The effect of different storage times at 5°C on the quality of yogurt with the addition of local taro starch (Colocasiaesculenta) as stabilizer

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Abstract. The purpose of this research was to determine the effect of storage time at 5°C on the quality of yogurt with the addition of local Taro Starch as Stabilizer. The materials were used: fresh cow's milk, skim milk, starter and taro starch. The research method used was a laboratory experiment using a Completely Randomized Design (CRD) with different storage times at 5°C, namely: 5 treatments including: P1: 1 day, P2: 7 days, P3: 14 days, P4: 21 days, P5: 28 days. Each treatment was repeated 4 times so that 20 research units were obtained. The variables observed were the syneresis, WHC, pH, and total acid of the yogurt. Data were analyzed by one way Anova and followed by Duncan's multiple range test (DMRT). The results showed storage time at a refrigerator temperature of 5°C gave a very significant difference (P≤0.01) to the syneresis, WHC, pH, and total acid of the yogurt. Based on the research results, it can be concluded that the storage time of yogurt can last up to 21 days.

1. Introduction
Yogurt is a product of fermentation technology through the process of breaking down organic compounds or complex materials into simpler compounds involving microorganisms. The milk fermentation process is carried out with the help of lactic acid bacteria (LAB) with the main aim of extending the shelf life because microorganisms are difficult to grow in acidic and viscous conditions. In the fermentation process, a substrate is needed as a microbial growing medium that contains the nutrients needed during the fermentation process. The substrate can be a carbon source and a nitrogen source. The results of fermentation of milk produce semi-solid products by bacterial starter activity. High total acid and low pH value as an indicator of the result of fermentation of milk lactose into lactic acid.

Improving the quality or added value of yogurt can be done by engineering the manufacturing process, namely: adding stabilizers, modifying the composition of milk ingredients, type of starter, incubation time and temperature and storage time [1]. The addition of a stabilizer to the yogurt serves to overcome the syneresis problem, creating the desired stability during yogurt processing and storage. The results of research using Corn Starch (CS) [2], Milk Powder (MP) and Baobab Fruit (BF) as stabilizers had an effect on the chemical composition, sensory properties and microbial content of Zebu milk yogurt. The characteristic properties contained in taro starch, it has the potential to be applied as a
stabilizer, besides that it can function to support yogurt products as functional food because the addition of taro starch can act as a prebiotic by contributing as a source of energy and nutrition for the growth of probiotic bacteria [3,4].

The storage time of yogurt at a cold refrigerator temperature of 5°C has a major effect on pH, acidity, syneresis, taste, and texture of yogurt [5,6]. During storage, the viability of lactic acid bacteria (LAB) decreases, thereby reducing the ability of LAB metabolism to break down lactose into lactic acid. Yogurt that has clotted is then stored at a temperature of 4-5°C to slow or stop the fermentation process [7]. Storage of yogurt at low temperature in the refrigerator is one way of controlling the activity of microorganisms, so that the metabolic process will be slow. The results of [8] showed that probiotic bacteria were able to maintain the recommended cell concentration of 10^6 (cfu.ml-1) until the end of the 21 day storage time. Based on the description above, a research was conducted on the effect of storage time on yogurt based on local taro starch as a stabilizer.

2. Materials and methods
The material used in this research is taro starch from traditional markets in Malang, East Java. Cow’s milk from the Jabung Agro Niaga (KAN) Cooperative, skim milk and starter consisting of lactic acid bacteria S. thermophilus, L. bulgaricus, and L. acidophilus.

The research method used was a laboratory experiment with a completely randomized design consisting of 5 treatments for the storage time of yogurt at a refrigerator temperature of 5°C, namely:
- P1 = 1 day storage time
- P2 = 7 days storage time
- P3 = 14 days storage time
- P4 = 21 days storage time
- P5 = 28 days of storage time

Each storage time treatment was repeated 4 times.

2.1. The procedure for making yogurt
Stages of making yogurt includes pasteurized cow’s milk with a temperature of 85°C for 30 minutes with the addition of skim milk 4% and local taro starch 1.5%. Decrease the temperature quickly done to a temperature of 42°C with a glass beaker containing milk immersion into cold water. The next stage of the addition of inoculation of bacteria starter 3% (S. thermophilus, L. bulgaricus, and L. acidophilus). After the inoculation process is completed followed by yogurt fermentation anaerobic incubation for 36 hours at room temperature. After completion of the incubation period. Then analyzed the quality of yogurt.

