EFFECTS OF SUPERCRITICAL CO_2 FOR APPLICATION OF PILOT PLANT SCALE ON MEAT QUALITY AND MICROBIAL CHANGES IN SEASONED PORK

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Introduction

Supercritical fluid (SCF) technology exploits the solvent power and physical properties of a pure or mixed compound at temperatures and pressures at or near the critical point in phase equilibrium (Palmer and Ting, 1995). Food processing applications of SCF technology employ CO_2 as a solvent. The SC-CO_2 is not only a powerful solvent for a wide range of compounds of interest in food processing, but it is also relatively inert, inexpensive, nontoxic, high density, low viscosity, recyclable, readily available in high purity, and leaves no residue (Clifford and Williams, 2000). The application of SC-CO_2 for inactivation of microorganisms in food products continues to attract attention, even though the sterilization of fresh meat with SC-CO_2 results in excessive protein denaturation and paler color (Choi et al., 2007). In this study, we investigated the effects of SC-CO_2 treatment for application of pilot plant scale on meat quality and microbial changes in seasoned pork loin.

Materials and Methods

Nine batches of pork loins obtained from a commercial market were cut into 2 cm of intact shaped thickness, and each weighing 60 ± 5 g. Two seasonings, including soy sauce (SS) and hot pepper paste (PP), were used. The instruments of pilot scale of SC-CO_2 treatment consist of 2 x 12 liter two vessels (Supercritical system, Tharex Co., Korea). The conditions of SC-CO_2 treatment were 7.4 (7.4-T), 12.2 (12.2-T), and 15.2 (15.2-T) MPa at 31.1 °C for 10 min, respectively. After treatment, SC-CO_2 treated samples were stored at 4 °C with aseptic condition, and were tested for total plate count (TPC) at 0, 3, 5, 7, and 10 days. The treatment loss was expressed as a percentage of the initial sample weight. The pH was measured using a spear type electrode (Model IQ150, IQ Instrument, USA). The color of the seasoned pork was measured with a chromameter (CR-300, Minolta Camera Co., Japan). The result was expressed as C.I.E. (Commission International de l'Eclairage) lightness (L^*), redness (a^*), and yellowness (b^*). Statistical analysis was performed using computer system equipped with the SAS statistical package (SAS Institute, 2001). An analysis of variance was used to evaluate differences ($P < 0.05$) between the different SC-CO_2 treatments. The results were presented as means for the three groups and the standard deviations of these means.

Results and Discussion

Meat quality measurement. The effects of SC-CO_2 treatment on meat quality traits were shown in Table 1. The treatment loss and pH of samples were not significantly different from those of the control and the 15.2-T samples in both SS and PP. In PP, SC-CO_2 treated samples showed higher lightness and yellowness value than the control samples ($P < 0.001$). Lightness of 15.2-T was the highest value in SS ($P < 0.001$).

Microbial changes. The effects of SC-CO_2 treatment for pilot plant scale on microbial changes were shown in Figure 1. The log number of colony forming unit (CFU) of SS was 0 log at 5 days, whereas that of PP was recorded 1 log at 5 days. When comparing to the control, SC-CO_2 treatment at 15.2 MPa had a lower CFU in SS.

Table 1. Effects of supercritical CO_2 (SC-CO_2) treatment at 31.1 °C for 10 min on meat quality traits in seasoned pork loin

