FUNCTIONAL PROPERITIES OF EMULSION-TYPE PORK SAUSAGES BY ADDITION OF NATURAL SHELL CALCIUM POWDER

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Abstract— **This study was conducted to evaluate effects of natural shell calcium powder(NSCP) addition on functional properties of emulsion-type pork sausages in order to substitute the phosphates as a curing agent. Emulsion-type pork sausages were processed in 7 treatments: T1(no additive), T2(sodium tripolyphosphate 0.3%), T3(NaCl 1.5%), T4(NaCl 1.5% + whey protein 0.5%), T5(NaCl 1.5% + whey protein 0.5% + NSCP 0.15%), T6(NaCl 1.5% + whey protein 0.5% + NSCP 0.3%), T7(NaCl 1.5% + whey protein 0.5% + NSCP 0.5%). In the proximal analysis, there were significant($p<0.05$) differences in moisture and fat contents of pork sausages among treatments, but differences were small. However, addition of NSCP significantly($p<0.05$) increased the ash content of pork sausages. Addition of 0.3% or 0.5% NSCP significantly($p<0.05$) increased pH and water holding capacity values, but decreased cook-test loss of pork sausages. In the surface color, addition of NSCP had no effect($p>0.05$) on Hunter L^*, a^* and b^* values of pork sausages. In the texture profile analysis, addition of 0.15% or 0.3% NSCP significantly($p<0.05$) increased the hardness and chewiness values of pork sausages. However, there were no significant differences in cohesiveness and springiness values of pork sausages among treatments. As a result, natural shell calcium powder, when whey protein(0.5%) was simultaneously added to pork sausages at reduced level of salt(1.5%), could be used as a substitute for phosphates and optimal addition level seemed to be 0.3% in processing of emulsion-type pork sausages.**

Keywords— **Natural shell calcium powder, Inorganic Polyphosphate, Emulsion-type pork sausages.**

I. INTRODUCTION

Phosphates, like many other curing agents, perform multiple functions when added to meat products. One of the most important functions of phosphates is the increasing solubility of meat proteins to bind and retain water in meat emulsion. The result of improved water retetion is not only improved cooking yields, but also improved product texture, tenderness and juiciness(Xiong, 2005). Although there are many forms of the phosphates that may be used in cured meat, the regulations do not differentiate between the various phosphates and phosphate blends. All are restricted to 0.5% based on finished product weight when used to reduce moisture loss, to protect flavor, or as a cure accelerator(USDA-FSIS, 1982).

Shell contains calcium carbonate($CaCO_3$) as the main component and can be used as a source of calcium. By heat treatment, $CaCO_3$ in the shell is converted to CaO, which exhibits antibacterial activity(Sawai et al., 2001). Oyster shell powder was applied to prepare noodles, fried chicken, sardine ball(Suhara, 1995), *Kimchi*(Choi et al., 2006) and tofu(Kim et al., 2007) for quality improvement or extension of shelf life.

However, the effect of shell powder addition on functional properties of meat products was not fully studied yet. Therefore, this study was conducted to evaluate effects of natural shell calcium powder addition on functional properties of emulsion-type pork sausages in order to substitute the phosphates as a curing agent.

II. MATERIALS AND METHODS

Certified organic grade vacuum packed, refrigerated lean pork and frozen pork backfat were obtained from Doorae Food Ltd.(Goesan, Korea). Emulsion-type pork sausages were processed in 7 treatments(Table 1): T1(no additive), T2(sodium tripolyphosphate 0.3%), T3(NaCl 1.5%), T4(NaCl 1.5% + whey protein 0.5%), T5(NaCl 1.5% + whey protein 0.5% + NSCP 0.15%), T6(NaCl 1.5% + whey protein 0.5% + NSCP 0.3%), T7(NaCl 1.5% + whey protein 0.5% + NSCP 0.5%)(Table.1). Basic formulations for emulsion-type pork sausages were as followed: lean

pork(52.1%), pork backfat(22.3%), ice(18.6%), potato starch(2.2%), glucose(0.6%), and seasoning(2.7%). The mixed emulsions were stuffed into a collagen casing(2.0cm of diameter, Nippi Collagen Industry, Shizuoka, Japan), dried(25min), smoked(55℃ for 13min) by sawdust, and then cooked to an internal temperature of 72℃ in a smokehouse(Bastramat 1500; Bayha & Strackbein Gmbh, Amsberg, Germany). The cooked sausages were cooled with water spray and kept at 4℃ for 12 hr before vacuum packaging. The samples were stored at 4℃ and functional properties were evaluated. The results were analyzed using the SAS(2002) program and the significance was defined at $p<0.05$.

