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Evaluation of The Chemical Properties, Chewiness Level, and Sensory of Yellow Pumpkin (*Cucurbita moschata*) Jelly Candy as Affected by Various Ratios of Carrageenan and Gum Arabic

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ABSTRACT

This research seeks to investigate the impact of carrageenan and gum arabic combinations on the chemical attributes, elasticity levels, and sensory characteristics of pumpkin jelly candy. The goal is to identify the optimal carrageenan and gum arabic formulation that yields high-quality jelly candy. The study employed a Completely Randomized Block Design with a single factor and four replications. The treatments consisted of different ratios of carrageenan to gum arabic: 5%:0% (K1), 4%:1% (K2), 3%:2% (K3), 2%:3% (K4), and 1%:4% (K5). Data were subjected to homogeneity analysis using the Bartlett test, ANOVA, and the Tukey test at a 5% significance level. The optimal treatment for pumpkin jelly candy was determined using the De Garmo method. Results indicated that the most favorable jelly candy formulation was K3 (3% carrageenan; 2% gum arabic), achieving a texture score of 3.80 (chewy), color score of 3.97 (dark yellow), taste score of 4.11 (likable), water content of 7.66%, ash content of 0.99%, reducing sugar content of 14.31%, and sucrose content of 27.7%. The combination of carrageenan and gum arabic significantly influenced the chemical properties, elasticity levels, and sensory aspects of pumpkin jelly candy.

1. INTRODUCTION

Pumpkin is a plant in the *Cucurbita moschata* family that can be found throughout the highlands of Indonesia. Pumpkin is characterized by its bright yellow color, making it one of food commodities with high beta-carotene (provitamin A) at around 180 IU. Beta-carotene compounds in pumpkins can be used as an alternative food ingredient to supplement the daily beta-carotene needed in the body (Usmiati *et al*., 2005). In addition to containing beta-carotene pigments, pumpkins also contain vitamins (B1, B2, B3, C, and E), minerals (phosphorus, iron, calcium, potassium, zinc, and copper), dietary fiber, and antioxidants (Pitricia, 2019).

The production of pumpkins in Indonesia tends to increase every year. Pumpkin production was 333 tons in 2011, 251 tons in 2012, 515 tons in 2013, 522 tons in 2014, and reached 530 tons in 2015, 539 tons in 2016 (BPS, 2016). However, pumpkin consumption in Indonesia is still very low, less than 50 kg/capita/year (Hayati, 2006). This is because Indonesians have not optimized the use of pumpkin as a raw material for food diversification. Pumpkin is generally only processed by boiling or as traditional food such as compote, pudding, dodol, pickles, and semi-wet cakes with a short shelf life and limited distribution (Rahmawati *et al*., 2014). Innovation in pumpkin processing is needed to increase food diversification and attract people to consume pumpkin, thus enhancing its economic value.

One way to diversify pumpkin products, extending their shelf life and making them suitable for daily consumption, is by making pumpkin jelly candy.

Jelly candy is a widely-loved food product for all ages, from children to adults. One of the preferred types of candy due to its distinctive characteristics is jelly candy. These characteristics include shape, taste, chewiness, and product elasticity (Rossi *et al*., 2017). According to the Indonesian National Standard (SNI) 3547.2-2008, jelly candy is made from fruit juice and gelling agents, having a chewy texture and a clear transparent appearance (BSN, 2008). Pumpkin juice can be used as a raw material for making jelly candy. The three requirements for gel formation in making jelly candy are sugar, acid, and pectin or other additives that, when heated, form a reversible gel (Isnanda *et al*., 2016). Jelly candy has a soft texture due to the addition of gelling agents such as gum, carrageenan, gelatin, agar-agar, pectin, starch, and others. Gelling agents significantly influence the texture of jelly candy (Estiasih & Ahmadi, 2009).