The variables measured are: Syneresis (%): according to procedure⁶; pH: pH testing using a pH meter that has been calibrated [9] by inserting the pH meter electrode into a buffer solution with a pH of 7 and a pH of 4; Total acid (%): acidity test is titrated using 0.1% NaOH solution until the color turns pink.

2.2. Data analysis
The data were analyzed by Anova. If significant the Duncan’s Multiple Range Test was applied (UJBD).

3. Results and discussion
3.1. Effect of storage time on physical-chemical properties and microbiology of yogurt
The effect of storage time on the physico-chemical and microbiological properties of yogurt can be seen in Table 1.
Table 1. Average value of physico-chemical and microbiological properties of yogurt with different storage time.

| Storage Time (days) | Syneresis (%) | WHC (%) | pH     | Total Acid (%) |
|---------------------|---------------|---------|--------|----------------|
| 1                   | 8.97±0.19<sup>a</sup> | 90.97±0.19<sup>d</sup> | 4.2±0.02<sup>d</sup> | 0.99±0.04<sup>b</sup> |
| 7                   | 9.45±0.44<sup>a</sup> | 90.46±0.5<sup>d</sup> | 4.15±0.03<sup>c</sup> | 1.05±0.04<sup>b</sup> |
| 14                  | 11.04±0.32<sup>b</sup> | 88.91±0.37<sup>c</sup> | 4.09±0.01<sup>b</sup> | 1.11±0.03<sup>b</sup> |
| 21                  | 15.84±0.79<sup>c</sup> | 83.92±0.77<sup>b</sup> | 4.04±0.01<sup>a</sup> | 1.17±0.02<sup>c</sup> |
| 28                  | 21.83±0.77<sup>d</sup> | 78.47±0.6<sup>a</sup> | 4.01±0.01<sup>a</sup> | 1.25±0.03<sup>d</sup> |

Description: Different superscripts (a-d) indicate differences very significant (P≤0.01)

3.2. Effect of storage time on syneresis of yogurt
Syneresis is the discharge of water from the gel, where a high syneresis number indicates the instability of the gel bond. Syneresis in yogurt production can be observed in the form of serum or whey accumulation on the surface of the yogurt. Storage time gave a very significant difference (P≤0.01) to the yogurt syneresis with the addition of local taro starch. This difference can be due to the longer the storage time causing a decrease in the bonding of amylose and amylopectin molecules with the protein matrix. The syneresis average of yogurt set with different storage times can be seen in Table 1. Yogurt syneresis at 28 days of storage gave the highest average value of 21.83%, and the lowest was 8.97% in 1 day. The longer the storage time results in an increase in the syneresis value [10,11]. Syneresis occurs due to the shrinkage of the three-dimensional (3D) structure of the protein network, which leads to reduced binding capacity of whey protein and its release from yogurt [12].

3.3. Effect of storage time on the water binding capacity (WHC) of yogurt
Storage time gave a very significant difference (P≤0.01) to the water binding capacity (WHC) of yogurt with the addition of local taro starch. This difference can be due to the longer storage time affects the recurrence of bonds between amylose amylopectin molecules. The binding of water by starch through physical and chemical means. Physically, starch granules absorb free water thereby increasing tissue density, and chemically, the hydrophilic nature of starch becomes a tissue medium with water molecules so that the binding capacity of WHC water from the gel becomes stronger. The average binding capacity of yogurt water with different storage times can be seen in Table 1. The binding capacity of yogurt water at 1 day of storage gives the highest average value of 90.97%, and the lowest is at 28 days of storage of 78.47%. The longer the storage time, the lower the water binding capacity (WHC) of yogurt. WHC at an incubation time of 36 hours gave an optimal contribution to the factors that influence WHC yogurt, among others: an increase in total solids and the addition of stabilizers to yogurt. WHC is related to the ability of protein to retain water in the structure of yogurt and the role of fat in milk to retain water [12,13].

