a good pH value due to the addition of stevia sugar, which is different in each treatment.

3.3 Total sugar content

Based on the results of ANOVA, the total sugar content in the effect of the ratio of sweet potato extract to stevia is significantly influenced; hence, it is necessary to conduct Duncan's test. The effects of the comparison of sweet potato extract with stevia on the physicochemical characteristics of effervescent granules are shown in Table 3.

Based on the results of Table 3, each treatment has a different total sugar content. The total sugar content in t_1 was 1.89%, in t_2 1.76%, in t_3 1.74%, in t_4 1.69%, in t_5 1.64%, and in t_6 1.61%. Hence, t_1 has the highest total sugar content, and t_6 has the lowest total sugar content as the higher the sweet potato extract, the higher the total sugar content in effervescent granules; on the other hand, the lower the sweet potato extract used for effervescent granules, the lower the total sugar content.

3.4 Hygroscopicity

The level of hygroscopicity affects the moisture content of a material. If the lower the moisture content of a material, the more hygroscopic it is. The moisture content of low water content causes the powder to be more hygroscopic and easily absorbs water, the solubility of the powder in water is low and is also greater. Based on the results of ANOVA, in terms of hygroscopicity on the effects of the comparison of sweet potato

Table 1. Moisture content (%) of effervescent granule sweet potato extract and stevia*.

Comparison of sweet potato extract and stevia	Moisture content (%)
t_1 (37.5:7.5)	5.73 ± 1.08^{d}
t_2 (35:9)	5.38 ± 1.40^{d}
t_3 (32.5:11.5)	5.24 ± 1.40^{b}
t_4 (30:14)	3.78 ± 1.06^{c}
t_5 (27.5:16.5)	3.32 ± 0.96^{d}
t_6 (25:19)	2.56 ± 0.87^{a}

*Different letters indicate that there is a significantly different effect on each treatment ($p < 0.05$) according to Duncan's test.

extract with stevia, it has a real effect and it is necessary to perform a further Duncan's test. The effects of the ratio of sweet potato extract to stevia on the characteristics of effervescent granules were also found. The physicochemical characteristics of effervescent granules are shown in Table 4.

Based on the results in Table 4, the treatment of 25% sweet potato extract with 19% stevia has the lowest result of 0.33%, while for the treatment of 35% sweet potato extract with 9% stevia has the highest result of 27.33%.

Hygroscopicity has several levels: the level of hygroscopicity < 10% (less than 10%) is classified as non-hygroscopic materials; the level of hygroscopicity 10.1–15% as slightly hygroscopic materials; the level of hygroscopicity 15.1–20% as hygroscopic materials; and 20.1 to > 25% as very hygroscopic materials (Gea Niro Research Laboratory, 2005).

3.5 Water solubility time

Based on the results of ANOVA, in the dissolving time the effects of the comparison of sweet potato extract with stevia have a significant effect; hence, it is necessary to perform a Duncan's test. The effects of the comparison of sweet potato extract with stevia on the characteristics of effervescent granules are shown in Table 5. Also, the physicochemical characteristics of effervescent granules are shown in Table 5.

Based on Table 5, the comparison of sweet potato extract with stevia affects the dissolving time. The fastest dissolving time was 39.96 s, and the longest dissolving time was 48.05 s. The fastest dissolving time was in the treatment of 25% sweet potato extract with 19% stevia, while the longest dissolving time was in the treatment of 37.5% sweet potato extract with 7.5% stevia.

Based on the results drawn by Pramulani (2014), the testing granule dissolving time with existing requirements is ≤ 5 min. All test results on each treatment meet the requirements of less than 5 min.

3.6 Color intensity analysis

Based on the results of ANOVA, the effects of the comparison of sweet potato extract with stevia had significant effects on the color profile. Duncan's test results are shown in Table 6. Based on the research results, in the effects of the comparison of sweet potato extract with stevia effervescent granules, each treatment has a different color profile in L* Notation, a* Notation, and b* Notation.

Table 2. pH of effervescent granule sweet potato extract and stevia*.

Comparison of sweet potato extract and stevia	pH
t_1 (37.5:7.5)	3.63 ± 0.06^b
t_2 (35:9)	4.27 ± 0.06^d
t_3 (32.5:11.5)	3.70 ± 0.10^b
t_4 (30:14)	4.00 ± 0.10^c
t_5 (27.5:16.5)	3.47 ± 0.06^a
t_6 (25:19)	3.43 ± 0.06^a

*Different letters indicate that there is a significantly different effect on each treatment (p < 0.05) according to Duncan's test.

Table 3. Total sugar content of effervescent granule sweet potato extract and stevia*.

Comparison of sweet potato extract and stevia	Total sugar content (%)
t_1 (37.5:7.5)	1.89 ± 0.005^f
t_2 (35:9)	1.76 ± 0.005^e
t_3 (32.5:11.5)	1.74 ± 0.004^d
t_4 (30:14)	1.69 ± 0.005^c
t_5 (27.5:16.5)	1.64 ± 0.007^b
t_6 (25:19)	1.61 ± 0.006^a

*Different letters indicate that there is a significantly different effect on each treatment ($p < 0.05$) according to Duncan's test.

Table 4. Hygroscopicity of effervescent granule sweet potato extract and stevia*.

Comparison of sweet potato extract and stevia (T)	Hygroscopicity (%)
t_1 (37.5:7.5)	15.10 ± 0.20^c
t_2 (35:9)	27.33 ± 0.15^f
t_3 (32.5:11.5)	19.37 ± 0.15^e
t_4 (30:14)	1.33 ± 0.25^b
t_5 (27.5:16.5)	15.63 ± 0.21^d
t_6 (25:19)	0.33 ± 0.15^a

*Different letters indicate that there is a significantly different effect on each treatment ($p < 0.05$) according to Duncan's test.

