EFFECT OF ADDING LEVELS OF SODIUM CHLORIDE AND NITRITE FOR SHELF-LIFE ON LOW-SODIUM PATTY

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Abstract – The aim of this paper was to study the changes of shelf-life of pork patties which were added with NaCl and sodium nitrite at different levels on. The pork patties were formulated: HSHN, 1.75% NaCl and 110 ppm sodium nitrite; HS, 1.75% NaCl; MSLN, 1.50% NaCl and 30 ppm sodium nitrite; LSLN, 0.75% NaCl and 30 ppm sodium nitrite; AKC, 0.75% NaCl, 0.25% KCl and 0.4% celery powder. The cooking loss of LSLN had the lowest values than other treatments that increased amount of salt levels (p<0.05). HS had been the highest TBARS values than other treatments (p<0.05). VBN did not show no significant differences according to storage day or treatments. The HSHN treatment was inhibited growth microorganism during storage period, but other treatments were showed growth microorganism by 4 log CFU/g at storage 20 d. AKC to storage 20 d showed a lower value than the HS treatment. In conclusion, 30 ppm of sodium nitrite considerably prevented the oxidation on low-sodium pork patties during storage. Also, the celery powder can be substituted for nitrite because it can inhibit the growth of microorganisms and fat oxidation.

Key Words – sodium, nitrite, patty, shelf-life

I. INTRODUCTION

Basically, consumers are trying to avoid intake of meat products that contains high levels of sodium chloride and nitrite due to the risk high blood pressure or cancer [1]. The addition of sodium chloride and sodium nitrite to prepare of meat products affects extracting myofibrillar protein, texture, flavor, and lipid oxidation etc. Recent study has reported that reduction in sodium chloride and sodium nitrite content results in the decline of quality in patties [2, 3]. However, previous studies did not deal with the effect of low concentration of sodium nitrite on the quality characteristics and shelf-stability of low-sodium patties. Therefore, the aim of this study was to evaluate the effects of decreasing sodium chloride and different levels adding sodium nitrite levels on shelf-stability of patties.

II. MATERIALS AND METHODS

1. Preparation of raw meat, KCl and celery powder

A commercial sample of pork meat and back fat were purchased from a local market. The KCl and celery powder was supplied by Sias Co., Ltd. (Seoul, Korea).

2. Manufacturing pork patties

Tabel 1. Formulation of pork patties prepared with various concentrations of NaCl and nitrite

Parameters (%)	HSHN	HS	MSLN	LSLN	AKC
Pork meat	80	80	80	80	80
Pork fat	15	15	15	15	15
Ice	5	5	5	5	5
Total	100	100	100	100	100
NaCl	1.75	1.75	1.50	0.75	0.75
Sodium nitrite	0.011	-	0.003	0.003	-
KCl	-	-	-	-	0.25
Celery powder	-	-	-	-	0.40
Phosphate	0.03	0.03	0.03	0.03	0.03
ISP1)	1.00	1.00	1.00	1.00	1.00
Spice	0.50	0.50	0.50	0.50	0.50
Sugar	0.50	0.50	0.50	0.50	0.50
Ascorbic acid	0.05	0.05	0.05	0.05	0.05

1)ISP: Isolated soy protein.

All subcutaneous and inter-muscular fat and disable connective tissue were removed from muscles. Pork meat and pork back fat were ground through an 8-mm plate using a meat grinder (PM-

70, Mainca, Barcelona, Spain). Each sample batch consisted of five different pork patties were formulated are given in Table 1. Each sample was then finely ground through a 3 mm plate, and the batches were mixed using mixer (RM-40, Mainca, Spain). The batches were processed into 80±1 g patties with 100 mm in diameter and 10 mm below in thickness using patty presses (Small ground press, Spikomat Ltd., Nottinghamshire, UK). The samples were stored at -20°C for 12 h to maintain shape and heated at 150°C until the core temperature of 75°C using converter oven. The pork patties also were vacuum-packaged with Nylon/PE film and stored in a 4°C refrigerator for analyses during 30 d.

3. Analysis of low-sodium pork patties

3.1 pH

The pH of 5 g samples blended with 20 mL distilled water for 60 s in a homogenizer (Ultra-Turrax T25, Janke and Kunkel, Staufen, Germany) was determined with a pH meter (Model 340, Mettler-Toledo GmbH, Schwerzenbach, Switzer-land)

3.2 Cooking yield

Cooking yield (%) was determined on individual treatments by calculating the weight differences before and after cooling as follows; Cooking yield (%) = [sample weight after cooking (g) / sample weight before cooking (g)] × 100

3.3 Salt content

The salt content of frankfurters (5 g) mixed with 20 mL distilled water for 60 s in a homogenizer (Ultra-Turrax T25, Janke and Kunkel, Staufen, Germany) at 8,000 rpm speed was determined with a salimeter (TM-30D, Takemura Electric Works Ltd., Tokyo, Japan).

3.4 Residual nitrite

Residual nitrite content was determined according to the Diazo coupling method and is expressed as ppm per kilogram of pork patties [4].