3.4. Effect of storage time on the pH of yogurt
Storage time gave a very significant difference (P≤0.01) to the pH of yogurt with the addition of local taro starch. The storage time of yogurt at a refrigerator temperature of 5°C causes the cessation of the fermentation process carried out by lactic acid bacteria to hydrolyze milk lactose. The average pH of the yogurt with different storage times can be seen in Table 1. The pH of yogurt at 1 day of storage gave the highest average value of 4.2, and the lowest was at 28 days of storage of 4.01. Storage time at refrigerator temperature stops the metabolic activity of lactic acid bacteria to produce lactic acid, so that numerically, the pH value of yogurt at variations in storage time does not give a significant difference. The decrease in pH is caused by the activity of lactic acid bacteria to ferment lactose in milk into glucose and galactose, then glucose is converted into lactic acid. The higher the production of lactic acid, the lower the pH value [14].
3.5. Effect of storage time on total acidity of yogurt
Total acidity is a measurement of the degree or level of acidity of a solution (pH = Potenz Hydrogen) depending on the concentration of H⁺ ions in the solution. The greater the concentration of H⁺ ions the more acidic the solution. Storage time at a refrigerator temperature of 5°C gave a very significant difference (P≤0.01) to the total acidic yogurt with the addition of local taro starch. The storage time of yogurt at a refrigerator temperature of 5°C causes the cessation of the fermentation process carried out by lactic acid bacteria to hydrolyze milk lactose. The average acidity of the yogurt with different storage times can be seen in Table 1. Total acidity yogurt at 28 days of storage gave the highest average value of 1.25%, and the lowest was 0.99% at 1 day of storage. Numerically, there is no difference in the total value of yogurt acid in the variation of refrigerator temperature storage time because the metabolic activity of lactic acid bacteria ends in cold storage. The addition of taro starch as a yogurt stabilizer can increase the development of acidity of yogurt because it stimulates the metabolic activity of lactic acid bacteria [15].

4. Conclusion
Based on the results of the study it can be concluded that the use of 1.5% local taro starch as a stabilizer with an incubation time of 36 hours at room temperature produces yogurt with optimal yogurt quality and can be maintained for up to 21 days at 5°C.

References
[1] Arioui F, Ait Saada D and Cheriguene A 2017 Physicochemical and sensory quality of yogurt incorporated with pectin from peel of Citrus sinensis Food science and nutrition 5(2) 358-364
[2] Olorunnisomo O A, Ososanya T O and Adedeji A Y 2015 Influence of stabilizers on composition, sensory properties and microbial load of yoghurt made from zebu milk International Journal of Dairy Science 10(5) 243-248
[3] Nurbaya S R and Estiasih T 2013 Pemanfaatan talas berdaging umbi kuning (Colocasia esculenta (L.) Schott) dalam pembuatan cookies Jurnal Pangan dan Agroindustri 1(1) 46-55
[4] Sulistyowati P V, Kendarini N and Respatijarti R 2014 Observasi keberadaan tanaman talas-talasan genus Colocasia dan Xanthosoma di Kec. Kedungkandang Kota Malang dan Kec. Ampelgading Kab. Malang Jurnal Produksi Tanaman 2(2)
[5] Chandan R C and Kilara A 2011 Dairy ingredients for food processing (Iowa: Blackwell Publishing Ltd.)
[6] Macit E and Bakirci I 2017 Effect of different stabilizers on quality characteristics of the set-type yogurt African Journal of Biotechnology 16(46) 2142-2151
[7] Tabatabaei F and Mortazavi A 2008 Studying the effects of heat and cold shock on cell wall microstructure and survival of some LAB in milk World Applied Sciences Journal 4(2) 191-194
[8] Isanga J and Zhang G 2009 Production and evaluation of some physicochemical parameters of peanut milk yoghurt LWT-Food Science and Technology 42(6) 1132-1138
[9] AOAC 2005 Official Methods of Analysis, 18th ed. (Washington, DC: Association of Official Agricultural Chemists)
[10] Shafiee G, Mortazavian A M, Mohammadifar M A, Koushki M R, Mohammadi A and Mohammadi R 2010 Combined effects of dry matter content, incubation temperature and final pH of fermentation on biochemical and microbiological characteristics of probiotic fermented milk African Journal of Microbiology Research 4(12) 1265-1274
[11] Sarvari F, Mortazavian A M and Fazeli M R 2014 Biochemical Characteristics and Viability of Probiotic and Yogurt Bacteria in Yogurt during the Fermentation and Refrigerated Storage Applied Food Biotechnology 1(1) 55–61
[12] Bahrami M, Ahmadi D, Alizadeh M and Hosseini F 2013 Physicochemical and sensorial properties of probiotic yogurt as affected by additions of different types of hydrocolloid Food Science of Animal Resources 33(3) 363-368
[13] Ibrahim A H and Khalifa S A 2015 The effects of various stabilizers on physiochemical properties of camel's milk yoghurt *Journal of American Science* **11**(1) 15-24

[14] Adamberg K, Kask S, Laht T M and Paalme T 2003 The effect of temperature and pH on the growth of lactic acid bacteria: a pH-auxostat study *International journal of food microbiology* **85**(1-2) 171-183

[15] Shima A R, Salina H F, Masniza M and Atiqah A H 2012 Viability of lactic acid bacteria in homemade yogurt containing sago starch oligosaccharides *International Journal of Basic and Applied Science* **12**(1) 58-62