A STUDY ON THE CHANGES OF MICROORGANISM BY TEMPERATURE DURING TRANSPORT AND DISTRIBUTION OF HANWOO MEAT

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***Abstract*— As a survey result of temperature change during distribution, the average temperature during the period of an icebox for a gift set and an ice box for home use were respectively recorded as 7.3℃ and 10.2℃, so the temperature of measuring the changes of microorganism according to temperature change was maximum 24.8℃ and minimum 6.1 ℃, and its average temperature was set as 8.8℃. The number of pseudomonas was 6.31 Log CFU/g and 6.15 Log CFU/g respectively on the surface of vacuum-packed top round and striploin, and it was in the stage of initial rot. The ice box for home use with 20mm thick can maintain the temperature less than 10℃ for around 20 hours, and the ice box for a present set with 25mm thick can maintain the temperature less than 10℃ for around 24hours at the average external temperature of 21.9±2.0℃, so when the ice box for home use must be delivered within 20 hours, and the ice box for a gift set must be delivered within 24 hours, the sanitary and safe Hanwoo meat could be supplied to the consumers.

***Index Terms*— distribution, microorganism, temperature, transport**

I. INTRODUCTION

The obligation of the traceability system that the government nationwide enforced recently became a momentum for promotion of its consumption by making consumers have more belief on Hanwoo meat. Also, the momentum that can consume more Hanwoo meat was prepared by reducing the multi-level distribution margin through a direct transaction method and cheaply selling Hanwoo produced by farmhouses or unit producer organizations(Agricultural Cooperative, Livestock Cooperative and Farming Association Cooperation), etc. In addition, the consumption pattern of consumers shows a trend changing from purchase at wholesaler and retailer to delivery(home delivery) purchase such as internet shopping and home shopping, etc., namely, a consumption form of a direct transaction method due to development of the IT industry and rapid spread of the internet. Accordingly, the systematic history management in the overall process such as processing, circulation and sale, etc. is necessary for storage and safety of chilled meat. As the growth and metabolism of a microorganism receives the biggest influence by its storage temperature, the storage life can be said to depend on its storage temperature(Zamora and Zaritzky, 1985). Accordingly, the strict temperature management in the overall distribution network from slaughterhouses to consumers is essential to sanitarily distribute meat(Lee, 2000). This is because the psychrotolerant bacteria increases by one generation every 27 hours at -2℃, and the generation of a microorganism quickly multiplies every 19 hours at 0℃, every 12 hours at 2℃, every 8 hours at 5℃, every 4 hours at 10℃, and every 20 minutes at 20℃.

Accordingly, the present research was carried out for setting of a proper circulation period on storage and safety during distribution of Hanwoo meat and preparation of a safe distribution management system of Hanwoo meat in the future by surveying temperature change during boning, cutting, packing, ripening and transport and observing change of a microorganism according to a ripening period and temperature change.

II. MATERIALS AND METHODS

A. Treat of sample

The raw meat used for processing of sample blank-microorganism test is a bullock of Hanwoo with living weight of 680~720kg and dresses carcass of 380~420kg, and received as first class of meat in case of grading, and after the boned and top round and striploin were stored for 5, 7, 10, 15 days in a refrigeration room of 4.5±2℃ at a meat processing plant, its surface of 10 cm^2 was used. The raw meat used for a microorganism test according to distribution temperature was used after being ripened for 10 days in a refrigeration room of 4.5±2℃ at a meat processing plant, and ttop round and striploin of each 100±5g was sliced with a slice machine of refrigerated meat(WMC-330, Watanabe, Japan) at a workplace inside a store and executed individual vacuum packaging and MAP(Modified Atmosphere Packaging). The packed samples are rapidly transported to a laboratory in an icebox, and it was used after being stored in an BOD Incubator(J-IB01, Jisico, Korea) for 0, 6, 12 and 24 hours according to distribution temperature change.

B. Workplace environment

The samples were repetitively surveyed 5 times during July~September, when there are much trading volumes of Hanwoo meat. The temperature and humidity were measured by using a hygro-thermometer(testo-635, Testo, Germany). The temperature and humidity of a prechilling room, a refrigeration room and a workplace were measured at 4 corners and one place of the center, and showed its mean value, and the temperature change inside a refrigeration vehicle used for transport of carcass was measured in an interval of 10 minutes by using a data logger(testo-174, Testo, Germany).

C. Changes of temperature in meat

The surface temperature and core temperature of Hanwoo meat were measured the temperature of longissimus muscle of sirloin of a bullock 15 times by using an infrared thermometer(testo-831, Testo, Germany) and a core measurement thermometer(testo-105, Testo, Germany) after going through a prechilling room of a slaughterhouse and a meat-processing factory, boning, cutting and vacuum shrink packaging.

