# The Effect of Blast Chilling and Blast Freezing System on The Quality of Processed Beef Product

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## ABSTRACT

*Beef, the third most widely consumed meat in the world is very popular for the people. However, beef is one of the perishable meats. Therefore, a proper beef storage process is needed. The storage process used blast chilling and blast freezing system. Blast chilling and blast freezing are the method of storing products with certain temperature conditions and fast cooling time, which can maintain the physico-chemical quality without affecting the taste of the meat in order to maintain its quality. The purpose of this study was to determine the effect of storage using the blast chilling and blast freezing method for 30 days on the physico-chemical quality of beef and to determine the level of panelists' acceptance of sensory attributes including color, texture, taste, and overall acceptability. The research method was carried out in blast chilling, the temperature was 3℃, while for the blast freezing the temperature was -18℃. The meat storage period for each method was 30 days, then pH, moisture content, water holding capacity, cooking loss, and sensory tests were carried out. Based on the research results, blast chilling and blast freezing methods tend to increase the water content of beef, but the pH level of beef tends to decrease significantly (P<0.05). The results of the water holding capacity and cooking loss test showed non-significant results. Sensory test results also showed non-significant results. From this study, it can be concluded that the method of storing meat (blast chilling and blast freezing) is able to maintain the water content and pH of the meat, as to minimize the cooking loss, the sensory results indicate that the blast chilling and blast freezing are able to maintain consumer acceptance of processed beef products even after being stored for 30 days.*

**Keywords:** *Blast chilling, blast freezing, beef*

## INTRODUCTION

Food is one of the basic needs that are very important in human life. One of the most consumed meat is beef. The meat product from beef is a protein source of animal that is easily damaged. One of the ways to prevent food spoilage is the preservation system (1).

At this time, food preservation is very important. Meat preservation aims to secure meat from damage or decay by microorganisms, inhibit the growth and development of microorganisms or pathogenic bacteria and spoilage so as to maintain and improve the physical quality of meat, extend shelf life, and increase meat supplies (2).

One way to preserve beef product is by refrigeration. In order to maintain the quality of food, the growth of pathogenic bacteria must be slowed (inhibited) by lowering the room temperature. The proliferation of the bacteria with a temperature below 10℃ becomes very low so that the process of food spoilage can be slowed down as well. However, frozen storage also has the consequence of decreasing the quality of the physical and chemical characteristics of the product (3).

Therefore, it is necessary to have a system that is able to maintain the quality of the meat by cooling it in a short period, namely blast chilling and blast freezing. The function of blast chilling is to lower the temperature up to 3℃, retain the color of the product, and maintain the tenderness of the meat texture. While the blast freezing is also used for fast freezing with a temperature of -18°C so as to maintain the quality of the meat (4).

## MATERIAL AND METHODS

The processed beef product was stored using a blast chill system (Irinox MF Next S machine) for 19 mins with the temperature 3°C. The beef product was separated between vacuum and non-vacuum. The vacuum process was carried out using the (Orved Cuisson 31 machine). After that, the beef product was stored for the blast chilling method in the chiller for 30 days at a temperature of 3°C (5).

For beef research sample with using the blast freezing method, the samples was stored in (Irinox MF Next S) with the temperature of -18°C for 24 minutes. After that, the samples were separated between vacuum and non-vacuum. The vacuum process was carried out using the (Orved Cuisson 31 machine). Next, the sample for the blast freezing method was stored in the freezer at a temperature of -18°C for 30 days.

After 30 days, the sample was separated for control, vacuum blast chilling, non-vacuum blast chilling, vacuum blast freezing, and non-vacuum blast freezing. After completion of storage, for the blast freeze method, thawing is carried out first in the chiller until the meat is not frozen. Next, grilled the beef until it was half cooked (200°F) using the (Convotherm Maxx 6.10 ET ES machine). The observations were pH level, water content, water holding capacity test, cooking loss test, and sensory.

The principle of water content analysis was to determine the content or amount of water contained in a material by evaporating the free water molecules contained in the sample by heating, then it was weighed to a constant weight (6)

The test for pH levels used a pH meter. The instrument was calibrated with a buffer at pH 4 and pH 7. The electrode was rinsed with distilled water for 1 min. The 0.5 g of meat sample was mashed with a mortar and put in 1 mL of distilled water. Then, the electrode was dipped into the sample and the pH value could be read on the pH meter screen (7).

