

The Effect of *Lactobacillus plantarum* Addition on Cooking Loss and Water Holding Capacity of Beef with Different Temperatures and Storage Time

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ABSTRACT

Meat is a food ingredient produced from livestock that is rich in nutritional content and is favored by some people because of its delicious taste. In general, people can buy beef in traditional markets. Traders in traditional markets sell fresh meat in large pieces. Beef is expected decent quality for consumption. Beef that has been contaminated by microorganisms will experience damage and decrease in shelf life, thereby reducing the quality of these foodstuffs. To prevent a decrease in quality and damage to the meat, it is necessary to preserve it. Control of the preservation process is carried out using natural ingredients, namely using *Lactobacillus plantarum* bacteria. The use of *Lactobacillus plantarum* bacteria, its can prevent the beef from being contaminated by microorganisms that can damage and reduce the quality of the beef. The characteristics of meat quality are determined by one of them is cooking loss and water holding capacity. This study used a factorial completely randomized design (RALF) which consisted of 3 factors, namely factor A (Bacterium *Lactobacillus plantarum*), factor B (temperature), and factor C (storage time) with a 2×2×2 pattern with 3 replications so that there were 12 treatments. From the results of this study, it can be concluded that the addition of *Lactobacillus plantarum* levels with different temperatures and storage periods did not affect the physical quality of cooking loss and the water holding capacity of beef.

Keywords: *Lactobacillus plantarum*, cooking loss, water holding capacity, beef.

1. INTRODUCTION

The need for meat consumption in Indonesia is increasing every year. Meat is a food ingredient produced by livestock that is rich in nutrients. Beef is one of the foodstuffs that contain a source of vitamin B12 and a source of vitamin B6. Vitamin B12 is only found in animal products and is essential for cell metabolism, maintaining a healthy nervous system, and the production of red blood cells in the body. Beef also contains good protein, carbohydrates, water, non-protein substances, and iron and contains selenium and phosphorus [1].

Beef is expected to have a quality that is suitable for consumption. Meat quality is a characteristic of meat that is judged by consumers which includes meat color,

smell, and texture. Meat is susceptible to microbiological damage due to its high nutrient and water content. In general, beef traders in traditional markets obtain freshly cut meat from the Slaughterhouse (RPH) as well as a slaughter by farmers and traders which are then brought to be sold to the market.

Traders in traditional markets sell fresh meat in large pieces, the meat is hung so that the remaining blood comes out so that the color of the meat produced is not too dark. Conditions of exposure to air can also cause damage to the meat. Damage to the meat is characterized by changes in the smell and the appearance of mucus that occurs in the meat.

Beef that has been contaminated by microorganisms will experience damage and decrease in shelf life,

thereby reducing the quality of the food. Based on this, an effort was made to reduce the quality damage to the meat by handling it in the form of a preservation process.

Meat quality can be maintained through a preservation process using natural ingredients. The preservation process can extend the shelf life of meat by reducing spoilage and spoilage by microorganisms. Therefore, it is necessary to control the microbes that can damage the physical appearance of the meat so that the meat remains fresh and fit for consumption. One way to prevent physical damage to meat due to microbes is by utilizing bacteriocin derived from lactic acid bacteria. Bacteriocins can be produced by *Lactococcus*, *Lactobacillus*, and *Pediococcus* [2]. One of the lactic acid bacteria that produces bacteriocin is *Lactobacillus plantarum*.

Lactobacillus plantarum can produce lactic acid and bacteriocin to prevent microbial growth in meat. The utilization of *Lactobacillus plantarum* on meat improves the physical quality of meat in terms of pH value, cooking loss, and water holding capacity. Physical testing is done to see the overall quality of the meat. Knowing the cooking loss and water holding capacity can ensure that the meat is of good quality or not.

