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QUALITY CHARACTERISTICS OF EMULSION TYPE SAUSAGES MANUFACTURED WITH BAMBOO SALTS

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Introduction

Sodium chloride is added in the processing to extract salt soluble protein and thus increase the binding, yield and juiciness of meat products. Also salt is involved in texture, taste, and flavor, safety as well as the shelf life of the products (Lin at al., 1991; Schwartz & Mandigo, 1976). In emulsion type products, the salt contributes to the formation of a stable emulsion which, upon heating, results in a product of acceptable quality characteristics (Schmidt et al., 1981). However in recent years high salt consumption has been associated with hypertension and other disorders in sensitive individuals and the current trend is to reduce the salt in processed foods (IFT, 1980). In order to reach these aims, many scientists have studied the possibility of salt reduction in meat products and a number of binding agents have been used to overcome property problems in low-salt products, including problems associated with water and fat binding properties and texture.

In Korea, the bamboo salts are mainly ingested for the health of the human body because bamboo salts that are produced through the several processes give the decrease in toxicity and the conversion of acidity into strong alkalinity compared to sun-dried salts. It is also known to have various therapeutic effects on diseases such as inflammations, viral disease, diabetes, circulation organ disorder and cancer (Shin et al., 2004). The production process of bamboo salts is ordinarily as follows: stamping inside bamboo hardens sun-dried salt and plugging with yellow mud; it is baked with pine wood and pine resin at about 1,000-1,500℃ for 8-10h in a kiln, resulting in composing a lump of salt through bamboo's resin soaking into sun-dried salt; the lump is powdered; repeatedly stamped inside bamboo and baked, and lastly, it is baked at about 1,300-2,000℃ of higher temperature. Compared with crude salt, the contents of iron, silicon, potassium, and phosphate in the bamboo salt were higher whereas the sulfate content was lower (Kim et al., 1998). No reports have been found on the emulsion stability, texture, and sensory characteristics of meat batter and cooked sausage with added bamboo salt as a sodium chloride substitute.

Objectives

The objective of this study was to evaluate bamboo salt as a substitute of NaCl in emulsion type sausages.

Methodology

Sample preparation: Fresh pork hams and pork backfats were purchased from a retail meat market in Seoul, Korea. Baking frequency two times (BS-2) and nine times (BS-9) bamboo salts were used as a NaCl replacer. The sausages used in this study were made from lean pork (60%), ice (20%), backfat (20%), and salts. The studied variable was salt types (NaCl, BS-2, and BS-9) and the added salt content was 1.5%. Phosphate and other spices were not added. Pork meat was trimmed of visible fat and connective tissue. Meat and pork fat were passed through a grinder with an 8 mm plate. Ground meat and fat were frozen and stored at -20℃ until use. Partially thawed ground meat was cut for 1min in a cutter at low speed and mixed with salt. The mixed meat was dry chopped for 1min at high speed. After dry cutting the pork fat and part of the ice were added and the batter was cut at high speed to 8℃. At that point the remaining ice was added and the batter was cut at high speed to 14℃. Immediately after cutting, the batter was stuffed by hand stuffer, in 24mm diameter cellulose casings. Sausages were hand-linked at 15 cm intervals, weighed and cooked at 75℃ to achieve an endpoint product temperature of 72℃ (30min) and cooled in an ice water bath for 30 min. The sausages were stored in a cooler at 4℃ overnight. After chilling the sausages were weighed, then peeled and vacuum packed with a vacuum packaging machine in film pouches and stored in the dark at 4℃ until subsequent analysis.

Proximate analysis: Moisture, fat (ether-extractable), protein and ash contents of cooked samples were determined according to standard AOAC (1990) procedure.

pH: The pH values of the meat batters and cooked sausages were determined by blending 5 g of samples with 20 mL distilled water for 30 s. Readings were taken with a digital pH meter and combination electrode.

Emulsion stability: Emulsion stability of the batters was determined according to the procedure by Ensor et al. (1987).

Color determination: The CIE L*a*b* values of samples were determined as indicators of lightness (L*), redness (a*) and yellowness (b*) using a Minolta Chromameter (Model CR200, Minolta, Japan).

Cooking yield: Cooking yield was determined by weighing the sausages before cooking and after cooling.

Sensory evaluation: Samples were assessed for color, flavor, texture, juiciness, and overall acceptability by an eight-member trained panel. The characteristics were evaluated using 10-point hedonic scale. A score of 1 indicated very low desirability and a score of 10 indicated very high desirability. Samples were heated in boiling water for 6 min and sliced into 3 cm lengths and three random samples were immediately served to panelists.

TBARS value: The thiobarbituric acid reactive substances (TBARS) content of the samples was determined according to Tarladgis et al. (1960).

Statistical analysis: Statistical analyses were by Duncan's multiple range test using the statistical analysis system.

Results & Discussion

The effects of bamboo salts on pH and emulsion stability of meat batters are shown in Table 1. The bamboo salts used in this study increased the pH value of meat batters. The mean pH values of the meat batter made with NaCl was pH5.82 while those of meat batters containing BS-2 and BS-9 were pH6.04 and pH6.48, respectively.

