Characteristics and organoleptic properties of nutmeg (*Myristica fragrans*) candy coated with edible film

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Abstract. Edible Film wrapped candy is safe to consume and can provide a unique taste to the candy. This research aims to determine the characteristics and organoleptic properties of nutmeg candy. Nutmeg pulp slices with weight per volume values of 6.7%, 6.9%, 7.1%, and 7.3% were the first factor in a completely randomized factorial research design and the second factor was tapioca with a concentration of 1.2%, 1.4%, 1.6%, 1, 8% w/v. Characteristics: Edible Film has a thickness of 0.12 mm. elongation 5.75%, tensile strength 24.84 (KPa) and solubility 99.80% and hygroscopic content 7.36% - 10.54%. The organoleptic test results for color, aroma, taste, texture, and overall value ranged from 2.80 (3 neutral) to 3.70 (4 like). The best treatment was a combination of 6.7 grams of sliced nutmeg and 1.8 grams of tapioca with the lowest water content of 1.07%, hygroscopicity of 0.03% and the highest organoleptic test of 4 (like). Candy wrapped in Edible Film can maintain quality and make it easier to consume nutmeg soft candy. One alternative use of nutmeg flesh that has not been utilized optimally is to process it into soft candy.

1 Introduction

Nutmeg (Myristica fragrans Hout) is a native plant originating from Indonesia that has been known as a spice since the 18th century. The majority (70–75%) of the world's nutmeg production is now being produced in Indonesia [1]. The components of nutmeg are the meat (77.2%), mace (4%), shell (5.1%), and seeds (13.1%)[2]. Nutmeg also contains a variety of important vitamins such as B-complex, vitamin C, folic acid, riboflavin, niacin, vitamin A, flavonoids, and beta-carotene [3].

Nutmeg is known as a spice plant with economic and versatile value because almost every component of the plant may be used in a wide range of industries. The parts of nutmeg that has high economic value are the seed and mace which are used as ingredients in the beverage, food, pharmaceutical and cosmetic industries [4]. The largest part of nutmeg is the flesh with a percentage of 77.8%. In nutmeg production areas, after the seeds and mace are taken most of the flesh of the nutmeg have not been used optimally and end up as waste [4]. Nutmeg

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flesh contains nutrients such as calories (42 cal) per 100 g. (42 cal), protein (0.30 g), fat (0.20 g), carbohydrates (10.90 g), calcium (32 mg), phosphorus (24 mg), iron (1.50 mg), vitamin A (29.50 IU), vitamin C (22 mg) and water (88.10 g) [5]. Seeing the nutritional composition of nutmeg flesh, it has the potential to be developed into high-value processed products. Processed products from nutmeg flesh that exist today are preserved nutmeg flesh and syrup. However, to make preserved nutmeg flesh and nutmeg syrup requires a lot of sugar which has an impact on high production costs so that it also has an impact on the price which is quite expensive and unsafe for people with diabetes to consume. In addition to the nutritional composition of nutmeg which is quite high, another advantage of nutmeg flesh is that it has a sour, sweet taste, and a distinctive aroma which is one of the characteristics of candy, so that it could be used as a raw ingredient in the production of candy [1,4,6]**.**

There are two kinds of candy, hard candy and soft candy. Soft candy is a soft candy made from a mixture of granulated sugar, sugar syrup, water, gel foaming, color and flavor additives that are cooked at a predetermined temperature and have a soft texture [7]. Candy is a hygroscopic product that easily absorbs moisture from its surroundings and easily changes its physical, chemical, and sensory properties during storage [8]. Therefore, it is also necessary to design good packaging and product labels so that the resulting candy has a long shelf life and an attractive appearance.

Consumer attitudes toward quality food product packaging, as well as environmental concerns, encourage researchers and manufacturers to develop sustainable packaging based on biomaterials and circular economy processes in the modern period. Edible packaging can be a potential alternative to environmentally friendly food packaging. Apart from being edible, the ingredients are derived from natural food grade polymers such as polysaccharides, proteins, or lipids and are harvested from plants and animals. [9–12]. Edible packaging preserves food quality, extends shelf life, and minimizes waste to some extent.

Parameters that play a role in the quality of soft candy are moisture content, hygroscopic and organoleptic [13]. Processed nutmeg in the form of candy coated with edible film can maintain the quality and increase the sensory value of the candy. In addition, it can provide convenience in consuming nutmeg, adding to the types of processed nutmeg products while at the same time increasing the added value of nutmeg farming. The purpose of this study is to determine the influence of sliced nutmeg and tapioca flour on the properties of nutmeg soft candy, as well as the effect of edible film packaging on the characteristics and sensory aspects of the nutmeg candy produced.