Some gelling agents come from natural sources like pectin in fruits and carrageenan in seaweed. Pumpkin contains 1.2g/100g of pectin, so additional gelling agents are needed. Gelatin is a commonly used gelling agent. The widespread use of pork gelatin has raised concerns about the halal status of food products. Therefore, alternative gelling agents like carrageenan are used to make them more acceptable to the Muslim community in Indonesia. Carrageenan is a substance from seaweed in the form of powder, serving as a gelling agent, emulsifier, stabilizer, and thickener, affecting the final characteristics of jelly candy (Murdinah, 2010). Carrageenan contains 18% sulfate and is hydrophilic, resulting in a gel that is less prone to syneresis (BeMiller & Whistter, 1996). However, carrageenan has a drawback: the gel it produces has a less elastic and brittle texture. Therefore, a combination with other gelling agents is needed to improve it, and one such agent is gum arabic. Gum arabic is derived from the sap of *Acacia sp*. trees in Sudan and Senegal. Gum arabic dissolves more easily compared to other gelling agents. Food products with high sugar content usually use gum arabic to prevent sugar crystallization and aid in forming a stable fat emulsion. Gum arabic also enhances viscosity, thus increasing stability. Gum arabic is heat-resistant, but the heating temperature of food products must still be considered as gum arabic can gradually degrade. Gum arabic is unique due to its low viscosity and high solubility. The number of hydroxyl groups (-OH) and molecular mass affect the ability of gum arabic to bind water (Santoso *et al*., 2013).

Carrageenan has free OH ions that can bind with H2O, allowing it to retain a relatively high amount of water and strengthen the gel. Gum arabic has arabinogalactan protein (AGP) and glycoprotein (GP) groups that can be used as thickeners and emulsifiers. However, gum arabic cannot form a thick gel like carrageenan; it primarily function is to reinforce the gel (Funami, 2011). The addition of gelling agents affects the texture by forming a gel and having water-holding capacity, thus influencing the water content of the product. The ash content increases with the addition of gelling agents due to the high mineral content. The optimal formulation of carrageenan and gum arabic in making pumpkin jelly candy is expected to produce a product that is acceptable to consumers. Based on the above description, this research is conducted to evaluate the chemical properties, chewiness level, and sensory characteristics of pumpkin jelly candy at various ratios of carrageenan and gum arabic.

2. MATERIALS AND METHODOLOGY

The main ingredients used were pumpkin obtained from the local market in Bandar Lampung, carrageenan (brand Indogum), and gum arabic (brand Tic Gums). Additional ingredients included citric acid, sucrose, glucose syrup, and water. Chemicals for analysis purposes included DPPH reagent, ethanol, distilled water, Luff schrool solution, starch indicator, lead acetate, $(NH_4)_2HPO_4$ 10%, HCl, NaOH, KI 20%, H_2SO_4, and 0.1 N Na-thiosulfate. The equipment for making pumpkin jelly candy included scales, thermometer, stirrer, stove, stopwatch, molds, measuring cups, knife, spoon, blender, mixing bowl, tray, Teflon pan, pot, aluminum foil, and oven. The equipment for analysis included Brookfield CT-3 Textur Analyzer, analytical balance, porcelain cup, oven, desiccator, furnace, glassware, and a set of tools for sensory testing.

The study was designed in a Complete Randomized Block Design (CRBD) with 4 replications. The single-factor treatment consisted of 5 levels of carrageenan and gum arabic concentration formulations, namely 5%:0% (K1), 4%:1% (K2), 3%:2% (K3), 2%:3% (K4), and 1%:4% (K5). Data homogeneity was tested using the Barlet test, and data were analyzed using Tuckey's test for significance. Analysis of variance was conducted to determine the effects

among treatments, and differences between treatments were tested with Least Significant Difference (LSD) at a 5% significance level. The best treatment for pumpkin jelly candy was determined using the method of De Garmo (1984).

2.1. Pumpkin Juice Preparation

Pumpkin juice was prepared based on the method by Insani *et al*. (2017). Pumpkin fruits were peeled, cleaned from seeds and fibers. The pumpkin was cut into small cubes, washed with running water to remove sap and impurities, then weighed and steamed at 70ºC for 25 minutes. The steamed pumpkin was blended with water at a ratio of 1:1 (w/v). The pumpkin puree was filtered through a cloth to obtain pumpkin juice.

