COMBINATION EFFECTS OF HIGH PRESSURE AND VINEGAR ON THE QUALITY PROPERTIES OF EMULSION-TYPE SAUSAGES

Dong Jin Shin[1], Juhui Choe, Sang Hui Lee, Hae In Yong, Cheorun Jo[1]*

[1]Seoul National University, Seoul 08826, Republic of Korea

*Corresponding author email: cheorun@snu.ac.kr

I. INTRODUCTION

In general, nitrite was added to control *Clostridium* species, especially *C. Botulinum*. When these pathogens are present in vacuum-packed meat products, they could outbreak a serious problem due to its exotoxin. Also, nitrite improves quality of meat products by production of desirable red meat color and characteristic flavor, and prevention of lipid oxidation. In spite of these beneficial functions, nitrite has been being avoided because of the consumers concern about the relationship between nitrite and carcinogen, nitrosamine. According to the needs of consumers, researchers are looking for alternatives to replace nitrite. As an emerging technology, high pressure processing (HPP) has been highlighted owing to its ability to destroy pathogenic bacteria in the food. Vinegar is also well known as a common disinfectant. However, the combined treatment of these on microbial quality and quality properties of meat products are not yet elucidated. Therefore, it is worth to investigate the effect of a combined treatment of HPP and vinegar on quality of nitrite-free meat products to develop a novel mean of processing. The objective of this study was to evaluate the quality properties of emulsion-type sausage that is treated with high pressure and vinegar to replace nitrite.

II. MATERIALS AND METHODS

Emulsion-type sausage was manufactured with different levels of vinegar (0, 1, and 2%; V0, V1, and V2). Also, positive control (PC; sausages with 0.2% sodium nitrite) was prepared. After stuffing of meat batter, samples were vacuum-packed (HFV-600L, Hankook Fujee Co., Ltd., Hwaseong, Korea) and cooked in a water bath at 80°C until the core temperature reached 75 ± 1°C. On half of sausages with 0, 1, and 2% vinegar, HPP was conducted four times using a HPP system (500MPA-INNOWAY, Innoway, Anyang, Korea) at 500 MPa, 2 ± 2°C, for 3 min with a 10 min interval of each trial. Cooking and HPP processing yield of sausage was calculated by the comparison of the weight before and after cooking or processing. Samples were stored at 5 ± 1°C and analyzed on 0, 1, 3, and 5 weeks (only the data of 0 and 5 weeks is shown here). Texture profile analysis was performed by texture analyzer (TA1, Lloyd, Hampshire, UK). CIE - L^*, a^*, b^* value of cooked sausage were measured using a colorimeter (CM-5, Konica Minolta Co., Ltd., Tokyo, Japan). 2-Thiobarbituric acid reactive substances (TBARS) values were evaluated according to a modified method of Witte *et al*. (1970). Data was analyzed using General Linear Model procedure with the fixed effects (HPP, vinegar, storage day). Mean values with standard deviation of means were reported and the Student-Newman-Keul's multiple range test (P<0.05) was used to determine differences between treatment means.

III. RESULTS AND DISCUSSION

In the previous study, by the treatment of HPP and vinegar, the number of vegetative *C. perfringens* was reduced about 2 log CFU/g. Though reduction was not observed on spore, there was no growth of spore for 5 weeks (data not shown). Owing to the pH of vinegar (pH 7.50 ± 0.01), the addition of vinegar raised the pH of cooked pork sausage (V0, pH 6.25; V1, 6.29; V2, 6.35; P<0.05). Water holding capacity (WHC) was also increased in the same order according to the increased pH of sausage. The treatment of 500 MPa of high pressure also increased WHC of sausage. Cooking yield and processing yield was not affected by the treatment of vinegar and/or high pressure (data not shown). The color of sausage was tarnished according to treatment of HPP and vinegar and tended to change according to storage time (P<0.05, Table 1). Sausage added with vinegar showed significantly higher hardness, cohesiveness, and chewiness

compared to that without vinegar or with nitrite. TBARS values indicated that HPP accelerated lipid oxidation of sausage. However, vinegar inhibited lipid oxidation of sausage storage for 5 weeks (P<0.05, Table 2).

