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Alginate Addition from Sargassum Seaweed (*Sargassum* sp.) on Pumpkin Ice Cream (*Cucurbita Moschata Durch.*) Characteristics

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ABSTRACT

It is necessary to boost the protein, vitamin C, and calcium content of ice cream by using a variety of flavors. Pumpkin is one of the fruits that has protein. Ice cream is frequently made with CMC, gelatin, sodium alginate, pectin, gum Arabic, and agar as stabilizers. The brown seaweed *sargassum* sp. is one of the sources of sodium alginate that is widely distributed along the coast of West Sumatra province. The goal of the study was to ascertain how adding alginate to pumpkin ice cream affected its quality and to identify the optimal alginate addition that the panelists preferred. The treatment in this study was an alginate stabilizer with concentrations of Treatment A = 0.6%; Treatment B = 0.9%; Treatment C = 1.2%; Treatment D = 1.5%; Treatment E = 1.8%. According to the study's findings, the addition of sodium alginate significantly changes the amount of water, protein, fat, antioxidant activity, overrun, and melting time. The SNI 01-3713-2018 standards for ice cream quality were met by all treatments except for overrun. Based on the results of the organoleptic test, the best treatment was treatment C with the addition of sodium alginate (1.2%) with an average organoleptic 5.61, with a water content value 56,52%, protein content 11.54%, fat content 29.98%, antioxidant activity 54.97%, overrun 17.13%, melting time 34.44 minutes with aroma value 5.75%, color 5.26%, taste 5.89%, and 5.52% texture.

Key words: Ice cream, pumpkin, alginate, Sargassum

INTRODUCTION

According to Achyadi et al. (2020), ice cream is a frozen food product manufactured from pasteurized and homogenized dairy products, sugar, stabilizers, emulsifiers, and other additives. In order to create a volume that gives ice cream its delectable flavor, aromatic aroma, appealing color, and not too dense and soft texture, air spaces must be created in the mixture of components used to make ice cream (Lanusu et al., 2017). Ice cream is increasingly available in a wide range of flavors and presentation styles. Many ice cream vendors include extra ingredients such chocolate, vanilla, strawberries, dragon fruit, pineapple, and pumpkin in order to enhance flavor and the ice cream's performance while also attracting more customers. The research about making ice cream has been done a lot, such as adding green bean flavor to pumpkin ice cream by Budaraga et al. (2016), the addition of dragon fruit ice cream flavor has been done and flavors of kawista fruit ice cream have been made by Manzalina et al. (2019). Adding a variety of flavors to ice cream requires protein, vitamin C, and calcium. One type of fruit that contains protein is pumpkin (Genovese et al., 2022).

The yellow pumpkin (*Cucurbita moschata* Durch) is a plant that is quite common, easy to grow, productive, and low maintenance (Mardhiah, 2020). As a defense against free radicals and cancer, yellow squash contains caroteneprotein, fat, calcium, phosphorus, iron, and vitamins (Lozada et al., 2021). Pumpkinyellow offers numerous health advantages, including boosting kids' appetites, treating high blood pressure, bladder issues, stomach ulcers, brightening dull skin, and getting rid of black spots. Pumpkin can be used to flavor and color ice cream (Prayitno & Rahma, 2019); additionally, because of its soft texture, ease of digestion, and high levels of beta-carotene (provitamin A), pumpkin can also enhance the appeal of food (Sari et al., 2017). Adding a stabilizer is important for manufacturing ice cream.

The final ice cream's quality will be impacted by the stabilizer addition. The use of a stabilizer serves several purposes, including preserving the stability of the emulsion, preventing the growth of large ice crystals, ensuring product consistency, slowing down the melting process, improving the characteristics of the product, and enhancing texture. The fast freezing method can also be used to obtain the ice cream's texture, which results in its tiny, slick, and soft consistency. CMC, gelatin, sodium alginate, pectin, gum arabic, and agar are stabilizers that are frequently used in the production of ice cream (Violisa et al., 2012).

Sargassum sp., a brown seaweed species, is one source of sodium alginate that is widely distributed along the shore (Holinesti et al., 2019). seaweed varieties including *sargassum* sp., *gelidium* sp., *eucheuma spinosum*, and *eucheuma cottoni*.