2. MATERIALS AND METHODS

2.1. Place and time of research

This research was carried out at the Milk Processing Technology Laboratory for the breeding of *Lactobacillus plantarum* bacteria, at the Meat Processing Science and Technology Laboratory for the preparation of meat samples, meat soaking treatment using *Lactobacillus plantarum*, and meat cooking loss testing. The water-holding test was carried out at the Laboratory of Food and Agricultural Product Analysis, Department of Agricultural Product Technology, Faculty of Agriculture, Syiah Kuala University, Banda Aceh. This research was carried out from November 16 to December 17, 2020.

2.2. Tools and materials

The tools used in this study consisted of a knife, cutting board, basin, sample cup, sample paper, mask, gloves, blender, incubator, analytical scale, pan, stove, sample plastic, centrifuge tube, centrifuge, Erlenmeyer, baker glass, laminar flow, and stationery. The materials used were beef as much as 1 kg of beef which were weighed 25 grams and 10 grams for each test, *Lactobacillus plantarum* bacteria, tomato juice, brown sugar, aquates, and 70% alcohol.

2.3. Research procedure

Preparation of the place and equipment, the floor of the room to be used is cleaned first with alcohol and sterilized before use. Equipment is sterilized by immersing the tool in warm water. Preparation of *Lactobacillus plantarum* culture as Bulk Culture, 1 ml of *Lactobacillus plantarum* culture was taken and inoculated on 9 ml of de Man Rogosa Sharp broth (MRSB) media. The culture was then incubated at 37°C for 24 hours.

Propagation of culture (*Lactobacillus plantarum*), *Lactobacillus plantarum* obtained from the Microbiology Laboratory of the Center for Food and Nutrition Studies, Gadjah Mada University, Yogyakarta was stored on de Man Ragosa Sharpe (MRS) agar media. Propagation was done by inoculating culture stock into MRS broth liquid media to which 20% tomato extract had been added and incubated at 37°C for 24 hours [3]. Preparation of working culture of *Lactobacillus plantarum* as much as 200 ml of broth + 50 brown sugar then added 6% *Lactobacillus plantarum* then incubated for 24 hours.

Beef sample preparation. 1 kg of beef that has been prepared is then cut and weighed 10 and 25 g respectively for each test. After the cutting process, the sample is separated and placed in a sample container. Preparation of meat samples that have been cut and then soaked using *Lactobacillus plantarum* bacteria as much as 0% (control) and 6%. Then the cooking shrinkage test and the water holding capacity test were carried out on the sample.

2.4. Cooking shrinkage test

The process for the cooking loss test for beef is as follows:

1. Prepare beef weighing 25 g each as a sample.
2. Put the sample into the plastic.
3. Samples were removed from the plastic and boiled at 100°C for 20 minutes.
4. Cool at room temperature
5. The sample is placed on tissue paper to absorb water on the surface of the meat.
6. Weigh the sample after cooking [4].
7. Calculating cooking loss with the formula:

$$\text{Cooking Loss (\%)} = (a-b)/a \times 100\%$$

Note :

- a = Weight before cooking
b = Weight after cooking

2.5. Water holding capacity test (WHC) [5]

The process for testing the water holding capacity of beef is as follows:

1. Beef as much as 10 g.

2. The sample is put into a bottle and 10 cc of distilled water is added and then homogenized.
3. The bottle is closed to be stored for 24 hours at room temperature 25°C.
4. After 24 hours, the bottles were opened to be centrifuged for 20 minutes at 3000 rpm.
5. Then filtered using filter paper and measured in a measuring cup.
6. Calculate the water holding capacity with the formula:

$$WHC (\%) = \frac{a - b}{a} \times 100\%$$

Note :

a = Amount of water added (cc)

b = Amount of unabsorbed water (cc)

2.4. Statistical analysis

The analysis was carried out using the Analysis of Variance (ANOVA) variance. If there is a difference between the treatments, the Duncan Multiple Range Test (DMRT) will be carried out [6].