3.5 Thiobarbituric acid reactive substances (TBARS)

Lipid oxidation was assessed using the TBARS method of Tarladgis, Watts, Younthan, & Dugan [5] with minor modifications. Absorbances were measured using a UV/VIS spectrophotometer (Optizen 2120 UV plus, Mecasys Co. Ltd., Seoul, South Korea) at 538 nm against a blank prepared with 5 mL distilled water and 5 mL TBA reagent. TBARS values were calculated from a standard curve (8-50 nmol) of malondialdehyde (MDA), which was freshly prepared by acidification of 1,1,3,3-tetraethoxy propane (TEP). Reagents were obtained from Sigma-Aldrich (St. Louis, MO, USA). TBARS levels were calculated as mg MDA/kg samples.

3.6 Volatile basic nitrogen (VBN)

Volatile basic nitrogen (VBN) method was performed to determine the extent of protein deterioration. VBN values were measured by the modified microdiffusion assay according to the method of Pearson [6].

3.7 Total plate counts (TPC)

For microbial analysis, total aerobic bacteria counts were determined by plating the diluted samples onto plate count agar and incubating the plates at 37 °C for 48 h. Each microbial count was the mean of three determinations.

3.8 Statistical analysis

An analysis of variance was performed on all the variables measured using the two-way ANOVA procedure of the SAS statistical package [7].

Table 2. Change in pH and color of cooked pork patties with different salt and nitrite concentration during refrigerated storage for 30 days at 4°C

Storage days	HSHN	HS	MSLN	LSLN	AKC
0	$6.08±0.04^{X}$	$6.05±0.03^{VWX}$	$6.08±0.04^{W}$	$6.09±0.04^{W}$	$6.07±0.05^{VW}$
5	$6.08±0.01^{BWX}$	$6.07±0.02^{AX}$	$6.08±0.01^{BW}$	$6.09±0.01^{CW}$	$6.08±0.01^{CW}$
10	$6.09±0.03^{BX}$	$6.06±0.02^{ABWX}$	$6.05±0.03^{AV}$	$6.07±0.03^{ABVW}$	$6.07±0.04^{ABVW}$
20	$6.08±0.02^{BVW}$	$6.04±0.01^{AWX}$	$6.04±0.01^{AV}$	$6.06±0.03^{BV}$	$6.04±0.01^{AV}$
30	$6.07±0.02^{V}$	$6.06±0.03^{V}$	$6.07±0.03^{V}$	$6.10±0.04^{W}$	$6.09±0.03^{W}$

All values are mean ± SD

[A-D]Means sharing different letters in the same row are significantly different (p<0.05).

[V-X]Means sharing different letters in the same column are significantly different (p<0.05).

Duncan's multiple range test (P < 0.05) was used to determine the differences between treatment means.

III. RESULTS AND DISCUSSION

Table 2 shows the changing of pH on sodium and nitrite different levels for pork patties during storage for 30 d. According to the storage days, the pH value of all treatments decreased during 20 d, but thereafter was increased (p<0.05). HSHN treatments had the highest pH values each storage for 10 and 20 d than the other treatments.

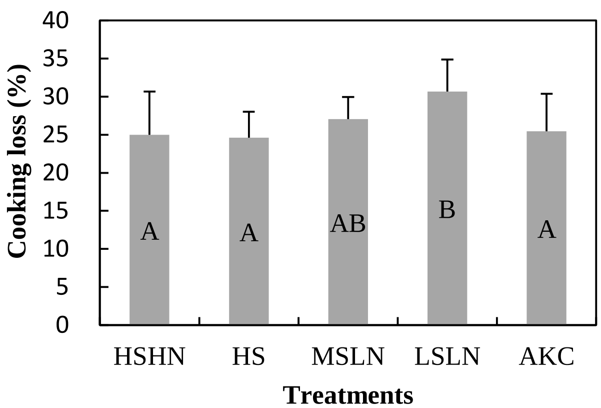

Figure 1. Change in cooking loss of pork patties with different salt and nitrite concentration during refrigerated storage for 30 days at 4°C. A, B Mean sharing different letters within each storage day are significantly different (p<0.05).

Figure 1 shows the cooking loss of pork patties which were produced with different levels added NaCl and nitrite. The cooking loss of LSLN had the lowest values than other treatments that increased amount of salt levels (p<0.05). On the other hand, the added of KCl was decreased to cooking loss compared with the LSLN (p<0.05).

The residual nitrite was showed in proportion to the amount added nitrite, and passing the storage period was reduced (p<0.05). HS had been the highest TBARS values, while, HSHN was the lowest TBARS values. And AKC treatment also showed result that inhibit fatty oxidation. This result is determined to be due to the interaction according to the amount of salt and nitrite. VBN did not show no significant differences according to storage day or treatments.