Brown algae known as *Sargassum* sp. can be found growing alongside the waters of Bungus Padang. How can this trash be used to create selling points given that the existence of this seaweed is frequently disregarded and thought of as garbage that litters the waterways' surface. In addition to having good carbs, *sargassum* sp. also has vitamins, minerals, protein, and necessary amino acids (Utami, 2022). By generating a gel as a result of the extraction of *sargassum* sp., the by-product of *sargassum* sp. can be used in the production of sodium alginate (Mohammed et al., 2020).

D-mannuronic acid and L-guluronic acid are the two monomeric components of the linear copolymer known as sodium alginate. Salts such as calcium, magnesium, sodium, and potassium alginate make up the sodium alginate that is found in the cell walls of brown algae (Fernando et al., 2022). The capacity of sodium alginate to create a gel that reacts with calcium ions is one of the substance's most crucial usage characteristics (Rhein-Knudsen et al., 2017). Typically, calcium carbonate, calcium sulfate, calcium chloride, and calcium phosphate are the sources of calcium. Sodium alginate may create gels and is also employed as an emulsion stabilizer in ice cream, a suspension in chocolate milk, a viscosity regulator in yogurt, and other applications (Rashid, 2005). The impact of adding seaweed as a stabilizer for soy milk ice cream is based on research findings by Violisa et al. (2012), it demonstrates that a 0.5% concentration has the highest quantities of fat, protein, viscosity, and melting time. produces the texture and aroma that are most delicate. The objectives of this study were to ascertain the impact of alginate addition on the quality of pumpkin ice cream and to identify the optimal alginate addition that the panelists preferred.

MATERIAL AND METHODS

From March to April 2023, this study was conducted at the Agricultural Product Technology Laboratory of Ekasakti University in Padang. HCl, Na_2CO_3, NaOCl, isopropyl alcohol, and distilled water are the ingredients used to make alginate. Pumpkin, alginate, coconut milk, skim milk, sugar, whip cream, TBM, and water are required to make ice cream. Analytical balance, watch glass, measuring pipettes, flasks, beakers, cups, funnels, stirring rods, spatulas, PH meters, filter paper, baking sheets, sieves (60 mesh), and basins are the equipment needed to make alginate. Gas burners, pans, analytical scales, spoons, wooden spoons, basins, blenders, freezers, measuring cups, knives, cutting boards, plates, glove bowls, measuring cups, closed containers, and ice cream cups are some of the equipment used to make ice cream. Destruction flasks, Kjeldahl heaters, Soxhlet heaters, electric heating ovens, analytical balances, measuring cups, filter paper, stopwatch fat flasks, micropipette, and desiccator are some of the equipment used in chemical analysis.

In this work, a completely randomized design (CRD) with 5 treatments and 3 replications was employed for the quantitative analytic approach. ANOVA and Duncan's Multiple Range Test (DNMRT) were used to evaluate observational data at the 1% significance level. The treatment in this study was alginate stabilizer with the following concentrations (Mulyani et al., 2017): Treatment A = 0.6%; Treatment B = 0.9%; Treatment C = 1.2%; Treatment D = 1.5%; Treatment E = 1.8%. The formulation for making pumpkin ice cream is based on the formulation made by Budaraga et al. (2016). The formulation for making pumpkin ice cream is presented in Table 1 and Figure 1.

Table 1. Formulation for Making Yellow Pumpkin Ice Cream.

Material	Unit	A	B	C	D	E
Pumpkin	g	62.5	62.5	62.5	62.5	62.5
Alginate	g	0.6	0.9	1,2	1.5	1.8
Coconut milk	g	60	60	60	60	60
Skimmed milk	g	15	15	15	15	15
Sugar	g	62.5	62.5	62.5	62.5	62.5
Whip cream	g	25	25	25	25	25
TBM	g	3	3	3	3	3
Water	g	225	225	225	225	225

Source: Budaraga et al. (2016).

Fig. 1. Appearance of ice cream with 5 treatments.

Fig. 3. Alginate.

Research Implementation

A. Alginate Manufacturing Process (Wathoniyyah, 2016)

1. Brown seaweed species sargassum sp is washed using clean water to remove all adhering dirt as shown in Figure 2 below.
2. Then the brown seaweed is dried in the sun 2-3 days for 7 hours
3. Dried brown seaweed species sargassum sp was weighed as much as 100 g
4. Seaweed soaked in 1% HCl solution for 1 hour
5. Seaweed was washed with distilled water repeatedly until pH 7
6. Then extracted in 5% Na_2CO_3 solution for 2 hours
7. Furthermore, the extract formed was separated with a filter and added 10% HCl to a pH of 2.8-3.2 and produced alginic acid.
8. The alginic acid formed is converted into sodium alginate by adding Na_2CO_3 to pH 7 while stirring.
9. Then 4% NaOCl was added and left to stand until the brown pigment disappeared. The filtrate is poured slowly into isopropyl alcohol to form sodium alginate fibers
10. The fibers formed are then filtered
11. The alginate that has been formed is dried in the sun for ± 5 hours and pulverized with a blender to form a powder.
12. Then 60 mesh was sieved
13. Alginate flour. As shown in Figure 3 below.

