5-P59

EFFECT OF HUMIDITY STABILIZING SHEET ON COLD STORAGE OF BEEF

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Background:
It is already known that humidity, temperature and air velocity are used to evaluate the effects of cold storage conditions on the color of exposed beef surface. Relative humidity of near 90%, air velocity of near 0.5 m/s, and near freezing temperature appear to represent the best environment for beef color maintenance[1]. From a practical point of veiw, however, it is difficult to keep this proper condition in a commercial refrigerator. Under the condition without air velocity, drip coming out from the meat must be removed from the surface to keep the optimized surface humidity. Pulp or absorbing sheets are used for this purpose, but it causes surface desiccation of the meat. Fluctuation of temperature significantly affects relative humidity at near freezing temperatures. Strict temperature control is required to maintain high humidity without occurrence of dew. Recently humidity stabilizing sheet (Red Keeper, Showa Denko Plastic Products) is used in expectation of maintaining the color of meat suface or keeping the freshness of meat in the kitchen of restaurants or backyard of supermarkets in Japan. Red Keeper contains glycerol,as humidity stabilizer, pulp and absorbing polymer,as liquid absorbing material. Glycerol absorbs and transpires moisture quickly according to the equilibrium hygroscopic curve at low temperatures. It prevents the meat surface from occurrence of dew and desiccation. However, the effect of Red Keeper on maintaining freshness during cold storage beef was not confirmed so far.

Objectives:
The objectives of this study is to obtain the effect of humidity stabilizing sheet on ATP and related compounds (ARCs) and percent metmyoglobin (Met%) of cold storage beef. Measurements made on the samples stored for 7 days included : evaluation of myoglobin oxidation rate by photospectrometry and ARCs are determined by HPLC as freshness index.

Methods:
Materials ;
Meat used in this study was muscles biceps femoris of Japanese Black Cattle obtained from Minamikyushu Chikusan Kogyo K.K. It was vacuum packed and stored 4 days in chilled refrigerator after slaughter. Humidity stabilizing sheets (containing stabilizing agent at different levels :0g/cm^2 as reference,10g/m^2,40g/cm^2) were obtained from Showa Denko Plastic Products K.K. Glycerol was used as humidity stabilizer in this study. Fig.1 shows the cross-section of the humidity stabilizing sheet. Humidity stabilizing agent is sprayed onto pulp containing absorbing polymer. This pulp is held between nonwoven-fabric sheet and polyethylene film.
Sample preparation;
Muscles biceps femoris was divided into 5 pieces of a 200g portion. Each portion is wrapped with a humidity stabilizing sheet, put into Tapper-ware and covered tightly with a lid. Portions wrapped without sheet or wrapped with sheet having no glycerol were also tested as a reference. Each Tapper-ware was kept 7 days in refrigerator at 4 ℃ . From each sample, a 1g portion of 2cm square was removed from surface of meat and pretreated for further analysis.
Percent metmyoglobin;
Myoglobin was extracted from meat portion with cold (0 ℃) water. 1g sample was homogenized twice for 1 min with a 10-s interval on setting 5 using Polytron homogenizer in 15ml of water. Homogenates were centrifuged for 20 min (16000rpm, 2 ℃) and the supernatants were filtered through Advantec No.5 filter paper. Absorbance of the filtrates was measured at 525, 572 and 730 nm using Bio Spec (Shimadzu) model 1600 double beam spectrometer with 1 cm crystal cell. Percent metmyoglobin was calculated using the following formula described by Krzywicki (1979)[2] with the turbidity correction suggested by Goldbloom and Brown (1966):[3]

$$\text{Metmyoglobin}\,(\%) = \left(1.395 - \left\{\frac{[A572-(A730\times 1.45)]}{[A525-(A730\times 1.73)]}\right\}\right)\times 100$$

ATP and related compounds;
ATP (adenosine triphosphate) , ADP (adenosine diphosphate) , AMP (adenosine monophosphate) , IMP (inosine monophosphate) , RHx (inosine) and Hx (hypoxanthin) are determined by HPLC as ARCs. ARCs were extracted from the meat portion with cold (0 ℃) trichloroacetic acid (TCA). 1g of minced sample was homogenized twice for 1 min with a 10-s interval on setting 5 using Polytron homogenizer in 20ml 5%TCA and stored 1 hour at 4 ℃ . Homogenate was centrifuged for 20 min (16,000rpm, 2 ℃) and supernatant was filtrated through Advantec No.5 filter paper. Ppt was extracted again with 20 ml 5% TCA. Two supernatants are combined and 5% TCA was added until 50 ml. 5 ml of supernatant was extracted 3 ml of diethylether 3 times. Diethylether was removed from aqueous layer by rotary evaporator. Water was added until 5ml. 0.2ml of solution was diluted with eluent and was used for HPLC analysis. ARCs were determined by HPLC on HAISIL ODS 100-C18-4D (Showa Denko K.K.) column with MetOH:20mM KH_2PO_4-5mM tetra-n-butyl-ammonium hydroxide=3:7, and the absorbance of the eluate was measured at 254nm. K value is regarded as freshness index. It is calculated using the following formula described by T. Saito et al. (1969):[1]

$$K\,(\%) = \frac{RHx+Hx}{ATP+ADP+AMP+IMP+RHx+Hx}\times 100$$

As formula shows, fresh meat gives small K value.

