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Determination of the expiration time of Dangke ripening cheese through physico-chemical and microbiological analysis

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Abstract. Dangke ripening cheese is a dangke cheese that is processed by ripening with lactic acid bacteria to improve the taste, self-life of the product, and diversify it with new flavors. In this study, consumer tests were carried out after the packaging process and product self-life test at cold storage, room temperature, and freezing temperature, to see the product expiry period. The parameters measured were consumer acceptance, physical, chemical, and microbiological quality. The results showed that the physical characteristics of Dangke ripening with *L. lactis* inoculation and packaged with banana leaves and vacuum plastic were the best quality when stored at refrigerator temperatures and still not damaged until storage for 15 days, while at room temperature storage has shown a decrease quality. Frozen storage indicated that physical quality was still good for 15 days but tends to be less favored by consumers, possibly because the texture has changed.

1. Introduction

The short shelf life of Dangke cheese is classified as very perishable; this causes the market reach of this product to be limited. This is the main factor of the aim of this research for the development of this dangke cheese product to extend its shelf life through ripening technology and vacuum packaging. Local Dangke cheese from Enrekang regency, South Sulawesi province, Indonesia, is a highly nutritious local white cheese originally made from buffalo milk. But now dangke is generally made from cow's milk. Dangke is a local product made by the dairy farmers community as a home industry in Enrekang regency, South Sulawesi province [1, 2, 3]. Dangke has been known since 1905. The name dangke comes from the Dutch language when the Dutch saw the type of food made from milk, they said: "DANK WELL" which means thank you [4]. People who hear the word "Dangke" think that is the name of the food. Particularly in Enrekang regency, milk and buffalo fresh milk, which is milked is mostly intended for the manufacture of Dangke; only a small portion is consumed as another product [5]. In general, dangke cheese is a template using a coconut shell [6], it takes about 1.25-1.50 liters/one Dangke cheese of fresh milk, depending on the breeds of cows, papaya sap, and salt through a heating/cooking process which is then packaged using banana leaves [7, 8]. The nutritional content in dangke is arginine 3.6%,



histidine 2.3%, isoleucine 5.1%, leucine 9.2%, lysine 7.3%, methionine 4.1%, tryptophan 1.3%, calcium 216 mg, 101 grams of phosphorus, 0.2 grams of iron, 80 grams of vitamin A, 0.8 grams of vitamin B2, 5-10% fat content, 16-17% protein, 4-8% lactose and calorie value of 362-380 kcal [9].

The method of making dangke is cow's milk or buffalo milk, which is pasteurized, then papaya sap is added to coagulated milk protein, and sometimes salt is added [10]. After the separation between the curd and the yellow liquid (whey), the curd is put into a special template made from a coconut shell (the edges are perforated to escape the whey) while being pressed so that more whey comes out from the curd [11]. The process of heating the milk to a boil is likely to damage the protein and affect the quality of the final product [12]. The clotting material for the manufacture of dangke is a papaya sap containing the papain enzyme, which coagulates protein [13, 14]. Optimum papain activity is at temperatures 50-60°C, although this enzyme is resistant to higher temperatures [15, 16].

Several types of proteins are able to form curd and gel or coagulum, which play an important role in the characteristics and texture of various high-protein and nutritious food and beverage products. The ability of proteins to form a gel is very dependent on temperature and pH. In the processing of dairy products such as dangke cheese is expected to form a gel and coagulum with a smooth, shiny, and compact structure. Generally, milk protein (casein) aggregation occurs at the isoelectric point when the pH reaches 4.8 or when there is a separation between polar and non-polar poles due to enzyme activity [17].

Based on observations, some dangke producers take papaya sap by tapping sap from fruit or papaya tree trunks; others take sap from fruit that has been picked by peeling the skin. The papain enzyme in papaya sap is a proteolytic enzyme [18, 19] whose content can reach 50% of the dry weight of papaya sap. The addition of the papain enzyme contained in papaya latex to milk with improper concentrations can cause the optimal gelatination and agglutination process not to be achieved so that the final product is not as expected as for example the product becomes bitter or the surface of the product is rough and not compact [20].

The formation of gel (gelatinized) milk is influenced by processing such as heating, pH, the concentration of basic ingredients [21]. Gelatinization furthermore causes coagulation of milk protein and finally occurs milk clotting [22, 23, 24]. Dangke processing can be viewed from the effect of heating temperature, the addition of papaya sap, the process of template and coating, as well as the process of ripening and storage.

The quality of the final product of a dairy product can be reviewed in physicochemical and microbiological properties to determine changes in product quality after the packaging and storage process in the actual environment. This can also be done to see how this product can be developed and can be commercialized after going through the consumer acceptance test, and how long the shelf life of the product at various storage temperatures.

