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Yoghurt Syneresis with Addition of Agar as Stabilizer

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Abstract

Yogurt quality is greatly influenced by many factors, including incubation time, incubation temperature, or addition of stabilizer. Agar is a type of hydrocolloid which can be used as a stabilizer ingredient in food product, because can function as thickening agent. Syneresis is one indicator of measuring yogurt quality. In this study, a starter *Lactobacillus bulgaricus* was used which was obtained from isolated cultures from commercial yogurt. During the study, the culture was routinely propagated in 10% reconstituted skimmed milk (RSM). The experiment design used was a completely randomized design, with an agar concentration as dependent factor of 0%; 0.1%; 0.2%; 0.3%; 0.4% and 0.5%. The variable measured was syneresis (%) using the drainage method. Each treatment was repeated 5 times. Based on variance analysis, indicated that agar addition with a concentration of 0 - 0.5% has a very significant effect on yoghurt syneresis. The syneresis decreased along with the increase in agar levels with the lowest syneresis value in the addition of 0.5% agar with an average value of 10%. From this study it can be concluded that the addition of 0.5% agar level reduces the syneresis (value of 10% syneresis), although this syneresis is still quite high, where in the manufacture of yogurt there should be no syneresis (0% syneresis).

Keywords: Yogurt, syneresis, milk, agar

INTRODUCTION

Yogurt is one of the livestock milk products that have become known and popular in the community. Yogurt is a milk product made from fresh milk or reconstituted milk fermented by the bacteria *Lactobacillus bulgaricus* and *Streptococcus thermophilus* (Purnama *et al*., 2011; Malaka and Laga, 2005). It has been known for a long time that yogurt has beneficial properties for health (Dianasari *et al*., 2020), because the yogurt starter bacteria can be probiotic which inhibits the colonization of pathogenic bacteria in the intestine (Markowiak and Slizewska, 2017). In addition, yogurt can have anti-hypertensive, anti-cholesterol, anti-tumor (Malaka *et al*., 2016), anti-constipation properties, and several other health benefits and is very suitable for consumption by lactose intolerant sufferers. Therefore, yogurt can be consumed from various age groups ranging from children to the elderly.

The word "yoghurt" comes from the Turkish word (Jogurt) which means thick, sour milk. This fermented milk product has developed in several countries with different terms (Tamime and Robinson, 1985; Malaka, 2014). Yogurt is a milk product in the form of "custard" which is made through the fermentation process of lactose by lactic acid bacteria. In general, the starters used in making yogurt are *Streptococcus thermophilus* and *Lactobacillus bulgaricus*, but in Turkey they also use yeast (Kosikowski, 1975). According to Noprianto *et al*. (2020), yogurt has a distinctive color, smell and taste, and thickness or consistency. It is white in color, tastes sour with a liquid-solid consistency. The composition of yoghurt consists of 4 to 4.9% protein, 1.5 to 2.4% fat, and 4% carbohydrates (More *et al.*, 2018). Based on the fat content in yogurt, yogurt can be divided into 3 categories, are: (a) high-fat yogurt, i.e. if the fat content is at least 3.25% (b) low-fat yogurt if it contains milk fat 0.5 - 2.0 % and (c) nonfat yogurt if it contains less than 0.5% milkfat.

The stages of making yogurt are simples (Smith, 2015). There are heating milk, cooling, starter inoculation, incubation, and packaging. Heating milk before making yogurt is to evaporate some of the water in the milk, so that the total solids and certain fat content are obtained. This is what causes the yogurt to have a slightly thick consistency, besides heating it can reduce the cow or goatee flavor in the final product (Gradhege and Thurell, 1978). It was further suggested that by evaporating and heating the milk, it also increases coagulants and reduces syneresis during storage. Total solids in yogurt can be increased by adding milk solids such as milk powder (cream or skim), or casein powder (Karam *et al.*, 2013). Furthermore, cooling the milk before inoculation is to reduce the temperature to 43^{o}C, which is a temperature close to the incubation temperature. Inoculation using lactic acid bacteria in milk for yogurt products is *Streptococcus thermophilus* and *Lactobacillus bulgaricus* as much as 5% of the amount of milk used (Bostan *et al*., 2017).

The quality of yogurt is greatly influenced by many factors, including incubation time, incubation temperature, or the addition of ingredients for making yogurt. One of the undesirable things that occur in the manufacture of yogurt is the occurrence of syneresis, namely the discharge of whey from the curd mass (curd). One way to overcome the occurrence of syneresis is by adding stabilizers, among others, by adding agar.