The method for analysis of water holding capacity was by calculating the total water content. Then, the free water content was calculated based the data from total water content (8).

Cooking loss analysis was carried out by weighing a 20 g sample as the initial weight and the sample was put into a plastic bag. After that, the sample was cooked at 75°C for 15 mins, then the sample was cooled at room temperature for 1 h and weighed again for final result (9)

The sensory test was carried out using the hedonic test method on 30 semi-trained panelists. The rating scale used includes a scale of 1 to 5 (10)

The research data were analyzed by One Way ANOVA test using the SPSS statistical program, there was five replications for all treated samples. Further testing was carried out by using Duncan's test with a level of 5%.

## RESULT

Based on Table 1, it can be seen that the control beef was significantly different (P<0.05) with vacuum blast freeze, non vacuum blast freeze, vacuum blast chill, and non vacuum blast chill methods on pH value and water content.

**Table 1. Effect of blast chilling and blast freezing on pH and water of beef**

| Treatments | Parameters | |
|---|---|---|
| | pH | Water |
| Control | $5.48 \pm 0.01^{a}$ | $54.02 \pm 0.66^{d}$ |
| Vacuum freeze | $5.27 \pm 0.01^{c}$ | $60.77 \pm 1.06^{a}$ |
| Non vacuum freeze | $5.32 \pm 0.02^{b}$ | $61.10 \pm 0.63^{a}$ |
| Vacuum chill | $5.12 \pm 0.01^{e}$ | $55.57 \pm 0.28^{c}$ |
| Non vacuum chill | $5.24 \pm 0.02^{d}$ | $58.67 \pm 0.81^{b}$ |

The results from Table 1 also showed that beef using the vacuum blast freeze method was not significantly different from beef using the non-vacuum blast freeze method.

**Table 2. Effect of blast chilling and blast freezing on WHC and cooking loss of beef**

| Treatments | Parameters | |
|---|---|---|
| | WHC | Cooking Loss |
| Control | 34.41 ± 4.68[a] | 13.75 ± 4.78[a] |
| Vacuum freeze | 33.52 ± 5.93[a] | 16.25 ± 4.78[a] |
| Non vacuum freeze | 35.61 ± 7.66[a] | 15.00 ± 4.08[a] |
| Vacuum chill | 27.44 ± 2.92[a] | 11.25 ± 2.50[a] |
| Non vacuum chill | 36.70 ± 5.97[a] | 12.50 ± 2.88[a] |

The result from Table 2 showed that all samples were not significantly different (P>0.05) in water holding capacity (WHC) and cooking loss. The storage period for 30 days also showed the non-significant effect in every parameters.

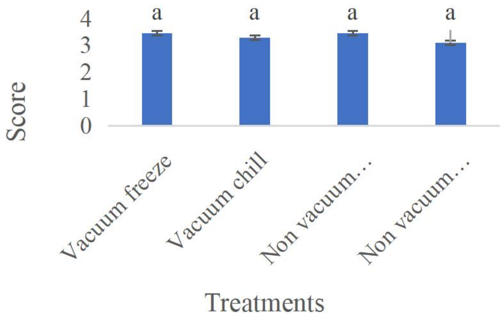


**Figure 1. Graph of color parameters**

The color parameter as shown in Figure 1, it can be seen that all samples were not significantly different (P>0.05). The total of 30 semi-trained panelists reported the non-significant sensory score in color.

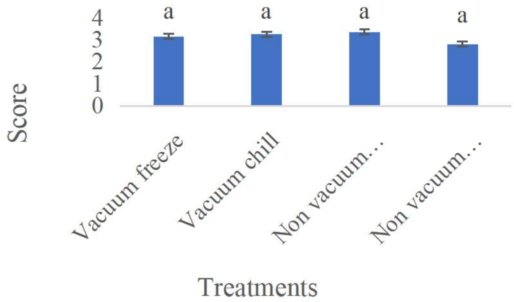


**Figure 2. Graph of texture parameters**

In the texture parameters as showed in Figure 2, it can be seen that vacuum blast freeze, non vacuum blast freeze, vacuum blast chill, and non vacuum blast chill methods were not significantly different (P>0.05).

