

Antioxidant Properties of *Radix Puerariae* Extracts in Precooked Pork Sausage during Storage Period

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ABSTRACT- The objective of this study was to determine the antioxidant effects of *Radix Puerariae* (RP) extract in precooked sausage during 3 weeks of storage at 4°C. The treatments were five groups; control, added 0.02% BHA/BHT, added 1% RP, added 2% RP, added 4% RP. The added RP groups had higher pH and lightness, and lower redness than the control. The cooking loss values of added RP groups were decreased but, hardness values were increased during storage period. TBARS value was decreased by the added of RP groups compared to the control. Especially, 1% RP was more effective in delaying lipid oxidation compared to the other added RP groups. Sensory panelists recorded greater color and juiciness scores to the sausage samples with added RP ($P < 0.05$). These data suggest that precooked pork sausage with RP can enhance eating quality because sensory panels found that added RP sausages had better acceptable color and texture. Also, a significant observation in this study was that RP used at 1% level was as effective as BHA/BHT for retarding lipid oxidation of precooked pork sausages.

Index term – *Radix Puerariae* (RP), antioxidant, precooked pork sausage, BHA/BHT

I. INTRODUCTION

Precooked pork sausages were highly sensitive to lipid oxidation with significant development of off-flavor and loss of meat flavor upon reheating following chilled storage (Nissen et al. 2004). Antioxidants due to the oxidation of various undesirable compounds were added to prevent the formation. The most common antioxidants used in the food industry were butylated hydroxyanisole (BHA) and butylated hydroxytoluene (BHT). The two antioxidants, BHA and BHT were free radical scavengers, which terminate the oxidation cycle and give stability to the system. However, the use of antioxidant such as BHA or BHT in food has potential chemical cause disease, used different criteria depending on the country. Recently, many studies reported to the use of natural substances to get the antioxidant effects. *Radix Puerariae* (RP), the root of *Pueraria lobata* (Wild.) Ohwi, was one of the earliest and most important edible crude herbs used in oriental medicine (Liu, Wang, Liu, Wen and Liu, 1998). RP has been widely used in eastern Asia to treat the relieve fever, common cold, influenza, wrist and shoulder stiffness. RP contains an abundance of isoflavones, including puerarin, daidzin, daidzein, and genistein. Isoflavonoids exhibit a wide range of biological activities; antiinflammatory, antithrombotic, antihypertensive, antiarrhythmic, and cancer chemopreventive properties (Jiang et al. 2005). Yu, Zho and Shu (2004) reported that isoflavone composition of *radix puerariae* reduces Reactive Oxygen Species (ROS) to promote oxidation, such as superoxide anion ($\cdot\text{O}_2^-$), hydroxyl radical ($\text{OH}\cdot$), lipid-derived radical ($\text{R}\cdot$), singlet oxygen ($^1\text{O}_2$). Thus, the propose of this study was to determine the antioxidant properties of *Radix Puerariae* extracts in precooked pork sausage during storage at 4°C for 3 weeks.

II. MATERIALS AND METHODS

Ingredient composition of precooked pork sausages were presented in Table 1. Lean trim was combined with fat trim in grinder twice a 7 mm plate. Added to this emulsified meat batters were of a spice preblend, water (ice), and the appropriate antioxidant treatments. A mixture of crystalline BHA (0.01%) and BHT (0.01%) was pulverized and blended with the seasoning preblend. The emulsified meat batter were stuffed into polyvinylidene chloride casings (50 mm diameter) and cooked in steam chamber (programmed at 120°C for 7 min). Thereafter samples were cooled in ice water and then stored at 4°C. Precooked pork sausages samples were divided into five treatments: control, BHA/BHT, 1% RP, 2% RP, 4% RP. The RP fried incubated for 30 min at 180°C then put into 100 ml distilled water per 5g and reflux extracted for 4 hr at 99°C. Filtered and concentrated in the rotary vacuum evaporator at 70°C to 50°C. The extraction solutions were dried by freeze dryer. The pH and meat color ($\text{CIE } L^*, a^*, b^*$) were determined using pH-meter (MP230, Mettler Toledo, Switzerland) and Chromameter (CR-300, Minolta Co., Japan), respectively. Cooking loss (%) was recorded for each sample by weighing before and after cooking (Boles and Swan, 1996). Textural property was determined an Instron 3343 (US/MX50, A&D Co., MA, USA) equipped with plunger No. 3 (ø 0.2 mm). Five cooked sausage cores (diameter 2.5 cm, height 2.0 cm) per treatment were axially compressed to 70% of their original height. Force versus time curves were obtained with a 10 kg load cell. 2-Thiobarbituric acid-reactive substance (TBARS) was determined according to the method of Buege and Aust (1978). Sensory evaluation score was performed by a panel of 8 semi trained tasters. The panelists evaluated each characteristic of the sample using 9-point hedonic scale, where one (1) was “dislike extremely” and nine (9) was “like extremely.” The statistical analysis was performed by SAS (2000) program. The data were subjected to analysis of variance (ANOVA) and Duncan’s test to compare the sample means. The significance level was 0.05.

