EFFECTS OF TUMBLING CONDITION ON PHYSICOCHEMICAL AND TEXTURAL PROPERTIES OF SOY SAUCE CURED PORK LOIN (*M. Longissimus dorsi*)

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Abstract – This study was conducted to evaluate the effect of tumbling time and temperature on physicochemical and textural properties of soy sauce cured pork loins. The pork loins (*M. longissimus dorsi*) were tumbled during 5 h under two temperatures –(1 or 4 °C). The increase in tumbling time results in the increased water holding capacity, tumbling and cooking yields, and protein solubility of the pork loins. As a result, the soy sauce cured pork loin tumbled over 3 h showed the lowest shear force. In addition, the low temperature tumbling (-1 °C) contributed to the improvement of cooking yield and shear force. Our results suggested that tumbling technology is a useful method for manufacturing meat based cuisines using soy sauce.

Key Words – Pork loin, Soy sauce, Tumbling

I. INTRODUCTION

Soy sauce is one of the traditional fermented soy products in East Asia, and there are several meat based cuisines prepared with soy sauce [1]. In Korea, numbers of traditional cuisines including *bulbogi* (Korean-style barbequed beef) and *galbi-jjim* (braised short ribs) has been used to season with only soy sauce without salt. Generally, the fermented soy sauce contains high amount of water, salt (approximately 15-20%), components such as peptides and amino acids derived from soybean, maillard reaction products (melanoidin), free sugar, and organic acids [2]. In addition, immersion for the long-term has been traditionally used to manufacture meat based cuisines using soy sauce [3].

Tumbling technique, which is one of the marination methods, has been commonly applied to accelerate and ensure uniform distribution of brine in cured meat products. In previous studies reported that the effects of meat tumbling were affected by tumbling time, temperature, and speed [4-6].

Therefore, the objectives of this study were to determine the effects of tumbling time and temperature on physicochemical and textural properties of soy sauce cured pork loins.

II. MATERIALS AND METHODS

Twenty four boneless pork loins (*M. longissimus dorsi*) were purchased from a local processor at 48 h postmortem. All subcutaneous and inter-muscular fat and visible connective tissue were removed from the fresh pork loin. Lean muscles were cut to 1 inch (2.54 cm) thickness with meat slicer and randomly assigned to six treatments (n = 4 per each treatment).

Commercial soy sauce (fermented and heat sterilized soy sauce, Sempio Foods Co., South Korea) was purchased from the local market. The pH and salt concentration of soy sauce were 4.8 and 16%. Each loin was pumped to 115% of original weight using a syringe injector to contain 75% soy sauce solution (75% fermented soy sauce and 25% water, w/w). After pumping, loins were vacuum-tumbled (MKR-150C, Rühle GmbH., Germany) at 4 °C, 8 rpm, and 610 mmHg for 1, 2, 3, 4, and 5 h to determine effect of tumbling time. Under the identical condition, the pumped pork loins were vacuum-tumbled at two temperatures (-1 and 4 °C) for 4 h to determine effect of tumbling temperature. After tumbling, all loins were weighed, and the samples were individually placed in polyethylene bags. The tumbled pork loins were stored in a 4 ºC refrigerator during analysis.

To determine physicochemical properties of tumbled pork loin, pH, water holding capacity [7], tumbling and cooking yields, protein solubility [8], Warner-Bratzler shear force, and SDS-PAGE [9] were examined.

An analysis of variance was performed on all the variables measured using the general linear model (GLM) procedure of the SAS statistical package.

III. RESULTS AND DISCUSSION

The effect of tumbling time on change in pH value and water holding capacity (WHC) of soy sauce cured pork loin is shown in Figure 1. The pH value decreased at tumbling 1 h, since then gradually increased until 5 h. The change in WHC of pork loin tended to the time dependent increase during tumbling.

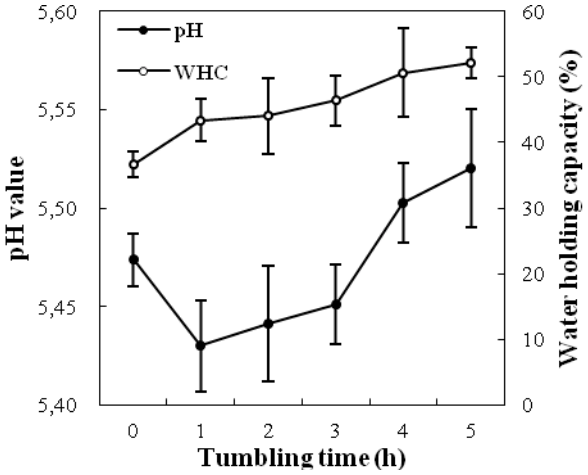

Figure 1. The effects of tumbling time on changes in pH value (●) and water holding capacity (WHC, ○) of soy sauce cured pork loin.

Reflecting the result of WHC, the increase in tumbling time results in the improvement of tumbling and cooking yields (Table 1). The highest yields of tumbled pork loin were observed at tumbling 4 h.

