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IMPROVEMENT OF MEAT QUALITIES DURING THE PROLONGED CONDITIONING OF VACUUM-PACKED PORK LOINS AT 4℃

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Backgrounds and Objectives:

It is well known that pork qualities are improved during the postmortem conditioning, resulting in increment of tenderness, taste and aroma intensities of the meat. The increment of tenderness is caused by the actions of Ca^{2+} and proteases on Z disks and myofibrillar proteins, while the improvement of flavor is brought by the increase in free amino acids and oligopeptides during the storage of pork [1,2]. The conditioning of pork without vacuum packing is recognized to be completed within 5-7 days after slaughter [3]. Recently, in Japan, we consume a lot of vacuum-packed pork imported from USA, Canada, Taiwan and so on. However, their meat qualities have never been evaluated yet and there has been no research on the changes in meat qualities during the storage under vacuum at low temperature.

The objectives of this work were to organoleptically analyze the changes in taste, aroma and tenderness and to clarify how long pork loin should be stored under vacuum to obtain its best qualities. The second one was to examine the changes in physical and chemical properties during the storage of pork loins under vacuum packaging for 30 days at 4℃. Finally, some indicators to evaluate conditioning objectively were found by the comparison of changes in physical and chemical properties with results of sensory evaluation.

Materials and Methods:

Preparation of pork loins: Each of eight loins obtained from porcine hybrids (Landrace×Large white×Duroc) was aseptically portioned into 4 blocks. Blocks were put into polyvinylidene chloride bags, vacuum-sealed, and stored at 4℃ from 2 through 30 days postmortem. After each piece was stored for 2, 10, 20 or 30 days, it was frozen at -30℃.

Sensory evaluation: Samples for sensory evaluation were chops (12-mm thick), and their both sides were grilled for two min at 180℃. Tenderness, intensities of taste and aroma were evaluated by well-trained panels using paired-preference tests. Each panel wore a nose clip to avoid influence of aroma in sensory evaluation.

Meat tenderness: Pork loin was sliced into 20-mm thick, vacuum sealed, and then heated in a water bath for 30 min at 80℃. After removal of excessive surface water, they were stored in a refrigerator overnight. Their tenderness values were determined by Tensipresser™ (TTP-50BX, Taketomo) with a cylindric plunger of 5.5 mm in diameter [4].

Amino acid analyses: Five grams of ground pork were homogenized with 22 ml distilled water containing 0.1 % mercaptoethanol in a centrifuge tube. Three milliliters of 50 % trichroloacetic acid were added into the homogenate and mixed. After these slurries were centrifuged for 20 min at 10,000 x g, supernatants were filtered through filter paper. Free amino acids (FAA) in the filtrates were analyzed with an amino acid analyzer (6300E, Beckman). Oligopeptides were also analyzed after hydrolysis of the filtrates in 6 N HCl for 24 h at 110℃. The amounts of oligopeptides were calculated by subtraction of the amounts of FAA from the total amino acid ones in the hydrolyzed filtrates.

Analyses of peptides: The peptides were also analyzed by HPLC with a reversed-phase column (Senshupack VP-318, Senshu). Peptides solution was applied on the column and eluded with a linear gradient of acetonitrile concentration (0-40%) containing 0.1% TFA for 80 min at 40℃. Flow rate was 1.0 ml/min and peptides were detected at 220 nm. The sequences of the purified peptides were determined with an ABI amino acid sequencer (Model 430), and the origin of their peptides was examined by the homologous reference with sequences of muscle proteins.

Results and Discussion:

Table 1 shows the sensory properties of the pork loins stored at 4℃. Their aroma and taste intensities continuously increased during the storage for 20 days. Tenderness of pork loins gradually increased during the storage and was largest at 20 days postmortem. As for palatability including aroma, taste and tenderness, pork loins stored for 20 days were evaluated to be most preferable. However, sour odor was detected only in the pork loin stored for 30 days after killing, suggesting that the 30-day storage was not so good to improve the meat quality from a viewpoint of shelf life. It was shown that sensory properties of the vacuum-packed pork loins were most preferably improved by the storage at 4℃ for 20 days.

The changes in tenderness of vacuum-packed pork loins during the storage for 30 days were examined by the share force value with Tensipresser™. The share force value continuously decreased during the storage for 20 days and unchanged thereafter.

The FAA contents gradually increased with the storage period. Especially, Ala, Glu, Gly, Ser and Leu increased during the 30-day storage. The concentration of oligopeptides in the acid-soluble fraction of the pork loins also increased and reached a plateau by the storage within 20 days at 4 ℃. The increase in FAA and oligopeptides was consistent with that of the tenderness, taste and aroma intensities, and total palatability.

