

# Effect of Adding Stevia Sweetener (*Stevia rebaudianna*) and Arabic gum Filler on the Physicochemical Properties of Chayote Squash (*Sechium edule*) Powder Drink

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## ABSTRACT

Chayote squash (*Sechium edule*) is renowned for high potassium (125 mg), fiber (1.7 g), and antioxidant compounds including flavonoid, polyphenol, tannin, and saponin. The plant has the potential to be processed into powder drink with the addition of stevia powder and arabic gum. Stevia provides 200 – 300 times the sweetness of sucrose and non-calorie, while arabic gum is used as a bulking agent to improve the physical character of powder drink. Therefore, this study aimed to determine the physicochemical properties of chayote squash powder drink with variations of stevia powder and arabic gum. The method used was a two factorial complete randomized design with variations in stevia powder of 2% and 4% as well as arabic gum of 10% and 15%. Each treatment was repeated three times and powder drink was processed using foam mat drying method at 70 °C for 6 hours. The parameters observed include yield, water holding capacity (WHC), solubility, hardness, springiness, water content, ash content, pH, total dissolved solids (TDS), and antioxidant activity, while the data were analyzed using Two-way ANOVA without interaction. The results showed that the addition of stevia powder and arabic gum significantly affected yield, WHC, water content, pH, TDS, and antioxidant activity. However, no significant effect was observed on solubility, hardness, springiness, and ash content. The best formulation was found to be S2A2 containing 4% stevia powder + 15% arabic gum, with 9.69% yield, 37.65% solubility, WHC 37.44%, hardness 257.61 N, springiness 0.683, moisture content 5.02%, ash content 5.43%, pH 5.73, TDS 5.7 °Brix, and antioxidant activity of 143.00 ppm.

**Keywords:** Arabic gum; chayote squash; foam mat drying; stevia leaf; powder drink

## INTRODUCTION

Chayote squash (*Sechium edule*) is a member of the family Cucurbitacea growing in subtropical climates. The variety commonly cultivated and commercialized is *virens levis* which has oval fruits without thorns on the skin. Approximately 100 g of chayote squash contains

4.5 g carbohydrates, 1.7 g fiber, 19 kcal calories, 125 mg potassium, 17 mg calcium, 2 mg magnesium, 7.7 mg vitamin C, 0.3 mg iron, and 0.1 mg vitamin D (Riviello-Flores et al., 2018). The availability of this vegetable in Indonesia is very sufficient due to the relatively high productivity of the plants. Based on data from 2020, the production of chayote squash from 2016 – 2020 was

603.325 tons, 566.845 tons, 454.001 tons, and 511.014 tons respectively (Badan Pusat Statistik, 2020).

In general, antioxidants, which reduce free radicals by donating electrons is usually found in vegetables and fruit (Kavitasari, 2021). Chayote squash contains polyphenolic compounds, flavonoids, proanthocyanidins, and vitamin C based on the results of ethanol extraction (Sulistiani et al., 2018). Other additional content include phenolics, condensed tannins, and ascorbic acid according to the results of methanol extraction. These compounds potentially induce chayote squash as an antioxidant resource (Inês et al., 2006). Additionally, the main secondary metabolites identified and related to biological activity include alkaloids, sterols, saponins, triterpenes, saturated fatty acids, esters, glycosylated flavonoids, and tannins (Salazar-Aguilar et al., 2017). Antioxidant compounds have free anti-radical activity to protect against cell damage caused by oxidative stress which might lead to diseases such as cancer, heart disease, and arteriosclerosis (Amelia, 2020). With this potential, chayote squash can be used more optimally as a functional product, including powdered drink. This product, which refers to food processed in the form of powder, easily dissolves in water and is practical for serving (Silvy et al., 2020). The moisture content ranges from 3 – 5%, causing powder drink to have a longer shelf life and decreased microorganism growth (Yuliawaty and Susanto, 2015).

Amelia (2020) examined chayote squash powder drink with variations in maltodextrin as an additional ingredient, obtaining low total dissolved solids (3.47°Brix) and antioxidant activity (165.52 mg/mL) (Amelia, 2020). Therefore, additional ingredients are needed to improve the quality of the product in terms of sweetness, antioxidant activity, and solubility. Compared to maltodextrin, arabic gum forms better emulsions, stable in acidic solutions, and is more resistant to heat (Khasanah et al., 2015). Stevia leaves (*Stevia rebaudianna*) can also increase the sugar content thereby increasing the total dissolved solids. As a natural sweetener, stevia has a sweetness level 200 to 300 times than sucrose (Tamrin, 2019). Glycoside compounds in leaves can be converted into sugar compounds such as fructose, glucose, sucrose, raffinose, xylose, and rhamnose capable of increasing the sugar content. The sugar compounds increase the total dissolved solids in chayote powder drink (Ariffah, 2018). Stevia also contains antioxidant compounds such as phenolics, flavonoids, saponins, and tannins which are quite high (Jahan et al., 2010). The presence of antioxidants supports the potency of chayote squash powder drink as a functional food. Stevia leaves have been used to improve dental health, lower blood sugar

levels, as well as treat obesity and diabetes (Harismah, et al., 2014).

