EFFECT OF MAGNETIC FIELD FREEZING ON PORCINE *Longissimus dorsi* MUSCLE QUALITY TRAITS

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Abstract - This study was designed to perform analysis on the changes in pork meat when thawed after being applied air blast freezing, immersion freezing and magnetic fields freezing. Core temperature was measured while magnetic fields freezing were being processed on the sliced loins. The water-holding capacity was compared before and after the freezing and thawing according to the freezing methods. The magnetic fields-frozen loins were then thawed in four ways—cold water thawing, refrigerator thawing, room-temperature thawing, and water-thawing—after which water-holding capacity and meat color were evaluated. As a result, for the water-holding capacity, the magnetic fields-frozen sample shows the drip loss (1 day storage) and cooking loss the closest to fresh meat ($P < 0.001$). Among the thawing methods, cold-water thawing showed the lowest drip loss (1day storage) ($P < 0.01$). To sum up, based on the water-holding capacity, we can conclude that the magnetic fields freezing method is better than any other suggested. This is because the size of the ice crystal is small enough to prevent severe damage of the tissue thus allowing it to maintain the quality until after thawing.

Key Words – Fast freezing, Thawing, Pork quality

I. INTRODUCTION

Freezing is the mostly used way to preserve meat for a long time. The quality of frozen meat is determined by means to freeze, and thaw [1]. Meat is well-preserved if froze quickly in low temperature, and the ideal temperature is known as -15℃ to -35℃.Quick freezing can prevent drip loss in thawing because it forms small ice crystals in Cell membrane [2]. Quick freezing can prevent drip loss in thawing because it forms small ice crystals in Cell membrane [3]. The ideal preserva tion temperature to prevent quality loss during freezing meat is suggested as 55℃ [4], as enzyme reaction, rancid odor, and recrystallizability is minimized in this temperature. On the other hand, recently in Japan, freezer was developed using the principle of preservation of super-cooled state below the freezing point while water molecule both intra and extra-cellular is vibrating by magnetic fields. By co-working with ABI corporation LTD., Ltd., which produces freezer by using this magnetic field, we developed the "Cell Alive System (CAS)" and it is expected that this freezing method using the magnetic field can be applied to various food and raw materials for food.

II. MATERIALS AND METHODS

Freezing method

The *longissimus dorsi* muscles were obtained from the pigs (Jeju black pig, n=22) selected at a slaughtering house after 24 hours of chilling. Loin were cut into 5 ㎝, Separated and wrapped those pieces with polyethylene bag and put them on the tray. The pieces were froze successively (n=6) by air-blast freezing (ABF) in -40℃, magnetic fields freezing (MFF) in -50℃, and immersion freezing (IF) in -65℃ after vacuum packing. For the quality comparison of pork loin by different freezing methods, Thawed the froze pieces in the refrigerator (4℃). After thawing until the core temperature of pork loin became -1 to 2℃, The thermometer(177-T4, Testo, Germany)was inserted to conduct meat quality traits

Thawing method

Sample used cold water thawing in 4℃, refrigerator thawing in(RT) 5℃, room temperature thawing(RTT) in 17℃, and water thawing(WT) in 14℃. After thawing until the core temperature of pork loin became -1 to 2℃ by inserting thermometer (390D, Giltron Co., Taiwan) in the core of froze loin, samples were evaluated meat quality traits.

Water holding capacity

To measure water holding capacity(WHC) samples were measured drip loss and filter-paper fluid uptake(FFU). Drip loss was calculated by means of Honikel [5], which is the percentage of drip loss of the starting weight, after sampling pork loin with 4 ㎝-core, measuring weight, and storing for 48 hours in refrigeration temperature (4℃)

Cooking loss

Sample was cut in standard pieces(2x4x6 ㎝), measured weight, wrapped with polyethylene bag, and cooked them until the core temperature reaches 72℃ in 80℃ water bath(Kmc-1205SW1, Vision co., USA). Sample were cooled it for a while and measured weight of the diminished, and found out percentage of diminished weight of starting weight.

Meat color

In terms of color, we measured L*, a*, b* using Minolta chromameter(CR-300, Minolta Camera Co., Osaka, Japan) in the section of pork loin for three times, after cutting samples in low temperature (4℃) then exposing them in the atmosphere for 30 for minutes.