Results and discussions:

Percent metmyoglobin;

Myoglobin oxidizes, changing in color from pink-red (oxymyoglobin, MbO2) to brown or gray (metmyoglobin) . This is known as one of the major reaction of undesirable beef surface discoloration. To keep Met% low is effective for keeping color of the meat portions. Fig.2 shows photospectroscopy of meat portions stored 7 days at 4 ℃ , examined in this study, and Fig.3 shows Met% of meat portions calculated from the result of photospectroscopy. Samples stored without sheet give ca.90% of Met%, those stored with a sheet containing no glycerol (drip absorbing sheet) give 60%, those stored with a sheet containing 10g/m^2 give 50%, and those stored with a sheet containing 40g/m^2 give 35%. Drip absorbing sheet is effective and humidity stabilizing sheet is more effective for preventing the increase of Met% in cold storage beef.

ATP and related compounds;

The changes of extractive components in relation to freshness of beef have been studied extensively. ARCs component ratio is considered as a freshness index of the meat. ATP is metabolized into uric acid through ADP, AMP, IMP, RHx, Hx. Progress of this metabolism is regarded as deterioration of the freshness. Fig.4 shows the ARCs determination of the meat portions wrapped with glycerol containing sheets and stored for 7days and Fig.5 shows Kvalue calculated from ARCs determination result. As peaks of RHx and Hx were not baseline resolution, RHx + Hx is described as Hxs in this study. Portions wrapped with drip absorbing sheet and portions stored without were also examined as a reference. Metabolization from ATP to IMP is known as fast reaction. Most of ARCs determined in this study were IMP and Hxs. Storing the portions by wrapping with the sheet containing glycerol seems to be effective for maintaining the total ARC and IMP concentration. Hx consumption to uric acid may cause a reduction of total ARC consentration of portions stored without glycerol. IMP/Hxs ratio of portions stored without glycerol also decreased. K value --freshness index-- of the portion stored without sheet was 67%, with drip absorbing sheet was 70%, with a sheet containing 10g/m^2 was 48% and with a sheet containing 40g/m^2 glycerol was 51%. Portions wrapped with a sheet containing glycerol gives lower K value. From these results, glycerol is considerd effective for keeping the freshness of cold storage beef.

Conclusions:

THe use of the sheet containing humidity stabilizing agent (glycerol) inhibits the increase of percent metmyoglobin and K value of cold storage beef. It is effective for keeping freshness of exposed beef during refrigerated storage.

Pertinent literature

1) Tyre C. Lanier et al., J. Food Sci., 860-865,42 (1977)

2) Krzywicki, K.:Meat Sci.,3,1, (1979)

3) Goldbloom, D.E.& Brown,W.D.:Biochem. Biophys., Acta., 112,584 (1966)

4) Saito,T., Arai, K. and Matsuyoshi, M. : Bull. Japan. Soc. Sci.Fish., 24,749-750 (1969)

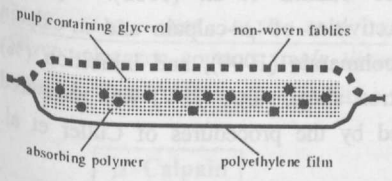

Fig.1 Cross-section structure of humidity stabilizing sheet.

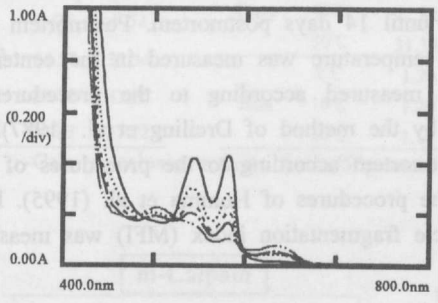

Fig.2 Photo Spectroscopy of meat portion wrapped with sheet and stored 7 days in Tapper-ware.
— sheet contains 0g/m2, — — — 10g/m2 of glycerol.
- - - - - 40g/m2. Stored wothout sheet - - — and initial portion ——— also examined as reference.

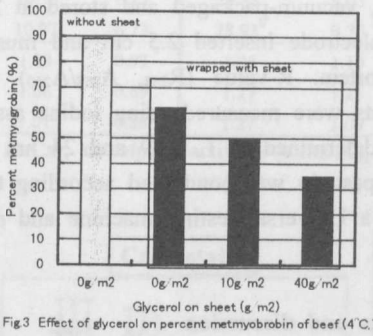

Fig.3 Effect of glycerol on percent metmyobrobin of beef (4℃,7days)

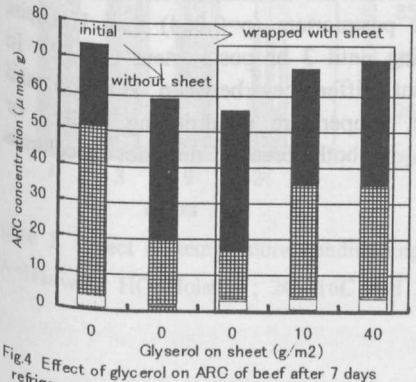

Fig.4 Effect of glycerol on ARC of beef after 7 days refrigerated storage at 4℃. ATP, ADP, AMP, IMP, Hxs(RHx+Hx). ARC deterimined by HPLC.

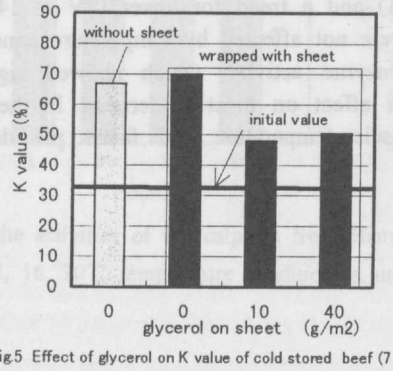

Fig.5 Effect of glycerol on K value of cold stored beef (7 days).