Fig. 2. *Sargassum* sp.

B. Making Yellow Pumpkin Puree (Anam and Handajani, 2010)

1. The pumpkin is washed using clean water to remove all the dirt that sticks to the skin.
2. Then the pumpkin is peeled using a manual peeler
3. The peeled pumpkin is then split open and the flesh is separated from the seeds and contents
4. Then it is cut in the form of dice
5. After cutting, it was steamed at 100°C for 15 minutes
6. Then the pumpkin is crushed
7. Yellow pumpkin puree.

C. Making Yellow Pumpkin Ice Cream (Budaraga et al. 2016)

1. Pumpkin, alginate, coconut milk, skim milk, sugar, whip cream, TBM, and water are weighed according to the formulation
2. The mixture was heated to 80°C for 25 seconds while stirring
3. The finished dough is then mixed for 10 minutes
4. The ice cream mixture was then placed in the freezer for 4 hours at 4 °C
5. Then mix again for 10 minutes
6. Put in the freezer for 30 minutes
7. Mix again for 10 minutes
8. Then the ice cream is packed in an ice cream cup, then stored in the freezer and the ice cream is ready to be served.

Observations made on ice cream are: Moisture content (AOAC, 2005), protein content (AOAC, 2005), fat content (AOAC, 2005), antioxidants (Burda & Oleszek, 2001), overrun (Zahro & Nisa, 2015), melting time (Zahro & Nisa, 2015), and organoleptic test (Setianingsih, 2017)

RESULTS AND DISCUSSION

Moisture Content

The findings of the analysis of variance revealed that the addition of sodium alginate changed the moisture content of the pumpkin ice cream in a very significant way (P=0.01). Table 2 displays the typical ice cream water content.

Table 2. Average water content of pumpkin ice cream.

Concentration of sodium alginate (%)	Water content %
A = 0.6	52.64 a ± 0.78
B = 0.9	55.73 b ± 0.41
C = 1.2	56.52 b ± 0.89
D = 1.5	60.45 c ± 1.09
E = 1.8	62.46 d ± 0.41
KK = 1.33%	

Note: The numbers at the same rate are followed by unequal lowercase letters, indicating a highly significant different effect according to the DNMRT test at the 1% level.

Table 2 displays a range of 52.64% to 62.46% for the water content of pumpkin ice cream. Treatment E had the highest water content (62.46%), while Treatment A had the lowest water content (52.64%). A very substantial variation in the water content of pumpkin ice cream was revealed by the DNMRT follow-up test at the 1% level for each treatment. The water content of pumpkin ice cream increases with alginate concentration.

Table 2 also reveals that treatment E's pumpkin ice cream had the highest water content, at 62.46%. The water content of pumpkin ice cream increases with the amount of alginate added. This is due to alginate capacity to absorb water from meals. Hygroscopic sodium alginate can result in alginate having a high water content (Diharningrum & Husni, 2018). Koesoemawardani (2016) asserts that sodium alginate has a wide range of uses due to its capacity to bind water. Because sodium alginate is a linear polymer with a high molecular weight, it rapidly absorbs water. According to research by Yufidasari et al. (2018), alginate at concentrations of 0%, 0.75%, and 1% can also absorb water by forming a gel because the polysaccharide gel will form a hydrogen bridge that will trap the water in it. As a result, the water present in snakehead fish meatball products will be trapped in the alginate matrix. Ice cream must have a minimum water content of 55% in order to be of high quality, pumpkin pumpkin ice cream's water content satisfies the benchmark.

Protein Content

The difference in alginate addition had a highly significant (P=0.01) impact on the protein content of pumpkin ice cream, according to the results of the analysis of variance. Table 3 displays the typical protein level of pumpkin ice cream.

Table 3. The average protein content of pumpkin ice cream.