Table 1. Effect of vinegar and high pressure processing on texture profiles of emulsion sausage storage for 5 weeks

HPP (MPa)[1)]	Treatment	Hardness			Cohesiveness			Chewiness		
		0 week	5 week	SEM[4)]	0 week	5 week	SEM[4)]	0 week	5 week	SEM[4)]
0.1	PC[2)]	46.52^{B}	47.84^{B}	2.917	8.20^{ABb}	7.96^{Ba}	0.034	8.20^{AB}	7.96^{B}	2.828
	V0	43.56^{B}	47.06^{B}	2.004	7.01^{Bb}	9.02^{Ba}	0.031	7.01^{Ba}	9.02^{Ba}	0.925
	V1	63.62^{A}	71.27^{A}	3.532	9.04^{ABb}	17.25^{Aa}	0.027	9.04^{ABb}	17.25^{Aa}	1.069
	V2	70.82^{A}	73.20^{A}	3.359	11.51^{Ab}	18.35^{Aa}	0.016	11.51^{Ab}	18.35^{Aa}	0.804
500	V0	50.48^{B}	54.16^{B}	4.393	9.33^{ABb}	12.08^{Ba}	0.020	9.33^{Aba}	12.08^{Ba}	1.353
	V1	65.19^{Ab}	74.42^{Aa}	1.769	9.15^{Bb}	17.98^{Aa}	0.020	9.15^{Aba}	17.98^{Aa}	1.486
	V2	63.12^{Ab}	74.26^{Aa}	2.180	8.84^{ABb}	19.58^{Aa}	0.032	8.84^{AB}	19.58^{A}	1.763
	SEM[3)]	2.656	2.847		0.790	1.287		0.790	1.287	

[1)]HPP, high pressure processing; V, vinegar; SP storage period, [2)]PC, Sausage with 0.02% sodium nitrite; V0, vinegar 0%; V1, vinegar 1%; V2, vinegar 2%, [3)]Standard error of the mean (n=21), [4)](n=6) [A,B]Means within a column with different letters are significantly different (P<0.05). [a,b]Means within a row with different letters are significantly different (P<0.05).

Table 2. Effect of vinegar and high pressure processing on 2-thiobarbituric acid reactive substances (TBARS) value and color of emulsion sausage storage for 5 weeks

HPP (MPa)[1)]	Treatment	TBARS value			Color (L*-value)			Color (a*-value)		
		0 week	5 week	SEM[4)]	0 week	5 week	SEM[4)]	0 week	5 week	SEM[4)]
0.1	PC[2)]	0.33^{B}	0.39^{C}	0.018	67.49^{Ba}	64.83^{Bb}	0.234	8.13^{Ab}	8.80^{Aa}	0.124
	V0	0.50^{Bb}	1.47^{Ba}	0.064	67.39^{Bb}	67.06^{Aab}	0.436	3.45^{Cb}	4.11^{Ba}	0.130
	V1	0.36^{B}	0.43^{C}	0.016	64.68^{A}	64.71^{C}	0.389	3.06^{C}	3.01^{D}	0.118
	V2	0.37^{B}	0.39^{C}	0.012	64.83^{A}	63.70^{B}	0.364	3.16^{C}	3.45^{C}	0.148
500	V0	0.93^{Ab}	1.53^{Aa}	0.039	67.38^{Ba}	64.70^{Bb}	0.394	3.74^{B}	4.41^{B}	0.300
	V1	0.39^{Bb}	0.43^{Aa}	0.008	66.23^{Aa}	62.34^{Cb}	0.400	2.91^{C}	2.78^{D}	0.136
	V2	0.36^{Bb}	0.40^{Aa}	0.005	64.83^{Aa}	62.05^{Bb}	0.348	3.39^{B}	3.42^{C}	0.120
	SEM[3)]	0.057	0.018		0.438	0.390		0.140	0.122	

P-value	HPP	V	SP	HPP x V	HPP x SP	V x SP
	<0.0001	<0.0001	<0.0001	0.5663	<0.0001	0.0440
	0.0029	<.0001	0.7681	0.0001	0.9726	0.9402

[1)]HPP, high pressure processing; V, vinegar; SP storage period, [2)]PC, Sausage with 0.02% sodium nitrite; V0, vinegar 0%; V1, vinegar 1%; V2, vinegar 2%, [3)]Standard error of the mean (n=21),[4)](n=6) [A-C]Means within a column with different letters are significantly different (P<0.05). [a,b]Means within a row with different letters are significantly different (P<0.05).

IV. CONCLUSION

Previous study showed that the combined treatment of HPP and vinegar on emulsion-type sausage had effect on controlling vegetative cell and spores of *C. perfringens.* In the present study, this combination may provide acceptable product quality in emulsion-type sausage.

ACKNOWLEDGEMENTS

This research was supported by the Cooperative Research Program for Agriculture Science and Technology Development (Project No. 011617).

REFERENCES

1. Witee, V. C., Krause, G. F., & Bailey, M. E. (1970). A new extraction method for determining 2-thiobarbituric acid values of pork and beef during storage. Journal of food Science 35(5): 582-585.
2. McLauchlin, J., & Grant, K. A. (2007). Clostridium botulinum and Clostridium perfringens. In *Foodborne Diseases* (pp. 41-78). Humana Press.