Gel formed from milk that has been given rennet or acidified under certain conditions will show syneresis, namely the discharge or separation of liquid (whey) caused by gel contraction (curd) (Walstra, 1993). Syneresis is caused by an increase in the degree of cross-linking in the polymer network, which causes variations in the dissolved polymer interaction coefficient (Ako, 2015).

Separation of the whey from the coagulum (syneresis) is undesirable in the manufacture of yogurt but very important in cheese making. Many factors play a role in the syneresis of yogurt, including: low product acidity (pH> 4.6) or high acidity (pH <4.0); high temperatures during incubation or storage, and agitation during manufacture or during product transportation (Octavia *et al*., 2016). Factors that influence the syneresis of yoghurt include pH, which means that syneresis will increase when the pH is too low. This is most likely due to the decrease in the water binding power of the micelles casein molecule bonds due to a decrease in the electrostatic power of the cell molecules (Pearce and Mackinlay, 1989; Rani *et al*., 2012).

One method to control and reduce syneresis is the use of thickening agents or stabilizers such as polysaccharide components, namely carrageenan, starch, gelatin, agar, or other polysaccharides or the use of bacteria that produce mucus or fortification of yogurt with protein milk, such as whey protein (Habwalker and Kalab, 1986). Some of the stabilizers recommended by the FAO (WHO) are polysaccharide components, including agar. Jelly is a food ingredient from seaweed in the form of a polysaccharide which can be used as a cake or pudding. Agar can also be added as a food additive which functions as a stabilizer, thickener and gel-making material. In making yogurt, the concentration of agar when it is added as a stabilizer, the recommended maximum is 0.5%. However, not many studies have studied the effect of agar concentration on the occurrence of yoghurt syneresis. It is hoped that the addition of this agar will improve the quality of yogurt by maintaining the characteristics of yogurt such as texture, viscosity, color, taste and smell as well as preventing the breakdown of curd during transportation.

The main purpose of adding stabilizers to the manufacture of yogurt is to improve and maintain the desired characteristics of yogurt such as shape and texture, viscosity, color and taste (Tamime and Robinson, 1985). Stabilizers are generally in the form of hydrocolloids and in their action in yogurt components include two basic functions, namely first to bind water and second to increase viscosity (Tasneem *et al.*, 2014). The hydrocolloid function in yogurt is also as a gel or adhesive and balancing agent. The permissible levels in the manufacture of yogurt are 0.02-0.2% of pectin and modified flour; 0.2 - 0.5% of gelatin, locust latex, alginate, gelatin or carrageenan; 1.2% of processing flour. The factor that determines the addition of a stabilizer to yogurt is the percentage of milk density.

Agar is a daily ingredient, especially in Indonesia, which is used as pudding. The source of agar is from several types of sea algae (algae), especially red marine algae, which are abundant in the seas around Indonesia (Syamdidi *et al*. 2016). Agar as a food ingredient is very good for those who experience digestive disorders. In addition, agar is also used for laboratory purposes, namely as a cultivation medium or culture media (microorganism growth media). Agar is also used in the pharmaceutical industry and paper industry, it can also be used as a stabilizer, emulsifier, thickener, filler and gelling agent (Mortensen *et al.*, 2016) . Agar can be added to yogurt as a stabilizer with a maximum concentration of 0.5%. This research is very important to get the optimal agar concentration in making yogurt by measuring the syneresis of the final product.

RESEARCH METHOD

Experiment Design

The experimental design used in this study was a completely randomized design. The factor to be used is the concentration of stabilizer "agar" which consists of six treatments with each treatment being repeated five times, namely:

K1 = 0%
K2 = 0.1%
K3 = 0.2%
K4 = 0.3%
K5 = 0.4%
K6 = 0.5%

The variable measured was syneresis (%) using the drainage method and the centrifugation method.

Yoghurt Making

Reconstituted milk with a concentration of 10% is made from creamy powder milk dissolved with distilled water in 1000 ml Erlenmeyer, then put in fermentation bottles with a volume of 100 ml. The samples were then pasteurized at 70oC for 15 minutes, then cooled to 40oC and inoculated with 1% *Lactobacillus bulgaricus* and *Streptococcus thermophilus* starter respectively, then incubated at 37^{o}C for 12 hours. All processes of making this yogurt are aseptically processed. Yogurt is then measured the percentage of its syneresis in the final product.