Concentration of alginate (%)	Protein content %
A = 0.6	9.01 a ± 0.12
B = 0.9	9.45 b ± 0.13
C = 1.2	11.54 c ± 0.13
D = 1.5	15.56 d ± 0.12
E = 1.8	18.32 e ± 0.22
KK = 3.75%	

Note: The numbers at the same rate are followed by unequal lowercase letters, indicating a highly significant different effect according to the DNMRT test at the 1% level.

The protein composition of the produced pumpkin ice cream ranges from 9.01% to 18.32%, according to Table 3. Treatment E had the highest protein content (18.32%), while treatment A had the lowest protein level (9.01%). It was determined that there was a very substantial difference in the protein content of pumpkin ice cream based on the DNMRT follow-up test at the 1% level for each treatment. The protein content of pumpkin ice cream increases with the amount of alginate that is added to it.

Table 3 further demonstrates that the addition of alginate concentration increased the protein content of the pumpkin ice cream. This is because alginate, used in a variety of drug delivery applications or other bioactive ingredients, protects the protein matrix. Proteins can be protected from degradation by hydrogels made of alginate, which keeps them functional and active. When maintaining cell cultures or in other environments, alginate helps keep proteins stable and intact. The use of alginate as an adjuvant to shield, transport, or precipitate proteins in diverse industrial and biological applications is the main aspect of the interaction between alginate and protein. Protein stability can be maintained using a matrix made of sodium alginate (Puscaselu et al., 2020).

The protein level of Sargassum crassifolium talus is 3-9% of fresh weight, while that of red and green seaweed is 6-20% of fresh weight, according to research by Handayani et al. (2004). Alginate is only one source of protein utilized in pumpkin ice cream; other sources include pumpkin, coconut milk, skimmed milk, and whip cream. According to Oksilia et al. (2012), ice cream's high protein content plays a significant influence in flavor development, nutritional value, and the development of soft ice cream.

Protein ingredients in the production of ice cream, according to research by Failisnur (2013), serve to stabilize fat emulsions after the homogenization process, add flavor, aid in foaming, increase and stabilize water holding capacity, which affects the thickness and texture of soft ice cream and can also raise the overrun value of ice cream. All treatments have a minimum 2.7% protein content, which satisfies the standards for quality established by SNI 01-3713-2018.

Fat Content

The difference in sodium alginate addition had a highly significant (P = 0.01) impact on the fat level of pumpkin ice cream, according to the results of the analysis of variance. Table 4 displays the typical fat content of pumpkin ice cream.

Table 4. Average fat content of pumpkin ice cream.

Concentration of alginate (%)	Fat level %
A = 0.6	25.12 a ± 0.45
B = 0.9	27.40 b ± 0.77
C = 1.2	29.98 c ± 0.97
D = 1.5	30.67 c ± 0.56
E = 1.8	33.56 d ± 0.42
KK = 2.27%	

Note: The numbers at the same rate are followed by unequal lowercase letters, indicating a highly significant different effect according to the DNMRT test at the 5% level.

Table 4 demonstrates that the generated pumpkin ice cream has a fat level that ranges from 25.12% to 33.56%. Treatment E had the highest fat content (33.56%), while Treatment A had the lowest fat content (25.12%). A very substantial difference in the amount of fat in pumpkin ice cream was revealed by the DNMRT follow-up test at the 1% level for each treatment. The amount of alginate used affects the amount of fat in pumpkin ice cream. fat content of pumpkin ice cream.

Table 4 also shows that the value of the fat content of the pumpkin ice cream increased as the concentration of alginate was increased. The introduction of alginate, a substance that can be used as a fat substitute, has increased the amount of fat in pumpkin ice cream. To give low-fat sauces and salad dressings a fat-like texture and thickness without significantly increasing the fat content, sodium alginate can be added.

This is in line with Nisak's (2015) research, which found that adding sodium alginate to biscuits' fat content resulted in a positive linear relationship. The use of white butter, which has a rather high fat level, in the production of these biscuits is regarded to be the cause of the increase in their fat content. In contrast to sodium alginate, which has a fat content between 0.119 and 0.129%, according to the findings of the study Srikandi et al., (2013), the fat content of Ca-alginate isolates increased with the length of the deposition process in $CaCl_2$ solution.