Table 1. Effect of tumbling time on tumbling and cooking yields of soy sauce cured pork loin

Traits	Tumbling time (h)					SEM
	1	2	3	4	5	
TY[A]	108.0	109.5	110.5	111.3	111.2	0.6
CY[B]	76.5	81.7	83.4	85.1	84.8	1.6

[A]TY: tumbling yield (%).
[B]CY: cooking yield (%).
SEM: standard error of the mean.

The effect of tumbling time on protein solubility of soy sauce cured pork loin is shown in Figure 2. After tumbling 3 h, the solubility of total and myofibrillar proteins significantly increased. In addition, the highest solubility of sarcoplasmic proteins was obtained from the pork loin tumbled for 5 h.

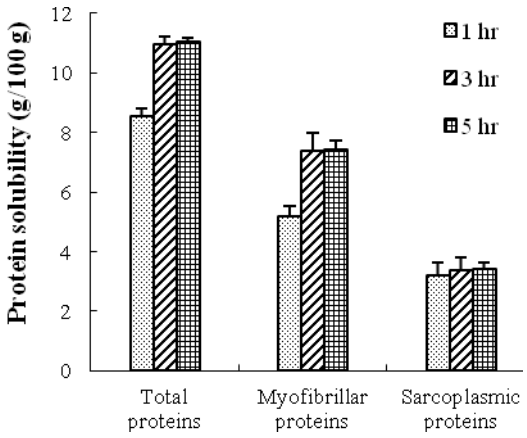

Figure 2. The effects of tumbling time on changes in protein solubility of soy sauce cured pork loin.

The result of Warner-Bratzler shear force indicated that the soy sauce cured pork loin tumbled over 4 h showed the lowest shear force value (Figure 3). This result is greatly associated with increased cooking yield and protein solubility.

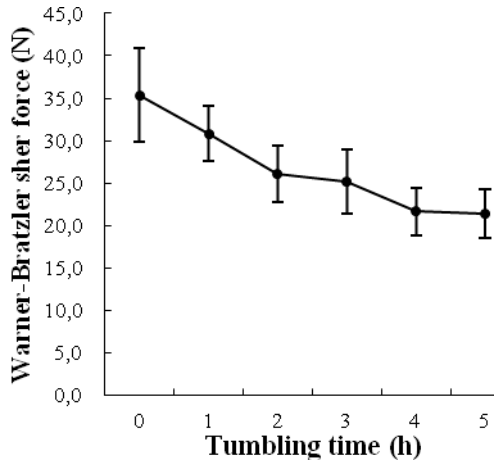

Figure 3. The effects of tumbling time on changes in protein solubility of soy sauce cured pork loin.

From the SDS-PAGE result of total proteins, there was no difference in electrophoresis patterns among treatments (Figure 4). However, the increase in intensity of some protein bands was observed for the soy sauce cured pork loin

tumbled for 3 h. According to Naveena *et al*. (2011), the increase in intensity of protein band is closely related to increased protein solubility. Similarly, our result suggested that tumbling for about 3 h improved the protein solubility of soy sauce cured pork loin.

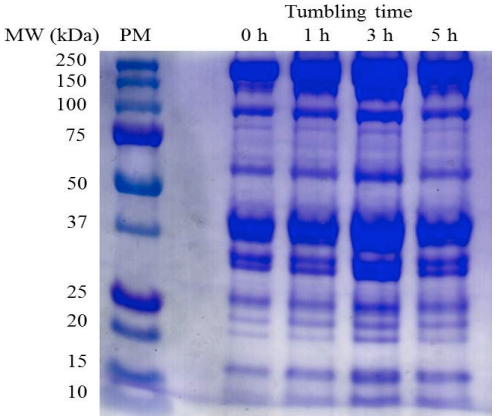

Figure 4. Sodium dodecyl sulfate-polyacrylamide gel electrophoresis (SDS-PAGE) photographs soy sauce cured pork loin tumbled for 0, 1, 3, and 5 h.

The effect of tumbling temperature on pH value, cooking yield, and Warner-Bratzler shear force of soy sauce cured pork loin tumbled for 4 h is shown in Table 2. There was no difference in pH value between two tumbling temperature. However, cooking yield and shear force of soy sauce cured pork loin were affected by tumbling temperature.

Table 2. Effect of tumbling temperature on pH value, cooking yield, and Warner-Bratzler shear force of soy sauce cured pork loin

Traits	Tumbling temperature		SEM
	-1 °C	4 °C	
pH	5.54	5.52	0.01
CY[A]	87.0	83.4	0.81
WBSF[B]	22.9	20.5	0.56

All samples were tumbled for 4 h under each temperature.
[A]CY: cooking yield (%).
[B]WBSF: Warner-Bratzler shear force (N).
SEM: standard error of the mean.

IV. CONCLUSION

The physicochemical and textural properties of soy sauce cured pork loin were positively affected by tumbling time and temperature. Our results suggested that tumbling technology is a useful method for manufacturing traditional meat based cuisines using soy sauce.

ACKNOWLEDGEMENTS

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