51st International Congress of Meat Science and Technology
August 7-12, 2005 – Baltimore, Maryland USA

EFFECT OF LACTOPEROXIDASE SYSTEM ON QUALITY OF GROUND PORK

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Key Words: Lactoperoxidase; Total plate counts; Lipid oxidation; Metmyoglobin; Ground pork

Introduction

Lactoperoxidase (LP) is one of the most prominent enzymes in bovine milk and catalyzes the inactivation of microorganism in a lactoperoxidase system (LPS). Its activity is based on the oxidation of sulphydryl groups of enzymes and other proteins by the products of reaction of LP with thiocyanate (SCN^-) and/or iodide (I^-) and hydrogen peroxide. (de Wit, 1995). LPS has been shown to be effective at reducing and inhibiting microbial populations on meats (Kennedy et al. 2000; Elliot, et al. 2004).

Objectives

Our objectives were to determine the effect of LPS with NaSCN or KI on total plate counts, lactic acid bacteria, coliforms, TBARS values, percent metmyoglobin, and color (a* value) of ground pork during storage at 4 for 0, 2, 4 and 6 days.

Methodology

Frozen and thawed ground pork loins were divided into three batches (1.7 kg each) and each one was randomly assigned to one of the following treatments: (1) no additive (control), (2) LPS-NaSCN treatment (lactoperoxidase system consisting 2 ppm lactoperoxidase, 20 ppm NaSCN and 75 ppm hydrogen peroxide), and (3) LPS-KI treatment (consisting 2 ppm lactoperoxidase, 20 ppm KI and 75 ppm hydrogen peroxide). Meat samples were placed on white polystyrene foam meat tray, wrapped with polyvinylchloride film and stored at 4 for 0, 2, 4 and 6 days. Total plate counts and lactic acid bacteria were enumerated in plate count agar (Difco) and de Man Rogosa Sarpe (MRS) agar (Difco), respectively, after inoculation at 35 for 48hr. Coliforms were enumerated in violet red bile agar (Difco) after inoculation at 35 for 24 hr. All bacterial population was expressed as the $\log_{10}$ colony forming units (cfu/g). Thiobarbituric acid reactive substances (TBARS) values of ground pork were determined according to Ockerman (1985). TBARS values were expressed as mg malonaldehyde/kg meat. Metmyoglobin (%) of ground pork was determined by the methods described by Chu et al. (1987). The color (CIE a*) of ground pork was determined using a color meter (ZE, 2000, Nippon, Denshoku, Tokyo, Japan). All evaluations were replicated four times.

Data were analyzed as a factorial design, using GLM procedures of SAS (SAS Inst. Inc., Cary, NC). Differences between treatments means were separated using least squares mean procedures. Means were considered different at $P < 0.05$.

Results & Discussion

From the results of the analysis of variance, it was found that total plate counts (TPC) of meat samples were not significantly affected ($P > 0.05$) by LPS. No differences in TPC between the LPS-KI treatment and the control were observed during storage (Fig. 1). However, at days 4 and 6, the LPS-NaSCN treatment had lower ($P < 0.05$) TPC than the control. This indicated that the growth of TPC probably could be inhibited by the LPS–NaSCN treatment at later storage period. Kennedy et al. (2000) reported that the LPS–NaSCN treatment could inhibit the growth of naturally present microbial populations in ground beef. Elliot et al. (2004) indicated that the treatment with LPS-NaSCN was more effective at storage temperatures not for rapid bacterial growth.

Lactic acid bacteria of meat samples were not affected ($P > 0.05$) by LPS. No significant ($P > 0.05$) differences were found in lactic acid bacteria between treatments during storage (Fig. 2). The growth of lactic acid bacteria was not inhibited by the LPS-NaSCN or by the LPS-KI treatment. Elliot et al. (2004) also found that the LPS-NaSCN did not prevent the development of native lactic acid bacteria in beef cubes stored at chilling temperatures. In general, Gram-positive bacteria (i.e. lactic acid bacteria) are more resistant to the LPS than Gram-negative bacteria (de Wit, 1995).