According to Srikandi et al. (2013), fat is a non-polar substance that disintegrates easily in non-polar solvents like n-hexane, chloroform, and ether. Because Ca-alginate is nonpolar in nature and insoluble in water, which results in a high fat content, it is assumed that the Ca-alginate isolate dissolves in the n-hexane solvent used. According to Shoheh et al. (2018), the fat level of ice cream influences the air capture process, which in turn impacts the ice cream's softness, overrun, and melting point. All treatments have a minimum fat content of 5.0%, which satisfies the quality standards established by SNI 01-3713-2018.

Antioxidant Activity

The findings of the analysis of variance revealed a highly significant (P = 0.01) relationship between the variation in the addition of sodium alginate content and the antioxidant activity of pumpkin ice cream. Table 5 displays the typical antioxidant activity of pumpkin ice cream.

Table 5. Average antioxidant activity of pumpkin ice cream.

Concentration of alginate (%)	Antioxidant activity %
A = 0.6	52.82 a ± 0.40
B = 0.9	54.26 a ± 1.09

C = 1.2	54.97 a ± 0.84
D = 1.5	57.79 b ±0.84
E = 1.8	58.73 b ± 1.68
KK = 1.90%	

Note: The numbers at the same rate are followed by unequal lowercase letters, indicating a highly significant different effect according to the DNMRT test at the 1% level.

The antioxidant activity of the resulting pumpkin ice cream ranged from 52.82% to 58.73%, according to Table 5. Treatment E had the highest antioxidant activity at 58.73%, while Treatment A had the lowest antioxidant activity at 52.82%. Based on the DNMRT follow-up test at the 1% level of each treatment, it was determined that pumpkin ice cream had a significantly different impact on antioxidant activity. The amount of antioxidant activity increases with the sodium alginate concentration in pumpkin ice cream. Pumpkin ice cream's amount of antioxidant activity.

Table 5 also demonstrates that the addition of alginate concentration increased the antioxidant activity of the pumpkin ice cream. In the production of processed foods like sauces, jams, and bakery items, sodium alginate can be employed as a stabilizer and binder. Alginate can bind to heavy metal ions in food during food preparation, preventing the metal ions' ability to cause oxidative damage. By lowering oxidation and raising the levels of antioxidants, sodium alginate can help maintain food quality (Wang et al., 2020). Brown seaweed called Sargassum duplicatum has the ability to act as an antioxidant since it includes active ingredients like fucoidan and phenolic components. Phlorotannin, which has a concentration range of 0.74–5.06% in brown seaweed, is the sort of phenolic compound that is frequently discovered there (Septiana et al., 2013). Cahyaningrum et al. (2016) claim that phenol is a substance with a hydroxyl group that has the capacity to transfer its hydrogen in order to be stabilized by resonance in the phenolic structure, allowing this substance to act as an antioxidant. Antioxidant activity and total phenolic content are directly inversely correlated, meaning that antioxidant activity increases with increasing phenolic concentration. Pumpkin and other components, such as sodium alginate, also include antioxidant properties.

According to Sangkala et al. (2014), pumpkin contains α-carotene, β-carotene, lutein, zeaxanthin. The beta carotene content is 6.9 mg per 100 grams. As an antioxidant, beta carotene has the potential to be very helpful in keeping carbon-nucleated radicals stable. According to Dhiyas et al. (2016), beta carotene activity can stop cholesterol or plaque buildup in blood vessels. According to studies, pumpkin ice cream has higher antioxidant levels the more alginate is utilized.

Overrun

The analysis of variance data revealed that the variation in sodium alginate addition had a highly significant (P=0.01) effect on pumpkin ice cream overrun. Table 6 shows the average overrun of pumpkin ice cream.

Table 6. Average overrun of pumpkin ice cream.

Concentration of alginate (%)	Overrun %
A = 0.6	21.07 e ± 0.07
B = 0.9	19.06 d ± 0.03
C = 1.2	17.13 c ± 0.05
D = 1.5	15.54 b ± 0.09
E = 1.8	13.15 a ± 0.06
KK = 0.37%	

Note: The numbers at the same rate are followed by unequal lowercase letters, indicating a highly significant different effect according to the DNMRT test at the 1% level.

Table 6 indicates the percentage of pumpkin ice cream created that was overrun, which ranged from 13.15% to 21.07%. Treatment A had the biggest overrun of 21.07%, while treatment E had the lowest overrun of 13.15%. The DNMRT follow-up test revealed a significant difference in the effect on pumpkin ice cream overrun at the 1% level of each treatment. The higher the alginate percentage in pumpkin ice cream, the lower the overrun content.