The aim of the research was to determine the expiration time of Dangke ripening cheese through physico-chemical and microbiological analysis.

2. Research methods

2.1. Raw milk, papain and *Lactococcus lactis*

Fresh raw milk has been obtained from smallholder dairy farms, from Enrekang regency, and transported in cold containers. Papain was made from dried papaya sap. *Lactococcus lactis* was a collection of dairy biotechnology laboratory, Faculty of Animal Husbandry, Hasanuddin University.

2.2. Dangke cheese manufacturing

Milk was pasteurized at 85°C for 15 seconds, then added with 0.03% papain and then cooled and inoculated with 0.1% *Lactococcus lactis*. After the milk has coagulated and the curd has formed, the curd was separated from the whey. Curd was then formed on a coconut shell template and pressed, then drained for 1 hour on a storage rack until the product becomes dried and whey comes out more. These cheese products were then wrapped in 3 types of packaging, and there were aluminum foil, imitation

banana leaves (plastic resembling banana leaves), and original banana leaves, finally packed with polyethylene vacuum plastic. The cheeses were stored on ripening shelves at room temperature, milk refrigerator (5°C), and at freezing temperatures.

2.3. Quality measurement

The quality of the dangke ripening cheeses was measured by the consumer's acceptability, pH, % lactic acid, product hardness, total plate count, *Escherichia coli*.

3. Results and discussion

3.1. Effect of storage on consumer favorable value

Panelist preference testing indicated consumer ratings of food products [25] subjectively. This was closely related to consumer habits regarding the existence of foods that were similar to the food to be assessed. The consumer rating scale focused on the middle of the nominal number displayed. Therefore the hedonic scale should not be odd but even so that the subjectivity and bias of the assessment can be avoided. The assessment also needs to be considered by the target panelists because if the panelists consisted of a community of good weight, generally or relatively more likely, the assessment will be good too because the average person of high body weight likes a variety of foods.

Figure 1 displaying the results of a panelist assessment of Dangke cheese, which has been inoculated with lactic acid bacteria and packed with banana leaves and vacuum polyethylene plastic. Panelists preferred Dangke cheese, which was stored in the refrigerator than that which was stored at room temperature or stored in the freezer. Dangke cheese that was stored at room temperature showed physical characteristics that change when the storage has reached six days, where the Dangke has begun to change color a little yellowish and began to appear visible mucus. Whereas in Dangke cheese, which was stored at freezing temperatures, it looks that the characteristics of Dangke change after 12 days where the structure of the Dangke was broken and grained.

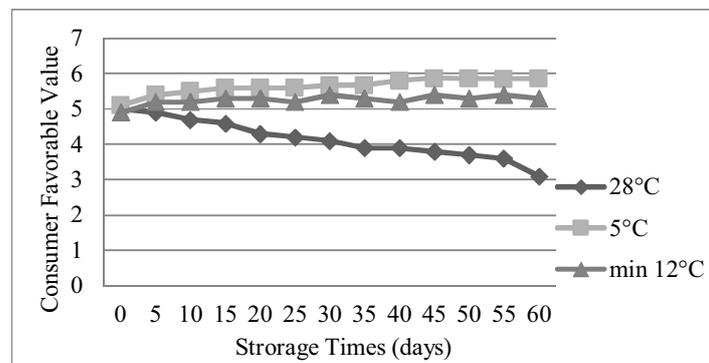


Figure 1. Hedonic value of panelists' preference for Dangke cheese inoculated by *Lactococcus lactis* and coated with beeswax and packed with banana leaves and vacuum polyethylene plastic. Hedonic value (0=dislike, 6=really like).

3.2. Effect of storage on pH of Dangke cheese

The pH of fresh raw milk was between 6.6 - 6.7, and when acidification occurred by bacterial activity, the pH decreased due to phosphate, citrate, and protein buffering activities. pH was minus the logarithmic H^+ , which described the Hydrogen activity in a solution. In milk, hydrogen ion activity averages 2×10^{-7} /liter or 0.00002, so the pH was $\log 5,000,000$, which means that the pH was equal to

6.7. Figure 2 showed changes in pH after storage of Dangke ripening with *L. lactis* inoculation and packaged with banana leaves and vacuum plastic. At room temperature, indicated that the pH decreased from 6.6 to 4.3 after ten days of storage, which illustrated the activity of lactic acid bacteria, in this case, *Lactococcus lactis*, which converted lactose to lactic acid [26], resulting in an increase in hydrogen ion activity in the product. Ripening time significantly was affected the pH value, where the pH was also seen to decrease from 5.3 to 4.8 after six days of ripening.