Chayote squash powder drink is processed using foam mat drying method, an alternative to spray and freeze drying. The liquid is whipped to form stable foam and dried at low temperatures (Sangamithra et al., 2015). Powder drink processing requires a bulking agent that functions to speed up drying, increase volume, and protect components susceptible to heat. Arabic gum contains a mixture of polysaccharides and glycoproteins which affect adhesiveness and stickiness (Mariod, 2018). In the natural polysaccharide or modified form, arabic gum binds flavor and components susceptible to heat, thereby protecting the materials during drying process (Suryani, 2017). The advantages compared to other fillers include solubility in hot and cold water, stability in acidic solutions, and better emulsification properties (Safitri, 2012). Therefore, this study aimed to determine effect of adding stevia leaf powder (2% and 4%) and arabic gum (10% and 15%) on the physical and chemical properties of chayote squash powder drink.

## METHODS

### Materials

The raw material for making powder drink include chayote squash variety *virens levis*, obtained from Argosari, Wonosari, Gunungkidul, stevia (*Stevia rebaudiana*) leaves powder (*Glaranadi*) from Tangerang SME's, and arabic gum (*TIC Gum*) from Mitra Jaya Chemical. Other supporting materials were egg white and water, while chemicals used for analysis include distilled water, ethanol, 1,1-diphenyl-2-picrylhydrazyl (DPPH) (Sigma-Aldrich Company Ltd., Gillingham, United Kingdom), aluminum foil, and Whatmann 42 filter paper.

The tools used include oven (*Memmert UN30*, Schwabach, Germany), juicer (*Philips*, Indonesia) mixer (*Philips*, Indonesia), analytical balance (*Ohaus*, Shanghai, China), furnace (*B-One FNC-2F*, China), texture analyzer (Lloyd type TA1, USA), LP Vortex Mixer (Thermo Scientific™, USA), centrifuge (Oregon, USA), pH-meter (Ohaus, China), refractometer (ATC, Germany), spectrophotometer UV-Visible (Thermo Fisher Scientific, Waltham, USA) and glassware laboratory equipment.

### Methods

The study was carried out using a completely randomized design method with two factors (Dosen, 2016), namely variations in the addition of stevia leaf powder (2% and 4% w/w) and arabic gum (10% and

Table 1. Formulation of stevia leaf powder and arabic gum

Arabic gum (A)	Stevia leaf powder (S)	
	S1	S2
A1	S1A1	S2A1
A2	S1A2	S2A2

Note:

$S_0A_0$  = Control sample (0% stevia leaf powder + 0% arabic gum)

$S_1A_1$  = Sample 1 (2% stevia leaf powder + 10% arabic gum)

$S_1A_2$  = Sample 2 (2% stevia leaf powder + 15% arabic gum)

$S_2A_1$  = Sample 3 (4% stevia leaf powder + 10% arabic gum)

$S_2A_2$  = Sample 4 (4% stevia leaf powder + 15% arabic gum)

15% w/w) as shown in Table 1. Parameters observed included physical properties namely yield, solubility, water holding capacity (WHC), and texture, as well as chemical including water content, ash content, pH, total dissolved solids, and antioxidant activity.

### Preparations of Chayote Squash Crude Extract

Chayote squash was cut into two parts and rubbed to release the sap, then the seeds were removed and peeled. The sample was cut into cubes (2x2 cm), then about 100 g was added with water (1:0.5) and blended for 10 minutes until puree was obtained. The puree was filtered to acquire chayote squash crude extract.

### Preparation of Chayote Squash Powder Drink

About 100 mL of chayote squash crude extract was added with stevia leaf powder (2% and 4% w/v) and arabic gum (10% and 15% w/v). The ingredients were mixed for 10 minutes until foam was formed, then 15% white eggs were added as a foaming agent followed by thorough mixing by spoon to produce a homogeneous mixture. Foam was poured into a tin covered using aluminum foil with a thickness of 0.05 cm and dried with foam mat drying method at 70°C for 6 hours. Subsequently, the dry foam was mashed with a blender and sieved (60 mesh).

### Physicochemical Analysis

#### Yield Test

Yield is defined as the ratio of the product's dry weight to that of the raw materials used. It is calculated by comparing final to initial weight and the value is related to the bioactive content in the raw material. Yield was calculated according to AOAC 1999 using Equation 1.

$$\text{Yield \% (g/g)} = \frac{\text{dry weight (g)}}{\text{raw material weight (g)}} \times 100\% \quad (1)$$

#### Solubility Test

The solubility test was carried out to determine the ability of powder drink to dissolve in water. The test was conducted by dissolving  $\pm 2$  g of the sample into 100 mL of distilled water followed by filtration using filter paper. Before filtration, the sample was dried in the oven for 30 minutes at 105 °C and weighed. The residue obtained was dried in the oven for 3 hours at 105 °C, weighed, then the solubility was calculated using Equation 2 (Adhayanti and Ahmad, 2021).

$$\text{Solubility (mL/g)} = \frac{d - c - a}{d} \quad (2)$$

Where: d=tube weight +material weight + water weight (g), c= material weight (g), and a= tube weight.