2 Materials and methods

2.1 Place and time

The study was conducted at the North Sulawesi Assessment Institute for Agricultural Technology Laboratory from February to June 2021.

2.2 Materials and tools

Nutmeg, glucose, sucrose, tapioca flour, potassium chloride, water, aluminum foil, 500 ml beaker, 250 ml beaker, hot plate/magnetic stirrer, stir bar, spatula, knife, digital infrared thermometer, digital scale, weighing scale analytical, silicon candy mold, candy wrapping paper, plastic cup, label sticker, 14 x 22 cm plastic candy packaging, oven, porcelain tray, desiccator, metal tongs, petri dish and RHS color chart

2.3 Research procedure

The research was carried out in 3 stages, namely making candied nutmeg slices, edible films, and soft candy.

2.3.1 The procedure for making candied nutmeg

Nutmeg is peeled and split, then the seeds and mace are separated, nutmeg flesh is soaked for 12 hours in 2% salt solution (produced by mixing 20 grams of salt with 1 liter of water.), the soaked nutmeg flesh is washed water and then cut into small cubes, the slices of nutmeg flesh are blanched for 5 minutes by dipping them in hot water at 90^0C, then removed and dipped in cold water, the slices of nutmeg flesh soaked in sugar, the ratio of sliced nutmeg to sugar (2: 1) for 3 days, After soaking with sugar solution, followed by draining, the nutmeg slices are ready to be used for candy making [23].

2.3.2 The procedure for making edible films

5 g of chitosan was dissolved in a solution of citric acid pH 4.0 and 1000 ml of distilled water in a beaker and heated with a plate stirrer at a temperature of 60-70^0C for 15 minutes, 10 g of nutmeg pectin and 1.6 g of CaCl2 were dissolved in 1000 ml of distilled water and heated for 15 minutes at 60-700 C, 10 mL of chitosan and glycerol were added and heated for 15 minutes on a hot plate at 800°C. If the volume was decreased, distilled water was added until it was 1000 ml. Heating was continued to a temperature of 85^0C for 15 minutes. In a 24 x 16 x 2-centimeter glass plate, dry for 10-12 hours in a 500C oven. Cooling at room temperature and releasing the edible film from the mold. It is ready to be wrapped to soft candy (14).

2.3.3 The procedure for making of soft candy

Table 1. The formulation of candy making

Code	Sucrose (g)	Glucose (g)	Tapioca (g)	Nutmeg Slice (g)	KCl (g)
T1B1	30	100	1.2	7.3	1.5
T1B2	30	100	1.2	7.3	1.5
T1B3	30	100	1.2	7.3	1.5
T2B1	30	100	1.4	7.1	1.5
T2B2	30	100	1.4	7.1	1.5
T2B3	30	100	1.4	7.1	1.5
T3B1	30	100	1.6	6.9	1.5
T3B2	30	100	1.6	6.9	1.5
T3B3	30	100	1.6	6.9	1.5
T4B1	30	100	1.8	6.7	1.5
T4B2	30	100	1.8	6.7	1.5
T4B3	30	100	1.8	6.7	1.5

Prepared the materials according to Table 1, heat the glucose using a hot plate and stir until it melts, add the sucrose according to the treatment gradually while stirring until it melts. After the glucose and sucrose melt and mix well, add 1.5 gr of potassium chloride gradually and stir until evenly distributed. After everything has been combined, gradually add the tapioca flour while stirring until uniformly distributed, If it has thickened, add the nutmeg slices according to the treatment gradually and stir until evenly distributed, pay attention to the temperature of the candy, don't let it reach 135°C. The average temperature for soft candy is 120-130°C. To find out if the candy is ready to be molded, a test is carried out by inserting a drop of the candy solution into the water and pressing it by hand, If the texture of the candy is soft and can be pulled without breaking, it is ready to be molded. Molding is done by placing the candy solution into a silicone mold, then allowed to cool and removed from the mold, The candy is coated with edible film and then wrapped in plastic candy packaging.

2.4 Experimental design

This study used a completely randomized design (CRD) with 12 treatments and three replications. The study compared the concentrations of tapioca (T) and sliced nutmeg flesh (B). The collected data was statistically evaluated using SPSS. If the calculated F is more than or equal to the F table, the Duncan's Multiple New Range Test (DNMRT) significant difference test is performed at the 5% level.

2.5 Data analysis

Soft candy parameters measured were moisture content, hygroscopic properties, color and organoleptic properties of aroma, taste, texture, and overall value.