2.2. Jelly Candy Preparation

For each of the 5 predetermined treatment ratios, 400 ml of pumpkin juice was measured, mixed with 100 ml of water to dissolve gum arabic and carrageenan, and added with 60 g of glucose syrup and 200 g of sucrose. The formulations of carrageenan and gum arabic for the five treatments were 20 g:0 g (K1), 16 g:4 g (K2), 12 g:8 g (K3), 8 g:12 g (K4), and 4 g:16 g (K5). The entire mixture was cooked and stirred until boiling and thickening, then citric acid was added at 0.6 g. The jelly candy mixture was poured into 1x1 cm molds, cooled for 1 hour at room temperature, and the jelly pieces were placed in a tray lined with aluminum foil and dried using a blower oven at 50 ℃ for 24 hours (Ardiansyah *et al*., 2021).

2.3. Observations

Observations on the jelly candy for the 5 treatments included chemical properties such as water content (BSN, 2008), ash content (BSN, 2008), chewiness level (Indiarto *et al*., 2012), and sensory characteristics of texture, color, and taste (Setyaningsih *et al*., 2010). The best treatment was observed for reducing sugar content (BSN, 2008) and sucrose content (BSN, 2008).

2.4. Dataset Training and Model Evaluation

Dataset training is the process of setup an algorithm model created to train the dataset that has been collected. This Observations on the jelly candy for the 5 treatments included chemical properties such as water content (BSN, 2008), ash content (BSN, 2008), chewiness level (Indiarto *et al*., 2012), and sensory characteristics of texture, color, and taste (Setyaningsih *et al*., 2010). The best treatment was observed for reducing sugar content (BSN, 2008) and sucrose content (BSN, 2008).

3. . RESULTS AND DISCUSSION

3.1. Water Content

Analysis of variance results indicate that the concentration of carrageenan and gum arabic significantly affects the water content of pumpkin jelly candy at (α=0.05). The research findings reveal that the water content of pumpkin jelly candy ranges from 7.21% to 9.69%. Further Least Significant Difference (LSD) test at 0.05% for water content can be seen in Table 1.

Table 1. LSD test results for water content (%) of jelly candy with carrageenan and gum arabic concentration formulations.

Treatment	Water Content (%)	Ash Content (%)
K5 (carageenan 1% : 4% gum arabic)	9.69^{a}	0.57^{e}
K4 (carageenan 2% : 3% gum arabic)	7.85^{b}	0.80^{d}
K3 (carageenan 3% : 2% gum arabic)	7.66^{b}	0.99^{c}
K2 (carageenan 4% : 1% gum arabic)	7.43^{c}	1.35^{b}
K1 (carageenan 5% : 0% gum arabic)	7.21^{d}	1.57^{a}
LSD 5%	0.202	0.097

Note: Numbers followed by the same letter indicate no significant difference in the LSD test at a 5% significance level.

The water content of pumpkin jelly candy in all five treatments is lower than the maximum water content of 20% according to SNI 3547-2-2008. This indicates that the water content of pumpkin jelly candy in all treatments meets the SNI standards. The research results show that higher proportions of added carrageenan and lower proportions of gum arabic decrease the water content of pumpkin jelly candy. This is because carrageenan is a hydrocolloid with the ability to bind a large amount of water due to its negatively charged sulfate groups along the polymer chain (Harijono, 2001). The addition of carrageenan to food ingredients reduces water content and increases the viscosity of the material (Estiasih & Ahmadi, 2009). According to Giyarto *et al*. (2019), higher concentrations of carrageenan reduce the amount of free water in the material, strengthening the gel structure and reducing water volume. Carrageenan in jelly candy production binds water, so the higher the addition of carrageenan, the more water it binds. As a result, the amount of free water molecules decreases, and this free water evaporates when heated. The higher the concentration of carrageenan used in the jelly candy, the higher the solid content, and the lower the water content (Juwita *et al*., 2014).

The results indicate that the increased concentration of gum arabic in jelly candy results in higher water content in pumpkin jelly candy. Gum arabic has a relatively low water-binding ability. The water-binding ability of gum arabic is due to proteins with amino and hydroxyl groups that are hydrophilic, forming hydrogen bonds with one or more water molecules, absorbing and retaining water in the molecular structure, and forming a thick colloid with a gel structure. Compared to other hydrocolloids, gum arabic has the lowest water-binding ability, around 7.49% (Praseptiangga *et al*., 2016). The concentration formulations of carrageenan and gum arabic in the five treatments in this study show differences in water content of pumpkin jelly candy among treatments (Table 1).

