EFFECT OF NISIN WITH THERMAL TREATMENT ON THE MICROBIAL CHARACTERISTICS OF MARINATED BROILER DRUMSTICKS

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Background

Currently, meat marination is practiced to improve product's physical and sensory attributes (Lyon and Lyon, 2000; Xiong and Kupski, 1999), and the process is usually not intended to improve the microbial quality of the product. Nisin, which is a natural, nontoxic, heat stable polypeptide produced by *Lactococcus lactis* strains, has been shown to inhibit many microorganisms, and has been approved for using in some dairy products. Nisin also has been studied to apply in some meat products. Shefet, S.M. et al. (1995) indicated that adding nisin could extend the shelf life of refrigerated broiler drumsticks by 1.5 to 3 days. Thermal treatment has been widely applied to reduce the load of microorganisms for years. In addition, Budu-Amoako et al. (1999) indicated that combined nisin and moderate heat increased the destruction of *Listeria monocytogenes* in cold-pack lobster meat. Limited information on the contribution of marination, nisin, and thermal treatment to the microbial quality of treated poultry products is available.

Objectives

The objective of this study was to determine the effect of various factors including nisin-adding levels (0, 50, or 100 IU/ml), thermal treatment (4 or 58°C for 2 min), and storage time (day 0, 2, 4, and 7) on the total microflora and psychrotrophs counts of the marinated broiler drumsticks.

Methods

A simplified water-base marinade that contains acetic acid (1%) and salt (3%) with pH adjusted to 4 was developed as a standardized marinade. Drumsticks were marinated with various nisin levels (0, 50, or 100 IU/ml) combined with thermal treatment (4 or 58°C for 2 min), and then stored at 4°C for 18 hrs. For those samples without thermal treatment, drumsticks were completely covered with 400 ml of autoclaved marinated at 4°C for 18 hrs. For those samples with thermal-marinating treatment, the marinade solutions with various levels of nisin added were autoclaved, placed in bags, and then heated in a water bath before marinating. Drumsticks with the thermal-marinating treatments were then aseptically removed into bags with the heated marinade solutions. After holding at 58°C for 2 min, the marinade-chicken mixes in bags were cooled by immersing in running tap water. When the marination mix was cooled to ~25°C (approximately 10 min), the marination mix were then refrigerated at 4°C for 18 hours (including the previous time of thermal marinating and cooling). Following marinating and a 5 min drip time, the drumsticks were packaged individually in plastic bags and stored at 4°C. The total microflora and psychrotrophs counts of the marinated chicken drumsticks were measured after 0, 2, 4, and 7 days of refrigerated storage. The study was designed as a $3 \times 2 \times 4$ factorial experiment, 3 nisin adding levels (0, 50, and 100 IU/ml), 2 thermal treatments (58 or 4°C for 2 min), and 4 storage times (day 0, 2, 4, and 7). Least square mean (LSM) was analyzed using the general linear model (GLM) of Statistical Analysis System's Procedures (SAS Institute Inc., Cary, NC) with a 5% level of significance. A complete three-way GLM model was first used to analyze each measurement. Then, a new two-way GLM reduced model was conducted by SAS after the three-way interaction was removed from the model if the three-way interaction was not significant at the 0.05 level ($p<0.05$).

Result and discussion

The two main effects including thermal treatment, and nisin-adding level significantly affected the total microflora counts of the samples. Table 1 indicates that the samples with the thermal treatment, in which the samples with marinade solution was first heating to 58°C for 2 min, cooled, and followed by refrigerated storage for 18 hours, had significantly lower total microflora counts ($p<0.05$) of 5.71 log CFU/ml, while compared with the ones without thermal treatment (6.55 log CFU/ml).

As the nisin adding level increased, significantly less total microflora counts of the samples were obtained (Table 1). When adding nisin at the level of 50 IU/ml, the total microflora count of the samples decreased significantly to 5.95 log CFU/ml ($p<0.05$) while the one without adding nisin was 6.76 log (CFU/ml). Adding more nisin to the level of 100 IU/ml reduced the total microflora count to 5.70 log (CFU/ml) but was not was significantly different from the 50 IU/ml level. This result implies that adding nisin at the level of 50 IU/ml to the marinade solution in this study sufficiently decreased the total microflora counts of the samples. On the other hand, the total microflora counts increased with storage time as expected. Table 1 indicates that the total microflora counts of the samples were significantly different between storage time of day 0 and 7 ($p<0.05$). There was no significant three-way interaction at the 0.05 level. Only one two-way interaction (thermal treatment × nisin-adding level) was significant ($p<0.05$), which indicates that with or without thermal treatment (58°C for 2 min), nisin added with the different levels would affect the total microflora counts of the samples. As illustrated in Figure 1, without thermal treatment, the total microflora counts of the samples with thermal treatment differed significantly with those of the samples without thermal treatment (6.12 vs. 7.40 log CFU/ml). Similarly, adding nisin at either 50 or 100 IU/ml, the total microflora counts of the samples with thermal treatment were significantly lower than those without thermal treatment ($p<0.05$). However, when no nisin was added, the difference of the total microflora counts between the samples with or without the thermal treatment was 1.28 log, which was approximately double the amount in the samples with nisin added either at the 50 or 100 IU/ml (0.57 and 0.75 log). This result implies that adding nisin at the level of 50 IU/ml with thermal treatment of heating marinade solution at 58°C for 2 min, cooled and then refrigerated storage at 4°C for 18 hours significantly decreased the total microflora counts of the samples.