Table 6 further reveals that the increase of alginate concentration reduces pumpkin ice cream overrun. The higher the concentration of alginate added, the less overrun in pumpkin ice cream. The process of raising the volume of pumpkin ice cream is primarily determined by two factors: agitation and freezing. When the ice cream mixture is vigorously beaten or mixed, air is trapped inside. This results in the development of microscopic air bubbles, which contribute to the overall volume of the ice cream. The freezing process subsequently solidifies the ice cream's structure, keeping the trapped air inside. In ice cream, alginate functions as an emulsifier and stabilizer. This suggests that alginate aids in the stability of dough and inhibits phase separation (Hasibuan, 2022).

According to Oksilia et al. (2012) research, the more alginate added to ice cream, the lower the overrun value. The decrease in overrun value is produced by the hydrophilic character of seaweed, which may bind water; the higher the water holding capacity, the thicker the dough becomes, allowing only a small amount of air to enter the dough (Filiyanti et al., 2013). Thick ice cream dough makes it difficult for air to enter, resulting in no increase in ice cream volume or less overrun. The thick dough will result in low overrun since the dough has difficulties expanding and air cannot permeate the surface of the dough.

Quality ice cream has an overrun of 70-80%, whereas domestic industries have an overrun of 35-50%. In contrast to processed ice cream from the factory, which has a high overrun value due to the process of pumping air into the dough, the low value of ice cream overrun in this study (less than 35-50% for home industry scale), is thought to be the cause in the mixing study using only a mixer, making air capture in the ice cream mixture not optimal, so that the ice cream becomes too hard. According to Failisnur (2013), sluggish stirring causes small air spaces to emerge, preventing the volume of the ice cream from increasing and the overrun value from increasing.

Melting Time

The findings of the diversity analysis revealed that the amount of sodium alginate added had a highly significant (P = 0.01) effect on the melting time of pumpkin ice cream. Table 7 shows the typical melting time of pumpkin ice cream.

Table 7. Average melting time of pumpkin ice cream.

Concentration of alginate (%)	Melting time (min)
A = 0.6	29.97 a ± 0.75
B = 0.9	32.17 b ± 0.09
C = 1.2	34.44 c ± 0.12
D = 1.5	36.15 d ± 0.05
E = 1.8	40.14 e ± 0.06
KK = 3.06%	

Note: The numbers at the same rate are followed by unequal lowercase letters, indicating a highly significant different effect according to the DNMRT test at the 1% level.

The melting times are shown in Table 7. The longest melting time was 40.14 minutes in treatment E, while the shortest was 29.97 minutes in treatment A. The resulting ice cream melting time range pumpkin is 29.97-40.14 minutes. The DNMRT follow-up test at the 1% level for each treatment revealed a very substantial difference in pumpkin ice cream melting time. The more alginate that is added to pumpkin ice cream, the longer it takes to melt.

Table 7 further reveals that the addition of sodium alginate concentration increases the melting time of pumpkin ice cream. When hydrated, sodium alginate is a hydrophilic polymer that can create hydrogels. Sodium alginate melting time refers to the temperature at which solid sodium alginate softens and transforms into a softer or liquid hydrogel form. This occurs because the structure of the sodium alginate polymer decomposes and dissolves in water as the temperature rises. Several factors influence the melting time of sodium alginate, including the kind of sodium alginate, the concentration of sodium alginate in solution, and the temperature. The physical and chemical properties of sodium alginate vary, which can affect their melting time. Furthermore, the higher the concentration of alginate in solution (Hasibuan, 2022), the higher the concentration of sodium alginate in solution.

Melting time is proportional to the degree of overflow. Because high overrun has a distinct heat transfer rate due to the presence of significant amounts of air, which speeds up the rate of heat transmission to the ice cream (Faridah et al., 2023), the greater the overrun, the faster the ice cream will melt. Melting time for all treatments fulfills SNI 01-3713-2018 criteria for ice cream with good melting quality in 15-25 minutes at room temperature.

Organoleptic

An organoleptic test is one of the variables that determines a product's quality and consumer approval. The organoleptic test was performed using sensory assessment, which included tasting the ice creampumpkin and analyzing its color, aroma, and texture. This test was conducted using ice creampumpkin prepared according to the treatment formulation. 25 untrained panelists were put through the test.

1. Aroma

The delicacy of a food is determined by its fragrance. The assessment of a food's scent is inextricably linked to the function of the sense of smell. The fragrance perceived by the nose and brain is usually a combination of the four basic aromas, which are aromatic, sour, rancid, and burnt (Winarno, 2012). Table 8 shows the results of the panelists' evaluations on the aroma of pumpkin ice cream.