III. RESULTS AND DISCUSSION

Precooked pork sausages with RP had higher pH, lightness and lower redness than the control. Added RP groups also

reduced cooking loss and hardness of precooked pork sausages (Table 2). The TBARS values of all precooked pork sausages increased with increasing the storage time (Fig 1). However, the TBARS values of added RP groups were lower than those of the control. Addition of 1% RP was more effective to decrease TBARS values compared to with addition of 2% or 4% RP in precooked pork sausages. As a result of lipid oxidation, complex mixtures of aldehydes, ketones, hydrocarbons, esters, lactones and alcohols can be produced and oxidative off-odor can be generated. Yu, Zho and Shu (2004) reported that isoflavone extracted from RP possessed powerful Reactive Oxygen Species (ROS) scavenging activities. Tea catechins were found to be more efficient than α -tocopherol in inhibiting minced muscle lipid oxidation in meat and poultry products (Tang et al., 2001). Lau and King (2003) reported that the addition of grape seed extract to dark poultry meat products at 1 and 2% effectively inhibited having the development of TBARS values compared to control. The addition of 2% orange fibre to bologna sausages were found to retard the development of TBARS of storage at 4°C when compared to untreated sausages (Fernández-López et al., 2004). It will supply the scientific evidence for application. Sensory evaluation scores indicated that acceptability of precooked pork sausages could be enhanced by addition of RP (Table 3). As a result of juiciness and texture were higher than control. It would be effective to improve texture of precooked pork sausages. Therefore, it is suggested that RP could be used to extend the shelf-life of the meat products, providing the consumer with food containing natural additives.

IV. CONCLUSION

The purpose of this study was to determine the nature antioxidant (Radix Puerariae) effects in precooked sausage during storage at 4°C. Precooked sausages were formulated to contain one of 5 antioxidant treatments: control, BHA/BHT, 1% RP, 2% RP, 4% RP. Added of RP groups had higher value pH, lightness and lower value redness than control. Also, cooking loss and hardness were lower value than control during storage period. TBARS were lower values in the added PR groups than control. A significant observation in this study was that RP used at 1% level was as effective as BHA/BHT for retarding lipid oxidation precooked pork sausages. Thus the inclusion of RP as a natural antioxidant may offer an additional natural alternative for suppressing lipid oxidation and improve texture in precooked pork sausage products.

ACKNOWLEDGEMENT

This research was supported by Rural Development Administration (Project No. 200905FP001) and the authors were supported by the Bain Korea 21 Project from Ministry of Education and Human Resources Development.

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Table 1. The basic formulation of sausage batter

Ingredient (%)	Treatments ¹⁾				
	Control	BHA/BHT	RP 1%	RP 2%	RP 4%
Pork lean	64.60	64.60	64.60	64.60	64.60
Pork fat	20.00	20.00	20.00	20.00	20.00
Water (ice)	10.00	10.00	10.00	10.00	10.00
Salt	1.45	1.45	1.45	1.45	1.45
Sugar	1.48	1.48	1.48	1.48	1.48
Isolated Soy Protein	1.72	1.72	1.72	1.72	1.72
Sodium tripolyphosphate	0.35	0.35	0.35	0.35	0.35
Spice/seasoning	0.40	0.40	0.40	0.40	0.40
<i>Radix Puerariae</i> (RP)			1.00	2.00	4.00
BHA/BHT		0.02			
Total	100.00	100.02	101.00	102.00	104.00

¹⁾Control: without RP extract and BHA/BHT; BHA/BHT: sausage batter added with BHA/BHT and without RP extract; RP 1%: sausage batter added with RP extract at 1% level and without BHA/BHT; RP 2% : sausage batter added with RP extract at 2% level and without BHA/BHT; RP 4%: sausage batter added with RP extract at 4% level and without BHA/BHT.

