Impact of environmental temperature to the content of protein on fresh, cold and frozen meat

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Abstract. This study aims to determine the amount of protein content in Aceh cattle beef in the quadriceps muscle (chuck) and to find out the best storage between cold and frozen to protein levels of beef. This study used 10 samples of Aceh cattle beef parts of the quadriceps (chuck) which were divided into 3 treatment groups, group I meat was treated in fresh condition, Group II meat was treated in cold at 8 °C and Group III meat will be treated in frozen at -19 °C. Protein content in meat was analysed by the Independent Samples Test. The results showed that the amount of Aceh beef protein in the quadriceps (chuck) in fresh; 15, 47%, cold 10, 20% and frozen; 9, 97. It was concluded that storing meat in cold and frozen ways is affect the protein content. Frozen meat storage is better to keep protein content than Cold meat storage.

1. Introduction
Meat of cow, or in other terms known as beef, is one of the livestock products that is widely consumed and utilized by many people throughout the country, including in Indonesia. The distinctive and delicious taste and nutritional content that is beneficial for the development of human organs make the demand for beef continues to increase every year [1]. The tenderness and taste of meat are factors that influence the level of consumer preference for meat, plus meat has high protein quality and contains complete and balanced essential amino acids [2,3].

Meat that comes from the muscles of the hamstrings tends to provide a higher level of meat consistency, and vice versa, meat that comes from the muscle type of front lamusir has meat with a softer texture. The quality factors of the meat eaten mainly include tenderness, color, and flavor and meat oil essence [4] In addition, intramuscular fat, cooking loss, nutritional value or chemical properties and pH of the meat also determine the quality of the meat. The chemical properties of meat include protein, fat, dry matter and water content. Protein is mostly found in muscle and connective tissue [5,6].

Protein is the main macro-molecular component needed by living things in the formation of new cells to replace damaged cells. Protein is the most important substance in every organism as the main source of energy in addition to carbohydrates and fats, as substances that regulate metabolism and is also part of all living cells which is the largest part of the body after water [7,8]. Protein is needed by the body in the formation of new cells. If there is a lack of protein in the body, it will experience growth inhibition [6].
The results of reported study mentioned that the average protein content of Aceh beef in the Longissimus dorsi region was 15.94% [7,9]. Meanwhile, regarding the protein content of Aceh beef in the chuck region in terms of fresh, cold and frozen conditions, there is not much information found, therefore it is necessary to do research on protein content testing in the chuck section of Aceh beef in fresh, cold and frozen conditions.

2. Materials and methods
2.1. Meat samples
Samples of 2-3 years old male aceh beef in the quadriceps muscle (chuck) were taken from the Lambaro market, kec. Want Jaya, Kab. Aceh Besar, NAD Province. A total of 10 meat samples were immediately taken to the laboratory in plastic bags and then weighed 50 grams per sample and divided into 3 treatment groups [1,10]. Group I fresh meat is meat that is directly inspected without undergoing any preservation process. Group II cold meat is meat that is treated with cooling at 4˚C for 5 days. Group III frozen meat was fresh meat which was treated with freezing at -18˚C for 10 days.

2.2. Protein Analyses
Then a laboratory test of the amount of Protein content was carried out using the Kjeldhal method which consists of three stages, namely the stage of destruction, distillation and titration [11].

2.3. Data Analyses
The results obtained were analyzed data. The data obtained from the results of this study were analyzed by Independent Samples Test with the help of the SPSS 16.0 for Windows program.

2.4. Freezing optimization
The freezing rate, temperature and time were optimized using a self-developed software. It is built with 3 forms of graphic user interface (GUI), where the first part is the splash screen, the second GUI is the main program, and the third GUI is for detailed software information. Several models were used to develop the computer simulation as follows:

\[ R - U = X^* - X^c = \frac{6}{\pi^2} \sum_{n=1}^{\infty} \frac{1}{n^2} \exp \left( -\frac{n^2 \pi^2 D_o t}{9} \right) \left( \frac{3}{R} \right)^2 \]  
(1)

\[ \eta_i = A X_{cp} \eta_{cp} + B X_{m} \eta_{m} + C X_p \eta_p + D X_g \eta_g \]  
(2)

\[ \frac{dN}{dt} = rN \left( 1 - \frac{N}{K} \right), \quad \frac{dN}{dt} = rN \left( 1 - \frac{N}{K} \right) - H \]  
(3)

\[ m = \frac{(1 - ka)}{m_m} \left( 1 - ka + Cka \right) \]  
(4)