3. RESULTS AND DISCUSSION

3.1. Cooking loss

The percentage of meat weight lost due to the cooking process and is a function of cooking time and temperature is called cooking loss. The weight of the meat lost is related to the temperature and cooking time, the longer the cooking process or the amount of cooking temperature, the more the amount of liquid meat is lost until it reaches a constant point. Cooking loss is also an indicator of the nutritional value of meat related to the juice content of the meat, namely the amount of water bound in and between muscle fibers.

Meat juice is a component of meat that determines the tenderness of meat [7]. The average cooking loss of beef on the effect of *Lactobacillus plantarum* with different temperatures and storage periods can be seen in Table 1.

The results of analysis of variance showed that the addition of *Lactobacillus plantarum* (a) with storage

temperature (b) and storage time (c) on the cooking loss value of beef had no significant effect

($P > 0.05$) and there was no interaction between the three factors on the value of reduced cooking beef. Based on Table 1, it can be explained that the lowest cooking loss value was found in the treatment of *Lactobacillus plantarum* 0% (a1) with a storage temperature of 10°C (b2) and a storage time of 0 days (c1) the average value obtained was 34.45±4.81. The highest cooking loss value was found in the addition of *Lactobacillus plantarum* 6% (a2) with a temperature of 27°C (b1) and storage time of 0 days (c1) the average value obtained was 49.10±5.12. This is in line with the opinion [4] which states that meat with a lower cooking loss is relatively good compared to a higher cooking loss of beef because meat can lose its nutritional content during the cooking process.

Table 1 shows that the results of Duncan's further test on factor A, namely the addition of *Lactobacillus plantarum* a1 and a2 levels. The table above shows that the cooking loss value with the addition of *Lactobacillus plantarum* a2 (6%) was higher than without the addition of *Lactobacillus plantarum* a1 (0%) with a mean value of 44.20^b and 38.55^a. Cooking loss of beef added with *Lactobacillus plantarum* as much as 6% had no effect, it is suspected that, in the treatment, without soaking *Lactobacillus plantarum* 0% in beef resulted in a lower cooking loss compared to beef that was soaked in *Lactobacillus plantarum* 6%. This is following the opinion [1] which states that beef without soaking the cooking loss value only comes from the meat, therefore the cooking loss value in the treatment without soaking is lower than the cooking loss of meat that is given the soaking treatment.

Likewise, Duncan's further test results showed that there was a difference in factor B, namely the storage temperature of B1 (28°C) and B2 (10°C). Duncan's further test showed that the cooking loss value of beef in storage treatment at room temperature of 28°C (b1) with a value of 43.72^a higher than the treatment of beef stored at a refrigerator temperature of 10°C (b2) with a value of 39.03^b. It can be seen from the comparison of values in factor B that the refrigerator temperature is better

Table 1. Cooking Loss Value of Beef

Addition <i>L. plantarum</i>	Storage Temperature	Storage Time		Average A	Average B	
		c1 (0 Day)	c2 (1 Day)		b1	b2
a1 (0%)	b1 (28°C)	38.53±4.28	42.83±1.89	38.55 ^a	43.72 ^a	39.03 ^b
	b2 (10°C)	34.45±4.81	38.39±1.29			
a2 (6%)	b1 (28°C)	49.10±5.12	44.41±2.98	44.20 ^b	43.72 ^a	39.03 ^b
	b2 (10°C)	39.96±2.06	43.31±8.80			
Average C		40.51	42.23			

Description: ^{a,b} Different Superscript in the same column or row showed a significant difference ($P > 0.05$)

than room temperature. This is presumably because meat stored at refrigerator temperature will last longer and can retain less water content so that the cooking loss of beef can be maintained.

This study is in line with the opinion [8] which states that storage of beef at low temperatures is expected to extend the shelf life of beef. This is because low temperatures can slow down microbial growth, prevent chemical reactions, and prevent the loss of water content of beef so that it can maintain the cooking loss of the beef. Refrigeration is the storage of food ingredients above the freezing temperature of the material, which is -2 to 10°C. Cooling that is usually done every day in the refrigerator is a temperature of 5-8°C [9].