3.2. Ash Content

Analysis of variance results show that the concentration of carrageenan and gum arabic significantly affects the ash content of jelly candy (α=0.05). The research results indicate that the ash content of pumpkin jelly candy ranges from 0.57% to 1.57%. Further LSD test at 0.05 for ash content can be seen in Table 1. The ash content of pumpkin jelly candy produced in all treatments is lower than the SNI 3547-2-2008 standard, which sets the maximum ash content at 3%. The pumpkin jelly candy product meets the established SNI standard.

The research results indicate that a lower proportion of carrageenan with a higher proportion of gum arabic results in a lower ash content of pumpkin jelly candy. Fajarini *et al*. (2018) state that the mineral content found in kappa carrageenan contributes to an increase in the ash content of black grape jelly candy. The higher the addition of carrageenan, the higher the ash content of the product because carrageenan comes from seaweed with relatively high mineral content (Isnanda *et al*., 2016). According to Milani & Maleki (2012), carrageenan can form a three-dimensional network. The three-dimensional network can bind mineral content in the product, preserving the contained minerals.

The research results indicate that the increased concentration of gum arabic in jelly candy causes a lower ash content in pumpkin jelly candy. This is supported by the analysis results conducted by Jumri *et al*. (2015), where carrageenan has an ash content of 14.78%, while gum arabic has an ash content of 2.08%. According to Wenno *et al*. (2012), carrageenan has an ash content of 16.60%, while gum arabic has an ash content of 3.4%. The mineral content in *Kappaphycus alvareisi* carrageenan consists of calcium at 2.8 mg/100g, magnesium at 2.9 mg/100g, sodium at 11.9 mg/100g, and potassium at 87.1 mg/100g (Santoso *et al*., 2004). According to Rabbah & Abdalla (2012), the mineral salt content in gum arabic per 100g material includes calcium at 1,117 mg, potassium 310 mg, magnesium 292 mg, and sodium 14 mg.

3.3. Chewiness Level

Chewiness level is a test to determine the physical or textural characteristics of pumpkin jelly candy. The chewiness level test for pumpkin jelly candy was conducted using Texture Profile Analysis (TPA) with a Brookfield AMETEK CT-3-4500-115 CT3 Texture Analyzer. The probe used was a cylindrical probe with a diameter of 36 mm, a test speed of 2.0 mm, a trigger force of 9.0 grams, and a deformation of 8.0 mm. In this study, the measured parameters were hardness, springiness, and cohesiveness. Further LSD test at 0.05 for chewiness level can be seen in Table 2.

The chewiness level on the hardness parameter of jelly candy ranges from 195.25 to 586.81 gf, and the cohesiveness of the jelly candy ranges from 0.34 to 0.95. LSD test at 0.05 (Table 2) shows that the hardness of pumpkin jelly candy in treatment K3 is not significantly different from treatments K2 and K4 but significantly differs from treatments K1 and K5. In terms of cohesiveness, treatment K2 is not significantly different from treatments K3 and K1 but significantly differs from K4 and K5. For the parameter of elasticity or springiness, treatment K5 significantly differs from all other treatments. This proves that there are differences in the hardness, cohesiveness, and springiness levels of each formulation of carrageenan and gum arabic concentration in the produced pumpkin jelly candy.

Hardness is one of the crucial parameters in candy products. The hardness level of jelly candy generally has a soft texture, making it easy to chew. The hardness of jelly candy is influenced by gel-forming ingredients and the concentration of the gelling agent (Mahardika *et al*., 2014). The gel-forming ingredients in the production of pumpkin jelly candy are carrageenan and the thickening agent, gum arabic, with various formulations. An increase of carrageenan as a gel-forming ingredient results in higher hardness of the pumpkin jelly candy product.

Table 2. LSD test results for the chewiness level of jelly candy with carrageenan and gum arabic concentration formulations.

Treatment	Hardness	Compactness	Elasticity
K1 (carrageenan 5% : 0% gum arabic)	586.81^{a}	0.95^{a}	3.65^{b}
K2 (carrageenan 4% : 1% gum arabic)	408.88^{b}	0.84^{ab}	4.18^{b}
K3 (carrageenan 3% : 2% gum arabic)	402.50^{b}	0.77^{b}	4.43^{b}
K4 (carrageenan 2% : 3% gum arabic)	284.81^{d}	0.53^{c}	4.55^{b}
K5 (carrageenan 1% : 4% gum arabic)	195.25^{d}	0.34^{d}	7.10^{a}
LSD (0.05)	122.23	0.111	1.630

Note: Numbers followed by the same letter indicate no significant difference in the LSD test at a 5% significance level.