D. The change of temperature during the distribution

The temperature change during distribution was repetitively surveyed 10 times during July~September, when there are much trading volumes of Hanwoo meat. This research measured temperature change from the start of products packaging and delivery completion time in a unit of 10 minutes by attaching a data logger(175-H2, Testo, Germany; testostor175, Testo, Germany) inside and outside iceboxes for a gift set and a home being used in case of delivery sale.

E. Measuring the changes of surface microorganisms

The surface microorganism test was repetitively carried out 5 times by a swab method(Kotula, 1966). The surface microorganism of top round and striploin under low temperature storage inside a meat processing factory was collected as samples. The samples were collected with a method horizontally and vertically rubbing 10 times respectively by using a surface sampling frame with 10 cm wide and long, and using gauze soaked with a sterilized saline solution. The collected samples were contained in a sterilized saline solution of 90ml and rapidly transported to a laboratory, and its total plate counts, lactic acid bacteria and *pseudomonas* were tested after diluting it in a fixed magnification(10^{-n}). The growing community was counted and shown in Log CFU/cm^2.

F. Measuring the changes of microorganism

After the outside of packaging paper was sterilized by spraying 70% alcohol to the vacuum-packed and MAP-packed samples inside a clean bench, the one side surface was opened by using a sterilized scissor in an Autoclave, and 10g of samples were collected from the center and both ends of samples(n=2). The collected samples were put into a sterilized envelope together with a sterilized saline solution of 90ml and were homogenized with a Stomacher for 90 seconds. The homogenized diluted solution was filtered by using sterilized gauze, and the filtered diluted solution was diluted in a fixed magnification(10^{-n}), and its total plate counts, lactic acid bacteria and *pseudomonas* were measured.

E. Statistical analysis

The result obtained in the statistical analysis-the present experiment was shown as an average±standard deviations by using the Microsoft office Excel 2007 program, and the significance test according to each group was analyzed with multiple range test of Duncan in a level of α=0.05 by using a Statistical Analysis System(SAS 9.1 ver. win 6.0) program.

III. RESULTS AND DISCUSSION

A. Workplace environment

According to the investigation of workplace environment, temperature of pre-chilling room at slaughterhouse was 8.1±1.3℃, and the temperature of primary processing plant was 16.2±1.3℃. The temperature of cool chamber was 4.5±2.0℃. The humidity of pre-chilling room at both slaughterhouse and meat processing plant was in the range of 93.0~96.8%rH, and the humidity of cool chamber was 66.8±9.6%rH. Internal temperature of refrigerator vehicle during the transport was 14.0~17.5℃, and temperature near the door was 7.0~12.8℃.

B. Changes of temperature in meat

For the change in temperature of fresh meat, the central temperature after the standardization in the primary processing progress was 7.2±1.2℃, so it was lower than temperature(10℃ or less) clarified in the notification of National veterinary research and quarantine service, but surface temperature after vacuum shrink packaging was

12.8±1.4℃. In the secondary processing, the temperature of fresh meat, after processing, and after packaging was 2.7±0.3℃, 3.5±0.5℃, and 11.2±0.8℃ respectively, so it was considered that the temperature of fresh meat was increased significantly according to the process.

C. The change of temperature during the distribution

The change of temperature during the distribution at intervals of 10 minutes for 24 hours was measured. The external temperature was 22.0℃. The mean temperature while distributing icebox with Hanwoo meat for gift set and home was 7.3℃ and 10.2℃, respectively. For home icebox, the temperature was kept at around 10℃ about 12 hours later, and it was increased up to around 15℃ from the moment that about 20 hours passed.