The growth of coliforms was significantly affected ($P < 0.05$) by LPS. The LPS-NaSCN treatment had lower ($P < 0.05$) coliforms than the other two treatments during storage (Fig. 3). This indicated that the LPS-NaSCN treatment could effectively inhibit the growth of coliforms. However, no significant differences were found in coliforms between the LPS-KI treatment and the control, suggesting that the LPS-KI treatment did not depress the growth of coliforms. Kennedy et al. (2000) reported that the LPS-NaSCN could inhibit the growth of *E. coli* O157:H7 in ground beef. Zajac et al. (1983) also reported that coliforms in LP-activated milk remained unchanged for a longer period than those in the controls.

The TBARS values of meat samples were significantly affected ($P < 0.05$) by LPS. At day 0, the TBARS values among all treatments were similar (Fig. 4); but at days 2 and 4, the LPS-NaSCN treatment had higher ($P < 0.05$) TBARS values than the LPS-KI treatment and the control; and at days 6, the TBARS values of all treatments were not different. In general, the TBARS values of the LPS-NaSCN and the LPS-KI treatments were higher than the control during storage. This indicated that the LPS treatments consisting of H_2O_2 and SCN^- or I^- anions could probably accelerate lipid oxidation in ground pork, and increase TBARS values. The LPS-NaSCN treatment had greater effect on TBARS values than the LPS-KI treatment. The TBARS values of all samples were low initially and remained low (less than 0.4 mg/kg) throughout the entire storage time.

The values for a* of meat samples were significantly affected ($P < 0.05$) by LPS. During storage, the LPS-KI treatment had lower a* values than the control (Fig. 5), suggesting that the LPS-KI treatment could accelerate meat discoloration in ground pork; however, a* values for the LPS-NaSCN treatment and the control were similar. As storage time increased, the values for a* of all treatments decreased. These color changes

were expected, since extended exposure of fresh meat, resulted in myoglobin oxidation and meat discoloration.

The percent metmyoglobin of ground pork was significantly affected (P <0.05) by LPS. The LPS-KI treatment had higher percent metmyoglobin, but the LPS-NaSCN treatment had lower percent metmyoglobin than the control during storage (Fig. 6). It was found that the higher percent metmyoglobin, the lower a* values (Fig. 5) for all meat samples. The percent metmyoglobin was negatively correlated (r = –0.512) with a* values (P <0.05). The percent metmyoglobin of all meat samples increased with storage time.

Conclusions

The growth of coliforms could be inhibited by the LPS-NaSCN treatment. Both the LPS-NaSCN and the LPS-KI treatments would accelerate lipid oxidation and increase TBARS values. Ground pork treated with LPS-NaSCN had lower percent metmyoglobin and higher a* values. The LPS-KI treatment had less effect on microbial growth, and it would increase percent metmyoglobin and decrease a* values of ground pork.

References

Chu, Y. H., Huffman, D. L., Trout, G.R. and Egbert, W. R. 1987. Color and color stability of frozn restructure beef steak: effect of sodium chloride, tripolyphosphate, nitrogen atmosphere, and processing procedures. J. Food Sci. 52, 869–875.

de Wit, J.N. 1995. Structure, functions and applications of lactoperoxidase in natural antimicrobial systems. DMV International, The Netherland.

Elliot, R.M., McLay, J.C., Kennedy, M.J. and Simmonds, R.S. 2004. Inhibition of foodborne bacteria by the lactoperoxidase system in a beef cube system. Int. J. Food Microbiol. 91, 73–81.

Kennedy, M., O'Rourke, A., McLay, J. and Simmonds, R. 2000. Use of a ground beef model to assess the effect of the lactoperoxidase system on the growth of *Escherichia coli* O157:H7, *Listeria monocytogenes* and *Staphlococcus aureus* in red meat. Int. J. Food Microbiol. 57, 147–158.

Ockerman, H. W.. 1985. Quality control of post-mortem tissue. Dept. of Animal Science. The Ohio State University.

Zajac, M., Gladys, J., Skarzynska, M., Harnulv, G. and Bjorck, L. 1983. Changes in bacteriological quality of raw milk stabilized by activation of its lactoperoxidase system and stored at different temperatures. J. Food Prot., 46(12), 1065–1068.