2.5.1 Moisture content

The oven method was used to measure the water content for 2 hours at a temperature of 105 C. The first step is to dry the empty cup in the oven for 1 hour then cool it in a desiccator for 30 minutes and then weigh it. 5 g of the sample was placed in a cup and weighed, then baked for 2 hours at 105 C, chilled in a desiccator for 30 minutes, and weighed again, heating twice. The water content of the candy can be calculated using the following formula [24]:

$$Water\ Content = \frac{a-b}{a-c} x\ 100\ \% \quad (1)$$

Notes:
a = before the oven, weight of cup + sample (g)
b = after the oven, weight of cup + sample, (g)
c = empty cup weight (g)

2.5.2 Hygroscopic test

A hygroscopic test is used to measure a substance's ability to absorb water molecules from its surroundings, either by absorption or adsorption. If a substance can absorb water molecules well, it is said to be hygroscopic. The hygroscopic test was performed by leaving the candy at room temperature for 30 minutes and examining the changes in the candy. The candy is then weighed to determine the hygroscopic level by reducing the weight after being left at room temperature with the initial weight divided by the initial weight times 100% [25].

2.5.3 Color observation

Color measurement on candy is carried out using the Royal Horticultural Society (RHS) Color Charts chart by matching the color of the candy with the color on the RHS chart. The results are recorded and then given a value in the form of numbers for statistical analysis and to determine differences between treatments [26].

2.5.4 Organoleptic test

Organoleptic tests have been carried out to determine the color, scent, flavor, and texture of soft candy using the senses of sight (color), smell (nasal), and taste (taste and texture). The organoleptic test was carried out with the help of 20 panelists with a rating scale of 1-6 where 6 (like extremely), 5 (like very much), 4 (like slightly), 3 (neutral), 2 (dislike slightly), 1 (dislike very much) [27].

3 Results and discussion

3.1 Edible film composite of nutmeg pectin and chitosan

The characteristics of the edible film used have a thickness of 0.12 mm. elongation 5.75%, tensile strength 24.84 (KPa) and solubility 99.80%. The packaging method uses edible film, namely cutting the edible film according to the size of the soft candy. The treatment consisted of soft candy coated in edible film and soft candy wrapped up in edible film with plastic candy packaging. Then measurements of water content, hygroscopic and organoleptic properties were carried out.

3.2 Water content and hygroscopic

Water content measurement attempts to determine the water content of the product produced by various treatments so that the product's durability may be estimated. Food quality is affected by its water content. High water content will facilitate the reproduction of bacteria, fungus, and other microorganisms, resulting in chemical alterations (15). Meanwhile, low water content can limit the formation of microbes and physiochemical processes, allowing the material to endure longer (16).

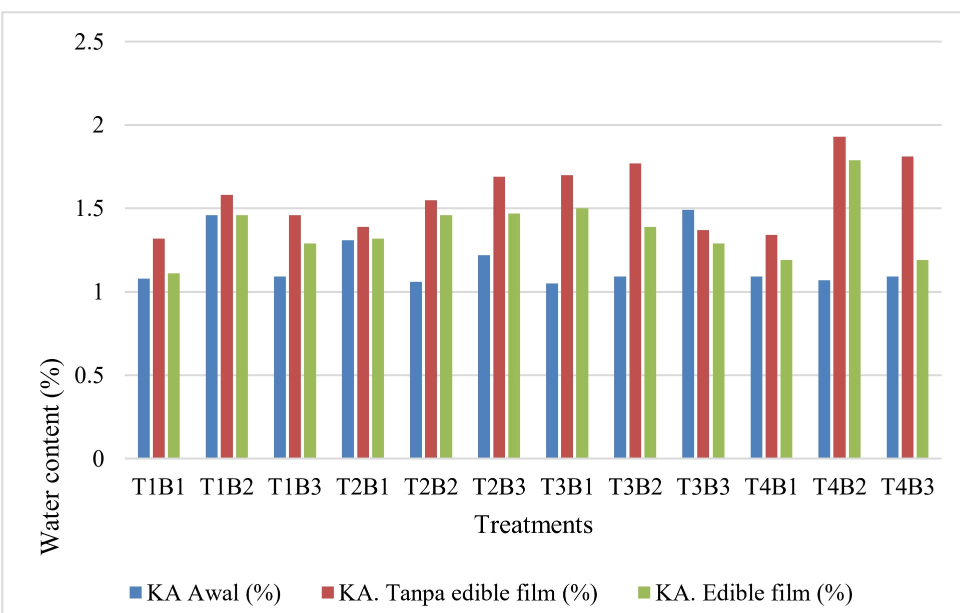

Fig. 1. Moisture content of soft candy after 2 months of storage

In Figure 1, it can be seen that there was an increase in the water content of the soft candy during 2 months of storage. The highest increase in water content was in soft candy that was not coated with edible film. This is because the use of edible film as a soft candy wrapper can act as a moisture barrier between food and the environment [14] causing lower moisture content. Films or coatings made of polysaccharides and proteins are hydrophilic, so they have high water vapor permeability [9].