Table 8. Pumpkin ice cream aroma test values.

Addition of alginate(%)	Aroma	Information
A = 0.6	5.21	Likes
B = 0.9	5.38	likes
C = 1.2	5.75	Much likes
D = 1.5	5.26	likes
E = 1.8	4.10	Kinda like

Notes: taste scores include 7 = strongly like, 6 = much like, 5 = like, 4 = kinda like, 3 = dislike, 2 = much dislike, 1 = strongly dislike.

Table 8 shows the panelists' maximum assessment of the aroma of ice creampumpkin found in treatment C (1.2%), which is 5.75 (much like), and the lowest rating of ice creampumpkin found in treatment E (1.8%), which is 4.10 (somewhat like). Because sodium alginate has no scent or is neutral, its addition has no influence on the aroma. Alginate's aroma association is more closely tied to its action as a binder or stabilizer in food compositions. Sodium alginate can be used to assist keep food products stable and texture, which can alter taste and scent. In general, sodium alginate does not transfer aroma, however its usage in food manufacturing can improve the taste and aroma of the finished product. The distinctive aroma associated with food or drink, on the other hand, is not directly tied to sodium alginate as a raw material.

Panelists like pumpkin ice cream with a pronounced milk aroma, which occurs as a result of the addition of skimmed milk and whip cream to the dough when preparing pumpkin ice cream. Because the ratio of seaweed flour to combined components is higher, the aroma of seaweed is muffled. Because more milk is used than other combined raw materials, the aroma created comes from the milk raw material used. According to studies (Hartie, 2011), the aroma of ice cream can be changed by substances with a higher concentration, specifically milk.

2. Color

Color is a crucial factor in satisfying human taste; if it has an unappealing color, it gives the idea that the food product has strayed (Winarno, 2012). Table 9 displays the findings of the panelists' color rating of the pumpkin ice cream.

Table 9. The average color value of pumpkin ice cream.

Addition of alginate(%)	Color	Information
A = 0.6	5.29	Much likes
B = 0.9	5.28	likes
C = 1.2	5.26	likes
D = 1.5	5.18	likes
E = 1.8	5.02	likes

Notes: taste scores include 7 = strongly like, 6 = much like, 5 = like, 4 = kinda like, 3 = dislike, 2 = much dislike, 1 = strongly dislike.

Table 9 reveals that treatment A (0.6%) received the highest rating for the color of pumpkin ice cream from the panelists, namely 5.29 (Much like). Treatment E (1.8%) received the lowest rating for pumpkin ice cream, namely 5.02 (Likes). The presence of sodium alginate can influence the amount of desire for color characteristics. The addition of sodium alginate to pumpkin ice cream can diminish the preference rating for the hue. The properties of sodium alginate in creating hydrogels are similar to sodium alginate with color. To make sodium alginate hydrogels, combine sodium alginate with a calcium salt solution. The color connection of sodium alginate is connected to its capacity to generate colorful hydrogels and its application in textile dyeing procedures. The look of sodium alginate, which tends to be yellowish-white in color, such that the more sodium alginate is added, the more the color of pumpkin ice cream with a strong yellow color fades and the level of desire decreases. The color of food products is determined by the ability of food products or food ingredients to reflect, scatter, absorb, and transmit visible light.

According to Dharmayanti et al., (2021), the addition of a higher concentration of sodium alginate affected the appearance and color, causing the color to be duller white, whereas the panelists preferred the 0.75% treatment for appearance and color parameters because the color was more glossy white. Color has a significant meaning and role in food commodities and other agricultural products, according to Tarwendah (2017). Color can assess the quality of food ingredients used as an indicator of freshness, as well as whether or not the mixing and processing procedure is good. Color in food can be created by a variety of factors, including pigments, the effect of heat on sugar, and the reaction of sugar and amino acids. Color is used to identify the quality of a food item because it shows first and sometimes impacts the quality of the dish (Winarno, 2012).

3. Flavor

Taste is a stimulation created by the components consumed, particularly as perceived by the sense of taste. The most essential factor in consumer acceptance of a product is its taste. Table 10 displays the results of the panelists' evaluations of the flavor of pumpkin ice cream.

Table 10. The average value of pumpkin ice cream flavors.