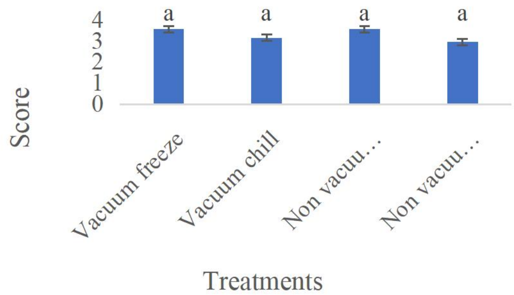


**Figure 3. Graph of taste parameters**

The result from Figure 3 showed that the processing of beef processed product by using the blast chilling and blast freezing, vacuum and non vacuum methods were not significantly different in taste parameters. All of the panelist reported the non significant (P>0.05) result in the taste score of all treatments.

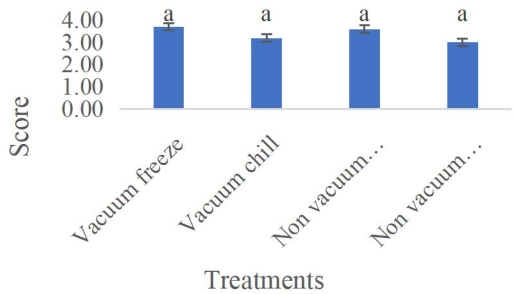


**Figure 4. Graph of overall acceptability parameters**

Based on Figure 4 it can be seen that all of treated samples were not significantly different (P>0.05) in overall acceptability score.

## DISCUSSION

The value of water content in processed beef products using the blast freezing, both vacuum and non-vacuum, has a higher value than the water content using the blast chilling method both vacuum and non-vacuum, because at -18°C the produced of ice crystals was higher in the muscle tissue of the meat, that was not damage the cells, so that the amount of drip of the meat was reduced. The freezing rate determines the size of the ice crystals formed (11).

The water content of the blast freezing method was also higher than the control. This correlated with the freezing rates that determines the size of the ice crystals formed, which in turn will affect the quality product. In fast freezing, soft ice crystals will form and if the freezing temperature is lowered very quickly, ultra-microscopic (very soft) ice crystals will form (12).

The pH value of beef processed products using the vacuum blast freezing and non-vacuum reported significantly higher compared to the vacuum blast chilling and non-vacuum. The storage for 30 days at -18°C slowed down enzyme activity. During the storage process, there was enzyme activity that causes the decomposition of chemical compounds from meat, especially proteins which are broken down into simpler compounds (13). The control sample had a higher pH value compared with all treated samples both at cold and frozen temperatures. However, all the pH levels of samples were still within the range pH (5.1 to 6.1), which means the beef was still in good quality.

The value of water holding capacity was not significantly different (P>0.05) because the water that comes out of the meat was free water, while strongly bound water and weakly bound water were still contained in the treated samples. The decrease in water holding capacity due to protein denaturation during cooking which causes a decrease in the water binding capacity of meat proteins (14). Meanwhile, the freezing process cause increase the damage of meat proteins, so that the water binding capacity of meat proteins will be weaker, which will cause a decrease in the value of water holding capacity (15).

The results from Table 2 showed that the cooking loss value in all of treated samples was not significantly different (P>0.05). During the frozen storage there were changes in muscle protein, which will reduce the water holding capacity of the meat protein and increase the amount of fluid that drips from the meat due to the freezing process and frozen storage of meat. In addition, the rate of freezing and the size of the ice crystals formed also determine the amount of drip when thawing frozen meat (16). The value of cooking loss was also related to the value of water holding capacity, the treatment of blast chilling and blast freezing to the beef in 30 days of storage period showed the non significant results.

Based on sensory parameters as listed in Figure 1, Figure 2, Figure 3, and Figure 4, it can be seen that all samples were not significantly different (P>0.05). The processing of beef using the blast chilling and blast freezing methods did not affect the color, texture, taste, and overall acceptability. This is because in slow freezing it will form large ice crystals (macrocrystals) in the extracellular space. While in blast chilling or blast freezing, the resulting crystal size is microcrystal so it doesn't have much impact on the color change of the meat. The rapid freezing process reduces the risk of microorganism growth so that it does not affect the taste and texture of the meat. This results was in accordance with (17) who stated the level of preference for the taste and texture is influenced by the microstructure of the meat and the risk of microorganism growth. The level of panelists' acceptance of beef storage with a blast chilling system showed a tendency to decrease consumer acceptance. This is because of each parameter, the most preferred sample is beef with the blast freezing method

## CONCLUSION

From this research, it can be concluded that the method of storing meat (blast chilling and blast freezing) is able to maintain the water content and pH of the meat, as to minimize the cooking loss. The sensory results indicate that the blast chilling and blast freezing system are able to maintain consumer acceptance of processed beef products even after being stored for 30 days.

