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Effects of High Pressure Treatment on Cured Colour Development and Residual Nitrite Level in Model System

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Introduction

The three roles of nitrite in curing are microbiological stability, flavour production, and colour development (MacDougall and Hetherington, 1992). In terms of colour development, Fox (1987) postulated only 4~6 ppm nitrite was enough to pinking development in frankfurters, and MacDougall and Hetherington (1992) reported that only 1~2 ppm nitrite was sufficient in sliced cooked pork. However, clostridia are considered as important bacterial genera in heat treated meat products, because of their facultative anaerobic and spore forming nature, *Clostridium botulinum* produces a deadly toxin which causes botulism (Yetim *et al.*, 2006). Nitrite, in addition, still receives much attention for its role in the formation of carcinogenous N-nitrosamines (Peters *et al.*, 1994). In the United States, sodium nitrite is permitted at level up to 156 ppm in cured meats (Heaton *et al.*, 2000). Although novel food technology such as irradiation could reduce N-nitrosamine and nitrite residuals in meat product (Ahn *et al.*, 2002), the effect of high hydrostatic pressure has not been reported. Therefore the aim of this study was to investigate the effect of nitrite levels under hydrostatic pressure and thermal treatment on cured colour development and nitrite residuals contents of pork meat.

Materials and Methods

Porcine *m. longissimus dorsi* stored 24 h after slaughter was trimmed all visible fat and connective tissue, and then ground through 8 mm plate three times. Meat was mixed with 1% NaCl and various levels of sodium nitrite, and filled into fibrous casing. All treatment was vacuum-packed with polyethylene bag and stored at 4°C for 24 h. Instrumental colour, cured pigment content and residual nitrite level were determined from untreated control

(C), thermal treatment at 75°C for 30 min (T), pressure treatment at 200 MPa for 30 min under ambient temperature (P) and thermal treatment after pressurisation (PT), respectively. Cured pigment and residual nitrite were determined according to Heaton *et al.* (2000) and AOAC (1990), respectively. The results were analysed by ANOVA using SAS statistical program 9.1 (SAS Institute, Cary, NC, USA).

Result and Discussion

Effects of low nitrite concentration on colour and cured pigment content of pork meat are given in Fig. 1. Added nitrite levels had no effect on L^*-values of all treatment ($p>0.05$), whilst significant difference was found among treatment ($p<0.05$). The most increasing in L^*-value was obtained at T treatment. Increasing nitrite level decreased a^*-value of C and P treatment. In contrast, a^*-value of T and PT treatment increased with increasing nitrite level. However, b^*-value of all treatments decreased with increasing nitrite level. PT treatment showed lower b^*-value than T treatment. Cured meat pigment content was also higher at PT than T treatment. P treatment also showed increased in

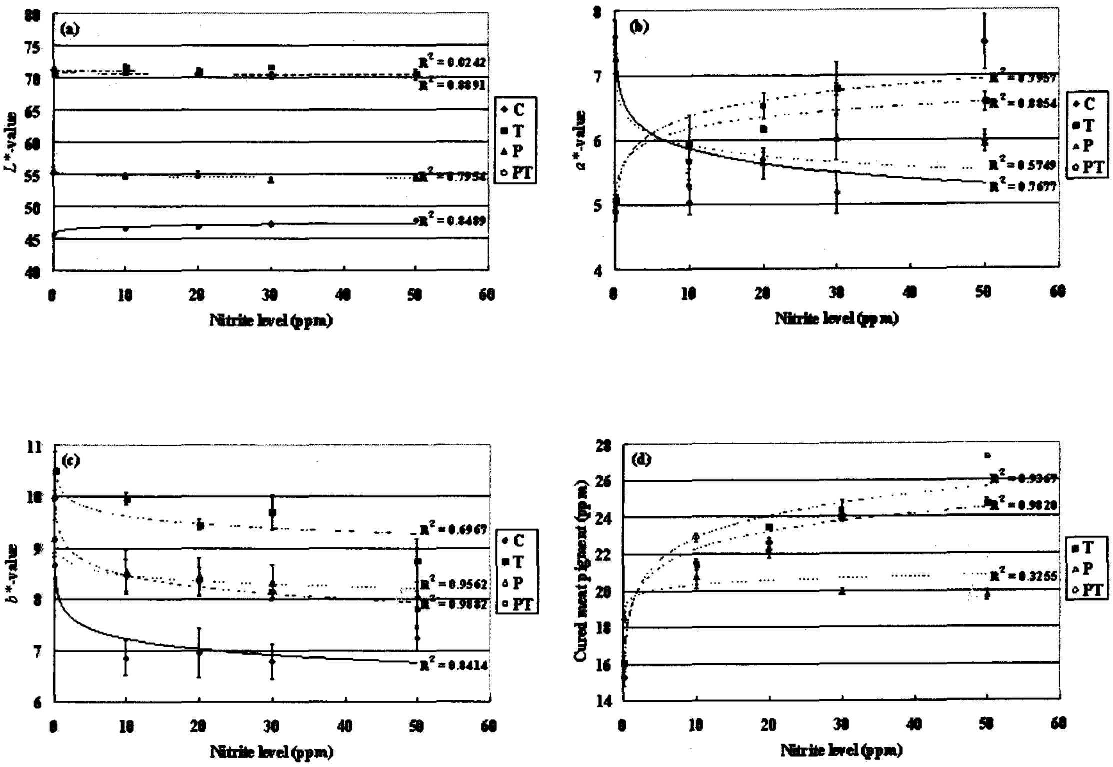

Fig. 1. Changes in (a) L^*-value, (b) a^*-value, (c) b^*-value and (d) cured pigment content of pork meat added low nitrite levels after various treatments.

cured pigment content with increasing added nitrite level, however, the effect was lower than T treatment. Therefore the result indicated although only pressurised treatment showed no pinking development in low nitrite level up to 50 ppm, treatment of combined with pressure and thermal processing improved cured meat colour comparing with that of only thermal processing.