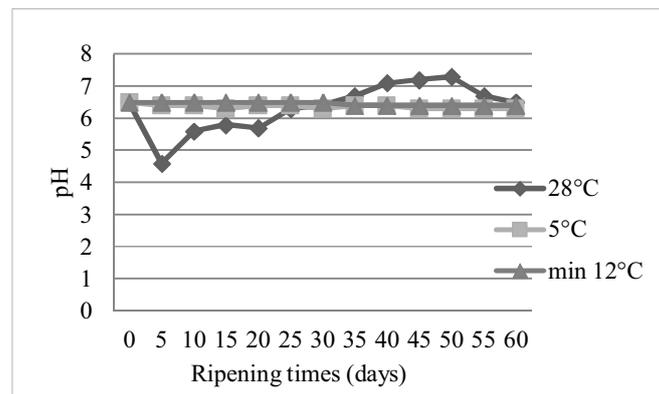


Figure 2. pH value of Dangke cheese inoculated with *Lactococcus lactis* and coated with beeswax and packed with banana leaves and vacuum polyethylene plastic.

3.3. Effect of storage on the percentage of lactic acid

Raw fresh milk, on average, contained lactic acid between 0.14-0.19% lactic acid. When milk was stored at room temperature, acidity increased, and it started to taste acidic when lactic acid raised to 0.25% when the pH reached 6.0. If acidity increased, casein precipitation occurred. Casein precipitation began when acidity reached 0.5 - 0.65% when pH reached 4.67 - 4.78.

Figure 3 provided data that Dangke ripening stored at room temperature showed an increase in the percentage of lactic acid from 0.04 to 1.24% after 15 days of storage. Dangke ripening inoculation of *Lactococcus lactis* on ripening 0 days of lactic acid was 0.42% and increased significantly to 0.48% on ripening six days.

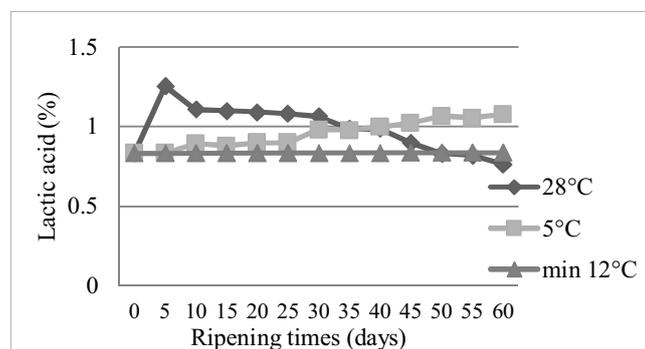


Figure 3. Percentage of lactic acid Dangke cheese inoculated with *Lactococcus lactis* and coated with beeswax and packed with banana leaves and vacuum polyethylene plastic.

3.4. *Effect of storage on hardness Dangke cheese*

Hardness is a measure of the product through measurements that illustrate how pressure must be applied to the product multiplied by earth gravity (the fixed value is 980). The tool used to measure the rheological properties of a product is called a rheometer. This tool is generally operated with a knife penetration speed of 1.44 mm/sec with a curve making the speed of 18 cm/min. This variable is then viewed in graphical form X and Y, where the hardness is X times 980 mpa/sec.

Figure 4. was illustrated storage time caused an increase in Dangke hardness from 83 - 379 mpa/ sec, with the greatest increase in refrigerator storage. This explained that the refrigerator storage still showed good quality until 60 days storage, as well as frozen storage, but at room temperature storage, there has been a change in quality with changes in color, taste, and appearance until storage for 15 days.

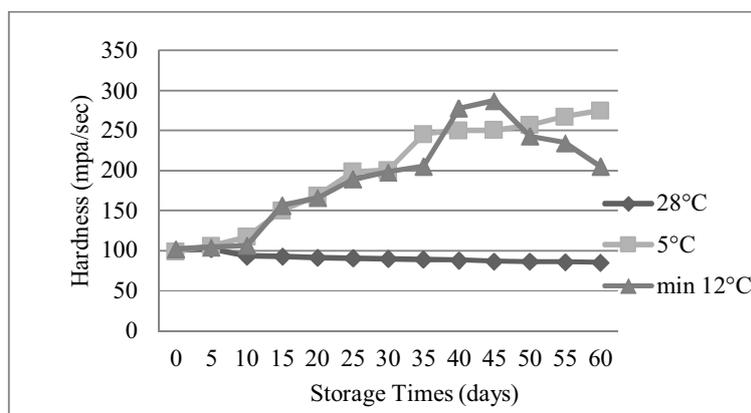


Figure 4. The hardness of Dangke cheese inoculated with *Lactococcus lactis* and coated with beewax and packed with banana leaves and vacuum polyethylene plastic.