An increase in the concentration of carrageenan and a decrease in the concentration of gum arabic in the production of jelly candy lead to an increase in the hardness and cohesiveness of pumpkin jelly candy, while elasticity decreases. Carrageenan has the property of binding water and forming a strong gel. Gel formation occurs through the binding of free carboxyl and hydroxyl groups of carrageenan with water. Yati *et al*. (2013) state that kappa carrageenan has the property of forming a hard and rigid gel. Gum arabic has arabinogalactan protein (AGP) and glycoprotein (GP) groups that can be used as thickeners and emulsifiers. However, gum arabic cannot form a concentrated gel like carrageenan because gum arabic only functions to strengthen the gel. The water-binding ability of carrageenan and gum arabic begins with the structure becoming random due to heat; polymer chains entwine and form a double helix, trapping free water when cooled, resulting in a solid and elastic gel texture (Funami, 2011).

The hardness and cohesiveness of pumpkin jelly candy are also influenced by the water content. The water content of pumpkin jelly candy (Table 1) show that a higher proportion of carrageenan and a lower proportion of gum arabic result in lower water content. This is because carrageenan has a high water-binding ability, resulting in a strong and firm gel. A strong gel produces high hardness and cohesiveness due to the binding of gel-forming ingredients with water. Herawati (2018) states that ease of water absorption and gel formation are the main characteristics of hydrocolloids. It is reported that elasticity and rigidity are gel properties similar to solids. The hardness value of jelly candy in the study ranges from 195.25 gf to 586.81 gf, which is lower than the hardness value of commercial jelly candy, which is 1792.07 gf. This is because the gel-forming ingredient used in commercial jelly candy is gelatin (Udin, 2013). According to Mariod & Adam (2013), one of the most important factors in gel formation that affects the strength and stability of the gel is the concentration of gelatin added to food products, including jelly candy. If the added concentration of gelatin is too low, the formed jelly candy texture will be soft, while a concentration of gelatin that is too high makes the jelly candy texture elastic. Gel formation occurs due to hydrogen bonding between gelatin molecules. The strength of gelatin gel influenced by the length of amino acid chains will affect the elasticity of the resulting product. Since the gelatin-formed micelles are strong, the gel strength increases with the increasing length of the amino acid chain of gelatin. Nguyen *et al*. (2017) state that protein content affects tissue strength during gel formation and makes the product chewier. The chewiness level measured using the Texture Analyzer in our research is

supported by sensory observations by the panelists (Table 3), where jelly candy with a texture that is either too soft or too hard and rigid receives negative responses from the panelists who conduct texture testing through scoring. The jelly candy preferred by the panelists is the one with a chewy texture but relatively easy to break when bitten.

Table 3. LSD test results for texture, color, and taste scores of jelly candy with carrageenan and gum arabic concentration formulations.

Treatment	Texture Score	Color Score	Taste Score
K1 (carrageenan 5% : 0% gum arabic)	4.29^{a}	2.94^{c}	3.52^{c}
K2 (carrageenan 4% : 1% gum arabic)	3.96^{b}	3.84^{b}	3.95^{b}
K3 (carrageenan 3% : 2% gum arabic)	3.80^{c}	3.97^{b}	4.11^{a}
K4 (carrageenan 2% : 3% gum arabic)	3.54^{d}	4.05^{ab}	3.98^{b}
K5 (carrageenan 1% : 4% gum arabic)	2.47^{e}	4.24^{a}	3.61^{c}
LSD (0.05)	0.152	0.215	0.103

Note: Numbers followed by the same letter indicate no significant difference in the LSD test at a 5% significance level.
Scoring value : Texture : 5 = very chewy; 4 = chewy ; 3 = slightly chewy ; 2 = slightly soft ; 1 = soft.
Color : 5 = clear yellow; 4 = dark yellow; 3 = brownish yellow; 2 = yellowish brown; 1 = brown.
Taste : 5 = highly liked ; 4 = liked ; 3 = slightly liked ; 2 = not liked ; 1 = highly not liked.