\[ \frac{\partial \left[ h(p(t)(1-\varepsilon)) \right]}{\partial t} - \left( k (1-\varepsilon) \frac{\partial T}{\partial x} \right)_{x=x} + \frac{h}{(1-\varepsilon)} \left( C_p p(t)(1-\varepsilon) \right)_{t} = 0 \]
This software is a development of the previous Freezing V2 which is used for optimization and simulation of freezing animal products such as meat. In addition to the heat transfer parameters in the freezing process, the *Freezop* computer program also optimizes the Rb1 and Rb2 constants and the Biot number coefficient. The final result of this simulation is the optimum freezing time and temperature to avoid freezing injury in frozen products. The software also provides an overview of the distribution of heat changes that occur along temperature changes during freezing. The software is provided in the form of an executable file (*.exe) and a setup installation package that can be run directly or installed on a computer with a Windows operating system (OS) base.

3. Results and discussion

3.1. The Protein content of Chuck of Meat

Examination of the protein content of Aceh beef in the quadriceps muscle (chuck) was carried out in fresh, cold and frozen conditions. The protein content of Aceh beef in the quadriceps muscle (chuck) in fresh, cold and frozen conditions has an average of 15.47%, 10.20% and 9.97%, respectively. The results of this study indicate that fresh beef which is then stored by cooling and freezing will experience a decrease in its protein content. Storage in cold and frozen conditions also has different values in reducing protein content in meat as shown in Figure 1.

![Figure 1](image_url)

*Figure 1.* The average protein content of Aceh beef in the chuck section in fresh, cold and frozen conditions

Storage of beef by cold and frozen method is the storage most often done by the community by using a refrigerator to maintain the quality of the meat for a certain period of time, along with the length of time the storage of protein structure in the meat will change and can weaken the ability of the meat to bind fluids. Based on the results of this study, cold and frozen storage of beef has the same effect on its protein content. In this study, frozen meat decreased protein content more with an average of 9.97% than cold meat with an average of 10.20%. The comparison between the protein content of cold and frozen meat examined using the sample T test was not significantly different (P>0.05).

3.2. The Protein content of Chuck of Cold Meat

Meanwhile, beef Aceh quadriceps muscle (chuck) with cold storage at a temperature of 8°C for 5 days in the refrigerator, the protein content obtained an average of 10.20%. A good meat storage temperature for one week is -19°C to -5°C. Cold storage commonly used for foodstuffs is 0° to -10°C, meat in cold
storage can be maintained its quality for 8 days. From the results of statistical tests carried out with the sample T Test by comparing the protein content of beef quadriceps muscle (chuck) in fresh and cold conditions was significantly different (P <0.05), this result indicates the cold storage treatment carried out on beef, the protein content will be significantly different compared to fresh meat that is not given any storage treatment.

Refrigeration is a simple preservation method and is often used to store meat for a certain period of time. The growth of germs in meat can be inhibited, because cold temperatures will reduce the kinetic energy of all molecules in the system, thereby reducing the speed of chemical reactions including the metabolic activity of germ cells. Storage of meat by cooling is expected to prolong the shelf life of beef. This is because refrigeration can prevent the loss of water content from beef, slowing metabolic activity and microbial growth.

3.3. The Protein content of Chuck of Frozen Meat

Frozen storage is one of the best ways to maintain the quality of meat that can be done on beef in order to prolong its shelf life. A temperature of around -20°C is needed to store frozen meat and food (frozen food) for a long time. In this study, frozen storage was carried out in a refrigerator at a temperature of -19°C for 10 days and the average fat content was 9.97%. Compared to fresh meat, the protein content of frozen meat has decreased. The results of the comparison of protein content in fresh and frozen conditions with the sample T test were significantly different (P<0.05). The graphical user interface of freezing optimization is presented in Figure 2.

Figure 2. user interface of developed software for freezing optimization

Frozen storage of beef will affect the protein content contained in the meat, based on this study after frozen storage for 10 days the protein content of the meat decreased. Storage of meat by freezing it will certainly affect the condition of the meat, both its physical and chemical quality. Frozen meat products are an alternative choice in preserving meat to make it last longer, because it can inhibit the process of damage to meat and the freezing process does not change the meat to other processed forms, so that the
freshness of the meat can be maintained. Based on research, the protein content of Wagyu meat and Bali beef at frozen temperature decreased. The cause of the decrease in protein levels is due to drip discharge during thawing, causing the nutritional content of the meat to be lost and the possibility of the difference in meat freshness being one of the causes of the difference.

4. Conclusions
Based on the results of the analysis and discussion, it can be concluded that cold and frozen storage reduces the protein content of meat. Consuming meat in its fresh condition is very good to get full nutrition from meat.

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