#### WHC

WHC was determined using the thermogravimetry method and centrifugation by calculating the difference between the dry weight of the sample and the wet weight after centrifugation. The test was carried out by dissolving 1 g sample with 10 mL of distilled water in a test tube, then vortexed until homogenous. The solution was centrifuged for 25 minutes at 3.000 rpm and the supernatant formed was separated and weighed. WHC was calculated with Equation 3 (Ntau et al., 2017).

$$\text{Solubility (mL/g)} = \frac{d - c - a}{d} \quad (3)$$

Where: d=tube weight +material weight + water weight (g), c= material weight (g), and a= tube weight (g).

#### Texture Test

Texture test was carried out using the Texture Profile Analysis (TPA) method with Lloyd's Texture Analyzer tool. The principle was based on applying a maximum compressive force to determine the hardness and springiness of the sample (Firmansya, 2019).

#### Water Content

Water content was tested using the thermogravimetric method by evaporating water in the sample material using heat followed by weight measurement. The weight loss during heating refers to the amount of water contained in the material/sample. To measure the water content, 2 g of sample was placed into weighing bottles and then weighed. Drying was carried out at 105 °C for 24 hours followed by

cooling in the desiccator, and weight measurement. The water content was calculated using Equation 4 (Badan Standarisasi Nasional, 2015).

$$\text{Water content (\% wb)} = \frac{(B - C)}{(B - A)} \times 100\% \quad (4)$$

### Ash Content

Ash content refers to the amount of minerals in a material and the principle of the test is based on the oxidation of organic substances at high temperatures (5000 °C – 600 °C) followed by measuring the weight of the residue as inorganic substances. A 2 g sample was placed into the furnace for 3 hours at 550 °C, put into the desiccator for 15 minutes, and weighed. The ash content was calculated using Equation 5 (Standard Nasional Indonesia, 1995).

$$\text{Ash content (\%)} = \frac{(\text{ash weight})}{(\text{sample weight})} \times 100\% \quad (5)$$

### pH Test

The pH test was carried out to determine the acidity level of chayote powder drink. The principle was based on dissolving the sample into distilled water then the pH value was measured using a pH meter (Adhayanti and Ahmad, 2021).

### Total Dissolved Solids

Total dissolved solids represent the amount of solids dissolved in a sample solution typically consisting of sugar and salt, with the value expressed in Brix. The measurement was performed using a hand refractometer. About 1 – 3 drops of the sample solution were dropped on the prism then the refractometer was pointed to a light source and the reading was taken (Nizori et al., 2021).

### Antioxidant Activity Test (IC<sub>50</sub>)

Antioxidant activity was tested using the DPPH method based on the ability of the solution to accept hydrogen atoms from antioxidants. The sample was diluted subsequently into 100 ppm, 200 ppm, 300 ppm, 400 ppm, and 500 ppm concentration by adding ethanol. About 1 mL of each diluted sample was added to the reaction tube, mixed with 1 mL of DPPH, and then stored in a dark room for 30 minutes. The mixture was subjected to absorbance reading at 517 nm wavelength with a UV-Vis spectrophotometer. The antioxidant activity value was determined by calculating the percent of inhibition and IC<sub>50</sub> value of the regression curve with Equations 6 and 7 (Molyneux, 2004).

$$\text{Inhibition \%} = \frac{(\text{abs. of control} - \text{abs of samples}) \times 100\%}{\text{Abs. of control}} \quad (6)$$

$$\text{IC}_{50} = \frac{\text{inhibition percentage (50)} - \text{regression constant}}{\text{regression coefficient}} \quad (7)$$

### Statistic Analysis

The physical and chemical test results were analyzed using the Two-Way ANOVA without interactions. When a significant effect was observed, the analysis was continued with the Duncan Multiple Range Test (DMRT) post hoc test ( $p < 5\%$ ). At a p-value greater than 0.05, an Analysis of Variance (ANOVA) test was conducted to determine the treatment effect. The existence of a treatment effect was showed when F-count exceeded F-table at a 5% significance level. All analyses were conducted using IBM SPSS Statistics 16 software.