3.4. Texture

Analysis of variance results show that the concentration of carrageenan and gum arabic significantly affects the texture of pumpkin jelly candy. The research results show texture scores of jelly candy ranging from 2.47 (slightly soft) to 4.29 (very chewy) (Table 3). Texture is one of the most important characteristics of jelly candy. Panelists assess the texture of jelly candy by pressing it with their fingers and during chewing. According to SNI 3547-2-2008, one characteristic of jelly candy is its chewy nature, making the texture parameter crucial for jelly candy. The texture of jelly candy is obtained from the gel-forming ingredients during processing. Gel formation occurs due to cross-linking of polymer chains, creating a three-dimensional network that binds water within and forms a strong texture (Zhaki *et al*., 2018). The research results indicate that an increase in carrageenan concentration with a decrease in gum arabic concentration in jelly candy production results in a more chewy texture. Conversely, a decrease in carrageenan and an increase in gum arabic reduce the texture score. Hidayati *et al*. (2021) state that hydrocolloids act as thickeners, so an increase in hydrocolloid content enhances the thickness of food products.

Carrageenan's ability to bind water is excellent, so an increase in carrageenan content will increase the amount of water bound to the jelly candy. Carrageenan polymer chains will coil around each other to form a double helix and trap free water during heating. As the helix increases during cooling, it forms a strong gel mass (Giyarto *et al*., 2019). This aligns with the opinion of Salamah *et al*. (2006) that a high carrageenan content produces a strong texture in jelly candy. According to the panelists, pumpkin jelly candy without added gum arabic has a hard and dry texture, making it difficult to bite. In contrast, pumpkin jelly candy with added gum arabic has a soft texture and is easier to chew. This is supported by the water content data (Table 1), which shows that a higher proportion of carrageenan and lower gum arabic content leads to a decrease in water content. The low water content in pumpkin jelly candy produces a firm and strong gel, resulting in a more compact texture.

3.5. Color

The analysis of variance results indicate that the concentration of carrageenan and gum arabic significantly affects the color of pumpkin jelly candy. The research findings show color scores for jelly candy ranging from 2.94 (brownish-yellow) to 4.24 (deep yellow) (Table 3). The yellow color of the jelly candy is derived from the natural color of yellow pumpkin fruit, which is yellow-orange due to the presence of carotenoid pigments. The total carotenoids in yellow pumpkin fruit range from 243.21 to 404.98 µg/g, consisting of α-carotene at 67.06-72.99 µg/g and β-carotene at 141.95-244.22 µg/g (Carvalho *et al*., 2012). Variations in the formulation of carrageenan and gum arabic concentrations in jelly candy production result in differences in color for yellow pumpkin jelly candy. Transparent color is observed in formulations with low carrageenan concentration and high gum arabic concentration, while a

more brownish color is evident in formulations with higher carrageenan and lower gum arabic concentrations. According to Putra *et al*. (2018), excessive addition of carrageenan leads to darker coloration. Estiasih & Ahmadi (2009) state that carrageenan can dissolve in water, forming a thick solution and influencing the color of jelly candy.

Increased carrageenan content causes the color intensity to become more brown (Table 3), presumably because the drying treatment during the baking process of yellow pumpkin jelly candy leads to water evaporation, making the jelly candy appear drier and darker. Gum arabic is a white to brownish powder that forms a clear gel when dissolved in water. Therefore, gum arabic produces the same color even when added in varying amounts to a solution. This aligns with the statement by Zulfalina *et al*. (2021) that gum arabic has no color, so adding gum arabic does not cause significant color changes.