3.2. Water holding capacity

The ability of meat to bind water or water added during the influence of external forces such as meat cutting, heating, grinding, and processing is an understanding of water-holding capacity by protein or water-holding capacity. The average value of the water holding capacity of meat cattle from the effect of *Lactobacillus plantarum* administration with different temperatures and storage periods is presented in Table 2.

The results of the analysis of variance showed that the addition of *Lactobacillus plantarum* (a) with storage temperature (b) and storage time (c) on the value of water holding capacity had no significant effect (P>0.05) and there was no interaction between the three factors on the value of the binding capacity. beef water. Based on Table 2, it can be explained that the lowest water holding value was found in the addition of *Lactobacillus plantarum* 6% (a2) with a temperature of 28°C (b1) and stored for 1 day (c1) the average value obtained was 24.00±17.09. The highest water holding value was found in the treatment without the addition of *Lactobacillus plantarum* 0% (a1) stored at 28°C (b1) for 1 day (c2) the average value obtained was 61.33±17.47. According to [4] which states that the normal range of

water holding capacity of beef is between 20% to 60%.

Duncan's further test results showed that there was an interaction between AB and AC treatments. Table 2 shows that the interaction without the addition of 0% *Lactobacillus plantarum* stored at room temperature of 28°C (a1b1) has the highest water holding value with an average value of 51.67^d, while the lowest water holding value is found in the addition of *Lactobacillus plantarum* 6% stored at room temperature. room 28°C (a2b1) with an average of 31.34^a. It is suspected that the water-holding capacity of beef stored at room temperature with the addition of *Lactobacillus plantarum* can work optimally, to produce lactic acid which can break down protein in meat. Thus the protein is no longer able to bind water in the beef. This is following the opinion [10] which states that the accumulation of lactic acid can damage myofibril proteins, which is followed by a loss of protein able to bind water in beef.

Likewise, the results of Duncan's further test showed that there was an interaction in the AC treatment. Table 2 shows that the interaction without the addition of *Lactobacillus plantarum* 0% stored for 1 day (a1c2) has the highest water holding value with an average value of 54.67^d, while the lowest value is found in the treatment with the addition of *Lactobacillus plantarum* 6% stored for 1 day (a2c1) with an average value of 32.34^a. According to [11] stated that during storage there will be degradation of collagen from proteins that make up cross-links between meat fibers, further stating that the main component that functions to hold water in meat is protein. Changes in the structure of the protein in meat along with the length of storage time can weaken the ability of the meat to bind to the liquid. In a more acidic condition, the meat causes the protein to break down easily.

According to [12] stated that the higher the concentration of starter *Lactobacillus plantarum* and the length of storage carried out can increase the total amount of acid.

Table 1. Cooking Loss Value of Beef

Addition <i>L. plantarum</i>	Storage Temperature	Storage Time		Average AB
		c1 (0 Day)	c2 (1 Day)	
a1 (0%)	b1 (28°C)	42.00±12.49	61.33±17.47	51.67 ^d
	b2 (10°C)	27.33±3.06	48.00±15.62	37.67 ^b
a2 (6%)	b1 (28°C)	38.67±13.32	24.00±17.09	31.34 ^a
	b2 (10°C)	41.33±2.31	40.67±5.91	41.00 ^c
Average AC		34.67 ^b	54.67 ^d	
		40.00 ^c	32.34 ^a	

Description: ^{a,b,c,d} Different Superscripts in the same column or row show significant differences (P>0.05)

4. CONCLUSION

Based on the results of the research conducted, it can be concluded that the addition of *Lactobacillus plantarum* levels with different temperatures and storage periods did not affect the physical quality of cooking loss and the water holding capacity of beef.

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