EXTENDING THE SHELF-LIFE OF CHILLED PORK BY COMBINATION OF CHITOSAN COATING WITH SPICE EXTRACTS

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Introduction

Chilled pork is highly susceptible to microbial contamination because of its high nutrient density. The principal factors that must be addressed in the preservation of chilled meat are the retention of an attractive, fresh appearance for the product on display, and the retardation of bacterial spoilage. In addition, minimization of exudates losses is of commercial concern (Steven et al., 1998). Extracts from many kinds of Oriental spice plants have long been known to possess antimicrobial activity (Djenanea et al., 2002). Inhibitory effects of rosemary, cinnima, and clove on the growth of *Escherichia coli, Pseudomonas fluorescens,* and *Lactobacillus plantarum* have been demonstrated. In particular, these mixed extracts were found to be bacteriostatic in vacuum-packaged fresh pork (Kong et al, 2007). Chitosan is a cationic polymer with antimicrobial activity (Zhang et al., 2003) and film-forming ability. The applications of chitosan in muscle foods have been reviewed by Gennadios et al. (1997) with particular emphasis on the reduction of weight loss, microbial load, and volatile flavor loss.

The present study was undertaken to evaluate the combined effect of spice extracts and chitosan coating on shelf-life of chilled pork. Total bacterial counts and some quality characteristics (drip loss, a* value) of chilled pork were also evaluated at the end of the storage period.

Materials and Methods

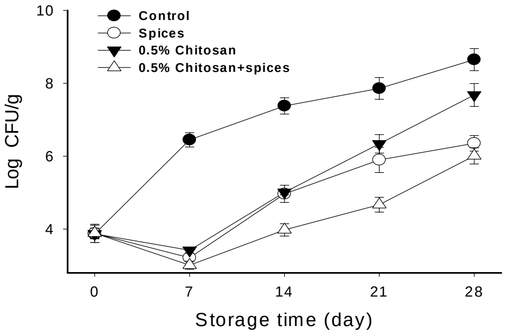
Chitosan was dissolved in 1% w/w aqueous acetic acid to prepare 0.5% w/w solution. Spice powders (rosemary, cinnima, and clove) were mixed together at a ration of 1.5:1.5:1 (dry weight basis) and added to ethanol solution at a final concentration of 4% (w/w).

Fresh chilled pork was purchased at a local grocery store and transported to the laboratory under refrigerated conditions in an ice filled cooler container. The chilled meats were divided into four separate groups：control; treated with mixed spices solution (dipping); treated with 0.5 % chitosan (dipping); and treated with 0.5 % chitosan + mixed spices solution (dipping). Samples were stored at 4 °C and tested periodically (days 0, 7, 14, 21 and 28) for microbial growth and biochemical characteristics (drip loss, a* value) of different groups.

Microbiological analysis of pork samples was conducted on 0, 7, 14, 21 and 28 days of storage. Serial dilutions of muscle sample solutions were mixed with a standard agar medium (0.5% casein digest, 0.25% yeast extract, 0.1% dextrose, 1.5% agar) and then poured into Petri dishes. Aerobic plate counts, expressed as colony-forming units per gram of muscle (CFU/g), were measured after incubation at 37°C for 48 h. The internal color of chilled meat was measured using a Color Difference Meter (Model WSC-S, Shanghai Physics and Optics Instrument Co., Shanghai, China). The values, expressed as a* (redness) units, were obtained from five different cut areas of each meat sample. Data from three replicated trials were analyzed using the General Linear Procedure. When the treatments were found significant ($P < 0.05$), differences between sample means were separated using the least significance difference method.

Results and Discussion

Microbial growths on pork chops with or without chitosan coating and spice extracts treatment during storage at 4 °C are shown in Figure 1. The initial bacterial population for control pork chops was 3.88 $\log_{10}$ CFU/g; the number steadily increased, reaching 8.56 $\log_{10}$ CFU/g after 28 days. This growth pattern was in general agreement with the observation of Venugopal et al. (1993) on beef. As displayed in Figure 1, the spice mixture or chitosan coating had a pronounced inhibitory effect on microbes grown in chilled pork. The spice mixture lowered the plate counts by 3.45, 2.36, 2.01 and 2.21 log10 CFU/g ($P < 0.05$) on days 7, 14, 21, and 28 when compared with control, and chitosan coating lowered the plate counts by 3.24, 2.31, 1.56 and 0.88 $\log_{10}$ CFU/g ($P < 0.05$). The combination of mixed spice extracts with chitosan coating produced stronger antimicrobial effects, showing 3.65, 3.34, 2.23 and 2.55 log reductions in microbial counts compared to the control on days 7, 14, 21, and 28.



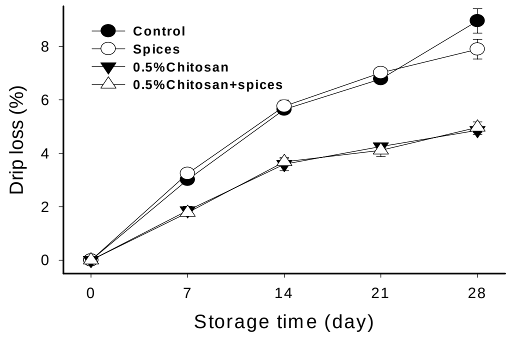


Figure 1. Microbial growth in refrigerated (4 °C) pork. Figure 2. Drip loss in refrigerated (4 °C) pork.

Figure 2 shows the effect with or without chitosan coating and spice extracts treatment on drip loss during storage at 4°C. Drip loss of all samples increased gradually. Control samples had the highest drip loss which reached 9.17% at 28 days. The chitosan coating treatment was effective in reducing drip loss (P < 0.05). The group treated with 0.5 % chitosan coating had 4.86 % drip loss in 28 days, which had approximately 4.09 % lower drip loss than that of control samples. The reason for lower drip loss could be attributed to the moisture retention properties of the chitosan coatings (Mallikarjunan et al., 1997). Similarly, Dong et al. (2004) reported that chitosan coating of peeled litchi fruit retarded weight loss. However, no significant (P > 0.05) difference was observed between spice extract treatments and the control.

The a* values of control meat samples were lower (P < 0.05) than treatment groups with chitosan coatings or spice extracts (Figure 3). Although a* values of all groups tended to decrease during storage times, the reduction (rate and magnitude) was significant only in the control samples (P < 0.05). The result suggests that chitosan coatings and spice extracts had an excellent protective effect on the color of chilled pork.

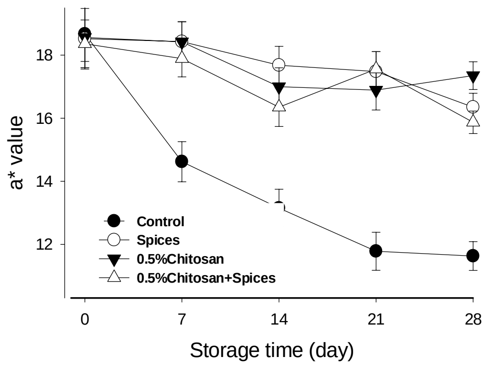


Figure 3. The a* value of refrigerated (4 °C) pork .

Conclusions

The findings validated that combinations of spice extracts and chitosan coating were capable of inhibiting microbial growth, retarding drip loss, improving surface colour, and extending the shelf-life of chilled meat during refrigerated storage. The combined spice extracts and chitosan coating can be used as natural antimicrobials for food preservations.

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