Water binding and gelation characteristics are important in determining the stability of comminuted meat products. In this study, the emulsion stability of meat batters was affected by bamboo salts. Water loss was highest in control sample and lowest in BS-9 treatment ($p<0.05$). As in water loss, the fat loss was also lowest in BS-9 sample. Substitution of NaCl with bamboo salts significantly decreased the water and fat release from meat batter and showed good fat and water-binding properties.

The effects of bamboo salts on proximate analysis, pH, cooking yield and color of cooked sausages are shown in Table 2. The moisture content of the products ranged between 58.30-62.59%. The protein content of cooked sausages ranged between 13.38% and 15.14% and the fat content between 24.52-25.80%. Protein and fat contents were inversely proportional to the moisture content of the product. Bamboo salts significantly affected the moisture and protein contents of cooked sausages. The BS-9 treatment had the highest moisture content (62.59%) and the lowest protein content ($p<0.05$). However, fat and ash contents were not significantly different among the treatments. The pH value of the control cooked sausage was pH 5.87 while these of BS-2 and BS-9 treatments were pH6.07 and pH6.55, respectively. The bamboo salts used in the present study increased the pH value of the product by about 0.2-0.68 pH-units. The cooking yields of BS-9 and BS-2 treatments were significantly higher than the control (NaCl) and cooking yield of BS-9 treatment was highest. The higher cooking yield with addition of bamboo salts was thought to be due to an increasing pH effect, resulting in a higher water binding and gelling capacity during heat treatment.

Ruusunen et al. (2003) reported that when frankfurters were made without phosphate, non-meat ingredients were needed at salt concentrations of less than 1.5%.While our results suggested that bamboo salts could increase emulsion stability and hydration properties of emulsion type sausages without phosphate.

The BS-2 and BS-9 treatments had significantly lower L*- and b*-values than the control ($p<0.05$). a*-values were highest in BS-9 sample ($p<0.05$) but a*-values of control and BS-2 samples were not significantly different ($p>0.05$). This difference of color values probably resulted from the different color of salts used.

The effects of bamboo salts on sensory properties are given in Table 3. The bamboo salts had a significant effect on sensory characteristics. Color, flavor, texture, juiciness and overall acceptability of BS-2 and BS-9 treatments were evaluated higher than control treatment. As expected, BS-9 treatment was more effective than the SB-2 treatment in sensory properties.

A major cause of meat product deterioration is oxidative rancidity. Oxidation of lipids in meat and meat products is responsible for changes in its nutritional quality, color, flavor, odor and texture. Several authors consider that sodium chloride acts as a

prooxidant in meat and meat products. The TBARS contents increase with increasing salt concentration and storage time (Hernández et al., 2002). It has also been demonstrated many times that spices inhibit rancidity, often showing synergism (Madsen & Bertelsen, 1995).

Changes in TBARS values of cooked sausages during refrigerated storage are shown in Table 4. Initial TBARS values did not differ among all treatments, but TBARS values of BS-9 treatment were lower than those of control since two weeks. These differences were significant from two weeks to the end of storage time. Especially, TBARS values of BS-9 treatment did not increase since one week, demonstrating the antioxidant effect of bamboo salt. It appears that bamboo salts inhibited lipid oxidation.

Conclusions

In conclusion, the results obtained in the present study provide evidence that bamboo salts improve emulsion stability, sensory properties, and antioxidation activity in cooked sausage. These suggest a possible use of bamboo salt in meat products, but further studies about the function of bamboo salt are needed.

References

AOAC. (1990) Official methods of analysis. Association of Official Analytical Chemists: Washington, DC.

Ensor, S.A., Mandigo., R.W., Calkins, C.R., & Quint, L.N. (1987). Comparative evaluation of whey protein concentrate, soy protein isolate and calcium-reduced nonfat dry milk as binders in an emulsion type sausage. Journal of Food Science, 52–1155.

Hernández, P., Park, D.K., & Rhee, K.S. (2002). Chloride salt type/ionic strength, muscle site and refrigeration effects on antioxidant enzymes and lipid oxidation in pork. Meat Science, 61, 405–410.

IFT (Institute of Food Technologists). (1980). Dietary salt – a scientific status summary. Expert panel on food safety and nutrition of the IFT committee on public information. Food Technology, 33, 85–91.

Kim, S.H., Kang, S.Y., Jung, K.K., Kim, T.G., Han, H.M., Rheu, H.M., & Moon, A. (1998). Characterization and anti-gastric ulcer activity of bamboo salt. Journal of Food Hygiene and Safety, 13, 252–257.

Lin, G.C., Mittal, G.S., & Barbut, S. (1991). Optimization of tumbling and KCl substitution in low sodium restructured hams. Journal of Muscle Foods, 2, 71–91.

Madsen, H.L., & Bertelsen, G. (1995). Spices as antioxidants. Trends in Food Science and Technology, 6, 271–277.

Ruusunen, M., Vainionpää, J., Puolanne, E., Lyly, M., Lähteenmäki, L., Niemistö, M., Ahvenainen, R. (2003). Effect of sodium citrate, carboxymethyl cellulose and carrageenan levels on quality characteristics of low-salt and low-fat bologna type sausages. Meat Science, 64, 371–381.

