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Effect of High Pressure Low Temperature Treatment on the Inactivation of Microorganism in Raw Milk

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Introduction

Pasteurization of milk for the destruction of pathogenic microorganisms and to reduce the natural microflora has been traditionally carried out by heat treatment (Mussa, 1997). Without heat treatment, Hite (1899) reported 6 decimal reductions in the microorganisms of milk by high pressure when subjected to 689 MPa for 10 min at room temperature. In this study, high pressure low temperature (HPLT) treatment has been proposed as a way to reduce microorganisms in raw milk at 200 MPa for 10, 20 and 30 min with various temperature ranges of −4 to 20℃. Changes with respect to color and pH−value were included as indicators of change in sensory qualities. The objective was to study HPLT inactivation conditions of microorganisms in raw milk for pasteurization.

Materials and Methods

Fresh raw milk was obtained from a local dairy farm (Konkuk Dairy, Korea). HPLT was progressed with pressurization fluid at the pressure of 200 MPa and maintained the respective pressurization time (10, 20 and 30 min). Before pressure induction, the temperature of pressurization fluid was set by −4, 4, 12 and 20℃ and the center temperature of the raw milk was recorded respectively on the pressure treatment. After HPLT, raw milk samples were immediately plated on plate count agar (PCA) and counted after incubation for 48 h at 37℃. The inactivation was characterized by viable cell counts. The raw milk was sealed into a germ−free plastic tube (volume = 2mL) and kept at 4℃ until use. The raw milk in sealed tubes was exposed to high pressure treatment at 200 MPa at the same temperature and time. Adiabatic heat generated during pressurization was about −4, 4, 12 and 20℃. Treatment temperature was monitored by a digital temperature

controller (YOKOGAWA, Japan). Ethanol was used as the pressure medium. The color of raw milk samples were measured in the L*, a*, b* mode by using a color analyzer (KONICA MINOLTA, Japan) after HPLT. The pH measurement of raw milk samples were carried out with a pH meter (Model 440, Corning, the Netherlands) after HPLT. All experiments were carried out in duplicate and the standard deviations were calculated from the duplicate experiments.

Results and Discussions

Combined treatments of pressure and temperature for inactivation of microorganisms were investigated within the range of −4 ~ 20℃ at 200 MPa. The application of high pressure reduces the freezing and melting point of raw milk to a minimum of −25℃ at 200 MPa (Fig. 1).

Therefore, HPLT at −4℃, ice was not formed in raw milk at 200 MPa. Fig. 2 shows the inactivation behavior of microorganisms subjected to the HPLT and time treatment. The minimum log reduction showed only about 0.38−log reduction after HPLT at 12℃ for 10 min, whereas the maximum log reduction showed about 1.36−log reduction after HPLT at −4℃ for 30 min. Therefore, Fig. 2 shows that the inactivation effect of HPLT for microorganisms was higher for 30 min compared to 10 min at any temperature.

Effect of HPLT on pH was shown in Table 1. All of pH−values in HPLT were not significantly different. Effect of HPLT on color changes was shown in Fig. 3. Milk color was not affected by HPLT to a large extend. A small decrease was observed with the L*−value, but a* and b* −values remained unchanged. A decrease was observed with the

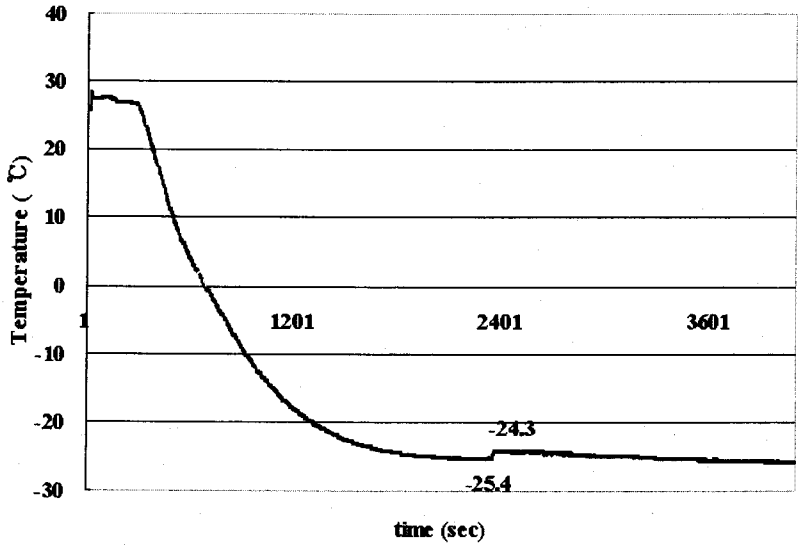

Fig. 1. Freezing point of raw milk at 200 MPa.