Tables and Figures

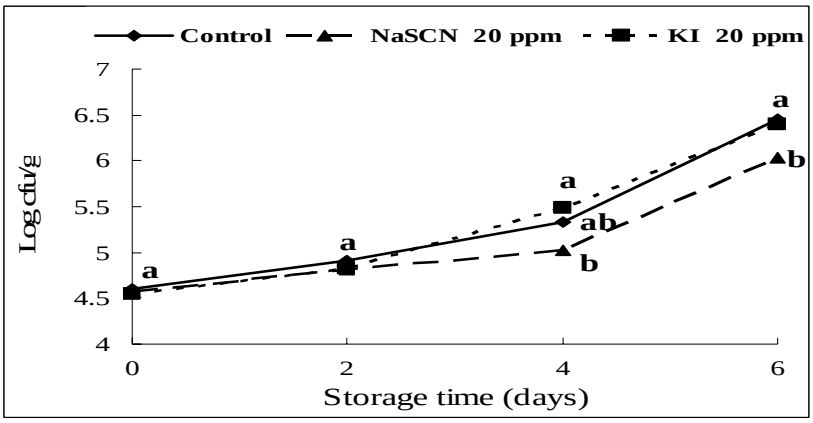

Fig. 1. Total plate counts in ground pork as affected by LPS with NaSCN or KI. [ab] Means within a storage period having the same superscripts are not significantly different (P<0.05).

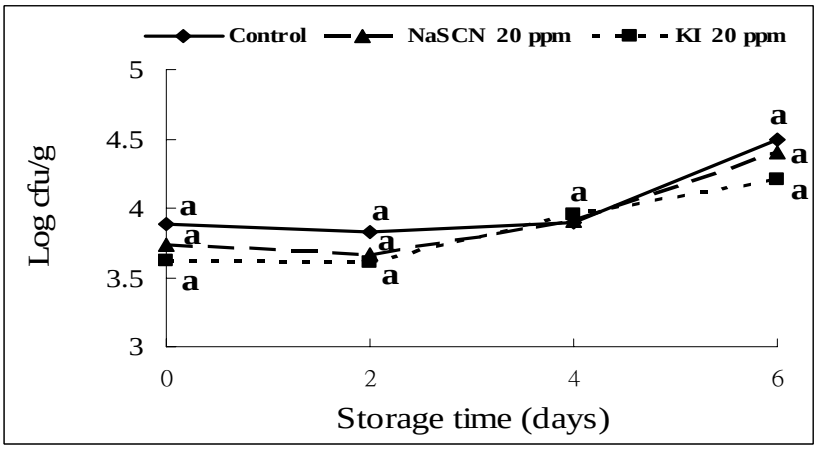

Fig. 2. Lactic acid bacteria in ground pork as affected by LPS with NaSCN or KI. [a] Means within a storage period having the same superscripts are not significantly different (P<0.05).

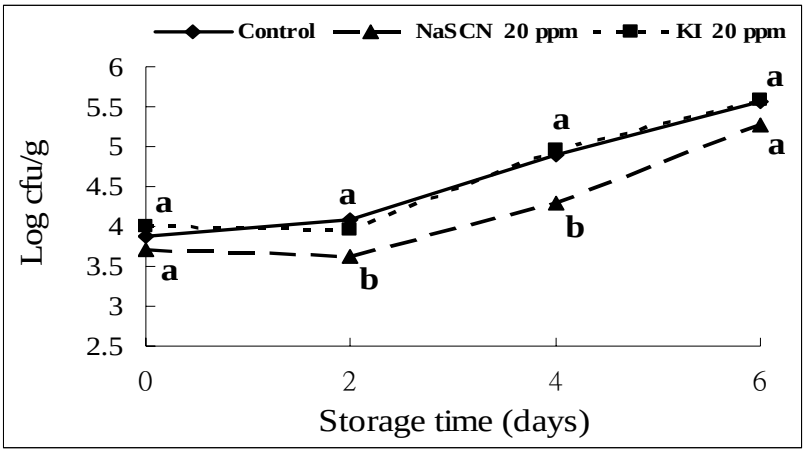

Fig. 3. Coliforms in ground pork as affected by LPS with NaSCN NaSCN or KI. [ab] Means within a storage period having the same superscripts are not significantly different (*P*<0.05).

