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Effects of Various Hydrocolloids on Physical, Sensory and Total Quality of Lactic Acid Bacteria on Frozen Yogurt with Corn Oil as Fat Sources

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Abstract

This study aims to determine the effect of various hydrocolloid on the quality of frozen yogurt with corn oil as its fat sources The ingredients used in this work were skim milk, corn oil, yogurt starter, arabian gum, carrageenan, gelatin, water and sugar. The different types of hydrocolloids T0 (0%), T1 (0.5% Arabian gum), T2 (0.5% carrageenan), T3 (0.5% gelatin) were used as stabilizer in order to characterize the pH, overrun, melting time, sensory test and total lactic acid bacteria of frozen yogurt product. pH of frozen yogurt was measured using a pH meter. Melting time was measured using a stopwatch, overrun was measured using beaker glass, sensory tests were done by panelists and total lactic acid bacteria was measured by Total Plate Count (TPC). Results show significant differences ($P<0.05$) on overrun, melting time, sensory test in frozen yogurt obtained using various types of hydrocolloids but show no significant differences ($P>0.05$) on pH dan total lactic acid bacteria. The best treatment was the addition of 0.5% gelatin because it has an optimal melting time, overrun and highest sensory test.

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Introduction

Frozen yogurt has a physical form like ice cream so that it has its own charm. Basically, the process of making frozen yogurt consists of a combination of the process of making plain yogurt and ice cream and the method of frozen yogurt that is plain yogurt, emulsifying, stabilizing, sugar and flavor then the mixture is frozen while continuing to be rotated in a container (Septiani et al., 2013). Frozen yogurt is not always made from animal fat but can also come from vegetable fat, that can be used as ingredients is corn oil. Frozen yogurt made from vegetable fat will make the melting time faster so that the addition of hydrocolloid ingredients is needed. Hydrocolloid is a polysaccharide that has high commercial value and has various benefits, including emulsifiers, gelling, and water-retention (Nussinovitch, 2013). Several types of hydrocolloids, such as carrageenan, Arabic gum, and gelatin, are widely used in the food industry as a thickening, emulsifying, and stabilizing agents. The use different types of hydrocolloid ingredients as a stabilizer will get the appropriate type of stabilizer and has the characteristics of frozen yogurt that has a soft texture, long-lasting tray and is accepted by the public.

Therefore, this research was done to evaluate the effect of hydrocolloid on the quality of frozen yogurt corn oil based on pH, overrun, melting time, sensory test and total lactic acid bacteria. This research may provide beneficial information to get an appropriate of hydrocolloid type that has characteristics that are soft texture, long-lasting tray and can be accepted by the public.

Materials and Methods

Materials

The materials used were skim powder, whipping cream, corn oil, gum arabic powder, gelatin powder, sugar, yogurt starter, water. The equipment used were ice cream maker (ICM), mixer, freezer, measuring instrument (scale and measuring cups), basin, spoon, cup, pan, stove.

Method

This research was conducted in December 2019 at the Laboratory of Food Chemistry and Nutrition and the Laboratory of Food Engineering and Agricultural Products, Faculty of Animal Husbandry and Agriculture, Diponegoro University, Semarang, and UPT Integrated Laboratory of Diponegoro University, Semarang.

The process of making frozen yogurt corn oil refers to Legowo et al. (2009). Skim milk powder, corn oil, sugar, and water are stirred until homogeneous and pasteurized at 70℃ for 5 minutes, then allowed to stand at 40℃. Inoculation with starter culture was 5% of the volume of frozen yogurt dough (density≥107 CFU/ml). The mixture was placed in a sterile container and then covered with aluminum foil and then incubated at 41ºC for 5 hours. Whipping cream was mixed with hand mixer for 10 minutes until fluffy. Arabic gum, carrageenan, and gelatin were dissolved in water at 50℃. Frozen yogurt mixture was added with a hydrocolloid according to the formula, T0 (without hydrocolloid), T1 (arabic gum 0,5%), T2 (carrageenan) and T3 (gelatin 0,5%) then mixed using a hand mixer until homogenous for 10 minutes. Subsequently, dough was subjected into the aging process in the refrigerator at 0°C - 4°C for 2-3 hours. The frozen yogurt dough was re-homogenized with 2-speed mixer for 5 minutes to homogenize the size of the fat globule. The frozen yogurt mixture put into the frozen yogurt maker for ± 30 minutes for foaming and uniform size of the crystals that are formed. Frozen yogurt is packaged in a cup and close tightly then stored in froze at a tempeteratur ± -18ºC for 24 hours.

