Effect of *Puerariae Radix* Extracts on pH, Color, 2-thiobarbituric acid reactive substances (TBARS) and Reduced Nitrite Content of Emulsion-Type Pork Sausage during Storage

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Abstract: The objective of this study was carried out to investigate the effect of addition of *puerariae radix* extract material with or without nitrite (70 ppm) on the changes in pH, color, TBARS and reduced nitrite content of emulsion-type pork sausage during 4 weeks of storage at 4℃. The treatments were; non-added nitrite and RP extract (C), added nitrite and non-added RP extract (T1), added nitrite and 1% RP extract (T2), added nitrite and 2% RP extract (T3), added nitrite and 4% RP extract (T4). The lightness (L*) of sausage containing nitrite and RP extract together were significantly lower than control and T1 (P<0.05). Nitrite and RP extract decreased the TBARS values (P<0.05). The residual nitrite content was decreased during storage time in all treatments except control and the effectiveness of decreasing ability was higher with increasing RP extract.

Index Terms: puerariae radix extract, emulsion type pork sausage, residual nitrite

I. INTRODUCTION

Nitrite can be used as a potent anti-bacterial agent to provide protection against food microorganisms (Gill & Holley, 2003), as well as a potent antioxidant. In addition, nitrite is reduced to nitric oxide, which then interacts with myoglobin to produce nitric oxide myoglobin, which contributes to the characteristic pink cured meat color (Honikel, 2008). Also, nitrite can be applied to preserve desirable meaty flavor (Hedrick *et al.* 1994). Even though nitrite is known to participate in numerous reactions in cured meats, with many desirable functions, as mentioned previously, concern regarding the levels of nitrite used in meat curing has arisen because of the possibility of nitrosamine, which is a known carcinogen, being formed in cured meat (Osterlie & Lerfall, 2005). In order to manufacture cured products without direct addition of sodium nitrite, a nitrate source and reducer must be utilized. Vegetables are well known to contain significant amounts of nitrate (Walker 1990; Fujihara and others 2001) and when added at high enough levels with a nitrate reducer may provide adequate amounts of nitrite to accomplish curing reactions. Spices and herbs are generally used in foodstuffs for enhancing the flavor or color attribute. *Puerariae radix* has been widely used in eastern Asia to treat the common cold, influenza, and wrist and shoulder stiffness and as an antidipsotropic agent (Kitagawa *et al.* 1995). *Puerariae radix* contains an abundance of isoflavones, including puerarin, daidzin, daidzein, and genistein (Chiang *et al.* 2005). *Puerariae radix* has been applied as antipyretic, antidiarrhetic, antioxidantic, spasmolytic, diaphoretic, and antiemetic agents (Jun *et al.* 2003). The purposes of this study were to compare the effects of *puerariae radix* extract on the qualities of low-nitrite sausages during refrigerated storage and to identify the *puerariae radix* extract and the sausages with *puerariae radix* extract added.

II. MATERIALS AND METHODS

Sausage preparation: lean pork and pork backfat were purchased from local meat processing plant. Excess fat was trimmed from the meat and then ground in a grinder twice through a 7-mm plate. Ingredient composition of the sausages is presented in Table 1. The emulsified meat batters were stuffed into polyvinylidene chloride casings (50-mm diameter) and cooked in a cooking chamber (programmed at 120℃ for 7 min). Afterwards samples were cooled in ice water for 20 min and then stored at 4℃.

***Puerariae radix* preparation:** about 5 g of 180℃ for 30min roasted and *puerariae radix* were mixed with 100 ml of water boiling at 99℃ for 5 hr. The extract was obtained by filtration and freeze-dried.

Analysis: the measurement of pH was carried out on 3 g of sample homogenized in distilled water (1/9 sample/water). The pH value of the sample was determined using a pH meter (MP230, Mettler, Switzerland). The color (CIE L*, a*, b*) were determined using Chromameter (CR-300. Minolta Co., Japan). TBARS of sausage were determined by the spectrophotometer method (Buege & Aust, 1978). Residual sodium nitrite contents in cooked sausages were determined according to AOAC methods no. 973.31 (AOAC, 1995). 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

The results showed that Table 2. The pH increased with storage 2 week period in all sausage samples. After that its values increased control. However, other samples were pH values decreased. Especially, pH was significantly higher in control compared with other sausage samples ($P< 0.05$). *Puerariae radix* extract retard the pH increase rate for the control.

In color, lightness increased with storage periods in T1 ($P<0.05$). Recording lightness where *puerariae radix* extract will increase decreased. Decrease in lightness represented formation of dark color in the *puerariae radix* extract due to the browning reaction. Statistical analysis indicated that lightness values of *puerariae radix* extract were not affected ($P>0.05$) by the addition of antioxidants. Redness increased ($P<0.05$) during 2 or 3 weeks of the storage period and then decreased the end of the storage period. However, yellowness decreased during storage time ($P<0.05$).

Changes of TBARS of emulsion-type pork sausage were followed during storage and the results are given in Fig. 1. Statistical analysis indicated that TBARS were affected significantly ($P<0.05$) by storage time and addition of antioxidants. TBARS during weeks of the storage period and then increased the end of the storage period (Witte et al., 1970; Park et al., 2000). Moreover, the natural antioxidants reduced TBARS formation more than nitrite. However, TBARS value was significantly lower in T1 and T2.

