DRIP LOSS AND MICROSTRUCTURAL CHANGES BY THAWING FROZEN PORK UNDER DIFFERENT CONDITIONS

Won-Ho Hong[1*], Dong-Seuk Kang[2], Chang-Hee Cho[3], Jiyeon Chun[1]

[1]Department of Food Technology, Sunchon National University, Jeonnam, Korea

[2]Department of Professional Engineer Food processing Research Institute, HYUPJIN CO., LTD., Siheung, Korea

[3]Department of Mechanical Engineering, Gyeonggi University of Science and Technology, Siheung, Korea

*Corresponding author email: cjyfall@gmail.com

I. INTRODUCTION

Pork is the most consumed type of meat worldwide. Generally, pork is stored in a frozen state after slaughter and thawed immediately before processing. Thawing is a major process that affects the quality of meat and final processed products, and the selection of a thawing method is important to obtain high-quality products [1]. Currently, the room temperature thawing method is the most widely used in the industry to reduce costs [2]. However, in this method, the defrosting time is long and the amount of drip generation during defrosting is high, which causes product quality deterioration and economic loss as well as environmental pollution. In this study, frozen pork was thawed using four different methods: tumbling thawing (low temperature-high vacuum) (high temperature-low vacuum); room temperature thawing and microwave thawing conditions. Changes in the quality characteristics of thawed pork were compared and analysed.

II. MATERIALS AND METHODS

Pork (foreleg) was frozen at -75ºC in a rectangular block shape with a size of 25x15x15 cm^3. Then, four different thawing conditions were applied: room temperature (20 ºC, under air), microwave oven (260 W), low-temperature-high vacuum tumbling (20 ºC and -66 kPa), and high-low vacuum tumbling (40 ºC and -35 kPa). The point at which the core temperature reached -1 to 0 ºC was set as the end point of thawing. After thawing, drip loss, cooking loss, scanning electron microscopy (SEM, JSM-7610F PLUS, JEOL Ltd, Tokyo, Japan), and texture (texture analyser, Stable Micro System Ltd., Surrey, UK) were analysed. Statistical analyses were performed using the SPSS (SPSS 21.0, SPSS Inc., Chicago, IL, USA). One-way ANOVA was performed, and differences between means of samples were analysed by and Duncan's multiple range test (P<0.05).

III. RESULTS AND DISCUSSION

Table 1 shows the drip loss and heating loss of pork thawed under four different conditions. Lowest drip loss of thawed pork (0.47±0.01%) was recorded in low temperature-high vacuum tumbling. On the other hand, the drip loss of pork tumbled under high temperature-low vacuum was the highest among all the thawing conditions at 3.17 ± 0.03%. Cooking loss (%) was remarkably high (1.15±0.01%) in high-temperature-low-vacuum tumbling, and there was no significant difference between the other three thawing conditions.

Table 1. Drip loss and cooking loss of pork thawed under different conditions.

Thawing conditions	Total thawing time (min)	Drip loss (%)[1)]	Cooking loss (%)[2)]
Room temp (20 ºC, under air)	220	2.08±0.01[c3)]	0.44±0.01[b]
Microwave (260 W)	60	1.62±0.02[b]	0.40±0.02[b]
Tumbling A (20 ºC, -66 kPa)	30	0.47±0.01[a]	0.30±0.00[b]
Tumbling B (40 ºC, -35 kPa)	40	3.17±0.03[d]	1.15±0.01[a]

[1)] Drip loss = {(sample weight before thawing- sample weight after thawing)/ sample weight before thawing}x100;

2) Cooking loss = {(sample weight before cooking- sample weight after cooking)/ sample weight before cooking}x100;
3) Different superscript letters (a-d) within the same column indicate significant differences ($P<0.05$).