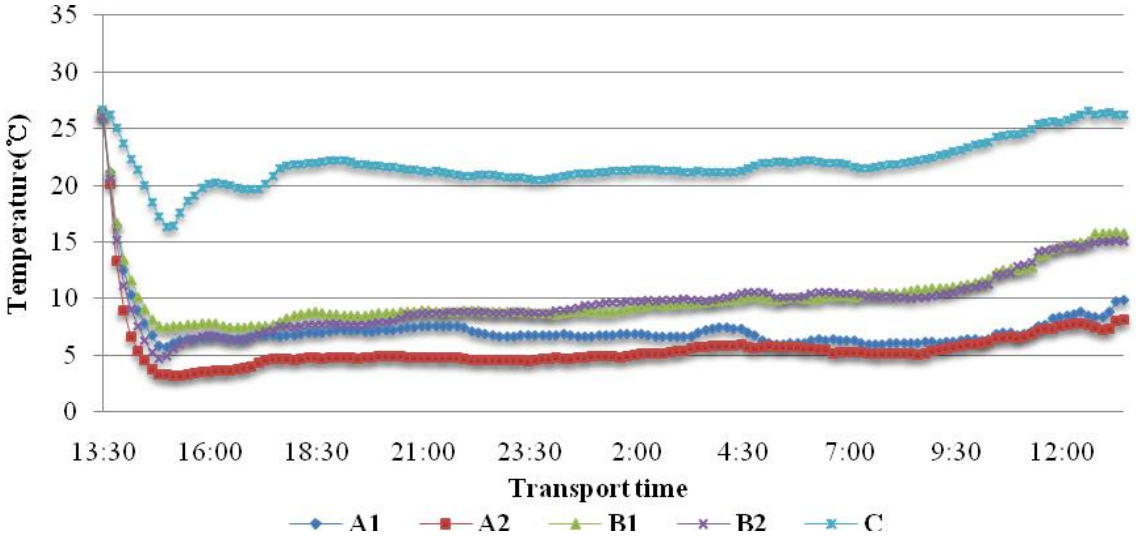

Fig. 1. Comparison of temperature by packaging methods in the vehicle during 24 hours.
A1: Gift set icebox with meat, **A2**: Gift set icebox, **B1**: Home icebox with meat, **B2**: Home icebox, **C**: Air temperature.

D. Measuring the changes of surface microorganisms

As the result of measuring the number of microorganisms on the meat surface during the storage periods of 5~15 days, for the total plate counts, it top round, and 4.08~4.73 Log CFU/cm^2 on the surface of striploin, so it was in the range of fresh beef. For the number of lactic acid bacteria, it was 3.69~4.30 Log CFU/cm^2 on the surface of top round, and 3.47~4.37 Log CFU/cm^2 on the surface of striploin. Finally, for the number of pseudomonas, it was 3.88~4.92 Log CFU/cm^2 and 4.17~4.96 Log CFU/cm^2 respectively on the surface of top round and striploin.

Table 6. Changes of numbers of microorganisms on the surface in Hanwoo meat during storage at 4.5±2□ for 15 days

Microorganism species (Log CFU/cm^2)	Cut	Storage days			
		5	7	10	15
Total Plate Counts	Top round	4.31±0.25	4.35±0.40	4.50±0.05	4.64±0.04
	Striploin	4.08±0.48^b	4.62±0.43^a	4.63±0.17^a	4.73±0.15^a
Lactic acid bacteria	Top round	3.69±0.21^b	4.02±0.25^a	4.21±0.14^a	4.30±0.15^a
	Striploin	3.47±0.45^b	4.23±0.15^a	4.23±0.13^a	4.37±0.10^a
Pseudomonas	Top round	3.88±0.10^c	4.44±0.32^b	4.85±0.22^a	4.92±0.20^a
	Striploin	4.17±0.47^b	4.66±0.36^a	4.89±0.20^a	4.96±0.19^a

Values are the Mean±SD.
$^{a-c}$: Mean significantly different(p<0.05).

E. Measuring the changes of microorganism

In measuring the changes of microorganism according to the change of temperature, the highest, the lowest, and the mean temperature were set at 24.8□, 6.1□, and 8.8□, respectively. The total plate counts was in the range of 5.24~6.03 Log CFU/g in case of vacuum packaging, and it was in the range of 4.37~5.37 Log CFU/g in case of MAP. The number of lactic acid bacteria was in the range of 4.55~5.69 Log CFU/g in case of vacuum packaging, and it was much higher as compare with MAP which indicated 3.96~4.89 Log CFU/g. The number of pseudomonas was 6.31 Log CFU/g and 6.15 Log CFU/g respectively on the surface of vacuum-packed top round and striploin, and it was in the stage of initial

rot.

