EFFECT OF DEHYDRATION ON MEAT QUALITY USING A CONTACT-DEHYDRATING SHEET

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SUMMARY

The behaviour of water removal in beef, veal and pork using a contact-dehydrating sheet was studied. This sheet comprise high osmotic pressure substance, polymeric water absorber and integrally covered with a semi-permeable membrane allowing permeation of water, and has an excellent dehydrating capacity. It was found that the layer directly in contact with the sheet dehydrated faster than the other parts. The dehydration rate was found largely dependent on the muscular water-binding capacity. The adipose tissue in bovine muscle was considered a hindrance in the diffusion of water molecule from the bottom layer to the upper layer and to the sheet.

After the removal of large amount of water in the upper layer of dehydrated beef, the myoglobin was concentrated, hence appeared a dark red colour. It was noticed that there is a positive proportional relation between the weight decrease and iron levels. There was a corresponding increase in redness and iron content in veal and pork where the iron content is in the range of 0.93-1.09 mg% and 0.88-1.16 mg%, respectively.

INTRODUCTION

Various dehydration methods have been used to preserve meats and other foodstuffs. Water can be removed directly or indirectly, however, the conventional methods pose many problems and one of them is protein denaturation which results to change in physical properties. In the conventional osmotic dehydration, mass transfer between solution and foodstuffs occurs when the food is immersed into an osmotic solution and stops when equilibrium is reached and their products are usually regarded harmful to health.

Recently, a dehydrating device called contact-dehydrating sheet was introduced to have an excellent capacity in dehydrating foods (Numamoto et al. 1976; Kurakake 1984; Matsubara 1985). The sheet is composed of high osmotic pressure substance, polymeric water absorber and integrally covered with a semi-permeable membrane allowing selective permeation of water. The high osmotic pressure in the sheet is the driving force which hastens removal of water when the foodstuffs come in contact with it. This sheet differs from the conventional osmotic dehydration method in the sense that osmotic agents in this sheet are not diffusable and so not harmful (Matsubara 1985). Furthermore, this sheet is considered superior to other methods due to its high speed of dehydration and low cost (it can be reused after air drying). This can be carried out without heat treatment so it can reduce protein denaturation.

Although this sheet offers an alternative to the conventional methods, there is not enough information on the behaviour of water removal and other changes on the quality of meat during dehydration. In this study, the effect of dehydration on meat quality using beef, veal and pork with a contact-dehydrating sheet was carried out.

MATERIALS AND METHODS

Materials

Bovine muscles chilled at 1°C from 12 day post mortem fillet (*M.psoas minor*), sirloin (*M.longissimus dorsi*) and round cut (*M.quadricepus*) were obtained randomly at a retail store. Chilled muscle samples from round cut of veal, ham and also ribs of beef were used. All the samples used were stored at 0°C to -2°C.

A contact-dehydrating sheet (Pichitto), a product of Showa Denko Co., Tokyo, was used throughout the study (Fig.1).

Methods (sample preparation and dehydration)

Bovine fillet and sirloin muscles were divided into three parts, one of the three parts was divided into two portions, one was used immediately and the other was stored at 1°C for 1 week and at -18°C for 4 weeks. The last two parts were used for dehydrating experiments at the end of the storage period. Frozen muscles were partially thawed at room temperature at 20°C for about three hours before dehydration.

Muscles were sliced into 1.5 cm thick and were wrapped in cellophane prior to the study. Dehydration was carried out by covering the wrapped samples with the sheet on the top side and stored at 3°C for a specified period. Dehydrated samples were sliced horizontally along the treated side into 3 layers of equal thickness. The layer directly in contact with the sheet during dehydration was coded upper layer, the next was middle layer and the last was lower layer. Veal and pork muscles were sliced into 1.5 cm thick and wrapped with the sheet. Dehydration was carried out at 3°C for a specified period.

Table 1. Percentage of expressible drip and its effect on the weight decrease of bovine muscle during 24 hr dehydration

Sample		Dehydrated				
Muscle	Treament	Expressible drip(%) [a]	Weight decrease(%) [b] U	M	L	Mean weight decrease(%) [c]
Fillet	fresh	41.4 ± 1.6	27.5	18.1	13.9	19.8
	chill storage	47.6 ± 0.7	32.9	19.1	14.9	22.3
	frozen storage	44.7 ± 1.6	25.6	12.7	8.1	15.5
Sirloin	fresh	37.9 ± 3.6	20.5	10.4	4.5	11.8
	chill storage	40.0 ± 3.6	28.1	16 1	3.7	16.0
	frozen storage	38.2 ± 2.1	24.5	9.3	3.5	12.4

a Each datum represents mean ± S.E. from 6 measurements
b U:upper layer; M: middle layer; L: lower layer
c Data in parenthesis show the amount of free drip loss during thawing

Table 2. Relation between the iron content and the color of veal, pork and beef.