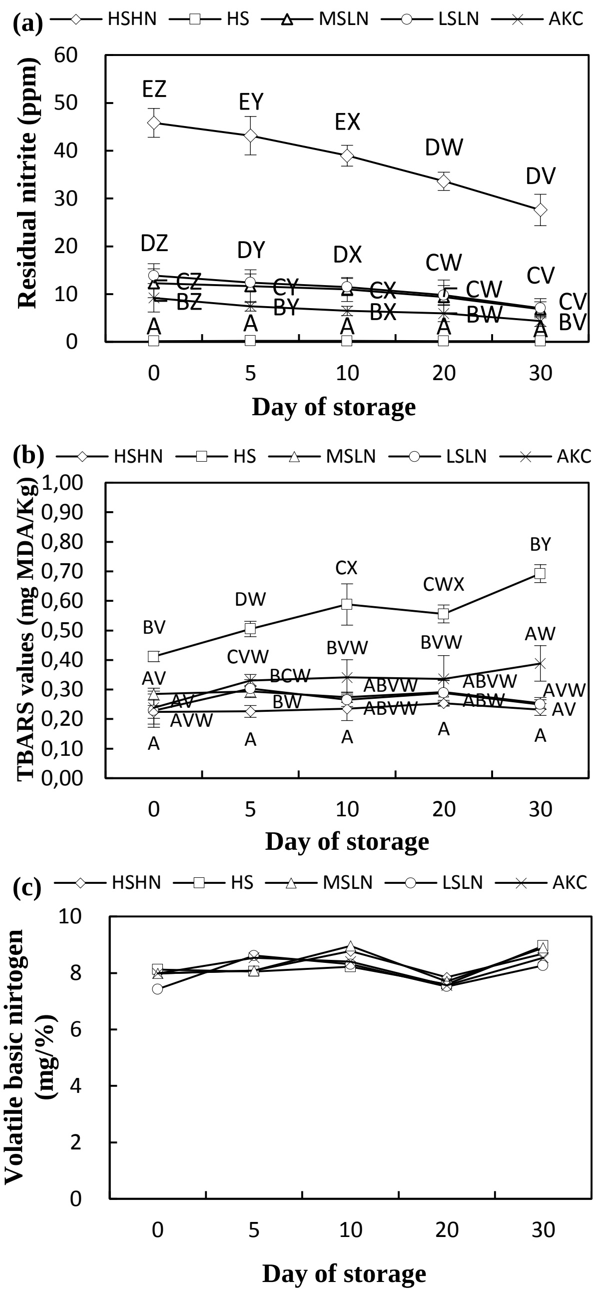

Figure 2. Change in residual nitrite (a), thiobarbituric acid reactive substances (b) and volatile basic nitrogen (c) of pork patties with different salt and nitrite concentration during refrigerated storage for 30 days at 4°C. A-E Mean sharing different letters within each storage day are significantly different (p<0.05). V-Z Mean sharing different letters within each treatment are significantly different (p<0.05).

Table 3. Change in total plate count (1og CFU/g) of cooked pork patties with different salt and nitrite concentration during refrigerated storage for 30 days at 4°C

Storage days	HSHN[1)]	HS	MSLN	LSLN	AKC
0	0.38±0.29	$0.54±0.28^{V}$	$0.72±0.67^{V}$	$0.46±0.38^{V}$	$0.39±0.33^{V}$
5	0.61±0.44	$0.39±0.27^{V}$	$0.71±0.50^{V}$	$0.42±0.34^{V}$	$0.31±0.23^{V}$
10	0.27±0.20	$0.41±0.35^{V}$	$0.65±0.52^{V}$	$0.42±0.24^{V}$	$0.27±0.32^{V}$
20	$0.65±0.26^{A}$	$4.01±0.34^{CW}$	$4.62±0.20^{DW}$	$5.58±0.09^{DW}$	$3.44±0.05^{BW}$
30	$0.49±0.16^{A}$	$4.80±0.56^{BX}$	$4.55±0.04^{BX}$	$5.84±0.02^{DX}$	$5.33±0.01^{CX}$

All values are mean ± SD

$^{A-D}$Means sharing different letters in the same row are significantly different ($p<0.05$).

$^{V-X}$Means sharing different letters in the same column are significantly different ($p<0.05$).

[1)]Treatments: HSHN, pork patties within 1.75% NaCl and 110 ppm sodium nitrite; HS, pork patties within 1.75% NaCl; MSLN, pork patties within 1.50% NaCl and 30 ppm sodium nitrite; LSLN, pork patties wit in 0.75% NaCl and 30 ppm sodium nitrite; AKC, pork patties wittin 0.75% NaCl, 0.25% KCl and 0.4% celery powder.

The growth of microorganisms has known to be affected pH, Aw, storage time and temperature, and the addition of the salt and the antimicrobial substance. Table 3 shows the changing of total palate count on sodium and nitrite different levels for pork patties during storage for 30 d. The HSHN treatment was inhibited growth microorganism during storage period, but HS (without nitrite) treatment was showed growth microorganism by 4 log CFU/g at storage 20 d. AKC treatment to storage 20 d showed a lower value than the HS treatment. This result showed effects of the microbial inhibition about that nitrite and its alternatives in pork patties.

IV. CONCLUSION

In conclusion, 30 ppm of sodium nitrite considerably prevented the oxidation on low-sodium pork patties during storage. Also, the celery powder can be substituted for nitrite because it can inhibit the growth of microorganisms and fat oxidation.

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