The addition of 1.8 g tapioca had no significant effect on the end result's water content when 1.2 g, 1.4 g, and 1.6 g were added. Duncan's test at 5% level showed no difference between treatments. The addition of 1.8 g of tapioca did not show a significant effect with the addition of 1.2 g, 1.4 g and 1.6 g of the resulting water content. It can be seen in table 2 for each treatment T1, T2, T3 and T4 has an average water content of 1.0299%, meaning these treatmenst resulting in candy which has low water content and has met the requirements of the 2008 Indonesian National Standard for soft candy with a maximum water content of 7.5%.

In Figure 1, it can be seen that the highest percentage of water content is in sample T4B2 which is 1.93% with a composition of 6.7 s of sliced nutmeg and 1.8 s of tapioca flour for soft candy without edible film. Meanwhile, soft candy coated with edible film has a water content of 1.79%. The moisture content produced is not much different because the candy wrappers used are the same which is OPP plastic with standing pouch packaging and this shows that the composition of sliced nutmeg and tapioca flour does not affect the water content of nutmeg candy because the process of making soft candy is made with the same cooking time and temperature with the same amount of raw materials 30 g of sucrose, 100 g of glucose and 1.5 gr of KCl [4].

3.3 Hygroscopic properties

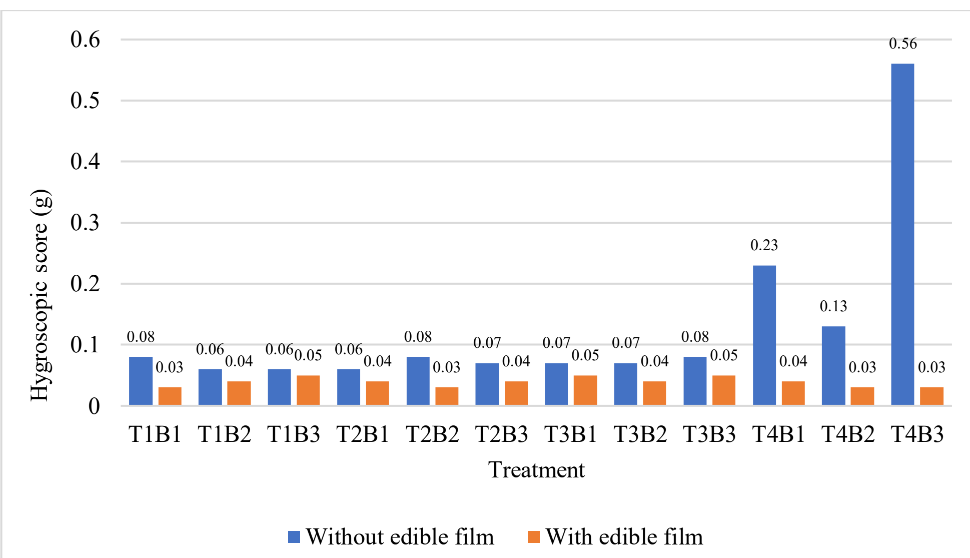

Fig. 2. The effect of using edible film on the hydroscopic soft candy

Sucrose is hygroscopic, meaning that it has the ability to bind water [15]. The hygroscopic nature of sucrose is due to the presence of free and reactive polyhydroxy groups capable of hydrogen bonding with water [16]. Simple sugars have different hygroscopic properties because they are influenced by relative humidity (RH) and ambient temperature. Sucrose has stronger hygroscopic properties than other sugars because it can bind water more strongly.

Hygroscopic tests were carried out on several samples of soft candy which were allowed to stand for 30 minutes, showing that the samples melted, meanwhile soft candy coated with edible film did not melt and there was no change in weight. This indicates that the edible film can protect soft candy from the influence of humidity and ambient temperature. The results of research by [17] that edible films from sweet potato starch with the addition of glycerol and sorbitol can be used as candy wrappers to maintain quality and extend shelf life. However, for long-term storage special packaging for candy is required and secondary packaging to protect it during storage and transportation. Soft candy requires good packaging and storage at the right room temperature. According to [21], edible packaging films have not completely replaced conventional packaging, but it is possible to use edible packaging alongside non-edible packaging as secondary packaging to increase the efficiency of food preservation and protection from the atmosphere, as well as to prevent contamination from microorganisms or foreign objects such as ants.