## RESULTS AND DISCUSSION

### Yield

Yield is a parameter that aims to determine the physical properties of products quantitatively by

Table 2. Yield of chayote squash powder drink

Sample	%Yield
Control (0% stevia powder + 0% arabic gum)	3.28% ± 0.60 <sup>a1</sup>
S <sub>1</sub> A <sub>1</sub> (2% stevia powder + 10% arabic gum)	5.52% ± 0.39 <sup>b2</sup>
S <sub>1</sub> A <sub>2</sub> (2% stevia powder + 15% arabic gum)	6.20% ± 0.34 <sup>b3</sup>
S <sub>2</sub> A <sub>1</sub> (4% stevia powder + 10% arabic gum)	7.58% ± 0.18 <sup>c2</sup>
S <sub>2</sub> A <sub>2</sub> (4% stevia powder + 15% arabic gum)	9.69% ± 0.54 <sup>c3</sup>

Note: all samples were significant as tested with two-way ANOVA continued with post hoc test ( $p < 0.05$ )

<sup>a-b</sup>Different letters on the same column show significant differences based on stevia leaf powder factors

<sup>1-3</sup>Different numbers on the same column show significant differences based on arabic gum factors



comparing the weight before and after drying. The results obtained for chayote squash powder drink with variations in stevia powder and arabic gum addition are shown in Table 2.

Based on the results, the addition of stevia powder and arabic gum had a significant effect ( $p < 0.05$ ) on the yield values of chayote squash powder drink. The value increased along with a higher amount of stevia powder and arabic gum. The highest yield was found in sample  $S_2A_2$  ( $9.69\% \pm 0.54$ ) with the addition of 4% stevia powder and 15% arabic gum. Similar results were obtained in a previous study conducted by (Aliyah and Handayani, 2019) on pumpkin powder drink. Suhag et al. (2016) also found that the use of arabic gum ranging from 35% to 45% increased the yield shown by a reduction in stickiness. However, in this study, arabic gum barely decreased the stickiness of the samples, leading to lower yield during drying process.

Arabic gum as a bulking agent functions to protect ingredients that are susceptible to heat and increase the volume of powder. It also increases total dissolved solids and maintains nutrient content during drying process, thereby enhancing yield (Firdhausi et al., 2015). Similarly, stevia powder affected the increase in the yield value of chayote squash powder drink due to the water-soluble components, such as carbohydrates, vitamin C, minerals, and proteins with a significant impact on the total solid (Marcinek and Krejpcio, 2015). The yield of powder drink obtained with the addition of stevia was higher compared to the use of other sweeteners (Roni, 2008). The higher the amount of materials used, the greater the level of total solids, leading to the binding of many particles by fillers (Farikha et al, 2013).

### Solubility

The solubility test was used to determine the rehydration degree of chayote squash powder drink. This parameter was calculated based on the difference

in weight of dry filter paper before and after drying divided by the weight of wet filter paper after filtration and then multiplied by 100%. Solubility is the ability of powder to dissolve in water and become homogeneous. The results obtained for chayote squash powder drink with the addition of stevia powder and arabic gum are shown in Table 3.

Stevia powder and arabic gum had no significant effect ( $p > 0.05$ ) on the solubility value of chayote squash powder drink. The solubility value of each sample was not significantly different, ranging from 23-38%, and categorized as low. The low solubility was attributed to the insoluble components of chayote squash, which left residue on the filter paper during the test. Stevia leaves contain steviol glycosides with hydrophobic properties, preventing interaction with water molecules (Celaya et al., 2016). Therefore, the addition of stevia powder did not affect the solubility of chayote squash powder drink.

Arabic gum did not affect the solubility of powder drink, contrasting the study by Do dan Nguyen (2018) where the addition at higher concentrations increased the solubility of mulberry powder (60.07%-71.58%). Basically, arabic gum dissolves efficiently in water due to the hydrophilic components that easily bind to water molecules. However, the chemical structure is complex with an arabinogalactan protein (AGP) group consisting of hydrophobic amino acids on the outside which inhibit the solubility of powder drink (Firdhausi et al., 2014).

### WHC

WHC shows the ability of powder to absorb and hold water in the particle at a maximum limit. The results for WHC measurement of chayote squash powder drink are shown in Table 4.

Based on statistical analysis results, the addition of stevia powder and arabic gum had a significant effect ( $p < 0.05$ ) on increasing the WHC of chayote squash powder drink. The highest value was found in sample

Table 3. Solubility of chayote squash powder drink

Sample	%Solubility
Control (0% stevia powder + 0% arabic gum)	22.69% $\pm$ 0.02 <sup>a1</sup>
$S_1A_1$ (2% stevia powder + 10% arabic gum)	32.34% $\pm$ 0.02 <sup>b2</sup>
$S_1A_2$ (2% stevia powder + 15% arabic gum)	35.70% $\pm$ 0.05 <sup>b2</sup>
$S_2A_1$ (4% stevia powder + 10% arabic gum)	35.21% $\pm$ 0.01 <sup>b2</sup>
$S_2A_2$ (4% stevia powder + 15% arabic gum)	37.65% $\pm$ 0.02 <sup>b2</sup>

Note: all samples were significant as tested with two-way ANOVA continued with post hoc test ( $p < 0.05$ )

<sup>a-b</sup>Different letters on the same column show significant differences based on stevia leaf powder factors