Veal				Pork				Beef			
Fe*	Hunter color			Fe	Hunter color			Fe	Hunter color		
	L	a	b		L	a	b		L	a	b
0.71	32.7	13.8	14.8	0.67	39.4	7.4	7.5	1.82	29.0	16.0	7.4
0.76	32.0	11.8	14.8	0.82	36.0	6.2	6.8	1.88	25.9	14.1	5.3
0.88	31.0	13.8	14.9	1.88	30.7	7.2	7.2	2.02	24.1	12.5	4.7
0.93	31.8	12.4	14.1	0.93	28.6	6.8	6.4	2.21	20.3	11.8	4.4
1.02	24.5	14.7	11.8	0.97	27.4	7.2	7.3	2.33	19,7	10.3	3.8
1.09	27.3	15.3	13.1	1.16	24.2	8.4	6.1	2.51	19.7	10.3	3.8

* : mg Fe/100 g meat

Photographing and colour measuring were performed at the same time after the 24 hr treatment.

Testing Methods

The moisture, ash and iron contents, and the crude fat were determined by the AOAC (1980) method. The water-holding capacity expressed as the amount of expressible drip was determined according to the modified method of Bito (1978). The weight decrease was calculated from the moisture content of the samples measured before and after dehydration. The drip was determined according to the method of Zarate et al. (1985). The surface colour was measured with a colour difference meter model ND-101 DP.

RESULTS AND DISCUSSION

The changes in the moisture content of each layer of samples after storage following a 24 hr dehydration is shown in Fig.2. It was found that the upper layers of both the fillet and sirloin samples dehydrated faster than the middle layers and the lower layers the slowest. The upper layer of sirloin compared with fillet was dehydrated more while the lower layer less.

The percentage of expressible drip and their effects on the weight decrease of fillet and sirloin muscles after 24 hr dehydration is tabulated in Table 1. The mean weight decrease of fresh muscle was found to be lower than the chill stored muscle. Considering the free drip loss during thawing, the 24 hr mean weight decrease of frozen stored muscles is almost the same as that of the fresh muscle. There is a little difference in dehydration rate between the fresh and the chill stored muscles in both the middle and lower layers but significantly different in the upper layers. Dehydrated frozen stored fillet has lower weight decrease than its counterpart layers in the dehydrated fresh and chill stored fillet muscles.

The decrease of water-holding capacity of beef muscle after a long storage as a consequence of protein denaturation is a well accepted fact (Lawrie 1974). Temperature and slow freezing also affect the water-holding capacity (Lawrie 1974; Khan et al. 1977).

Study on the effect of water-holding capacity on the behaviour of water removal during dehydration showed that fillet muscles stored at 1°C have a higher % of expressible drip than the fresh stored samples (Table 1). The expressible water which is non-binding was suggested to be easily removed during dehydration.

In Fig.2, the rate of water removal from the different depth of the fillet muscle was found varied. The water removal behaviour of dehydrated bovine sirloin muscles is similar to those of fillet. Chill as well as frozen storage increased the expressible drip and also increased the rate of water removal in sheet dehydration. The sirloin muscles seemed to have lower dehydration rate than the fillet. It appeared that sirloin has less non-binding water to be removed. Another factor which might be an obstacle in water diffusion is the presence of abundant adipose tissue in sirloin muscle which hinders removal especially in the middle and lower layers.

Study on the colour changes in beef muscles revealed that the upper layer had the darkest colour and the lowest Hunter colour values. The lower layer was quite similar to that of the control while the middle layer maintained redness better than the other layers.

The ratio of metMb and TBA value in the 5 day dehydrated and control samples are shown in Fig.3. A progressive increase in the amount of metMb formation and TBA value was found in the control while oxidation in the dehydrated samples was comparatively slow during the last three days of treatment. It shows that beef dehydrated for more than 2 days can have a preventive effect on oxidation of lipid and Mb. Since the TBA value and metMb ratio correlated well, the decrease in metMb formation could be utilized to determine the decrease of lipid oxidation in sheet dehydrated beef.

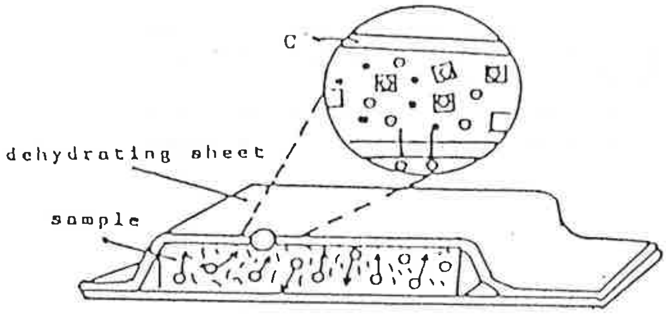

Fig.1. Principle and Construction of Contact-Dehydrating Sheet.

The free water in low osmotic pressure food is gradually conveyed to B by osmotic pressure as it comes in contact with B through A. The free water is then absorbed by C.