pH meter was used to measured pH (Septiani et al., 2013). Beaker glass and analytic scales was used to measured overrun (Susilawati et al., 2014). Stopwatch was used to measured melting time (Zahro and Nisa, 2015). The sensory quality test were tested by twenty-five panelists. Total Plate Count (TPC) was used to measured total test of Lactic Acid Bacteria (BAL) (Hidayat et al., 2013).

Data obtained from the pH, overrun, melting time and Total lactic acid Bacteria (BAL) were analyzed with normality tests to find out the data are normally distributed, and statistically analyzed using Analysis of Variance (ANOVA) with a significance level of 5% and and if there are differences followed by Duncan tests to determine the difference between treatments. Sensory test data were analyzed with the Kruskal-Wallis Test and if there was an effect further testing was done using the Mann Whitney U Test. Test using SPSS 26.0 application.

Results and Discussion

pH

Figure 1(a) shows that the different types of hydrocolloids had no significant effect ($p>0.05$) on the pH of the frozen yogurt. Yulistiani et al. (2013) stated that some hydrocolloids have neutral properties so it did not affect the pH value. Good frozen yogurt has a pH range from 4.5 to 5.5. Legowo et al. (2009) stated that good frozen yogurt is around 4.5-5.5 because at that pH can inhibit the growth of pathogenic bacteria so it is good for consumption. The results of this study are by the good pH of frozen yogurt, which range from 4.41 to 4.51. According to Suyadi et al. (2012) the longer for fermentation process, the more acid will be produced and the process of decreasing the pH can occur from the beginning of the fermentation caused by the formation of acids during the fermentation process.

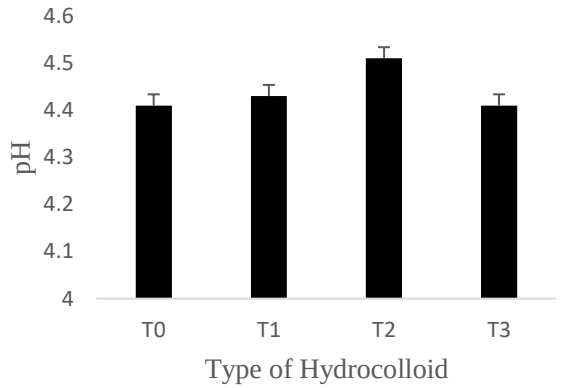

Figure 1. pH of frozen yogurt made of corn oil using difference types of hydrocolloid (Arabic gum, carrageenan, gelatin). The superscript shows significantly difference using Duncan's Multiple Range Test.

Overrun

Figure 2 shows that the different types of hydrocolloids had a significant effect ($p<0.05$) on the overrun of the frozen yogurt. The used of Arabic gum gets the lowest yield of 40.83%, it shows that the narrow space between particles causes the air to enter the dough during agitation less and less. Djajati and Palupi (2018) stated that the result overrun value is lower when the space between particles becomes narrower which causes air to enter the dough during agitation less. Standard overrun frozen corn oil yogurt is racing against the standard overrun of ice cream. According to the Indonesian National Standard (1995) that is for the large-scale industry is 70-80% while for household-scale is 30-50%. Frozen yogurt with the addition of Arabic gum, carrageenan, and gelatin will get a lower overrun compared to frozen yogurt that is not added hydrocolloid as a stabilizer. Pramono et al. (2014) stated that the stabilizing agent is hydrocolloid and can thicken the ice cream mixture so that the ice cream overrun decreases with the addition of many stabilizers. The overrun value will be related to the melting time due to the number of solids in frozen yogurt. Mulyani et al. (2020) stated that the decline in the capture of air can cause ice cream is difficult for melted or have the time of melting because crystals that are formed low. The higher the overrun value, the more air is trapped.