Table 5. Dissolving time of effervescent granule sweet potato extract and stevia*.

Comparison of sweet potato extract and stevia	Dissolving time (s)
t_1 (37.5:7.5)	48.05 ± 0.04^f
t_2 (35:9)	46.77 ± 0.04^e
t_3 (32.5:11.5)	45.32 ± 0.03^d
t_4 (30:14)	44.95 ± 0.02^c
t_5 (27.5:16.5)	41.78 ± 0.03^b
t_6 (25:19)	39.96 ± 0.03^a

*Different letters indicate that there is a significantly different effect on each treatment ($p < 0.05$) according to Duncan's test.

Table 6. Color intensity of effervescent granule sweet potato extract and stevia[@].

Comparison of purple sweet potato extract and stevia	L*	a*	b*
t_1 (37.5:7.5)	49.46 ± 0.02 a	16.55 ± 0.02 d	-4.21 ± 0.02 a
t_2 (35:9)	52.59 ± 0.02 b	11.08 ± 0.02 a	-4.72 ± 0.01 b
t_3 (32.5:11.5)	54.94 ± 0.02 c	14.73 ± 0.01 c	-3.39 ± 0.02 c
t_4 (30:14)	55.57 ± 0.02 d	12.66 ± 0.02 b	-3.75 ± 0.03 d
t_5 (27.5:16.5)	61.99 ± 0.02 e	17.60 ± 0.01 e	-2.81 ± 0.01 e
t_6 (25:19)	62.98 ± 0.01 f	23.25 ± 0.01 f	-2.65 ± 0.05 f

[@]Different letters indicate that there is a significantly different effect on each treatment ($p < 0.05$) according to Duncan's test.

Table 7. Color intensity of effervescent granule sweet potato extract and stevia.

Sample	Anthocyanin content (mg/g)
Effervescent granule	21.19

Notation L* states that the brightness intensity of the sweet potato extract effervescent granule with the addition of stevia has increased, while Notation a* has increased and decreased. Notation b* states that the effervescent granule of sweet potato extract with the addition of stevia shows an increasingly blue color.

The purple color derived from anthocyanin pigments in sweet potato determines the color quality of the effervescent granule; hence, t_1 is the best-quality effervescent granule as per the color attribute. The amount of anthocyanin content in sweet potato depends on the intensity of the purple color of the sweet potato; the more purple the color of the sweet potato, the higher the anthocyanin content (Kumalaningsih, 2006).

3.7 Anthocyanin content analysis

The anthocyanin content of sweet potato depends on the intensity of the color in the tuber. The more purple the color of the tuber, the higher the anthocyanin content (Winarno, 2004). Based on the results of Table 7, the total antioxidant activity by differential pH method on the effervescent granules of sweet potato extract with stevia at a ratio of 25:19 led to obtaining the total anthocyanin content of 21.19 mg/g.

According to Winarno (2004), the anthocyanin levels in concentrated sweet potato are 61.85 mg/100 g (138.15 mg/100 g dry basis) and 3.51 mg/100 g (9.89 mg/100 g dry basis) in young sweet potato. The anthocyanin content of processed products of light sweet potato ranged from 1.14 to 2.24 mg/100 g, and the concentrated sweet potato ranged from 6.19 to 46.14 mg/100 g. The anthocyanin levels after processing decreased compared to the anthocyanin levels in fresh sweet potato. The use of heat in the processing process reduces the anthocyanin content in processed products. At high temperatures, the stability and durability of anthocyanin dyes change and result in anthocyanin damage.

3.8 Scanning electron microscope

SEM is an instrument that uses a high beam of electrons to scan an object to produce the image of an object. SEM produces two types of images: sample surface and sample composition mapping (Masta, 2020). SEM works by firing at the surface of an object to produce a reflection of electrons or releasing secondary electrons from the surface of the object, resulting in a clear surface profile of the object (Masta, 2020). Based on the results of morphological observations, SEM results are shown in Figure 1. With a sample of effervescent granules of sweet potato extract with stevia, the shape of the effervescent granule particles was irregular (amorphous) and there is still agglomeration (clumping), meaning that the particles are not completely separated from each other and the surface of the particles appears to bind together irregularly.

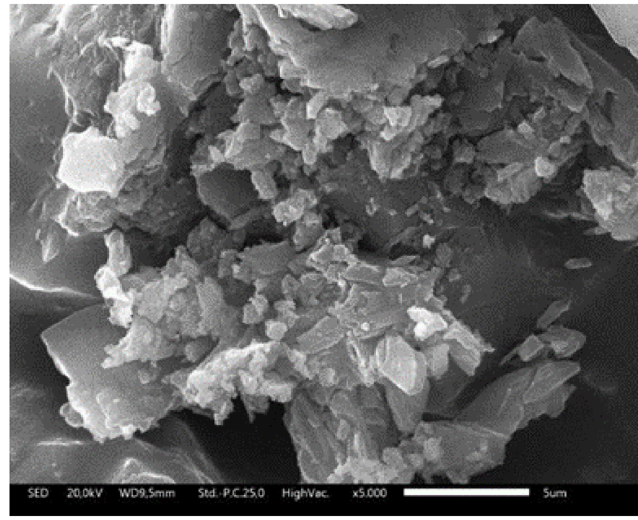

Figure 1. Scanning electron microscopy (SEM) effervescent granules of sweet potato extract with stevia in a ratio of 25:19.

4 CONCLUSION

The comparison of sweet potato extract with stevia on the physicochemical characteristics of effervescent granules affects the response of color intensity, hygroscopicity level, dissolving time test, and total sugar content. t6 was the best sample obtained from the results of physical response and chemical response.

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