Addition of alginate(%)	Flavor	Information
A = 0.6	6.04	Much likes
B = 0.9	5.21	likes
C = 1.2	5.89	likes
D = 1.5	5.95	likes
E = 1.8	4.42	Kinda like

Notes: taste scores include 7 = strongly like, 6 = much like, 5 = like, 4 = kinda like, 3 = dislike, 2 = much dislike, 1 = strongly dislike.

Table 10 shows the panelists' highest rating of the taste of pumpkin ice cream in treatment A (0.6%), which was 6.04 (much like). Treatment E (1.8%) had the lowest rating from panelists for the taste of pumpkin ice cream, namely 4.42 (Kinda like). Ice cream's flavor is a combination of taste and fragrance. Sugar, alginate stabilizer, and nonfat dry matter all have an impact on the quality and taste of ice cream. Sugar improves texture, increases thickness, and imparts a sweet taste (Hartie, 2011).

Alginate is frequently used in the sferification process. Sferification is a process used to create a unique flavor sensation in food. When sodium alginate is added to the ice cream mix, it aids in the management of water loss and the formation of a gel network, which prevents textural changes and melting of the ice cream as it melts. Because of the more cohesive and creamy quality and texture of ice cream, this can impact the taste experience. However, sodium alginate does not have a strong or distinguishing flavor. The flavor of foods containing sodium alginate is determined by the other components included in the recipe. Sodium alginate is more important in establishing the texture, look, and sensations in the mouth that influence how we taste and enjoy food.

The addition of sodium alginate has no influence on flavor since sodium alginate has tasteless or neutral properties (Violisa et al., 2012). Sweet was the panelists' favorite flavor. Sweet flavor is usually present in sugar-containing items and influences the panelists' degree of preference (Mulyani et al., 2017). Giving sodium alginate to ice cream thickens it, which impacts consumer approval of the mouthfeel (melting taste as ice cream is ingested). According to Syafarini (2009), sodium alginate binds water molecules in ice cream, making the ice particles smaller and less visible by the tongue when the ice cream is eaten.

4. Texture

Texture is a sensory characteristic that refers to a product's hardness and softness. Table 11 shows the results of the panelists' evaluations on the aroma of pumpkin ice cream.

Table 11. The average texture value of pumpkin ice cream.

Addition of alginate(%)	Texture	Information
A = 0.6	5.15	likes
B = 0.9	5.28	likes
C = 1.2	5.52	likes
D = 1.5	5.58	likes
E = 1.8	5.63	Much likes

Notes: taste scores include 7 = strongly like, 6 = much like, 5 = like, 4 = somewhat like, 3 = dislike, 2 = much dislike, 1 = strongly dislike.

Table 11 shows that the panelists' highest rating for the texture of pumpkin ice cream was 5.63 (Much like) in treatment E (1.8%). Treatment A (0.6%) had the lowest rating for pumpkin ice cream texture, precisely 5, 15 (Likes). With the use of alginate, the preference value for the texture of pumpkin ice cream can be increased. In terms of texture, sodium alginate is commonly employed in the food business as a thickener, stabilizer, and gelling agent. The capacity of sodium alginate to create a gel when reacting with calcium ions is unique. Cross-links form between sodium alginate chains when exposed to calcium ions, resulting in a stable gel structure. The process of gelling sodium alginate with calcium ions is frequently utilized in sferification, a procedure in which liquid substances such as sauces, juices, or purees are added to a sodium alginate solution and subsequently dripped into a calcium solution. As a result, a gelatinous ball with a distinct texture dissolves in the mouth.

Sodium alginate is also utilized in the production of hydrogels, which are used in a variety of biomedical applications such as wound dressings, drug delivery systems, and tissue regeneration. The properties of sodium alginate hydrogels can be altered to manage their texture, strength, and water absorption. In general, sodium alginate shapes and modifies food textures and has numerous applications in the food and biomedical industries (Syafarini, 2009).

CONCLUSION

The addition of alginate had highly significant different effects on water content, protein content, fat content, antioxidant activity, overrun, melting time. All treatments met the ice cream quality requirements set by SNI 01-3713-2018 except for overrun.

Based on the results of the organoleptic test, the best treatment was treatment C with the addition of sodium alginate (1.2%) with an average organoleptic 5.61, with a water content value56,52%, protein content 11.54%, fat content 29.98%, antioxidant activity 54.97%, overrun 17.13%, melting time 34.44 minutes with aroma value 5.75%, color 5.26%, taste 5.89%, and 5.52% texture.

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