Schmidt, G.R., Rawson, R.F., & Siegal, D.G. (1981). Functionality of a protein matrix in comminuted meat products. Food Technology, 35, 235–237 and 252.

Schwartz, W.C., & Mandigo, R.W. (1976). Effect of salt, sodium tripolyphosphate and storage on restructured pork. Journal of Food Science, 41, 1266–1269.

Shin H.Y, Na H.J, Moon P.D, Shin T.K, Shin T.Y, Kim S.H, Hong S.H, Kim H.M. (2004). Inhibition of mast cell-dependent immediate-type hypersensitivity reactions by purple bamboo salt. Journal of Ethnophamacology, 91, 153–157.

Tarladgis, B.G., Watts, B.M., Younathan, M.T., & Dugan, L. (1960). A distillation method for the quantitative determination of malonaldehyde in rancid foods. Journal of American Oil Chemist Society, 37, 44–48.

Tables and Figures

Table 1: Effect of bamboo salts of pH and emulsion stability of meat batters

		Treatment[1)]		
		Control	BS-2	BS-9
pH		5.82±0.04[c]	6.04±0.01[b]	6.48±0.04[a]
Emulsion Stability	Water loss (%)	19.67±0.33[a]	13.17±2.16[b]	8.33±1.66[c]
	Fat loss (%)	5.33±0.66[a]	4.50±0.83[b]	2.67±0.35[c]

[1)] Control: NaCl, BS-2: Bamboo salt that was baked two times, BS-9: Bamboo salt that was baked nine times.

[a-c] Means in the same row with different letters are significantly different ($p<0.05$).

Table 2: Effects of bamboo salts on proximate analysis, pH, cooking yield and CIE L*a*b*-values of cooked sausages

	Treatment[1)]		
	Control	BS-2	BS-9
Moisture (%)	58.30±0.59[b]	58.45±0.95[b]	62.59±2.33[a]
Crude protein (%)	15.14±1.01[a]	13.96±0.49[ab]	13.38±0.80[b]
Crude fat (%)	25.80±1.34	24.74±1.09	24.52±2.12
Crude ash (%)	1.59±0.19	1.41±0.21	1.53±0.16
Sausage pH	5.87±0.03[c]	6.07±0.04[b]	6.55±0.03[a]
Cooking Yield (%)	84.97±0.70[a]	91.06±0.96[b]	92.51±0.85[c]
CIE L*-value	69.15±0.74[a]	66.82±0.09[b]	67.56±0.07[c]
CIE a*-value	8.60±0.20[b]	8.79±0.38[b]	9.45±0.08[a]
CIE b*-value	9.91±0.03[a]	9.57±0.05[b]	9.32±0.05[c]

[1)] Control: NaCl, BS-2: Bamboo salt that was baked two times, BS-9: Bamboo salt that was baked nine times.

[a-c] Means in the same row with different letters are significantly different ($p<0.05$).

Table 3: Effects of bamboo salts on sensory properties of cooked sausages

Sensory properties[1)]	Treatment[2)]		
	Control	BS-2	BS-9
Color	6.88±0.35^{b}	7.25±0.46^{ab}	7.75±0.71^{a}
Flavor	6.38±0.74^{b}	7.25±1.04^{ab}	8.00±1.41^{a}
Texture	6.88±0.35^{b}	7.25±0.89^{ab}	8.00±1.20^{a}
Juiciness	6.38±0.74^{b}	6.50±1.31^{ab}	7.63±1.30^{a}
Overall acceptability	6.13±0.99^{b}	7.25±1.04^{ab}	8.25±1.04^{a}

[1)] Sensory scores were assessed on 10 point hedonic scale where 1 = extremely bad or poor, 10 = extremely good or much.

[2)] Control: NaCl, BS-2: Bamboo salt that was baked two times, BS-9: Bamboo salt that

[a,b] Means in the same row with different letters are significantly different($p<0.05$).

Table 4: Changes of TBARS-values of cooked sausages manufactured with bamboo salts during storage at 4℃

Treatment [1)]	Storage period (weeks)					
	0	1	2	3	4	5
Control	0.54±0.07^{d}	1.23±0.03^{c}	1.66±0.02^{bx}	1.61±0.13^{bx}	1.77±0.03^{ax}	1.78±0.03^{ax}
BS-2	0.59±0.02^{d}	1.26±0.12^{c}	1.59±0.08^{abx}	1.47±0.06^{bxy}	1.65±0.10^{ay}	1.63±0.15^{ay}
BS-9	0.53±0.06^{b}	1.22±0.99^{a}	1.26±0.10^{ay}	1.34±0.07^{ay}	1.29±0.10^{az}	1.31±0.12^{az}

[1)] Control: NaCl, BS-2: Bamboo salt that was baked two times, BS-9: Bamboo salt that was baked nine times.

[a-d] Means in the same row with different letters are significantly different($p<0.05$).

[x-z] Means in the same column with different letters are significantly different($p<0.05$).