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## REFERENCES

1. Elansari A, Bekhit DA. Processing, storage, and quality of cook-chill or cook-freeze foods. *Food Engineering Series*. 2014;1(7):777-830. http://dx.doi.org/10.1007/978-3-319-10677-9_7
2. Pizato S, Cortez-Vega WR, Prentice C. Quality assessment of cooked chicken breast meat at different storage temperatures. *International Food Research Journal.* 2015;22(1):143-154.
3. Pathare PB, Roskilly AP. Quality and energy evaluation in meat cooking. *Food Engineering Reviews*. 2016;8(4):435-447. https://doi.org/10.1007/s12393-016-9143-5
4. Tan FL, Fok SC. Freezing of tilapia fillets in an air blast freezer. *International Journal of Food Science and Technology*. 2009;44:1619-1625. http://dx.doi.org/10.1111/j.1365-2621.2009.01930.x
5. Tribst AAL, Falcade LTP, de Oliveira MM. Strategies for raw sheep milk storage in smallholdings: Effect of freezing or long-term refrigerated storage on microbial growth. *Journal of Dairy Science*. 2019;102(6):4960-4971. http://dx.doi.org/10.3168/jds.2018-15715
6. Hubáčková M, Ryšánek D. Effects of freezing milk samples on the recovery of alimentary pathogens and indicator microorganisms. *Acta Veterinaria Brno*. 2007;76(2):301-307. https://doi.org/10.2754/avb200776020301
7. Li J, Xie J. Numerical simulation of freezing time of shelled shrimps in an air blast freezer and experimental verification. *Transactions of the Chinese Society of Agricultural Engineering*. 2009;25(4):249-252.
8. Indrasena WM, Hansen LT, Gill TA. Effect of cold-smoking and drying on the textural properties of farmed Atlantic salmon (Salmo salar). *J. Aquat. Food Prod. Technol*. 2008;9:47-64.
9. Aaslyng MD, Bejerholm C, Ertbjerg P, Bertram HC, Andersen HJ. Cooking loss and juiciness of pork in relation to raw meat quality and cooking procedure. *Food Qual Prefer*. 2003;14:277-288.
10. Lagerstedt Å, Enfält L, Johansson L, Lundström K. Effect of freezing on sensory quality, shear force and water loss in beef M. longissimus dorsi. *Meat Sci.* 2008;80:457-461.

11. Zhu S, Le Bail A, Ramaswamy HS. Ice crystal formation in pressure shift freezing of Atlantic salmon (Salmo salar) as compared to classical freezing methods. *J Food Process Preserv*. 2003;27:427-444.
12. Tippala T, Koomkrong N, Kayan A. Influence of freeze-thawed cycles on pork quality. *Anim Biosci*. 2021;34:1375-1381. http://dx.doi.org/10.5713/ajas.20.0416
13. Choi MJ, Min SG, Hong GP. Effects of pressure-shift freezing conditions on the quality characteristics and histological changes of pork. *LWT-Food Sci Technol*. 2016;67:194-199. https://doi.org/10.1016/j.lwt.2015.11.054
14. Chun JY, Min SG, Hong GP. Effects of high-pressure treatments on the redox state of porcine myoglobin and color stability of pork during cold storage. *Food Bioproc Technol.* 2014;7:588-597. http://dx.doi.org/10.1007/s11947-013-1118-4
15. Kim EJ, Lee SY, Park DH, Kim H, Choi MJ. Physicochemical properties of pork neck and chicken leg meat under various freezing temperatures in a deep freezer. *Food Sci Anim Resour.* 2020;40:444-460. https://doi.org/10.5851/kosfa.2020.e24
16. Xanthopoulos G, Mitropoulos D, Lambrinos G. Estimation of heat and mass transfer coefficients during air-freezing of cucumber. *Int J Food Prop*. 2012;15:221-235. http://dx.doi.org/10.1080/10942911003778006
17. Pavlov A. Changes in the meat from aquaculture species during storage at low temperature and attempts for differentiation between thawed-frozen and Fresh chilled meat. A review. *Bulgarian Journal of Veterinary Medicine*. 2007;10:67-75.