Effects of high nitrite concentration on colour and residual nitrite level of pork meat are given in Fig. 2. In high nitrite levels, added nitrite level had no effect on colour parameters (p>0.05), though b^*-value tended to decrease with increasing nitrite level. However, significant difference was shown among treatments (p<0.05). Although T and PT treatment showed similar L^*- and a^*-value, PT had lower b^*-value than T treatment. In addition, P treatment increased L^*- and a^*-value compared to control. The result was possibly due to globulin denaturation by applied pressure (Hong *et al.*, 2005) leading to nitrosyl heme pigment fixation. For residual nitrite content, PT treatment was more effective than T treatment in terms of reducing nitrite residuals. In the current study, T treatment added 200 ppm of nitrite showed below 70 ppm of final nitrite residuals. However, PT treatment showed below 70 ppm of nitrite residuals at up to 300 ppm of

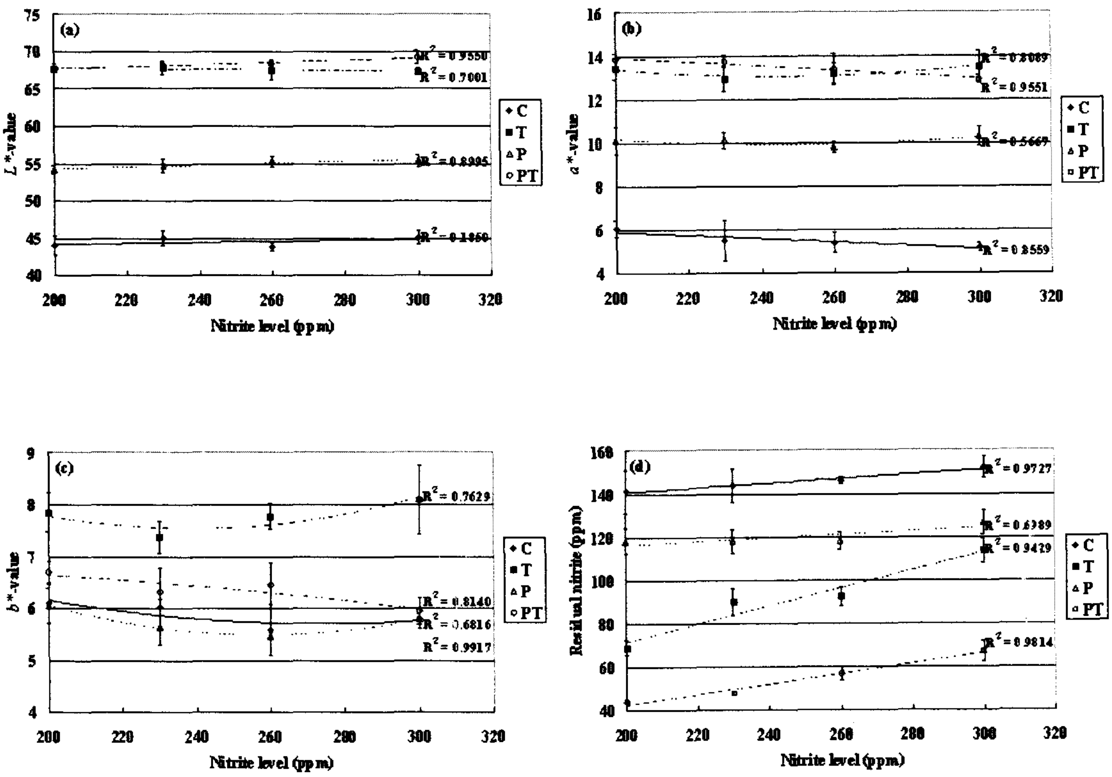

Fig. 2. Changes in (a) L^*-value, (b) a^*-value, (c) b^*-value and (d) residual nitrite content of pork meat added high nitrite levels after various treatments.

added nitrite level. Although added nitrite level was not proportional to the safety from food born disease in high nitrite level, the result showed some probabilities in food safety with reduced salt level which is one of the most concerns in meat product industry.

Summary

In low nitrite level, treatment of combined with pressure and thermal processing improved cured meat colour comparing with that of only thermal processing. However, visual colour of only pressurised treatment could not be improved at low nitrite level. Pressure treatment could develop cured meat colour when high nitrite level was added. Moreover, pressurisation combined with thermal processing decreased nitrite residuals compared to thermal processing. Therefore the results indicated that pressurisation combined with thermal processing had potential benefits in appearance of cured meat products, promising improved food safety.

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