Table 1. Experimental design for emulsion-type pork sausages

Items	*STPP	NaCl	Whey protein	Natural shell calcium powder
T1	-	-	-	-
T2	0.3%	-	-	-
T3	-	1.5%	-	-
T4	-	1.5%	0.5%	-
T5	-	1.5%	0.5%	0.15%
T6	-	1.5%	0.5%	0.3%
T7	-	1.5%	0.5%	0.5%

* Sodium tripolyphosphate

**T1(no additive), T2(sodium tripolyphosphate 0.3%), T3(NaCl 1.5%), T4(NaCl 1.5% + whey protein 0.5%), T5(NaCl 1.5% + whey protein 0.5% + NSCP 0.15%), T6(NaCl 1.5% + whey protein 0.5% + NSCP 0.3%), T7(NaCl 1.5% + whey protein 0.5% + NSCP 0.5%)

III. RESULTS AND DISCUSSION

In the proximal analysis(Table 2), there were significant($p<0.05$) differences in moisture and fat contents of emulsion-type pork sausages among treatments, but differences were small. However, addition of natural shell calcium powder(NSCP) significantly($p<0.05$) increased the ash content of pork sausages. Addition of 0.3% or 0.5% NSCP significantly($p<0.05$) increased pH(Table. 3) and water holding capacity values, but decreased cook-test loss of pork sausages(Table 3).

Table 2. Effect of natural shell calcium powder addition on proximate analysis of emulsion-type pork sausages*

Items	Moisture(%)	Protein(%)	Fat(%)	Ash(%)
T1	64.27±1.03 b	17.22±0.59	17.53±1.52 a	0.95±0.39 d
T2	64.96±0.69 ab	18.60±5.54	17.37±0.67 ab	0.98±0.35 d
T3	64.73±0.75 ab	17.08±0.62	16.89±0.94 ab	1.27±0.11 c
T4	64.69±0.64 b	17.25±0.56	16.72±1.05 ab	1.32±0.07 c
T5	65.05±0.67 a	17.10±0.46	16.28±0.28 b	1.55±0.11 b
T6	64.76±0.39 ab	16.98±1.04	16.54±1.28 ab	1.73±0.05 ab
T7	64.28±0.95 b	16.78±0.49	17.10±0.32 ab	1.82±0.03 a

* Treatments are the same as in Table 1.
a- d Means±SD with different superscription in the same column are significantly different($p<0.05$).

Table 3. Effect of natural shell calcium powder addition on quality properties of emulsion-type pork sausages*

Items	pH	WHC(%)*	Cooking loss(%)
T1	6.05±0.25 d	55.27±6.69 c	10.74±2.26 a
T2	6.34±0.43 c	54.77±4.05 c	0.74±0.11 c
T3	6.20±0.12 cd	55.14±4.76 c	2.78±0.80 b
T4	6.23±0.24 cd	55.40±6.12 c	1.11±0.14 c
T5	6.43±0.26 c	59.46±3.10 b	0.66±0.19 c
T6	6.69±0.09 b	65.26±5.46 a	0.96±0.36 c
T7	7.04±0.22 a	62.23±6.04 ab	0.71±0.14 c

* Treatments are the same as in Table 1.
** Consumer cook test weight loss.
a-d Means±SD with different superscription in the same column are significantly different($p<0.05$).

In the texture profile analysis(Table 4), addition of 0.15% or 0.3% NSCP significantly($p<0.05$) increased the hardness and chewiness values of pork sausages. However, there were no significant differences in cohesiveness and springiness values of pork sausages among treatments.