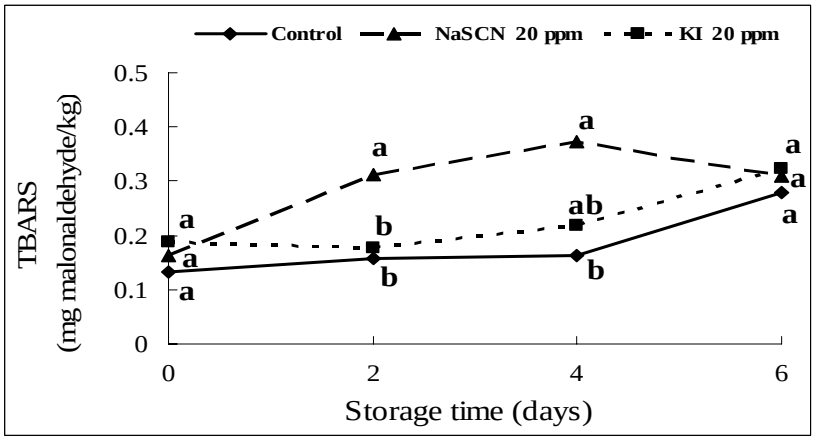

Fig. 4. TBARS values of ground pork as affected by LPS with NaSCN or KI. [ab] Means within a storage period having the same superscripts are not significantly different (*P*<0.05).

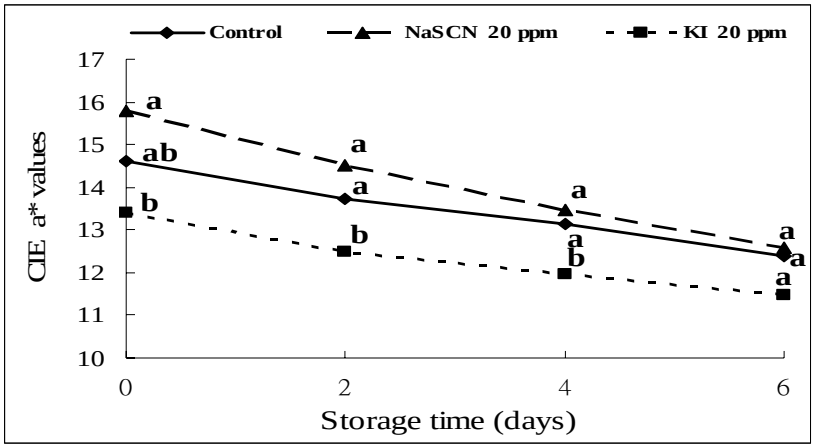

Fig. 5. The a* values of ground pork as affected by LPS with NaSCN or KI. [ab] Means within a storage period having the same superscripts are not significantly different (*P*<0.05).

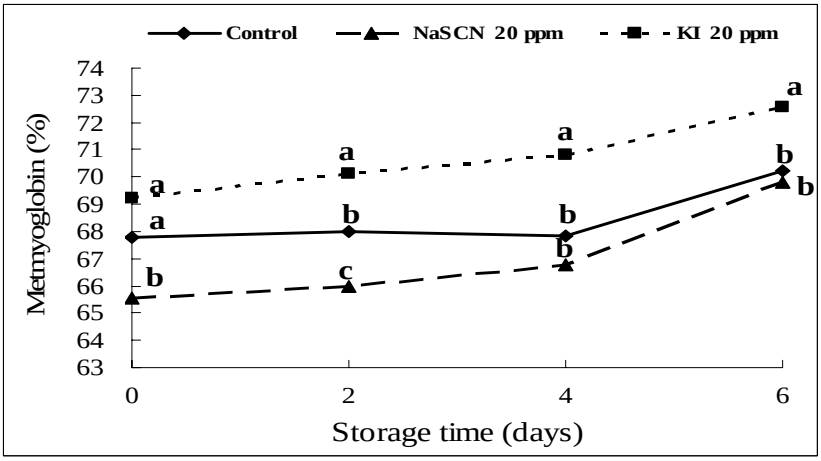

Fig. 6. Percent metmyoglobin of ground pork as affected by LPS with NaSCN or KI. [abc] Means within a storage period having the same superscripts are not significantly different (*P*<0.05).