Table 2. Changes in pH, color, cooking loss and Texture property of sausage during storage at 4°C for 3 weeks

Traits		Storage period (weeks)		
		1	2	3
pH	Control ¹⁾	6.01±0.02 ^{Bc}	6.05±0.01 ^{Db}	6.18±0.01 ^{Aa}
	BHA/BHT	6.05±0.02 ^{Bc}	6.13±0.01 ^{Ca}	6.09±0.01 ^{Cb}
	RP 1%	6.11±0.03 ^{Ab}	6.24±0.01 ^{Aa}	6.14±0.01 ^{Bb}
	RP 2%	6.11±0.02 ^{Ab}	6.20±0.01 ^{Ba}	6.08±0.02 ^{Cb}
	RP 4%	6.10±0.01 ^{Ac}	6.20±0.01 ^{Ba}	6.12±0.01 ^{Bb}
Lightness (L*)	Control	69.16±0.10 ^{BCb}	68.67±0.37 ^{ABb}	70.97±0.19 ^{Aa}
	BHA/BHT	65.96±0.19 ^{Cb}	70.83±1.52 ^{Aa}	70.35±0.18 ^{Aa}
	RP 1%	72.69±0.86 ^{Aa}	67.22±1.51 ^{BCb}	68.18±1.15 ^{CBb}
	RP 2%	72.06±0.19 ^{ABa}	65.87±0.58 ^{Cb}	63.48±0.31 ^{Cc}
	RP 4%	60.20±0.69 ^D	60.07±1.73 ^D	58.16±0.80 ^D
Redness (a*)	Control	9.66±0.20 ^A	10.39±0.51 ^A	9.96±0.37 ^A
	BHA/BHT	6.61±0.26 ^{Cb}	7.03±0.07 ^{Bb}	8.32±0.53 ^{Ba}
	RP 1%	4.92±0.36 ^{Dc}	7.19±0.51 ^{Bb}	7.99±0.23 ^{Ba}
	RP 2%	7.96±0.28 ^{Ba}	5.05±0.09 ^{Cb}	6.46±0.19 ^{Cc}
	RP 4%	7.05±0.31 ^{BCa}	5.69±0.49 ^{Cb}	6.32±0.12 ^{Cb}
Cooking loss (%)	Control	14.81±3.09 ^{Ab}	26.53±0.56 ^{Aa}	24.83±1.79 ^{Aa}
	BHA/BHT	9.88±3.14 ^{Bb}	24.65±0.67 ^{Aa}	22.49±0.98 ^{Ba}
	RP 1%	3.25±0.36 ^{Cc}	10.14±0.26 ^{Ca}	7.46±0.56 ^{Eb}
	RP 2%	4.38±0.91 ^{Cb}	13.28±3.11 ^{Ba}	9.64±0.31 ^{Da}
	RP 4%	7.55±3.93 ^{BCb}	15.59±0.69 ^{Ba}	14.68±0.71 ^{Ca}
Hardness (kg, f)	Control	0.25±0.14 ^b	0.45±0.05 ^{Aa}	0.38±0.05 ^a
	BHA/BHT	0.12±0.07 ^c	0.46±0.04 ^{Aa}	0.37±0.07 ^b
	RP 1%	0.22±0.07 ^b	0.37±0.03 ^{Ba}	0.37±0.03 ^a
	RP 2%	0.22±0.07 ^b	0.39±0.10 ^{ABa}	0.32±0.04 ^a
	RP 4%	0.18±0.07 ^b	0.34±0.05 ^{Ba}	0.33±0.03 ^a

^{a-c} Means within row with different superscripts are significantly different (p<0.05).

^{A-E} Means within columns with different superscripts are significantly different (p<0.05).

¹⁾Control: without RP extract and BHA/BHT; BHA/BHT: sausage batter added with BHA/BHT and without RP extract; RP 1%: sausage batter added with RP extract at 1% level and without BHA/BHT; RP 2%: sausage batter added with RP extract at 2% level and without BHA/BHT; RP 4%: sausage batter added with RP extract at 4% level and without BHA/BHT.