<sup>1-3</sup>Different numbers on the same column show significant differences based on arabic gum factors

Table 4. WHC of chayote squash powder drink

Sample	%WHC
Control (0% stevia powder + 0% arabic gum)	15.53%±0.11 <sup>a1</sup>
S <sub>1</sub> A <sub>1</sub> (2% stevia powder + 10% arabic gum)	24.11%±0.06 <sup>b2</sup>
S <sub>1</sub> A <sub>2</sub> (2% stevia powder + 15% arabic gum)	32.26%±0.03 <sup>b3</sup>
S <sub>2</sub> A <sub>1</sub> (4% stevia powder + 10% arabic gum)	31.59%±0.08 <sup>c2</sup>
S <sub>2</sub> A <sub>2</sub> (4% stevia powder + 15% arabic gum)	37.44%±0.11 <sup>c3</sup>

Note: all samples were significant as tested with two-way ANOVA continued with post hoc test ( $p < 0.05$ )

<sup>a-b</sup>Different letters on the same column show significant differences based on stevia leaf powder factors

<sup>1-3</sup>Different numbers on the same column show significant differences based on arabic gum factors

S<sub>2</sub>A<sub>2</sub> reaching 37.44% with 4% stevia powder and 15% arabic gum. This result was in line with a previous study where the addition of 15% arabic gum to instant paste produced the highest WHC (Firdhausi et al., 2015). The WHC value of chayote squash powder drink ranged from 15.53 – 37.44% with a tendency to increase, due to the concentration of arabic gum. This material has hydrophilic hydroxyl polymers, facilitating the formation of hydrogen bonds with water molecules. Additionally, arabic gum is capable of binding water due to the protein content, with the effectiveness influenced by the amount added (Kania et al., 2015). WHC varies due to several factors, including the hydrophilic-hydrophobic balance of amino acids in protein molecules, as well as lipid and carbohydrate fractions (Sarkar et al., 2018). This metric is also affected by water content, for example, powder with low moisture content easily absorbs water due to the hygroscopic nature (Firdhausi et al., 2015). Based on the results, the highest WHC value was found in sample S<sub>2</sub>A<sub>2</sub> which also had the lowest water content.

### Texture

Powder drink texture test was carried out using the Texture Profile Analysis by exerting maximum

compressive force on the material (Firmansya, 2019). The texture (hardness and springiness) of chayote squash powder drink added with stevia powder and arabic gum is shown in Table 5.

### Hardness

The hardness parameter shows the level of firmness in the sample and the fineness of powder. High values show that the texture of the material is significantly hard according to (Haliza et al, 2012). Based on the results, the addition of stevia powder and arabic gum had no significant effect ( $p < 0.05$ ) on the hardness value of chayote squash powder drink. The hardness values ranged from 217.65 – 436.47 N, fluctuating due to the addition of arabic gum into powder drink.

Arabic gum increased hardness due to the molecular weight and complexity, as observed in a previous study by (Ishak et al., 2022). Hardness value is inversely proportional to moisture content, hence, the lower the moisture content, the higher the hardness value. The release of moisture content was attributed to the crystallization of arabic gum hydrogen bonds with water molecules, which caused the texture to become hard (Engelen, 2018).

Table 5. Texture of chayote squash powder drink

Sample	Hardness (N)	Springiness index
Control (0% stevia powder + 0% arabic gum)	217.65±39.28 <sup>a1</sup>	0.623±0.02 <sup>a1</sup>
S <sub>1</sub> A <sub>1</sub> (2% stevia powder + 10% arabic gum)	353.79±5.94 <sup>b2</sup>	0.788±0.01 <sup>b2</sup>
S <sub>1</sub> A <sub>2</sub> (2% stevia powder + 15% arabic gum)	436.47±36.94 <sup>b2</sup>	0.768±0.02 <sup>b1</sup>
S <sub>2</sub> A <sub>1</sub> (4% stevia powder + 10% arabic gum)	419.76±2.47 <sup>b2</sup>	0.733±0.01 <sup>a2</sup>
S <sub>2</sub> A <sub>2</sub> (4% stevia powder + 15% arabic gum)	257.61±61.95 <sup>b2</sup>	0.683±0.07 <sup>a1</sup>

Note: all samples were not significant as tested with two-way ANOVA continued with post hoc test ( $p < 0.05$ )

<sup>a-b</sup>Different letters on the same column show significant differences based on stevia leaf powder factors

<sup>1-3</sup>Different numbers on the same column show significant differences based on Arabic gum factors

Table 6. Moisture content of chayote squash powder drink

Sample	%Water content
Control (0% stevia powder + 0% arabic gum)	7.40%±0.00 <sup>b3</sup>
S <sub>1</sub> A <sub>1</sub> (2% stevia powder + 10% arabic gum)	5.46%±0.00 <sup>a2</sup>
S <sub>1</sub> A <sub>2</sub> (2% stevia powder + 15% arabic gum)	5.09%±0.00 <sup>a1</sup>
S <sub>2</sub> A <sub>1</sub> (4% stevia powder + 10% arabic gum)	5.68%±0.00 <sup>a2</sup>
S <sub>2</sub> A <sub>2</sub> (4% stevia powder + 15% arabic gum)	5.02%±0.00 <sup>a1</sup>