III. RESULTS AND DISCUSSION

The result of WHC and cooking loss after thawing by different freezing method are presented in Table 1. 1 day, air-blast freezing showed the highest drip loss percentage as 6.08±1.26%. Magnetic fields freezing showed significantly same result as fresh meat ($P < 0.05$). 2d, drip loss generally increased. The lowest was that of fresh meat and the highest was that air-blast freezing as 9.47±1.26% ($P < 0.05$), and no difference was shown between magnetic fields freezing and immersion freezing. Analysis result of cooking loss showed significantly same figure between fresh meat and magnetic fields freezing, and air-blast freezing showed significantly high values. ($p<0.05$) Water holding capacity measurement result by filter-paper fluid uptake showed that fresh meat was the best in terms of number, followed by magnetic fields freezing, immersion freezing, and air-blast freezing. However, those differences were not significant.

Table 1. Effect of freezing methods on the water-holding capacity of the *longissimus dorsi muscle*

	Freezing methods				
	Fresh meat	ABF (-40℃)	MFF (-50℃)	IF (-65℃)	Levels of Significance[1)]
FFU(mg)	67.33 [a] (13.90)	110.06 [b] (44.78)	85.50 [ab] (37.42)	85.50 [ab] (37.42)	NS
Drip loss (%, 1d)	3.68 [a] (0.66)	6.08 [a] (1.26)	3.90 [a] (1.19)	4.30 [ab] (2.02)	***
Drip loss (%, 2d)	5.91 [ab] (0.87)	9.47 [c] (1.26)	6.87 [b] (1.45)	7.07 [b] (1.27)	***
Cooking loss(%)	18.95 [a] (3.26)	26.38 [b] (4.04)	18.79 [a] (3.14)	20.79 [ab] (2.44)	***

[1)] NS, Not Significant; *** $P < 0.001$.
[a-c] Means (SD) with different superscripts in the same row significantly differ($P < 0.05$).
FFU, Filter paper fluid uptake.
ABF, Air blast freezing.
MFF, Magnetic fields freezing.
IF, Immersion freezing.

A research [6] shows that lower the freezing temperature is, smaller ice crystals were formed within tissue, and lesser thawing loss and cooking loss were shown. Also if preservation was lengthened, maintenance is affected due to recrystallization by combining of small ice crystals into big ones. However, in this research we thawed right after the freezing without setting the storing period. This research can regard that recrystallization was prevented, and also less tissue destruction occurred due to small formation of ice crystals, considering that the best maintenance was shown magnetic fields freezing.

The result of WHC by different thawing method are presented in Table 2. 1day and 2day, cold-water-thawing showed significantly less drip loss than other methods. A research of Lee and Park [7] shows that low maintenance depends on high thawing temperature. Our research also showed that the maintenance in room-temperature thawing, which is the highest temperature, was the lowest. The thawing method which was the quickest and showing the least drip loss was cold-water-thawing. This result is same as previous studies [8].

Table 2. Effect of thawing methods on the water-holding capacity of the *longissimus dorsi muscle*

	Thawing methods				
	CWT	RT	RTT	WT	Levels of Significance[1)]

Drip loss (%, 1d)	4.40 [b] (0.64)	6.86 [a] (1.56)	7.50 [a] (2.26)	6.57 [a] (0.96)	*
Drip loss (%, 2d)	7.00 [c] (0.70)	10.94 [ab] (1.44)	11.77 [a] (2.58)	8.96 [bc] (1.31)	**
Cooking Loss(%)	26.62 [a] (1.28)	28.59 [a] (1.60)	28.74 [a] (2.05)	27.58 [a] (6.42)	NS

[1)] NS, Not Significant; *** $P < 0.001$.
[a-b] Means (SD) with different superscripts in the same row significantly differ ($P < 0.05$).
CWT, Cold water thawing.
RT, Refrigerator thawing.
RTT, Room temperature thawing
WT, Water thawing.

IV. CONCLUSION

This study compared magnetic field freezing with the exiting freezing method, and its results showed that the magnetic field freezing had better water-holding capacity than the existing method. The results came from the judgment that ice crystal was so small at the time of freezing that the meat quality did not worsen after its thawing. Accordingly, an analysis on the magnetic field freezing should continue to be performed to increase the freezing method. In further studies, it is necessary to research how the recrystallizability of ice crystal during a period of preservation of meat processed through magnetic field freezing affects the quality of the meat.

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