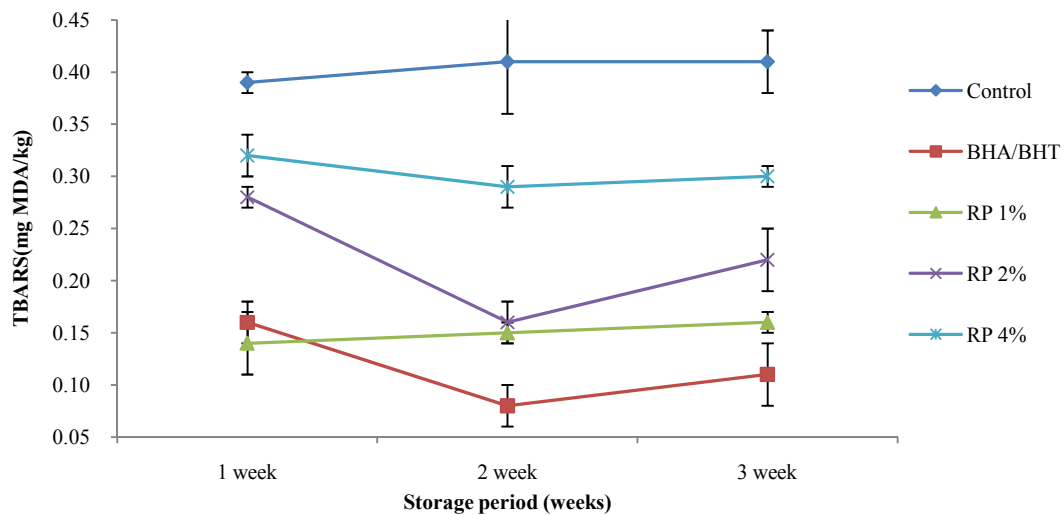


Figure 1. Changes in TBARS value of sausage during storage at 4°C for 3 weeks

Table 3. Changes in sensory evaluation score of sausage during storage at 4°C for 3 weeks

Traits		Storage period (weeks)		
		1	2	3
Color ²⁾	Control ¹⁾	4.17±0.75 ^{BC}	4.40±0.89	4.43±0.98 ^C
	BHA/BHT	3.67±1.03 ^C	4.00±1.41	4.00±1.15 ^C
	RP 1%	5.67±1.03 ^{AB}	5.00±2.24	5.43±0.79 ^B
	RP 2%	6.33±1.03 ^A	5.40±1.67	6.00±0.82 ^B
	RP 4%	6.67±2.34 ^A	6.20±1.48	7.29±0.76 ^A
Flavor	Control	1.50±0.55	2.20±0.45	2.43±1.27
	BHA/BHT	1.83±1.17	2.80±0.84	2.57±1.13
	RP 1%	1.50±0.55	2.40±1.14	3.00±1.29
	RP 2%	2.00±0.63	2.80±1.10	2.71±0.76
	RP 4%	2.67±1.03	3.20±0.84	2.86±0.69
Juiciness	Control	4.83±1.83	4.60±1.14	4.14±0.69 ^B
	BHA/BHT	5.00±2.37	4.80±1.30	4.00±0.58 ^B
	RP 1%	5.50±1.87	4.20±1.30	4.71±0.95 ^{AB}
	RP 2%	5.00±1.26	4.20±1.92	5.43±1.13 ^A
	RP 4%	5.33±1.75	3.60±1.14	5.29±0.76 ^A
Tenderness	Control	5.00±1.26	4.20±0.45	4.71±1.11
	BHA/BHT	4.33±1.63	4.60±1.34	5.00±1.15
	RP 1%	4.83±1.17	5.00±1.00	5.43±0.98
	RP 2%	5.00±2.61	5.40±0.89	5.00±1.00
	RP 4%	5.00±2.61	5.00±1.00	5.14±0.90
Overall acceptability	Control	4.67±0.82	5.60±1.14	4.57±1.40
	BHA/BHT	4.83±1.33	5.20±0.84	4.29±1.11
	RP 1%	5.50±0.55	5.60±0.89	5.14±0.69
	RP 2%	5.67±1.51	5.40±0.55	4.86±0.69
	RP 4%	6.33±1.21 ^a	4.80±0.45 ^b	5.00±1.00 ^b

^{a-b}Means within row with different superscripts are significantly different ($p<0.05$).

^{A-C}Means within columns with different superscripts are significantly different ($p<0.05$).

¹⁾Control: without RP extract and BHA/BHT; BHA/BHT: sausage batter added with BHA/BHT and without RP extract; RP 1%: sausage batter added with RP extract at 1% level and without BHA/BHT; RP 2%: sausage batter added with RP extract at 2% level and without BHA/BHT; RP 4%: sausage batter added with RP extract at 4% level and without BHA/BHT.