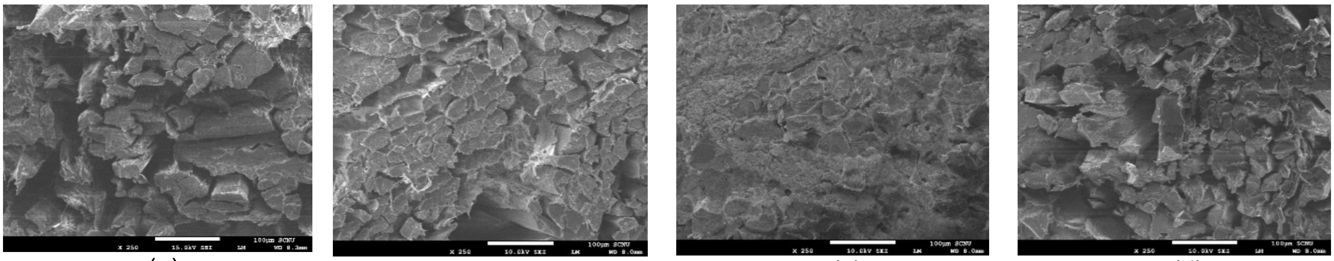
The hardness of heat-treated thawed pork was lowest in tumbling A (46.03±5.55 N) and highest in tumbling B (456.15±4.41 N) (Table 2). In addition, the chewiness of tumbling B thawed meat is about 4 times higher than the tumbling A (195.15 ± 21.11), showing a tough texture.

Table 2. Texture profiles of cooked pork after thawing under different conditions[1)].

Thawing conditions	Hardness (N)	Chewiness
Room temp (20 ºC, under air)	$212 \pm 13.69^{b2)}$	885 ± 56.60^{b}
Microwave (260 W, under microwave)	201 ± 3.25^{c}	812 ± 18.60^{c}
Tumbling A (20 ºC, -66 kPa)	$46 \pm 5.55^{d,1)}$	195 ± 21.11^{d}
Tumbling B (40 ºC, -35 kPa)	456 ± 4.41^{a}	957 ± 20.60^{a}

1) TA-25 probe (5 cm diameter and 10 mm height), pre-test speed 2.0 mm/s, post-test speed 5.0 mm/s, test speed 1.0 mm/s;
2) Different superscript letters (a-d) within the same column indicate significant differences ($P<0.05$).

As for the microstructure of the thawed pork (Fig. 1), it was observed that the myofibrils were tightly arranged in the tumbling A sample, whereas in the other samples, myofibrils were contracted, bent or entangled, and there was a large spacing between myofibrils. Results of this study shows that changes in microstructure according to thawing conditions can affect the drip loss, cooking loss, and texture of thawed meat.



(a) (b) (c) (d)

Figure 1. Scanning electron microscopy (SEM) images of the cross-sections of thawed pork under different conditions (x250). (a): room temp, (b): microwave, (c): tumbling A (20 ℃, -66 kPa), and (d): tumbling B (40 ℃, -35 kPa).

IV. CONCLUSIONS

It was confirmed that low-temperature-high vacuum (20 ºC, -66 kPa) tumbling thawing minimizes the changes in frozen pork myofibrils and consequently maintains high water retention during thawing and cooking. The results of this study proved that vacuum tumbling can possibly impart excellent quality characteristics in frozen meat thawing and can be applied in various livestock processing in the future.

ACKNOWLEDGEMENTS

This work was supported by the Korean Institute of Planning and Evaluation for Technology in Food, Agriculture and Forestry (IPET) through the development of a rapid defrosting machine for meat project, funded by the Ministry of Agriculture, Food and Rural Affairs (MAFRA) (321041-3).

REFERENCES

1. Kondratowicz, J., Chartwork, I. (2006). Effect of deep-freeze storage time and thawing method on the sensory and microbial quality of porcine meat. Animal Science Papers and Reports 24: 151-158
2. Lin, R., Yuan, H., Wang, C., Yang, Q. & Guo, Z. (2022). Study on the flavor compounds of Fo Tiao Qiang under different thawing methods based on GC-IMS and electronic tongue technology. Foods 11: 1330