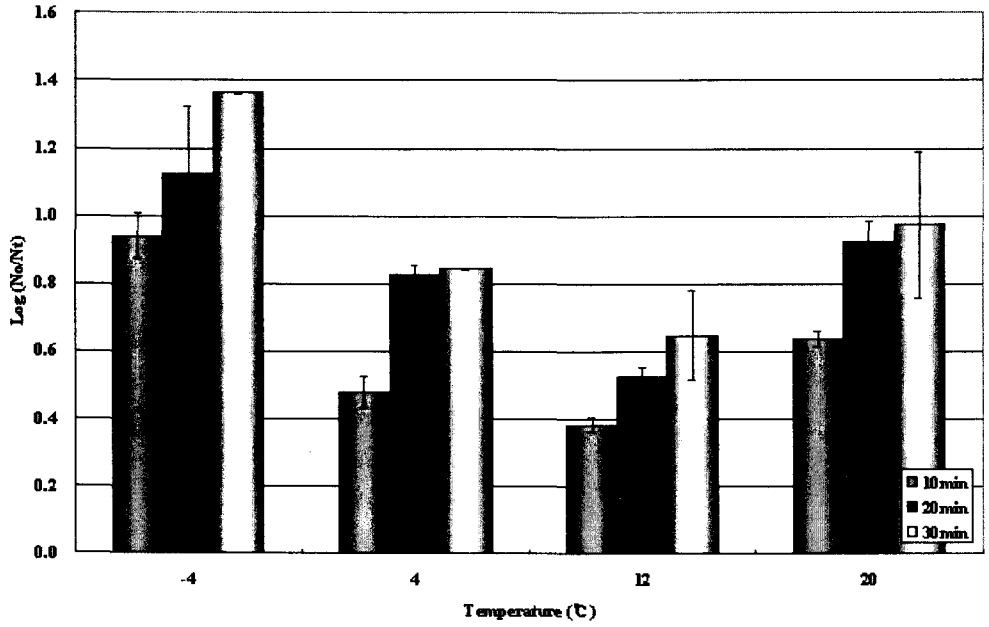

Fig. 2. Effect of HPLT time and temperature on inactivation of microorganism in raw milk at 200 MPa.

Table 1. Effect of HPLT time and temperature on pH-value of raw milk at 200 MPa

Temperature (℃)	Treatment time (min)		
	10	20	30
Control	6.73±0.05[a]	6.73±0.05[a]	6.73±0.05[a]
−4	6.78±0.02[a]	6.73±0.02[a]	6.71±0.02[a]
4	6.76±0.08[a]	6.76±0.05[a]	6.76±0.06[a]
12	6.74±0.03[a]	6.76±0.04[a]	6.76±0.04[a]
20	6.73±0.03[a]	6.72±0.04[a]	6.84±0.08[a]

L*-value by HPLT. Decrease in L*-values of milk could have been due to disintegration of casein micelles into small fragments that increase the translucence of the milk (Johnston, 1991). The maximum decrease of L*-value showed after HPLT at −4℃ for 10 min. From the results of the present study, it is concluded that HPLT at 200 MPa could inactivate microorganisms in raw milk. In conclusion, the pressure-inactivation of microorganism is strongly pressurization time dependent and microorganisms in raw milk were sensitive to sub-zero temperature during high pressure treatment.

sub-zero temperature during high pressure treatment.

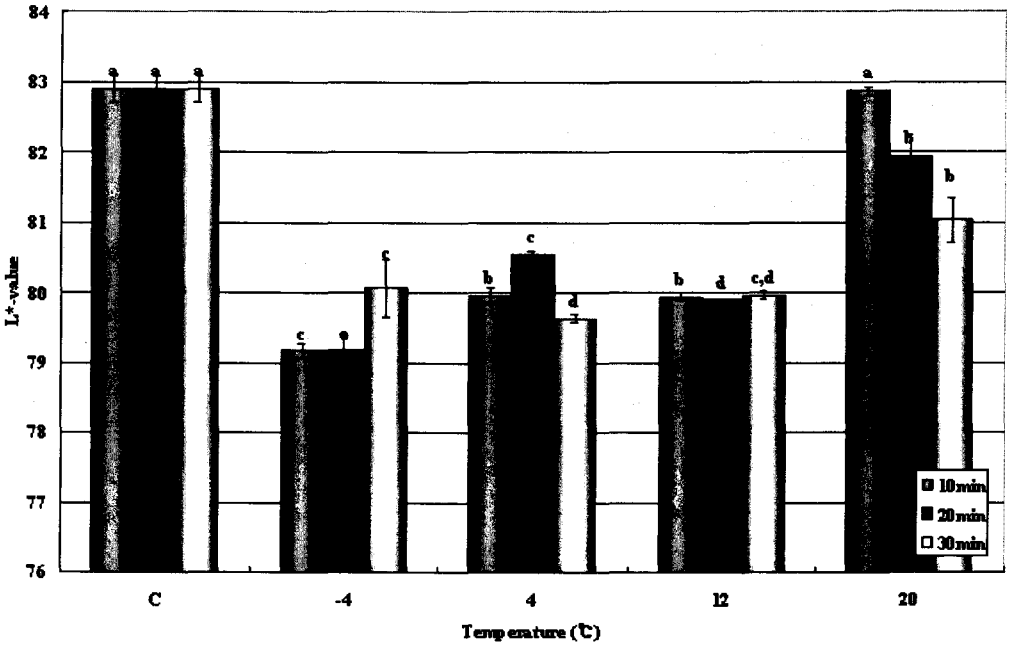

Fig. 3. Effect of HPLT on L*-value of raw milk at 200 MPa.

Summary

This study was carried out to investigate the effect of HPLT on the inactivation rates of microorganisms in raw milk depending on the pressurization time and temperature. Raw milk samples were submitted to HPLT of 200 MPa at −4, 4, 12 and 20°C, respectively. Inactivation increased with pressurization time and HPLT of microorganisms at 200 MPa was time dependent at any temperature. At sub-zero temperature of −4℃, high pressure pasteurization was the most effective in inactivating microorganisms.

References

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