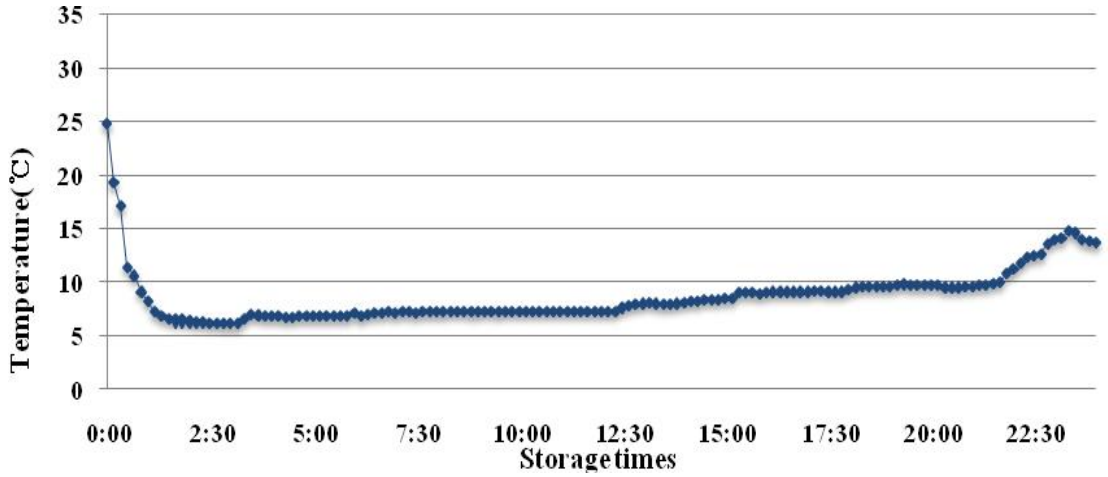

Fig. 3. Changes of temperature in BOD incubator.

Table 7. Changes of Numbers of microorganism in Hanwoo meat during storage(under condition of normal icebox with meat) at 24 hours

Microorganism species (Log CFU/g)	Cut	Packaging Methods	Storage times(hr) 0 (24.8℃)[2)]	6 (7.6±2.8℃)[3)]	12 (7.2±0.1℃)[4)]	24 (9.8±1.9℃)[5)]
Total Plate Counts	Top round	Vacuum Packaging	5.42±0.01^{dA}	5.48±0.02^{cA}	5.59±0.02^{bA}	6.03±0.03^{aA}
		MAP[1)]	4.60±0.02^{dB}	4.73±0.05^{cB}	4.97±0.01^{bB}	5.30±0.01^{aB}
	Striploin	Vacuum packaging	5.24±0.02^{dA}	5.42±0.01^{cA}	5.60±0.03^{bA}	5.91±0.02^{aA}
		MAP[1)]	4.37±0.01^{cB}	4.61±0.04^{bB}	4.71±0.06^{bB}	5.37±0.01^{aB}
Lactic acid bacteria	Top round	Vacuum packaging	4.77±0.02^{dA}	5.00±0.01^{cA}	5.39±0.01^{bA}	5.69±0.04^{aA}
		MAP[1)]	3.96±0.01^{dB}	4.27±0.04^{cB}	4.44±0.01^{bB}	4.89±0.03^{aB}
	Striploin	Vacuum packaging	4.55±0.03^{dA}	5.20±0.04^{cA}	5.46±0.02^{bA}	5.59±0.05^{aA}
		MAP[1)]	4.05±0.01^{dB}	4.29±0.03^{cB}	4.57±0.02^{bB}	4.77±0.03^{aB}
Pseudomonas	Top round	Vacuum packaging	5.42±0.03^{dA}	5.69±0.01^{cA}	6.03±0.02^{bA}	6.31±0.02^{aA}
		MAP[1)]	4.44±0.06^{dB}	4.84±0.01^{cB}	5.07±0.02^{bB}	5.37±0.01^{aB}
	Striploin	Vacuum packaging	5.79±0.01^{cA}	5.79±0.02^{cA}	5.84±0.01^{bA}	6.15±0.01^{aA}
		MAP[1)]	4.52±0.03^{dB}	4.73±0.03^{cB}	4.91±0.01^{bB}	5.46±0.01^{aB}

Values are the Mean±SD.

[1)] MAP(Modified Atmosphere Packaging) of gas composition is comprised of 80% O_2 and 20% CO_2., [2)] Temperature at 0 hour., [3)] Temperature of the Mean±SD at 0~6 hours., [4)] Temperature of the Mean±SD at 6~12 hours., [5)] Temperature of the Mean±SD at 12~24 hours.

[a-d]: Means with different letter in the same row are significantly different(p<0.05).

[A-B]: Means with different letter in the same column are significantly different(p<0.05).

IV. CONCLUSION

According to the result of this study, the biological sanitation and safety of Hanwoo meat during the distribution was in the level close to the stage of initial rot, and thus it is required for the customer to manage temperature for safe sanitation after the completion of distribution(purchase and delivery). Additionally, at the mean external temperature of 21.9±2.0□, for 20mm-thick home icebox, the temperature can be kept at 10□ or less for 20hours, and for 25mm-thick ice box for gift set, it can be kept at 10□ or less for 24hours, so home icebox and gift set icebox should be delivered within 20 hours and 24 hours, respectively, to provide sanitary and safe Hanwoo meat for customers.

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