Assessment of Dipping Treatment with Various Lactic Acid or Sodium Benzoate Concentrations to Extend the Shelf-life of Spent Hen Breast Meats

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Abstract

This study was conducted to investigate the effect of immersion treatment using lactic acid (LA) and sodium benzoate (SB) on the physicochemical quality and freshness of spent hen breast meats. A total of 135 spent hen breast meats were subjected to 9 different treatments using various concentrations of LA and/or SB in sterile DW. The 9 treatment groups were as follows: Control, sterile DW without LA or SB; T1, 1% LA; T2, 2% LA; T3, 4% LA; T4, 1% LA and 0.1% SB; T5, 2% LA and 0.1% SB; T6, 2% LA and 0.2% SB; T7, 2% LA and 0.4% SB; T8, 4% LA and 0.2% SB, respectively. All groups were kept at 4°C for 15 d. The microbial counts in the control group gradually increased during storage, but those for the treated groups were significantly lower than the control or were not detected. The pH values of the control were significantly higher than those of the treated groups (p<0.05). In the color measurements, the lightness (L*) and yellowness (b*) values increased during storage and the redness (a*) values decreased (p<0.05). The K-value and volatile basic nitrogen of the treated groups were significantly lower than those of the control group (p<0.05). Overall, the combined results of this study indicate that LA and SB could be used as favorable preservatives for spent hen breast meats to extend their shelf-life during refrigerated storage.

Key words: spent hen, lactic acid, sodium benzoate, shelf-life, freshness

Introduction

Laying hens are raised until approximately 70 wk of age in order to obtain eggs. A substantial proportion of these hens are referred to and marketed as spent hen meat. Spent hens meat is known to be very tough and this toughness prevents it from being consumed and sold as food in markets. On the other hand, consumers in certain regions of the world, such as Vietnam and East-south Asian countries, are willing to purchase more tough poultry meats. Thus, methods to improve the bacterial safety and refrigerated shelf life of spent hen meat over a relative long exportation are very important not only for foreign consumers but also for Korean spent hen processors.

Poultry meat is more susceptible to lipid and protein oxidation during storage compared to other meats. This is because microorganisms can penetrate poultry meat easily due to the indigestion of muscle and the distinct slaughter processes used for poultry. Meat such as pork and beef acquire improved meat quality by aging; however, this is not the case for chicken because it has a lower degree of rigor mortis, which impacts the quality of meat such as tenderness (Lee et al., 1994).

The type of muscle fiber and component ratio of chicken, which has more white muscle than pork and beef, can affect the oxidation of lipids and postmortem metabolic rate. These facts are also dependent on storage time (Brooke and Kaiser, 1970). For this reason, poultry products can only be stored for a short time before the quality of the meat deteriorates (Park et al., 1997). Therefore, inhibiting microbial growth and retarding lipid and protein oxidation during storage and retail display is essential to maintain the quality and safety of poultry meat (Vaithiyanathan, 2011).

Several studies have been suggested that microbial
growth and lipid oxidation in chicken meats can be effectively inhibited using lactic acid (LA) and sodium benzoate (SB). Undissociated LA and acetic acid have been shown to inhibit the growth of microorganism (Colberg and Izat, 1988; Marcel et al., 1988; Mossel and Drake, 1990; Mountney and O’Malley, 1965; Stern et al., 1985). Marcel et al., (1988) reported that decontamination of broiler carcasses with 1-2% LA before chilling improved the microbial safety and extended the refrigerated shelf life. Izat et al. (1989) also found that organic acid acids such as LA could be used to increase the shelf life of processed broilers. However, the organic acid concentrations needed to decontaminate poultry carcasses generally lead to unfavorable sensory changes.

Since the maximal antimicrobial activity of SB is accomplished in low-pH environments, its usage as a preservative is limited to high-acid foods such as apple cider, soft drinks, and tomato ketchup (Jay, 1992). SB has been shown to control yeast and some bacteria as well as to inhibit the growth and mycotoxin production by molds (Parish and Carroll, 1988; Roland and Beuchat, 1984; Valcarcel et al., 1986).