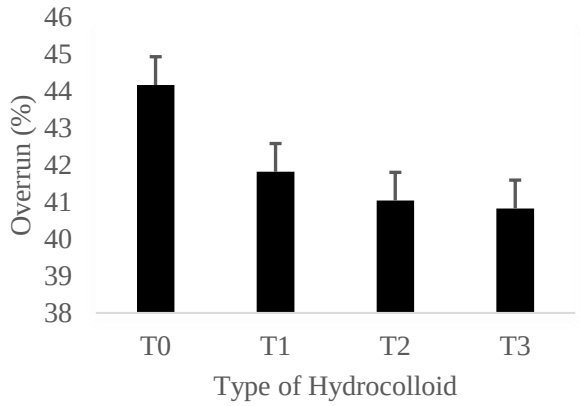

Figure 2. Overrun of frozen yogurt made of corn oil using difference types of hydrocolloids (arabic gum, carrageenan, gelatin). The superscript shows statistically significant differences using Duncan's Multiple Range Test.

Melting Time

Figure 3 shows that the different types of hydrocolloids had a significant effect ($p<0.05$) on the melting time of the frozen yogurt. The difference in frozen yogurt melting time shows that the type of hydrocolloid used can affect the melting power of frozen yogurt. Mulyani et al. (2017) stated that the melting rate is influenced by the ingredients used in making ice cream such as skim milk which is a source of protein, full cream milk, a type of modified stabilizer. The addition of hydrocolloid to frozen yogurt will bind water so that it is useful in slowing the melting of frozen yogurt. According to Handoko et al. (2017) the addition of hydrocolloid can prevent the formation of large and non-uniform air cavities so that with a small and uniform air cavity size the heat transfers evenly to frozen yogurt so that the melting rate becomes slower. The melting speed with the addition of gelatin can increase the viscosity of frozen yogurt and slow down melting. Panda (2010) stated that gelatin can increase the viscosity of yogurt, improve texture and slow down the melting and stabilizer to bind water causing water molecules trapped in the gel structure formed by the stabilizer.

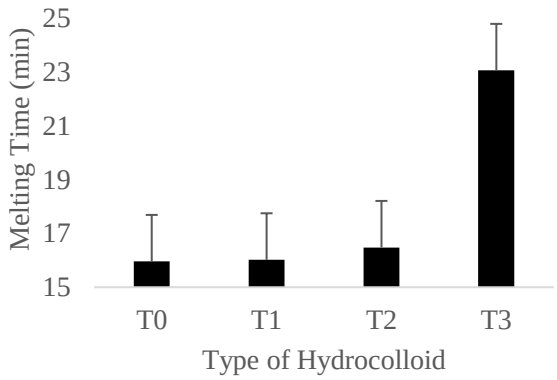

Figure 3. Melting time of frozen yogurt made of corn oil using difference types of hydrocolloids (arabic gum, carrageenan, gelatin). The superscript shows statistically significant differences using Duncan's Multiple Range Test.

Sensory Test

Table 1 shows that the different type of hydrocolloids had a significant effect ($p<0.05$) on the texture sandiness, color, creamy taste and overall passions. The panelist preferred the texture of the T1 and T3 treatments. The ideal texture for frozen yogurt is the same as the ideal texture of ice cream. Haryanti and Zueni (2015) stated that the texture of good ice cream is smooth and soft, not hard and looks shiny while the bad is the presence of fat greasy like flour, feels the presence of ice flakes and sandy. The color of frozen yogurt corn oil gets a yellowish-white color due to the addition of corn oil which effects the content of carotenoid pigments. The effect of gelatin concentration on frozen yogurt will change color white uniform signifies. According to Mulyani et al. (2020) the stabilizer to emulsify the dough as well as can help fat globules are not mutually joined so that the ice cream that was created has a white color and attractive for the consumer.