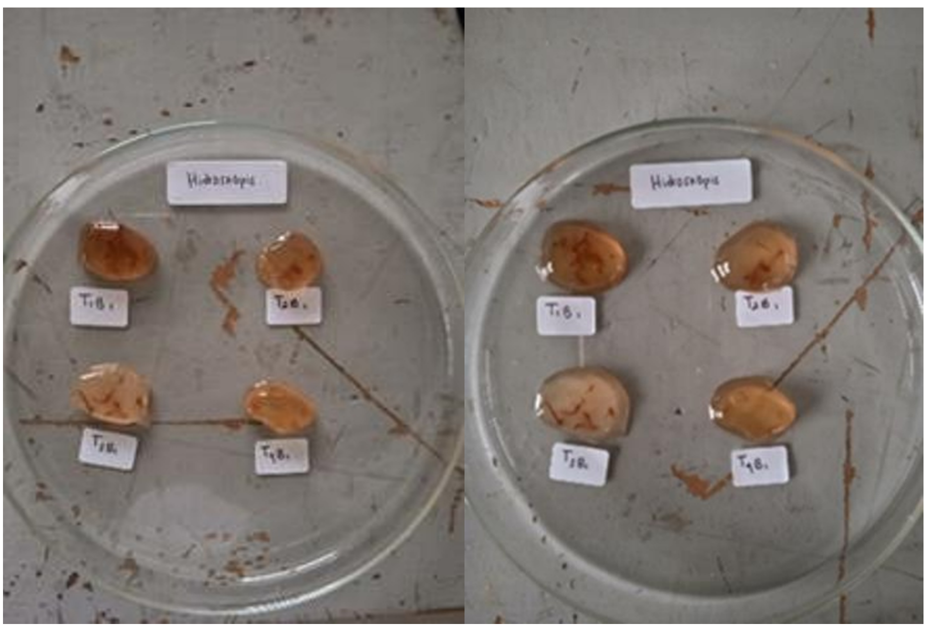

Fig. 3. Before and after picture of soft candy being left for 30 minutes

3.4 The color of soft candy

Color is a visual feature that can attract customers to a product. Color is an important consideration in product development since panelists will rate a new food product based on its visual appeal. Color is one of the visual forms regarded by customers [22]. In general, candy contains a fairly high sweetener. If consumed for a long time can increase the risk of suffering from diabetes and obesity at an early age [18]. This type of product also contains artificial coloring. According to various studies if consume excessively and more than the recommended dietary allowance can cause respiratory problems, allergies, thyroid tumors, chromosomal damage, hyperactivity, and stomach pain [19]. The researchers tried to replace it with natural colors that are generally from colored fruits. The results of research using 5g/100g of pineapple and papaya peel powder contribute to the improvement of color and texture of the candy, also reducing the calorie and adding flavor to the resulting product Because the color of candy is often impacted by the materials used, it is vital to observe the color of soft candy using both sensory and instruments. Sensory testing used human senses (sight, smell, and taste) to influence product acceptance and the decisions of respondents or panelists.

3.5 Color measurement using the royal horticultural society (RHS) color charts

Table 2. Color measurement with RHS color chart

Sample Code	Color	Group	Range
T1B1	Brownish Orange B	N167	4
T1B2	Moderate Orange C	N167	4
T1B3	Moderate Orange Yellow B	164	2
T2B1	Moderate Orange C	N167	4
T2B2	Brownish Orange B	N167	4
T2B3	Moderate Orange Yellow C	165	3
T3B1	Moderate Orange Yellow D	167	4
T3B2	Moderate Orange Yellow C	164	2
T3B3	Moderate Orange Yellow C	164	2
T4B1	Moderate Orange C	N167	4
T4B2	Moderate Yellow A	162	1
T4B3	Pale Yellow D	164	2