However, previous studies observed that treatment to extend shelf-life poultry have been mostly conducted to eliminate pathogens on poultry carcasses. Therefore, the aim of this study was to examine the effects of LA and SB on spent hen breast meat in regards to improving shelf-life especially using K-value and volatile basic nitrogen (VBN), which could be used as physicochemical indicator on poultry. The effects various levels of LA and SB were evaluated to investigate optimum concentration by examining changes in total bacterial count (TBC), pH, color, K-value and VBN.

Materials and Methods

Samples and allocation to treatments

Fresh spent hen breast meats were obtained from a commercial slaughter house. A total of 135 spent hen breast meats were subjected to 9 different treatments with various levels of LA and/or SB in sterile DW. The 9 treatment groups were as follows: Control, sterile DW without LA or SB; T1, 1% LA; T2, 2% LA; T3, 4% LA; T4, 1% LA and 0.1% SB; T5, 2% LA and 0.1% SB; T6 2% LA and 0.2% SB; T7, 2% LA and 0.4% SB; T8, 4% LA and 0.2% SB, respectively. After preservative treatments, samples were individually vacuum-packaged in PE/PP/nylon bags using a vacuum packer (FJ-500XL, Fujee Tech, Korea). All samples were kept at 4°C for 15 d (1, 3, 5, 9 and 15 d).

Total bacterial count evaluation

After preservative treatments, samples were removed from the vacuum packaging using a sterile scalpel. Sample (5 g) were placed in 50 mL of 0.1% peptone water in a sterile stomacher bag and homogenized using a Stomacher (Stomacher400 Circulator, UK) for 2 min. The samples were then serial diluted with peptone water for microbial count. Plate count agar (PCA, Difco, USA) was used to obtain the total bacterial count and experiments were performed in triplicate. The plates were incubated at 37°C for 48 h. Total bacterial count was reported as the mean of three determinations and expressed as CFU/g.

pH evaluation

The pH of the samples was determined by blending 5 g of samples with 20 mL distilled water at 2,000 g for 2 min in a homogenizer (Model AM-7, Japan). The pH values were measured using a digital pH meter (pH meter F-51, Japan) that had been calibrated at pH 4.0 and 7.0.

Color evaluation

Color measurements were taken using a color meter (Chromameter, CR210, Minolta, Japan; illuminate C, calibrated with white standard plate L* = +97.83, a* = -0.43, b* = +1.98). The measuring area was 8 mm in diameter measuring area and the illumination area was 50 nm in diameter. Color values (CIE L*, CIE a’ and CIE b’) were measured on the surface of the samples and measurements were acquired in triplicate for each sample.

K-value evaluation

The K value, which is a relative ratio of ATP and ATP-related compounds, can be used as a freshness indicator. To calculate the K value, 200 mg of samples and 600 µL of perchloric acid were placed in a test tube in order to precipitate the protein. The solution was then neutralized with 50 µL KOH. The K-value was calculated with a freshness checker (Freshness checker system HF-1000, Huetech, Korea) using the following formula, as described by Saito et al. (1959).

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\text{K-value} (%) = \frac{1^{1}\text{HxR} + 2^{1}\text{Hx}}{\text{ATP} + 4^{\text{1}}\text{ADP} + 6^{\text{1}}\text{AMP} + 6^{\text{1}}\text{IMP} + \text{HxR} + \text{Hx}} \times 100
\]

Where, \(1^{1}\text{HxR}: \text{hypoxanthine}, 2^{1}\text{Hx}: \text{inosine}, 3^{\text{1}}\text{ATP}: \text{adenosine triphosphate}, 4^{\text{1}}\text{ADP}: \text{adenosine diphosphate}, 5^{\text{1}}\text{AMP}: \text{adenosine monophosphate}, 6^{\text{1}}\text{IMP}: \text{inosine monophosphate}, \)

* The lower the K-value, the fresher the meat.