Similar to the total microflora counts, the psychrotrophs counts of the samples exhibited similar patterns (Table 1 and Figure 2).

Conclusion

In conclusion, adding nisin at the level of 50 IU/ml with thermal treatment of heating the marinade solution at 58°C for 2 min, cooling, and then refrigerated storage at 4°C for 18 hours, significantly decreased ($p<0.05$) the total microflora and psychrotrophs counts of the marinated chicken drumsticks. Based on the results of this study, the poultry industry would be able (after government approval) to apply this information to produce various high value-added and longer shelf life marinated products

Pertinent literature
Budu-Amoako, E.; Ablett, R.F.; Harris, J.; Delves-Broughton, J. 1999. J. Food Prot. v. 62 (1) p. 46-50.
Lyon, C.E. and Lyon, B.G. 2000. J. Appl Poult Res. v. 9 (2) p. 234-241.
Shefet, S.M.; Sheldon, B.W.; Klaenhammer, T.R. 1995. J. Food Prot. v. 58 (10) p. 1077-1082.
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Table 1. Effects of nisin-adding level, thermal treatment and storage time on total microflora and psychrotrophs counts of marinated chicken drumsticks.

Main Effect	Total microflora count	Psychrotrophs count
Nisin adding level (IU/ml)		
0	6.76[a]	7.02[a]
50	5.95[b]	6.55[b]
100	5.70[b]	6.37[b]
Thermal treatment[x]		
–	6.55[a]	7.00[a]
+	5.71[b]	6.29[b]
Storage Time (day)		
0	5.97[a]	6.34[a]
2	6.11[ab]	6.77[b]
4	6.11[ab]	6.70[b]
7	6.35[b]	6.78[b]

[ab]Means within a each main effect column lacking a common superscripts are different ($p \leq 0.05$).
[x]Thermal treatment: 58°C for 2min

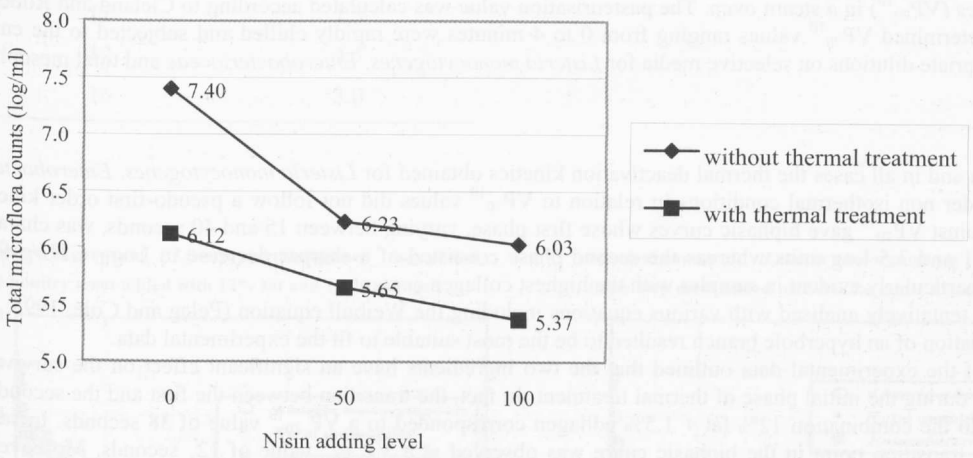

Figure 1. Interaction of nisin-adding level and thermal treatment for total microflora counts of marinated chicken broiler drumsticks

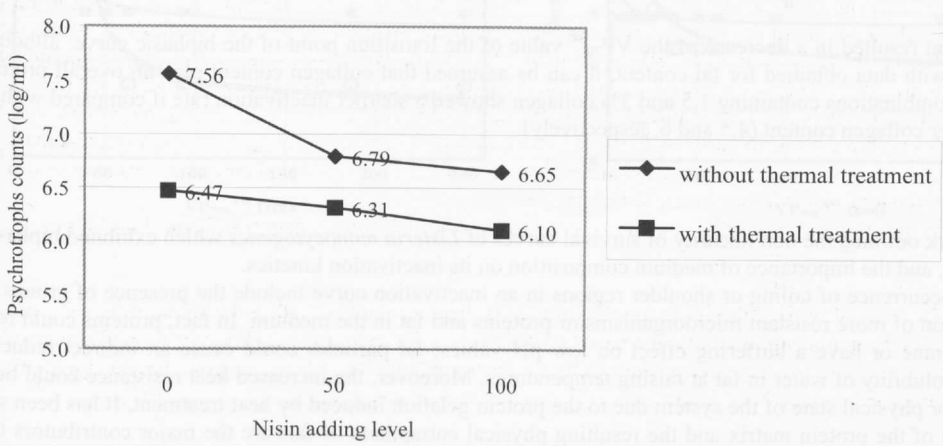

Figure 2. Interaction of nisin-adding level and thermal treatment for psychrotrophs counts of marinated chicken broiler drumsticks