A : □ semipermeable plastic sheet

B : • high osmotic pressure substance

C : superabsorbent

o water molecule

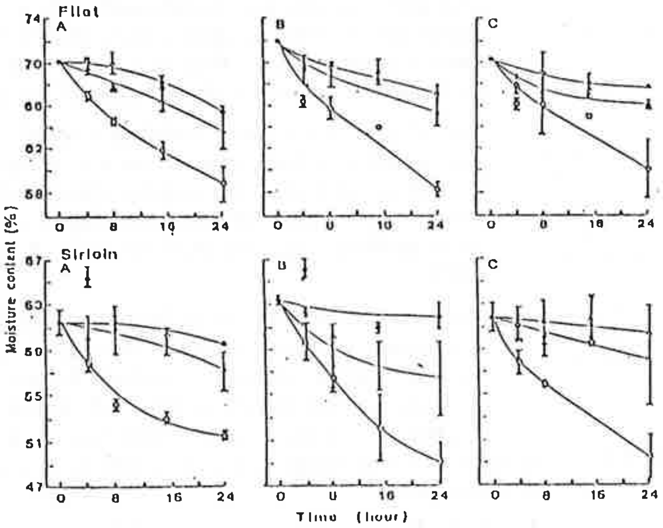

Fig.2. Changes in the moisture content of bovine fillet and sirloin muscles during dehydration.

Storage conditions:
A : immediately after purchasing
B : stored at 3°C for 1 week
C : frozen and stored at −18°C for 4 weeks

●: control ▵: lower layer
▲: middle layer o: upper layer

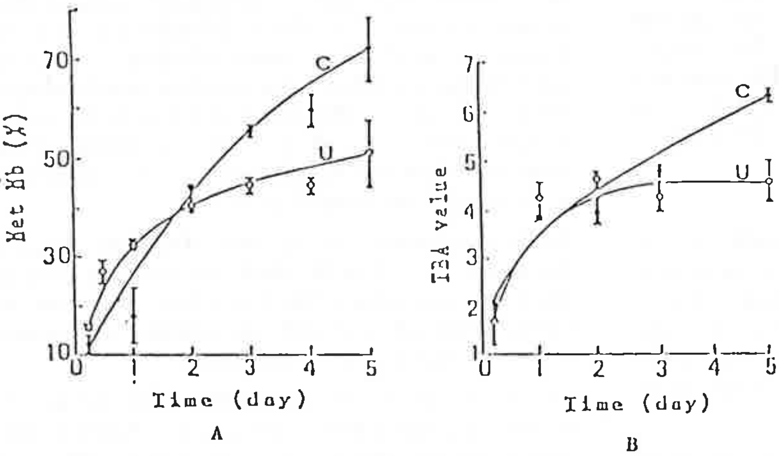

Fig.3.
A. Effect of dehydration on metMb formation in beef.
C : control
U : upper layer of undehydrated beef
B. Relationship between dehydration and TBA value in beef.

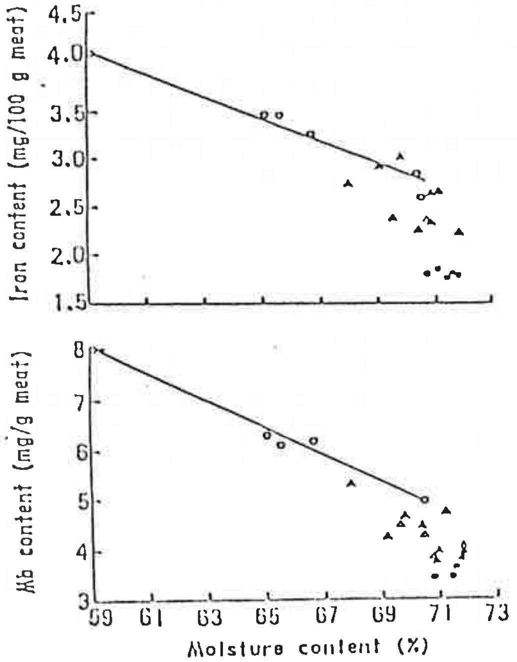

Fig.4. Relationship between moisture content and levels of iron and myoglobin in dehydrated beef.

●: control ▲: middle layer
o: upper layer ▵: lower layer

Although it has been widely accepted that oxidation of lipid and Mb are major factors causing the colour deterioration in meats, it was not so in this experiment because the upper layers ot the dehydrated samples showed significant changes in spite of low oxidation of Mb and lipid compared with the controls.

In Fig.4, we can find a corresponding increase in iron and Mb content with decreasing moisture content in all layers of dehydrated meat. The results demonstrate that bovine muscle red pigment was concentrated during dehydration. Since all the iron and Mb contents in the lower layer were a little higher than those of the control, it indicated that iron content of the lower layer was not reduced during dehydration. Only water was removed but the water soluble Mb in cytoplasm still remained. The relationship between the iron content and colour of veal, beef and pork is shown in Table 2. It was found that while the iron levels concentrated from 0.93-1.09 mg% in veal and from 0.88-1.16 mg% in pork, the corresponding increase in redness and iron content appeared. The colour changes was indistinguishable while the iron content of beef varied in the range of 2.02-2.51 mg%- the iron content of animal meats varies within the range ot about 1-2 mg%, the redness increase with the increase ot iron content while there appear no perceivable change in colour outside this range.

In conclusion, the dehydration rate is higher in the layer directly in contact with the sheet. The weight decrease and iron content are positively proportional and finally, the metmyoglobin and TBA values are lower in dehydrated beef than in the control.

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