Table 1. Sensory test of frozen yogurt made of corn oil using difference types of hydrocolloids (Arabic gum, carrageenan, gelatin).

Treatment	Parameters			
	Texture Sandiness (%)	Color (%)	Creamy Taste (%)	Overall Preferances (%)
T0	$3,52 \pm 0,87^{a}$	$3,80 \pm 0,76^{b}$	$3,80 \pm 0,81^{ab}$	$3,12 \pm 0,81^{a}$
T1	$4,16 \pm 0,74^{b}$	$3,48 \pm 1,22^{ab}$	$4,08 \pm 0,70^{bc}$	$4,20 \pm 0,91^{b}$
T2	$3,96 \pm 0,84^{b}$	$3,32 \pm 0,62^{ab}$	$3,48 \pm 1,22^{a}$	$3,88 \pm 1,01^{bc}$
T3	$4,40 \pm 0,64^{b}$	$3,20 \pm 0,57^{a}$	$4,36 \pm 0,63^{c}$	$4,40 \pm 0,64^{c}$

Results are mean standard deviation n=20; Different superscript letter in the same column indicate significant differences ($p < 0.05$).

In T3 treatment get the highest score obtained in the parameter of creamy. Gelatin is a natural protein that can be a good water-binding agent. According to Santoso et al. (2019) stated gelatin has the ability to

form a reversible gel and gelling is the process of forming hydrogen bonds between the semi-solid gelatin molecules that are bound to the water component T0 treatment get the lowest results, because there is no stabilizer in the manufacture of frozen yogurt corn oil so that the creamy texture obtained is not as maximal as using a stabilizer. Mulyani et al. (2020) stated the material of the stabilizer to emulsify the dough as well as can help fat globules are not mutually joined so that the ice cream that was created has a white color and attractive for the consumer. Overall, the panelists prefer the frozen yogurt with treatment T1 and T3 with taste and texture as the main factor. Assessment by panelists is subjective because each panelist has different sensitivity and tastes. Masuku (2014) stated that each person has a different sensitivity even though it can detect but the assessment is not necessarily the same for each other.

Total Lactic Acid Bacteria

Table 2 shows that the different types of hydrocolloids had no significant effect ($p>0.05$) on the total lactic acid bacteria of the frozen yogurt The total value of LAB with data from the resulting pH had no significant effect on the addition of hydrocolloids in frozen yogurt corn oil because it did not interfere with the activity of the Lactic Acid Bacteria produced. Evidenced by the relative value of pH and total LAB. The results obtained from the total LAB testing on frozen yogurt ranged from 1.5×10^7 - 3.8×10^8 CFU/ml. The SNI standard for Fermented Milk Drink (SNI 7552: 2009) which is 10^7 CFU/ml. The total value of LAB with data from the resulting pH had no significant effect on the addition of hydrocolloids in frozen corn oil yogurt because it did not interfere with the activity of the Lactic Acid Bacteria produced. Evidenced by the relative value of pH and total LAB do not equally affect because the concentration of added small hydrocolloids can also inhibit the recrystallization and formation of large ice crystals that will damage the LAB cell wall which will decrease the amount of LAB produced from frozen yogurt. Sawitri and Sari (2020) stated that the formation of ice crystals in the refrigerator in forming large ice crystals that can damage the cell membrane of probiotic bacteria found in frozen yogurt.

Table 2. Total Lactic Acid Bacteria of frozen yogurt made of corn oil using difference types of hydrocolloids (Arabic gum, carrageenan, gelatin).

Treatment	Total BAL (CFU/ml)
T0	$1,5 \times 10^7$
T1	$2,0 \times 10^7$
T2	$1,9 \times 10^7$
T3	$3,8 \times 10^8$

Results are mean standard deviation n=20;

Conclusion

Based on the results of the research can be concluded that the addition of hydrocolloid in frozen yogurt corn oil increase the time of melting, as well as the texture of sandiness, color, creamy taste and overall preferences. The best treatment was addition of 0,5% gelatin because it has an optimal melting time, overrun and highest sensory test.

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