Note: all samples were significant as tested with two-way ANOVA continued with post hoc test ( $p < 0.05$ )

<sup>a-b</sup>Different letters on the same column show significant differences based on stevia leaf powder factors

<sup>1-3</sup>Different numbers on the same column show significant differences based on arabic gum factors

### Springiness

Springiness shows the time taken for a material to return to the original shape after being subjected to maximum compressive force. The addition of stevia powder and arabic gum had no significant effect on chayote squash powder drink ( $p > 0.05$ ). The springiness value was inversely proportional to the hardness parameter, hence, the higher the hardness value, the lower the springiness value. Materials with hard textures tend to have low elasticity (Susilawati et al., 2022).

### Moisture Content

Moisture content is related to shelf-life and determines the quality of powder drink according to SNI standards. A high level of moisture content affects the growth of microorganisms that cause damage to products (Adhayanti and Ahmad, 2021). Table 6 shows the moisture content value of chayote squash powder drink with the addition of stevia powder and arabic gum

The addition of stevia powder had no significant effect ( $p > 0.05$ ) on the moisture content of chayote squash powder drink, while arabic gum had a significant effect ( $p < 0.05$ ). The moisture content decreased with the higher concentration of arabic gum. The addition

of 15% concentration led to a lower moisture content than 10%. Based on SNI 01-4320-1996, the maximum moisture content limit of powder drink ranges from 3 – 5%. The moisture content of control sample, S<sub>1</sub>A<sub>1</sub>, and S<sub>2</sub>A<sub>1</sub> exceeded the maximum limit, while S<sub>1</sub>A<sub>2</sub> and S<sub>2</sub>A<sub>2</sub> had close values at 5.09% and 5.02% respectively.

Arabic gum significantly affects the moisture content due to the hydrophilic side of the hydroxyl group that forms hydrogen bonds with water molecules during drying process, crystallization, and evaporation. The addition at higher concentrations caused faster crystallization and evaporation of water thereby reducing moisture content (Firdhausi et.al, 2015). However, the more complex structure of arabic gum compared to other bulking agents leads to stronger hydrogen bonds and greater energy required to evaporate water (Praseptiangga et al., 2016). Drying process also affects the moisture content of chayote squash powder drink. The use of high and stable temperatures will optimize the process of water evaporation. This was proven in a study on drying taro where the moisture content decreased as the temperature increased (Pratiwi dan Suharto, 2015). The temperature must also be kept stable to optimize drying process.

Table 7. Ash content of chayote squash powder drink

Sample	%Kadar abu
Control (0% stevia powder + 0% arabic gum)	7.86% ± 0.89 <sup>b2</sup>
S <sub>1</sub> A <sub>1</sub> (2% stevia powder + 10% arabic gum)	5.24% ± 0.09 <sup>a1</sup>
S <sub>1</sub> A <sub>2</sub> (2% stevia powder + 15% arabic gum)	5.16% ± 0.01 <sup>a1</sup>
S <sub>2</sub> A <sub>1</sub> (4% stevia powder + 10% arabic gum)	5.64% ± 0.03 <sup>a1</sup>
S <sub>2</sub> A <sub>2</sub> (4% stevia powder + 15% arabic gum)	5.43% ± 0.06 <sup>a1</sup>

Note: all samples were significant as tested with two-way ANOVA continued with post hoc test ( $p < 0.05$ )

<sup>a-b</sup>Different letters on the same column show significant differences based on stevia leaf powder factors

<sup>1-3</sup>Different numbers on the same column show significant differences based on Arabic gum factors

## Ash Content

Ash refers to non-combustible inorganic substances consisting of mineral components such as potassium, calcium, zinc, and others. The analysis aimed to evaluate the amount of mineral content in food ingredients (Arisanti and Mutsyahidan, 2017). The ash content of chayote squash powder drink with the addition of stevia powder and arabic gum is shown in Table 7.

The addition of stevia powder and arabic gum had no significant effect on the ash content of chayote squash powder drink ( $p > 0.05$ ). Meanwhile, the maximum limit of powder drink ash content is 1.5% based on SNI 01-4320-1996. The high value observed in this study was attributed to the heightened content of inorganic substances in the ingredients including several minerals, such as calcium, potassium, iron, magnesium, manganese, phosphorus, and selenium (USDA, 2013). Arabic gum is a polysaccharide consisting of minerals, such as calcium, magnesium, and potassium, contributing to a high ash content, ranging from 2 – 4%. The hydrophilic nature also facilitates binding to water molecules, which contain minerals such as calcium, sodium, potassium, and chlorine (Praseptianga et al., 2016). Therefore, the ash content increases with a higher concentration of arabic gum.