The HPLC profiles on ODS column of the extracts from pork loins stored for two, 10, 20 and 30 days at 4℃ were shown in Fig. 1. There were few peptides in the pork loin stored for two days at 4℃. However, many peptides gradually increased with the storage time. Most peptides continuously increased during the storage for 30 days. Of them, a peptide P1 increased markedly: a peptide P2 rapidly increased during the storage from 10 to 20 days and then slightly decreased. From the N-terminal amino acid analyses of the peptides, the peptide P1 possessed APPPPAEVHEVHEEVH, homologous to troponin T of rabbit muscle (70% identity) and the peptide P2 possessed VPTPNVSVVDLT, homologous to porcine glyceraldehyde 3-phosphate dehydrogenase (GAPDH).

Conclusions:

1. Sensory properties of the vacuum-packed pork loins were most preferably improved by the storage for 20 days at 4℃.
2. The changes in the shear force value and the amount of P2 peptide corresponded to that of the palatability of pork loins stored under vacuum packaging for 30 days at 4℃.
3. From N-terminal amino acids sequencing, P1 and P2 were identified to be homologous to troponin T and GAPDH, respectively.

Pertinent literature:

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2. Nishimura, T., *Food Sci. Technol.* Int. Tokyo, **4**(4), 241, 1998.
3. Morita, S., The Science of meat and meat products (1st ed.), Sohbunsya Press, Inc., Tokyo, Japan, pp.74, 1992.
4. Nakai, H., Tanabe, R., Ando, S., Ikeda, T. and Nishizawa, M., Proceedings of "The 38th ICoMST", Clermont-Ferrand (France), 5: p.947, 1992.

Table 1. Changes in taste and aroma intensities, tenderness and palatability of pork loins stored at 4℃

	Number of panels					
	2 days	10days	(P)	2 days	20days	(P)
Taste	9	32	***	9	29	**
Aroma	8	33	***	10	28	**
Tenderness	10	31	**	3	35	***
Palatability	8	33	***	8	30	***
	2 days	30days	(P)	10days	20days	(P)
Taste	9	32	***	16	24	NS
Aroma	9	32	***	4	36	***
Tenderness	24	17	NS	8	32	***
Palatability	15	26	NS	11	29	**
	10days	30days	(P)	20days	30days	(P)
Taste	15	25	NS	20	20	NS
Aroma	9	31	***	15	25	NS
Tenderness	15	25	NS	19	20	NS
Palatability	13	27	*	23	17	NS

Significant differences were indicated with asterisks;

*, $p<0.05$; **, $p<0.01$; ***, $p<0.001$

: NS, not significant (paired-preference tests)

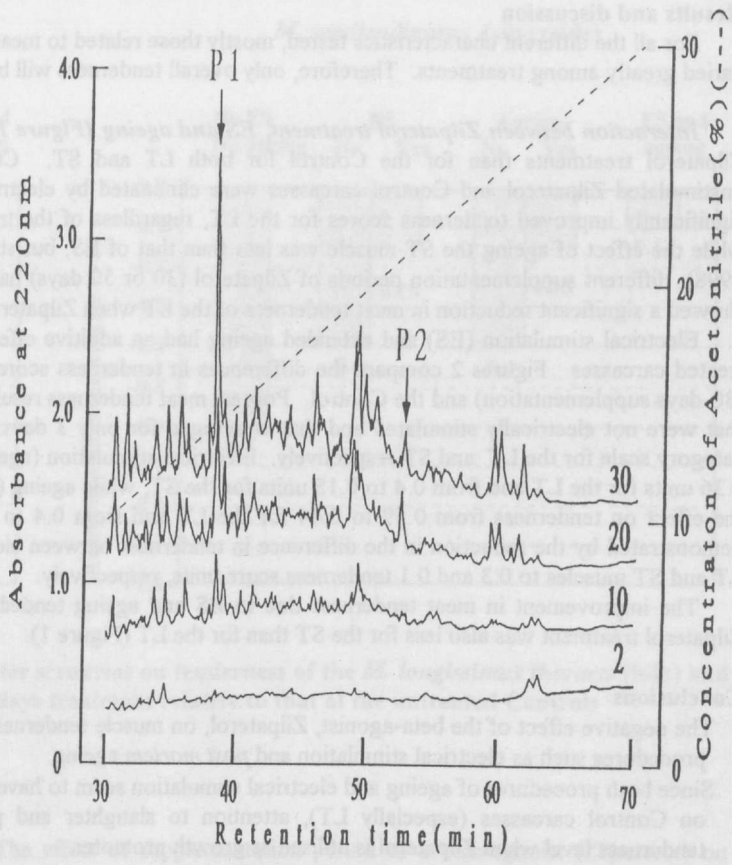

Fig 1. HPLC profiles of peptides in extracts from pork loin stored for 2-30 days at 4℃