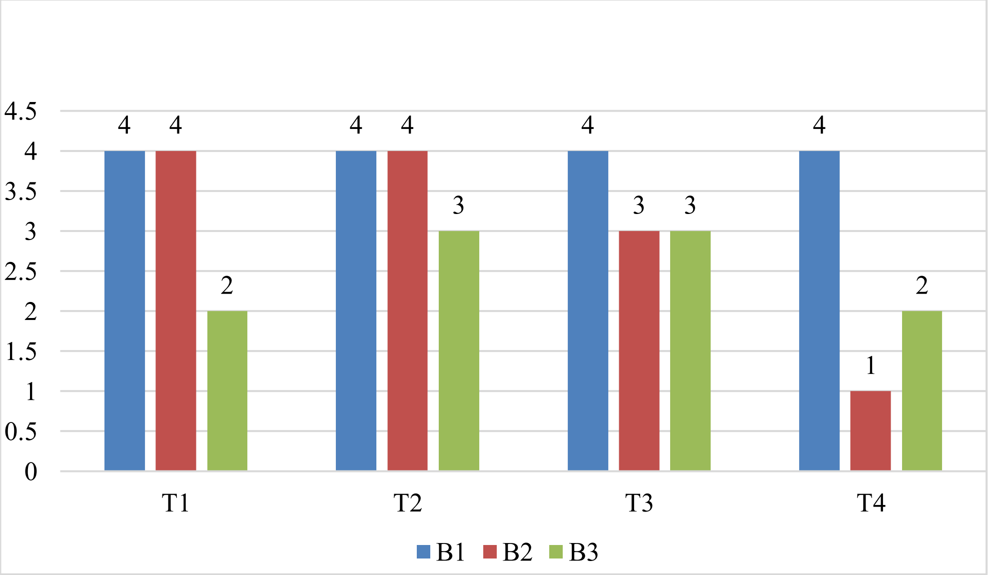

Fig. 4. Color histogram of soft candy using RHS color charts

The SPSS color analysis for soft candy indicated no interaction between tapioca and nutmeg slices, however the addition of tapioca and nutmeg slices showed a difference, requiring Duncan's follow-up test at the 5% level. However, after Duncan's test, it was seen that the addition of sliced nutmeg between treatments had no effect on the color of the resulting soft candy. However, the addition of tapioca showed a difference between B2 and B3 treatments. This is influenced by the concentration of tapioca, the higher the addition of tapioca the lower the color value of the resulting soft candy. This could also be due to the presence of glucose and sucrose which browned when heated at high temperatures and the color of the added nutmeg slices. The highest color value for soft candy can be seen in Table 2, and for more details it can be seen in the RHS Color Charts Histo where there are several

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soft candy samples that have the highest color values including T1B1 and T1B2 with a composition of 7.3 gr of nutmeg slices and 1.2 gr tapioca. T2B1 and T2B2 with a composition of 7.1 gr of sliced nutmeg and 1.4 gr of tapioca. T3B1 with a composition of 6.9 gr of sliced nutmeg and 1.6 gr of tapioca and T4B1 with a composition of 6.7 gr of sliced nutmeg and 1.8 gr of tapioca. The lowest color value is found in the T4B2 treatment with a composition of 6.7 gr of sliced nutmeg and 1.8 gr of tapioca. The same thing was obtained in the organoleptic test (Gambar 4) showing that the lowest color value was found in the T4B2 treatment which was 3.07 (neutral). The highest color value is found in the T1B3 treatment, this was influenced by the addition of small amounts of tapioca and red-brown slices of nutmeg. The reaction between glucose and sucrose with nutmeg slices during the heating process produced a shiny and transparent brownish orange color.

3.6 Soft candy organoleptic test

Panelist preference values for the resulting soft candy such as aroma, taste, texture, Overall Result can be seen in Figure 5 to Figure 8.

3.6.1 Aroma

Aroma is a sensation received by the nose either in the form of a smell or a breath of air that has a certain taste. Aroma can determine the level of consumer preference for a product. Consumers can smell which foods are delicious and which foods are not suitable for consumption based on the aroma they smell [20]. Figure 6 represents the aroma organoleptic test results, which show that the aroma of nutmeg soft candy ranges from 3.35 to 3.95 (neutral) or 3-4 (neutral/like slightly). The highest value for soft candy aroma is found in the T2B1 treatment with the addition of 7.1 g of sliced nutmeg and 1.4 g of tapioca flour. This is because the slices of nutmeg which contain essential oils acts as an aroma enhancers in the soft candy.