Stevia leaves contain high levels of ash content (4.35 – 12.06%) as a good source of inorganic minerals (Gasmalla et al., 2014). According to Chandra dan Tirtabudi (2014), stevia contains phosphorus, potassium, calcium, magnesium, sodium, and iron.

## pH (Degrees of Acidity)

The pH value of chayote squash powder drink with the addition of stevia leaves and arabic gum is shown in Table 8.

The addition of stevia powder and arabic gum had a significant effect on the pH value of chayote squash powder drink ( $p < 0.05$ ). The pH value decreased with

higher concentrations of stevia powder and arabic gum. The control sample had a pH value of 6.77, while treatment with 4% stevia powder and 15% arabic gum reduced the value to 5.73. This result was in line with a study on corn hair herbal drink, where the pH value decreased with the addition of stevia powder (Nurhidayat, 2019).

Stevia naturally has a pH value ranging from 5-6, hence, the addition to products will cause an increase or a decrease in pH value (Simarmata et al., 2019). A decrease in pH value occurs due to the donation of H<sup>+</sup> ions from stevia to powder drink. These hydrogen ions originate from organic acids and minerals, such as cinnamic acid and potassium which reduce the degree of acidity of the product (Hedyana et al., 2021).

The addition of arabic gum decreased the pH value of chayote squash powder drink. Naturally, the pH value of arabic gum ranges from 3.9 – 4.5 due to the acidic properties of glucuronic acid compounds that produce glucuronic acid. Arabic gum forms a stable solution at pH 5 – 7 (Jumansyah et al., 2017), hence, the pH of chayote squash powder drink tends to decrease with higher concentrations.

## Total Dissolved Solids

Total dissolved solids show the amount of solid in a material that dissolves in water, such as glucose, fructose, sucrose, and, protein expressed in °Brix (Bachtiar, 2011). Table 9 presents the total dissolved solids of chayote squash powder drink with the addition of stevia powder and arabic gum.

The addition of stevia powder and arabic gum had a significant effect on the total dissolved solids of chayote squash powder drink ( $p < 0.05$ ), which ranged from 5.1°Brix-6.3°Brix. This value was higher than that of a previous study (3.4°Brix) because powder was only added with maltodextrin (Amelia, 2020). The addition of stevia powder and arabic gum increased the total dissolved powder.

Table 8. pH value of chayote squash powder drink

Sample	pH
Control (0% stevia powder + 0% arabic gum)	6.77 ± 0.15 <sup>c3</sup>
S <sub>1</sub> A <sub>1</sub> (2% stevia powder + 10% arabic gum)	6.26 ± 0.12 <sup>b2</sup>
S <sub>1</sub> A <sub>2</sub> (2% stevia powder + 15% arabic gum)	5.87 ± 0.06 <sup>b1</sup>
S <sub>2</sub> A <sub>1</sub> (4% stevia powder + 10% arabic gum)	5.97 ± 0.06 <sup>a2</sup>
S <sub>2</sub> A <sub>2</sub> (4% stevia powder + 15% arabic gum)	5.73 ± 0.06 <sup>a1</sup>

Note: all samples were significant as analysed with two-way ANOVA continued with post hoc test ( $p < 0.05$ )

<sup>a-b</sup>Different letters on the same column show significant differences based on stevia leaf powder factors

<sup>1-3</sup>Different numbers on the same column show significant differences based on Arabic gum factors



Table 9. Total dissolved solids of chayote squash powder drink

Sample	°Brix
Control (0% stevia powder + 0% arabic gum)	6.3 ± 0.14 <sup>c</sup>
S <sub>1</sub> A <sub>1</sub> (2% stevia powder + 10% arabic gum)	5.1 ± 0.14 <sup>a</sup>
S <sub>1</sub> A <sub>2</sub> (2% stevia powder + 15% arabic gum)	6.3 ± 0.07 <sup>ab</sup>
S <sub>2</sub> A <sub>1</sub> (4% stevia powder + 10% arabic gum)	6.1 ± 0.10 <sup>ba</sup>
S <sub>2</sub> A <sub>2</sub> (4% stevia powder + 15% arabic gum)	5.7 ± 0.14 <sup>b</sup>

Note: all samples were significant as tested with two-way ANOVA continued with post hoc test ( $p < 0.05$ )

<sup>a-b</sup>Different letters on the same column show significant differences based on stevia leaf powder factors

<sup>1-3</sup>Different numbers on the same column show significant differences based on Arabic gum factors