3.5. *Effect of freezer storage on total plate count of Dangke cheese*

Storage at a certain temperature was very influential in the growth of microorganisms found in a product. Figure 6 illustrated the growth of microorganisms in freezer storage (-20°C), which was a description of the total microbial cheese and ripening cheese.

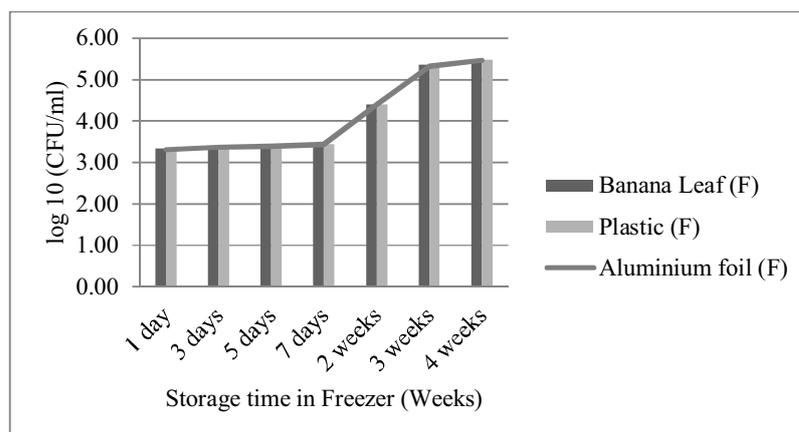


Figure 5. A total number of Lactic Acid Bacteria (LAB) in Dangke cheese in freezer storage (using MRS media).

Evaluation data on the possibility of *Escherichia coli* on Dangke using banana leaf wrapper, plastic, and aluminum foil in frozen storage can be seen in table 1. *Escherichia coli* was only detected at 4 weeks storage in Dangke wrapped in banana leaves. *Escherichia coli* is one of the bacteria belonging to Enterobacteriaceae and can be pathogenic [28, 29].

Table 1. Detection of *Escherichia coli* (CFU / ml) in Dangke cheese in freezer storage (using EMB media).

Storage	1 day	3 days	5 days	7 days	2 weeks	3 weeks
Banana Leaf	0	0	0	0	0	1
Plastics	0	0	0	0	0	0
Alum. foil	0	0	0	0	0	0

3.6. Effect of refrigerator storage on Dangke cheese bacteria

Bacterial growth in Dangke cheese by using 3 types of inner packs stored in a refrigerator can be seen in Figure 7. In the use of the three types of packaging, it appeared that the bacteria have begun to grow in storage for 3 days and continued to increase until storage 4 weeks. Therefore, to control the presence of microbial contamination in milk products, it was necessary to pasteurize milk before proceeding [30].

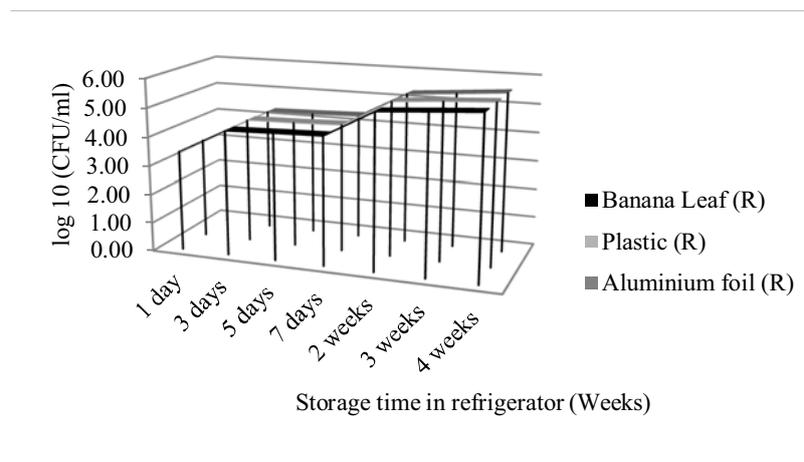


Figure 6. Bacterial growth after storing a refrigerator with different packaging in Dangke cheese.

4. Conclusion

The expiration period of Dangke cheese, which was inoculated with *Lactococcus lactis* and coated with beewax was more than 60 days when stored at refrigerator temperature (5°C), but at room temperature storage (28°C) it has begun to damage in 10 days of storage. Dangke stored frozen (-12°C) up to 60 days of storage quality was still good but not preferred by consumers.

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