3.6. Taste

The analysis of variance indicates that the concentration of carrageenan and gum arabic significantly affects the taste of yellow pumpkin jelly candy. The research results show taste scores for jelly candy ranging from 3.52 to 4.11 (Table 3). Differences in the formulation of carrageenan and gum arabic concentrations influence the preference level of the panelists for the taste of jelly candy. Higher additions of carrageenan and lower additions of gum arabic tend to provide a stronger sweetness and may overshadow the natural fruit flavor, resulting in less preferred taste for jelly candy with high carrageenan content. Fajarini *et al*. (2018) state that an increase in high carrageenan content produces a strong gel and an excessively sweet taste, fitting for jelly candy. Treatment K3 (carrageenan 3% : 2% gum arabic) obtained the highest taste score, indicating that jelly candy at this concentration is most preferred by the panelists. The decrease in carrageenan concentration increases the preference of the panelists for the taste of jelly candy. Panelists prefer candy with a less sweet taste (Giyarto *et al*., 2019). The characteristic of gum arabic is having no taste (Zulfalina *et al*., 2021). Yebeyen *et al*. (2009) state that gum arabic is pale to brownish, solid, and brittle, with no taste, making it suitable as a food additive without altering the sensory characteristics of food products.

The taste of food products is influenced by several factors, namely chemical compounds, temperature, concentration, and interactions with other taste components. The addition of sucrose and glucose syrup results in sweetness in jelly candy, while the acidic taste is obtained from citric acid. In this study, jelly candy was made by adding equal amounts of sucrose, fructose syrup, and acid. Based on the research results, sensory assessment of taste is related to texture. This is because the assessment of taste and texture involves the sense of taste. The more resilient texture of jelly candy is not preferred by the panelists, thus affecting the assessment of the taste of jelly candy.

3.7. Best Treatment

The determination of the best treatment for yellow pumpkin jelly candies based on water content, ash content, texture, color, and taste (Table 4) was established using the effectiveness weighting test (De Garmo, 1984). The weight values for each parameter were assigned in the order of water content, ash content, texture, taste, and color (Table 5). The water content and ash content parameters for all five treatments meet the Indonesian National Standard (SNI) for jelly candies (SNI 3547-2-2008). The calculation results using the effectiveness test weighting show the highest productivity value of 0.76 found in treatment K3 (carrageenan 3% : 2% gum arabic), making K3 as the best treatment. Treatment K3 has a sucrose content of 27.7% and a reducing sugar content of 14.31%, meeting the Indonesian National Standard for jelly candies (SNI 3547-2-2008).

Table 4. Recapitulation of the results of jelly candy testing with the BNT 5% test.

Parameter	Treatment					SNI
	K1	K2	K3	K4	K5	
Water content (%)	7.21^{d}	7.43^{c}	7.66^{bc}	7.85^{b}	9.69^{a}	Max. 20
Ash content (%)	1.57^{a}	1.35^{b}	0.99^{c}	0.80^{d}	0.57^{e}	Max. 3
Texture	4.29^{a}	3.96^{b}	3.80^{c}	3.54^{d}	2.47^{e}	-
Color	2.94^{c}	3.84^{b}	3.97^{b}	4.05^{ab}	4.24^{a}	-
Taste	3.52^{c}	3.95^{b}	4.11^{a}	3.98^{b}	3.61^{c}	Normal

Table 5. The best treatment of pumpkin jelly candy according to the weighting effectivity test (De Garmo, 1984)

Parameter	Order	Score	Weight	Productivity value				
				K1	K2	**K3**	K4	K5
Water content	1	5	0.333	0.33	0.30	0.27	0.25	0.00
Ash content	2	4	0.267	0.00	0.06	0.15	0.21	0.27
Texture	3	3	0.200	0.20	0.00	0.15	0.12	0.00
Taste	4	2	0.133	0.00	0.10	0.13	0.10	0.02
Color	5	1	0.067	0.00	0.05	0.05	0.06	0.07
Total		15	1	0.53	0.51	**0.76**	0.73	0.35

4. CONCLUSIONS

The combination of carrageenan and gum arabic has a significant impact on the chemical properties (specifically water content and ash content), elasticity levels (including hardness, compactness, and elasticity), and sensory attributes (texture, color, taste) of yellow pumpkin jelly candies. Among the various formulations, K3 (carrageenan 3% : 2% gum arabic) stands out as the most effective treatment, resulting in a texture score of 3.80 (chewy), a color score of 3.97 (deep yellow), and a taste score of 4.11 (preferred). The corresponding water content is 7.66%, ash content is 0.99%, reducing sugar content is 14.31%, and sucrose content is 27.70%. Importantly, the water content, ash content, sucrose content, and reducing sugar content of yellow pumpkin jelly candies comply with the standards outlined in the Indonesian National Standard for jelly candies (SNI 3547-2-2008).

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