Table 10. IC<sub>50</sub> value of chayote squash powder drink

Sample	IC <sub>50</sub> (ppm)
Control (0% stevia powder + 0% arabic gum)	738.19 ± 0.57 <sup>c3</sup>
S <sub>1</sub> A <sub>1</sub> (2% stevia powder + 10% arabic gum)	386.63 ± 0.59 <sup>b2</sup>
S <sub>1</sub> A <sub>2</sub> (2% stevia powder + 15% arabic gum)	367.66 ± 0.32 <sup>b1</sup>
S <sub>2</sub> A <sub>1</sub> (4% stevia powder + 10% arabic gum)	201.35 ± 0.76 <sup>a2</sup>
S <sub>2</sub> A <sub>2</sub> (4% stevia powder + 15% arabic gum)	143.00 ± 0.08 <sup>a1</sup>

Note: all samples were significant as tested with two-way ANOVA continued with post hoc test ( $p < 0.05$ )

<sup>a-b</sup>Different letters on the same column show significant differences based on stevia leaf powder factors

<sup>1-3</sup>Different numbers on the same column show significant differences based on Arabic gum factors

The control sample had the highest total dissolved solids because chayote squash acted as a great source of carbohydrates, reaching 3.3 – 7.7% with approximately 3.3% existing in the form of dissolved sugar. This result was in line with a previous study where the total dissolved solids of the beet syrup control was higher compared to the sample added with stevia (Simarmata et al., 2019).

Stevia powder increased the total dissolved solids due to the sweetness level being 200 – 300 times higher compared to sucrose. The glycoside compounds have carbohydrate molecules, which can be converted into several types of sugar, such as rhamnose, xylose, arabinose, fructose, glucose, sucrose, trehalose, and raffinose (Ariffah, 2018). Various types of sugar in stevia increased the total dissolved solids in the ingredients, as well as chayote squash powder drink.

Arabis gum as a bulking agent can form a film to protect materials sensitive to heat, thereby maintaining the dissolved components (Farikha et al., 2013). Moreover, the polysaccharides may be hydrolyzed into several types of sugar, such as D-galactose, L-arabinose (pyranose and furanose), L-rhamnose, D-glycoronic acid, and methyl acid (Suryani, 2017). The presence of sugar content and the ability of arabic gum to maintain the

nutritional content of the ingredients increased the total dissolved solids of chayote squash powder.

### Antioxidant Activity (IC<sub>50</sub>)

Antioxidant activity was influenced by the presence of antioxidant compounds in the material. Low IC<sub>50</sub> values show a high level of antioxidant activity. IC<sub>50</sub> value of chayote squash powder drink with the addition of stevia powder and Arabic gum is shown in Table 10.

The addition of stevia powder and arabic gum had a significant effect on the IC<sub>50</sub> value of chayote squash powder drink ( $p < 0.05$ ), which tended to decrease. The 4% stevia powder and 15% arabic gum produced the lowest IC<sub>50</sub> value of approximately 143 ppm. According to Molyneux (2004), the control sample, S<sub>1</sub>A<sub>1</sub>, S<sub>1</sub>A<sub>2</sub>, and S<sub>2</sub>A<sub>1</sub> had weak antioxidant activity because the IC<sub>50</sub> values were >200 ppm. Sample S<sub>2</sub>A<sub>2</sub> had moderate antioxidant activity because the IC<sub>50</sub> values ranged between 100 ppm-150 ppm. These results were in line with previous studies stating that chayote squash powder drink had an IC<sub>50</sub> value of approximately 123.64 ppm (Wahida et al., 2016).

Stevia leaves contain bioactive compounds, such as flavonoids and phenolics, which facilitate antioxidant

activity. The flavonoid compounds are in the form of saponins and tannins (Jahan et al., 2010), while phenolics include vanillic 4-HAI- $\beta$ -D-glucopyranoside, protocatechuic, caffeic, chlorogenic, and cryptochlorogenic acid (Zain et al., 2020). Therefore, stevia powder effectively increased the antioxidant activity of chayote squash powder drink. This result was in line with a previous study where stevia powder increased the antioxidant activity of the tamarind turmeric drink (Julianto et al., 2021).

The role of arabic gum as a filler is to minimize the damage of antioxidant compounds during drying process (Marpaung et al., 2009). According to Rini et al (2016), arabic gum could retain ascorbic acid on the food easily oxidized. In another study, sapota powder with arabic gum was distinct for the presence of bioactive compounds, which were not identified in samples without arabic gum. This result proved that arabic gum presented the best outcome and the action was significantly efficient in protecting bioactive compounds (Araujo et al., 2020).

## CONCLUSION

In conclusion, the addition of stevia leaf powder and arabic gum to chayote squash powder drink significantly increased the yield, WHC, water content, pH, total dissolved solids, and antioxidant activity. However, no significant effect was observed on solubility, texture (hardness and springiness), and ash content. The use of 4% stevia powder and 15% arabic gum produced the strongest antioxidant activity (143.00 ppm) and finest solubility (37.65%). This dominant formulation had 9.69% yield, 37.44% WHC, 257.61 N hardness, 0.683 springiness, 5.02% moisture content, 5.43% ash content, 5.73 pH, and 5.7°Brix TDS with improved quality.

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## CONFLICT OF INTEREST

The author declares that there is no conflict of interest between the author or with other parties.

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