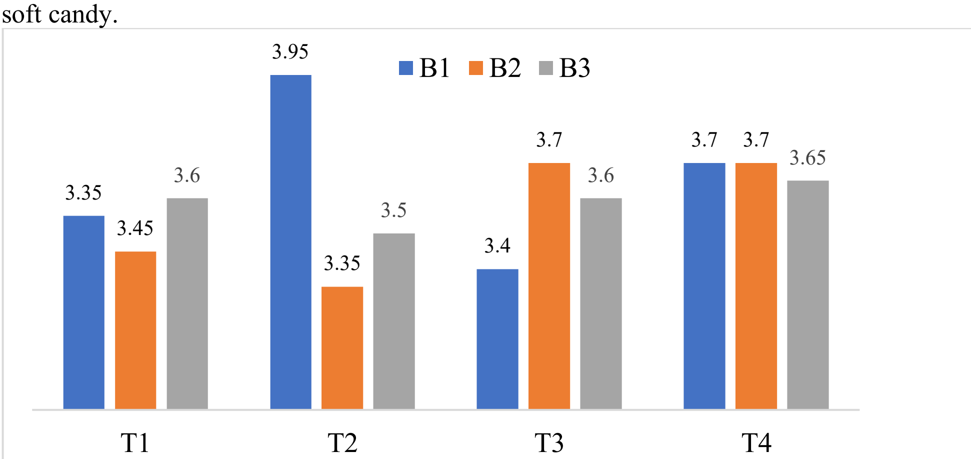

Fig. 5. Histogram of organoleptic test for soft candy aroma

3.6.2 Taste

Taste has an important role in determining the acceptance of a product. The four basic stimuli of taste are typically separated into sweet, sour, salty, and bitter [1]. Taste plays a very important role in food choice. Taste is a reliable determinant of whether or not a product is accepted by consumers. Consumers can determine whether the food is delicious or not when the taste they have tried gives an impression on the consumer, whether the resulting taste gives a good impression or vice versa [20].

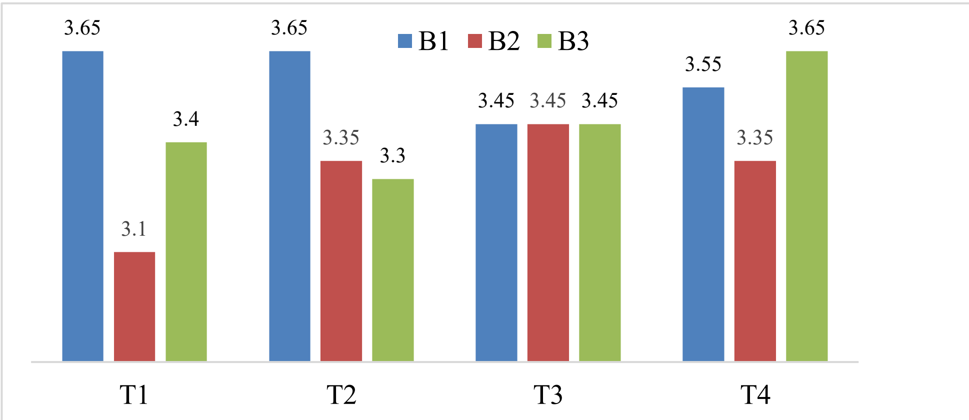

Fig. 6. Histogram of organoleptic test for soft candy taste

The results of the organoleptic test on the taste of nutmeg soft candy can be seen in Figure 7, which shows that the panelists' level of preference for the taste of nutmeg soft candy ranges from 3.35-3.65 (neutral) or 3-4 (neutral/like slightly). The highest organoleptic test for soft candy taste was found in several soft candy samples including T1B1 with a concentration of 7.3 gr of nutmeg slices and 1.2 gr of tapioca, T2B1 with a concentration of 7.1 gr of nutmeg slices and 1.4 gr of tapioca and T4B3 with a 6.7 gr sliced nutmeg and 1.8 gr tapioca. In addition, the taste is also caused by the addition of sucrose and glucose which undergoes caramelization to produce a distinctive aroma that is liked by the panelists.