Table 4. Effect of natural shell calcium powder addition on shear force and texture profile analysis of emulsion-type pork sausages*

Items	Shear force(g)	Hardness (g)	Cohesiveness (%)	Springiness (%)	Chewiness
T1	110.00 ±4.00	475.71 ±151.20 ^{d}	0.31±0.12 ^{ab}	0.38±0.11 ^{b}	51.82 ±18.86 ^{c}
T2	131.08 ±48.63	701.25 ±188.78 ^{cd}	1.30±0.09 ^{ab}	0.39±0.14 ^{b}	66.43 ±9.92 ^{c}
T3	109.66 ±30.09	711.66 ±94.74 ^{cd}	0.26±0.08 ^{b}	0.44±0.17 ^{ab}	100.96 ±57.60 ^{c}
T4	138.20 ±47.57	982.85 ±163.98 ^{bc}	0.27±0.09 ^{ab}	0.47±0.20 ^{ab}	122.35 ±76.13 ^{c}
T5	133.75 ±32.45	1331.25 ±199.45 ^{a}	0.39±0.13 ^{ab}	0.60±0.16 ^{a}	474.17 ±91.10 ^{a}
T6	137.0 ±25.65	1334.29 ±389.39 ^{a}	0.40±0.22 ^{ab}	0.64±0.20 ^{a}	318.83 ±162.25 ^{b}
T7	147.80 ±41.46	1076.25 ±448.42 ^{ab}	0.44±0.23 ^{a}	0.61±0.23 ^{a}	254.93 ±131.90 ^{b}

* Treatments are the same as in Table 1.
$^{a-d}$ Means±SD with different superscription in the same column are significantly different($p<0.05$).

In the surface color(Table 5), addition of NSCP had no effect($p>0.05$) on Hunter L^*, a^* and b^* values of pork sausages.

Table 5. Effect of natural shell calcium powder addition on Hunter color of emulsion-type pork sausages*

Items	L value	a value	b value
T1	86.08±6.28	8.65±4.53 ^{ab}	16.02±0.72 ^{b}
T2	81.44±8.87	10.98±5.77 ^{a}	18.41±5.19 ^{a}
T3	79.63±9.28	5.48±1.91 ^{b}	15.76±1.27 ^{b}
T4	81.70±7.81	5.36±1.93 ^{b}	15.68±0.83 ^{b}
T5	84.65±5.80	7.71±2.79 ^{ab}	15.94±0.46 ^{b}
T6	83.87±8.13	7.60±3.55 ^{ab}	15.99±0.41 ^{b}
T7	87.14±4.71	9.82±3.87 ^{a}	15.81±1.16 ^{b}

* Treatments are the same as in Table 1.
^{a,b} Means±SD with different superscription in the same column are significantly different($p<0.05$).

IV. CONCLUSION

Natural shell calcium powder, when whey protein(0.5%) was simultaneously added to pork sausages at reduced level of salt(1.5%), could be used as a substitute for phosphate and optimal addition level seemed to be 0.3% in processing of emulsion –type pork sausages.

REFERENCES

1. Choi, Y. M., Whang, J. H., Kim, J. M., and Suh, H. J. (2006) The effect of oyster shell powder on the extension of the shelf-life of *Kimchi*. Food Cont. 17, 695-699
2. Kim, Y. S., Choi, Y. M., Noh, D. O., Cho, S. Y. and Suh, H. J. (2007) The effect of oyster shell powder on the extension of the shelf life of tofu. *Food Chem.* 103, 155-160
3. SAS. (2002). The SAS System Release 9.1, SAS Institute Inc., Cary, NC.
4. Sawai, J., Hirokazu, S., and Hiromitsu, K. (2001) Kinetic analysis of the bactericidal action of heated scallop-shell powder. *Int. J. Food Microbiol.* 71,211-218.
5. Suhara, H. (1995) Application of antimicrobial calcium agent in food production. *Food Indus.* 38, 32-44
6. USDA-FSIS. (1982). Meat and poultry products : phosphate and sodium hydroxide. *Federal Register*. 47:1079
7. Xiong, Y. (2005). Role of myofibrillar proteins in water-binding in brine-enhanced meats. *Food Research International*, 38:281-287