Syneresis Measurement

The syneresis of yogurt was evaluated using the drainage method and the centrifugation method according to Habwalker and Kalab (1981). In the drainage method, the curd formed (yogurt) is sliced with a knife with cross slices 8 times in a glass container, then the whey that comes out is measured using a measuring cup. In the centrifugation method, yogurt is centrifuged at a speed of 10,000 rpm and then the volume of whey formed is measured.

$$\text{Syneresis (\%)} = \frac{\text{Whey Volume (ml)}}{\text{Yoghurt Volume (ml)}} \times 100\ \%$$

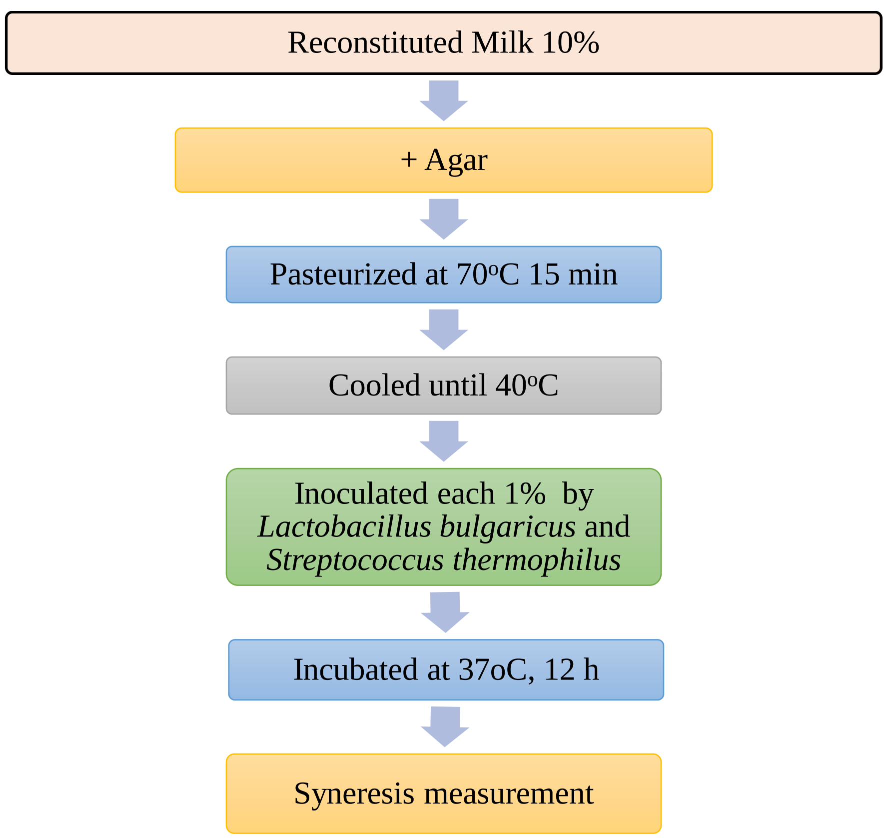

Figure 1. Experiment research flow

Data Analysis

Data were collected after each measurement immediately after the yogurt-making process. The data obtained were processed by analysis of variance based on a completely randomized design (CRD). The mathematical model is as follows:

$Y_{ij} = \mu + T_i + e_{ij}$

Where :

i = 1, 2, 3, 4, 5, 6

j = 1, 2, 3, 4, 5

Y_{ij} = The value of observations in the j experimental / test unit attreatment i

μ = General average of observations

T_i = The effect of the i stabilizer,

e_{ij} = Effect of errors (trial error and i treatment and observations j-th)

If the treatment has a significant effect, it is continued with the Smallest Significant Difference Test (LSD) (Chen and Dominik, 2004).

RESULTS AND DISCUSSION

Gel formed from milk added with rennet or the acidification process under certain conditions shows the occurrence of syneresis, namely the discharge of a liquid called whey as a result of gel contraction (Walstra, 1993). Syneresis is caused by an increase in the degree of bond strength between polymer networks. This is caused by changes in the charge on the polymer chains which vary depending on the solvent polymer interaction coefficient (Gawkowska *et al.*, 2018). Separation of whey or syneresis from the coagulum is undesirable in the process of making yogurt and some other fermented milk products, but it is very important in the cheese making process.