3.6.3 Texture

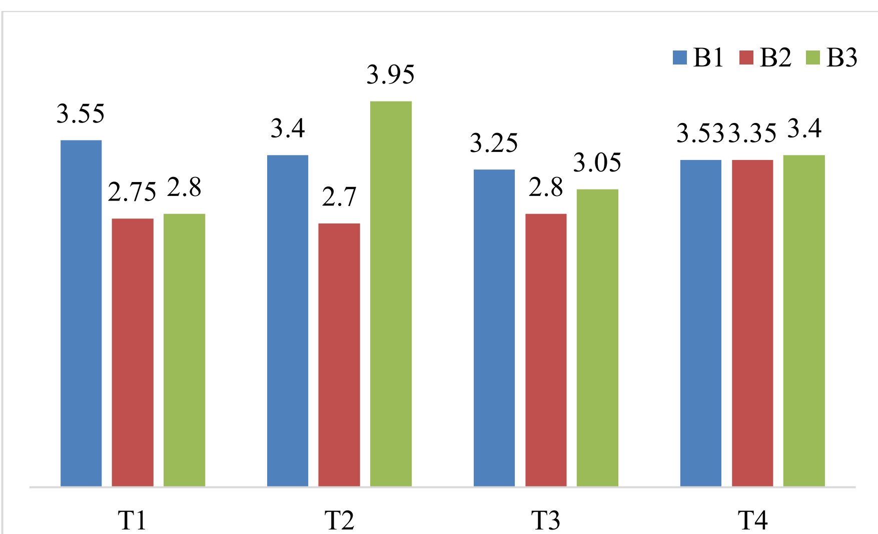

Fig.7. Histogram of Organoleptic Test for Soft Candy Texture

The formation of product texture can be influenced by the addition of sliced nutmeg and tapioca flour to the product. Table 3.6 shows the average results of the organoleptic test on the texture of soft candy, where texture is determined by how soft the candy is. Figure 8 shows that the texture values range from 2.80 - 3.95. The highest texture value was found in the T2B3 treatment with a concentration of 7.1 gr of nutmeg slices and 1.4 gr of tapioca which is 3.95. Soft candy texture is determined by the addition of tapioca and the ratio of sucrose and glucose used. In this study the best texture was obtained with the addition of 1.4 gr tapioca.

3.7 Overall Result

The average results of the organoleptic test on soft candy can be seen in Figure 9, which shows that the panelists overall preference for nutmeg candy ranges from 3.05 (neutral) to 3.70 or 3-4 (neutral - like slightly). The highest overall organoleptic test results is T1B1 treatment with a concentration of 7.3 gr of nutmeg slices and 1.2 gr of tapioca. It can be seen that the panelists prefer soft candy that uses more slices of nutmeg, this is because the nutmeg which has a distinctive taste and aroma causes the panelists to give a high score. According [20] taste is a reliable determinant of whether or not a product is accepted by consumers. Consumers can determine whether the food is delicious or not when the taste gives an impression on consumers, whether the resulting taste gives a good impression or vice versa.

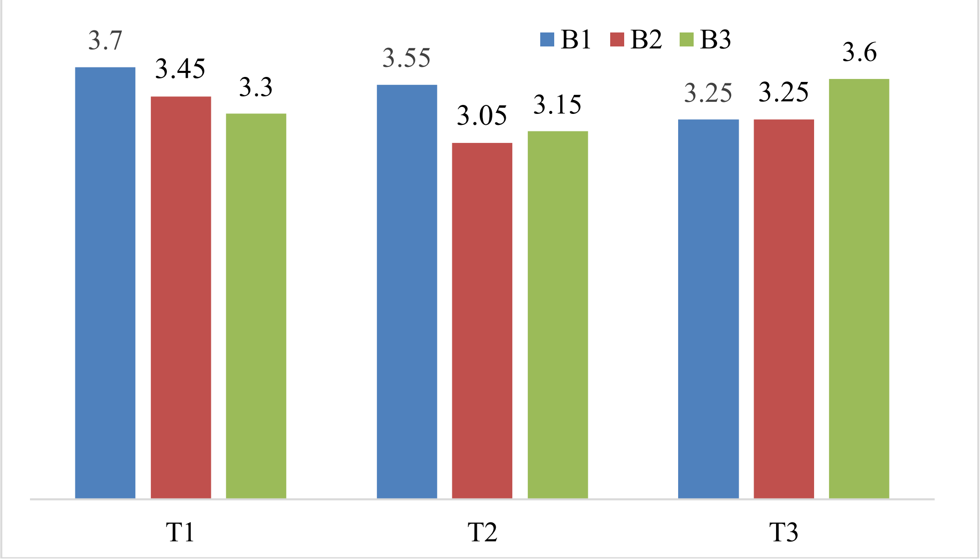

Fig. 8. Histogram of the overall organoleptic test of soft candy

4 Conclusion

Soft candy coated with edible film can maintain the quality where the average water content after 2 months of storage is lower (2.50%) than without edible film (2.91%) and increase the sensory value of neutral soft candy (3) to be somewhat like (4) and can provide convenience for consumers in consuming nutmeg soft candy.

The organoleptic test results of soft candy from nutmeg and tapioca can be accepted by consumers where consumer preferences are neutral (3) – like (4). The best treatment was T4B2 (the composition of sliced nutmeg 6.7 grams and tapioca 1.8 grams) with the lowest water content 1.07%, hygroscopic 0.03% and the highest organoleptic test 4 (like)

Overall soft candy has met the quality standard of soft candy (SNI 3574-2-2008) based on parameters of moisture content and organoleptic properties of normal taste, aroma and texture.

Processed products from nutmeg in the form of soft candy can be an alternative to the utilization of nutmeg flesh which has not been used optimally, so it will have a high selling value if it is developed continuously.

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