	Control	SC-CO_2 Pressure			Levels of significance
		7.4 MPa	12.2 MPa	15.2 MPa	
Soy sauce					
Treatment loss (%)	-	1.06 ± 0.21	1.16 ± 0.33	1.37 ± 0.09	NS
Meat pH	5.53 ± 0.02	5.95 ± 0.53	5.78 ± 0.37	6.05 ± 0.17	NS
Lightness (L^*)	34.10 ± 1.34^{d}	55.80 ± 4.27^{b}	48.84 ± 0.70^{c}	63.11 ± 3.84^{a}	***
Redness (a^*)	5.21 ± 0.51^{a}	3.55 ± 0.50^{b}	4.01 ± 0.45^{b}	3.50 ± 0.47^{b}	**
Yellowness (b^*)	11.54 ± 0.45^{c}	15.51 ± 0.78^{a}	13.39 ± 1.32^{b}	16.79 ± 0.92^{a}	***
Hot pepper paste					
Treatment loss (%)	-	1.35 ± 1.01	1.09 ± 0.92	2.19 ± 0.47	NS
Meat pH	5.53 ± 0.02	5.68 ± 0.37	5.66 ± 0.02	5.36 ± 0.12	NS
Lightness (L^*)	33.01 ± 0.94^{b}	52.33 ± 3.21^{a}	54.20 ± 2.93^{a}	56.96 ± 3.22^{a}	***
Redness (a^*)	6.31 ± 0.21^{ab}	7.79 ± 1.35^{a}	5.70 ± 1.54^{b}	5.72 ± 0.53^{b}	*
Yellowness (b^*)	8.17 ± 0.15^{c}	20.08 ± 1.58^{a}	15.10 ± 0.93^{b}	18.43 ± 2.80^{a}	***

Results are expressed as mean ± SD.
Levels of significance: NS = not significant; * $P < 0.05$, ** $P < 0.01$, *** $P < 0.001$.
Means within a row with no common superscript differ significantly ($P < 0.05$).

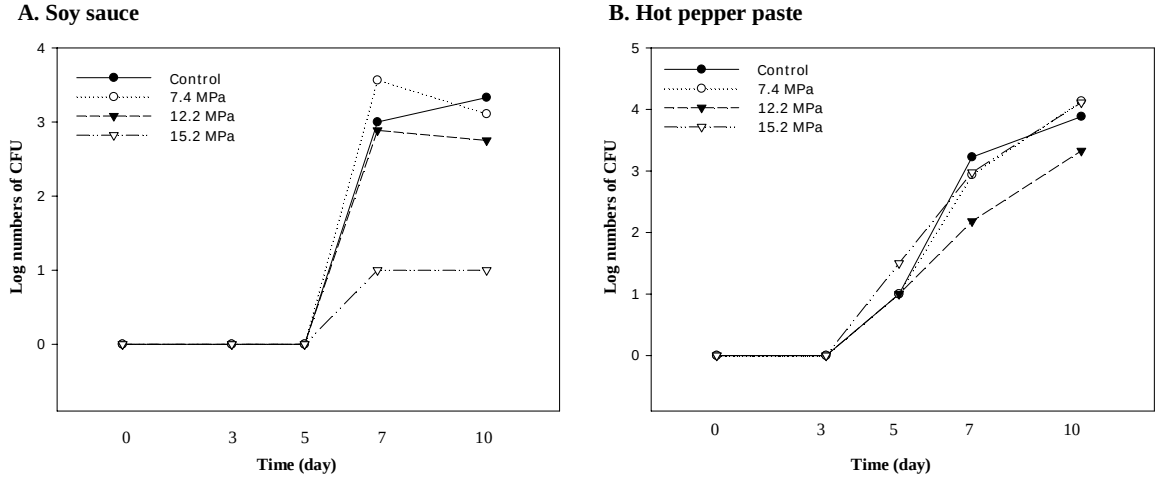

Figure 1. Change of total plate count in seasoned pork loin treated by supercritical CO_2 treatment at 31.1 °C for 10 min during storage at 4 °C. Abbreviation: CFU, colony forming unit.

Conclusions

In this study, the treatment loss and pH of seasoned pork loin were not significantly different through the pilot plant scale of SC-CO_2 treatment, including 7.4-T, 12.2-T, and 15.2-T, in both SS and PP. The SC-CO_2 treated pork induced higher lightness and yellowness values than control. SC-CO_2 treatment in pilot plat scale was effective in inhibition of microbial growth. Especially, SC-CO_2 treatment at 15.2 MPa for 10 min was most effective in inhibition of microbial growth in SS.

References

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