The average syneresis value of yogurt with agar concentration as a stabilizer can be seen in Table 1. The syneresis of yogurt with the addition of agar with a concentration of 0%; 0.1%; 0.2%; 0.3%; 0.4% and 0.5% gave a very significant difference ($P<0.05$) where the lowest average syneresis was the addition of 0.5% agar. But from this treatment, agar still gives a high enough syneresis level where in making yogurt to get good quality, the syneresis should be the lowest, which is 0%. These results indicate that agar is not a good stabilizer in the manufacture of yogurt. Concentrations higher than 0.5% are not recommended because they will likely affect taste and flavor. Tamime and Robinson (1985) state that the permissible levels as a stabilizer are 0.2 - 0.5% of agar, locust gums, guard, alginate, gelatin or carrageenan. Another factor that determines the addition of a stabilizer to yogurt is the percentage of milk density. Good yogurt is a milky white, sour taste with a liquid-solid consistency like pudding.

The LSD test showed that the agar concentrations of 0% and 0.1% were insignificantly different from yoghurt syneresis. The concentration of 0.1% was insignificantly different from the concentration of 0.2% but was significantly different from the concentration of 0.3; 0.4 and 0.5%. The concentration of 0.3% was insignificantly different from the concentration of 0.4% but was significantly different from other concentrations.

Table 1. Average value of yoghurt syneresis by Agar addition

Agar Concentration (%)	Syneresis of yoghurt (%)
0	21 ± 2.55[a]
0.1	19 ± 3.08[a]
0.2	18 ± 1.87[b]
0.3	15 ± 1.22[b]
0.4	14 ± 2.00[c]
0.5	10 ± 1.58[b]

Excessive heating of milk is avoided during yogurt production in order to avoid the development of syneresis in the final product. Other methods to control syneresis are the use of binders such as carrageenan, gel powder or gelatin, use of ropy-forming cultures or fortification of yogurt milk with milk proteins including whey protein. Some researchers have observed that the use of polysaccharides produced by bacteria in the manufacture of dairy products reduces the susceptibility to syneresis. The method used by some researchers to measure syneresis is the measurement of the volume of whey on the surface of the coagulum after a certain time after storage for a certain time, by pouring the coagulum on filter paper in a glass filter and the separate liquid is collected on a beaker at room temperature by counting time and measuring the amount of whey that separates out of the curd (Bierzunska et al., 2019).

Figure 2 shows the yohurt samples by addition of an agar stabilizer. Yogurt syneresis indicated decrease by increasing addition of agar concentration. This is because the agar can bind water in the formation of micellar casein molecule networks (Sebayang, 2019) in the yogurt microstructure. The addition of a stabilizer from hydrocolloid and its activity in the process of making yogurt has two main functions, first to bind water and second to increase viscosity. The addition of yogurt with a stabilizer above a concentration of 0.5% is generally avoided because the main purpose of adding a stabilizer to the basic mixture of making yogurt is to improve and maintain the desired characteristics of yogurt, namely body and texture, viscosity or consistency as well as the appearance and taste of the yogurt. (Tamime and Robinson, 1985).

In the sour milk curd, the chain of casein particles will bind randomly and form a matrix with the formation of relatively uniform holes that block the liquid phase (whey). The whey volume separated depends on the volume of whey present in the sour milk curd sample and the matrix's ability to hold the whey. The main factor contributing to syneresis with the drainage system testing is the gel crushing mechanism. The protein matrix in the drained sour milk curd was suppressed to limit the increase in mass itself with respect to sample dimensions. Increased syneresis increases with time, whereas the relative whey volume separated after one hour of drainage has been used to measure the susceptibility to syneresis by Harwalkar and Kalab (1986).

Figure 2. Syneresis of yogurt by different agar concentration as a stabilizer

The heating process of milk will cause denatured serum protein which will limit the increase in the rate of syneresis in sour milk curd. Decreased syneresis is often associated with denaturation of α-lactoglobulin (Walstra, 1993). Syneresis requires the retention of the gel matrix to become a more compact structure which is affected by the weakening of the bonds between the molecular bonds and consequently the formation of new bonds. Rear management requires stress which can be caused by external and internal stresses. Shrinkage of casein tissue is induced by a decrease in pH or an increase in temperature followed by gel formation. Shrinkage and compaction of the matrix through pressure depends on the moisture and forestry that passes through the matrix pores (Guinee *et al*., 2002). Large pores (holes) in the matrix will make it easier to get the whey out.

CONCLUSION

The addition of agar to a concentration of 0.5% reduced the syneresis rate by 10%, but the syneresis yield was still quite high for yogurt products.

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