Changes in the residual nitrite content of emulsion type pork sausage during storage are given in Fig. 2. Residual nitrite content was decreased during storage time in all treatments except control and the effectiveness of decreasing ability was higher with increasing *puerariae radix* extract. Similar nitrite depletion was also accomplished by lactic acid bacteria isolated from kimchi and other foods (Oh, Oh, & Kim, 2004). Faster nitrite depletion at lower pH values was also reported by Theiler, Sato, Aspelund, and Miller (1981). Therefore, a comparatively lower pH of the control samples in this study might be the reason why a lower residual nitrite content was observed after storage for more 2 weeks.

IV. CONCLUSION

The natural antioxidants *puerariae radix* extract were utilized in emulsion-type pork sausage and their affect on the antioxidant activity and quality were investigated during storage periods. Emulsion-type pork sausage with *puerariae radix* extract added had lower TBARS values and less nitrite degradation. The residual nitrite content decreasing ability was higher with increasing *puerariae radix* extract. Based mainly on the result of overall acceptance, it could be used in the production of low-nitrite emulsion-type pork sausages.

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Table 1. The basic formulation of sausage batter (Unit : %)

Ingredient	Treament[1)]				
	C	T1	T2	T3	T4
Lean pork	64.6	64.6	64.6	64.6	64.6
Pork backfat	20	20	20	20	20
Ice	10	10	10	10	10
Salt	1.45	1.45	1.45	1.45	1.45
Sugar	1.48	1.48	1.48	1.48	1.48
Hydrolyzed vegetable protein	1.72	1.72	1.72	1.72	1.72
Sodium nitrite	-	0.007	0.007	0.007	0.007
Sodium tripolyphosphate	0.35	0.35	0.35	0.35	0.35
Spice/seasoning	0.4	0.4	0.4	0.4	0.4
Puerariae radix	-	-	1	2	4
Total	100	100.007	101.007	102.007	104.007

[1)]C: control (without *puerariae radix* extract and nitrite), T1: sausage batter added with nitrite and without *puerariae radix* extract, T2: sausage batter added with nitrite and *puerariae radix* extract at 1% level, T3: sausage batter with added nitrite and *puerariae radix* extract at 2% level, T4: sausage batter with added nitrite and *puerariae radix* extract at 4% level.

Table 2. Changes of pH, color in added *puerariae radix* extract of cooked emulsion-type pork sausage during storage time at 4℃

Item[1)]	Treatment[2)]	Storage periods (weeks)			
		1	2	3	4
pH	C	6.01 ± 0.02^{Dd}	6.05 ± 0.01^{Dc}	6.18 ± 0.01^{Ab}	6.39 ± 0.03^{Aa}
	T1	6.18 ± 0.01^{Ab}	6.26 ± 0.01^{Aa}	6.17 ± 0.01^{Ab}	6.14 ± 0.03^{Bc}
	T2	6.12 ± 0.02^{Bbc}	6.20 ± 0.01^{Ba}	6.13 ± 0.01^{Bb}	6.11 ± 0.01^{BCc}
	T3	6.08 ± 0.01^{Cb}	6.12 ± 0.02^{Ca}	6.08 ± 0.00^{Cb}	6.08 ± 0.03^{Cb}
	T4	6.09 ± 0.01^{Cb}	6.18 ± 0.01^{Ba}	6.09 ± 0.01^{Cb}	6.10 ± 0.01^{BCb}
Lightness (L*)	C	69.16 ± 0.10^{Bb}	68.67 ± 0.37^{Cb}	70.97 ± 0.19^{Ba}	71.17 ± 1.13^{Ba}
	T1	66.68 ± 2.55^{Cb}	75.22 ± 1.51^{Aa}	74.97 ± 1.68^{Aa}	75.90 ± 1.50^{Aa}
	T2	68.60 ± 0.23^{BCb}	70.72 ± 0.42^{Ba}	70.65 ± 0.64^{Ba}	70.09 ± 0.66^{Ba}
	T3	77.73 ± 0.60^{Aa}	66.18 ± 0.41^{Db}	64.82 ± 0.63^{Cc}	65.30 ± 0.22^{Cbc}
	T4	63.13 ± 0.19^{Da}	62.22 ± 0.87^{Eab}	60.15 ± 0.61^{Dc}	61.17 ± 1.35^{Dbc}
Redness (a*)	C	9.66 ± 0.20^{A}	10.39 ± 0.51^{A}	9.96 ± 0.37^{A}	9.78 ± 0.49^{A}
	T1	5.42 ± 0.54^{Cb}	9.47 ± 0.21^{Ba}	9.38 ± 0.23^{Ba}	8.92 ± 0.30^{Ba}
	T2	7.56 ± 0.12^{Bb}	7.55 ± 0.53^{Cb}	8.29 ± 0.37^{Ca}	7.86 ± 0.27^{Cab}
	T3	4.43 ± 0.25^{Dc}	6.35 ± 0.14^{Db}	7.08 ± 0.24^{Da}	6.64 ± 0.12^{Db}
	T4	5.40 ± 0.18^{Cc}	7.08 ± 0.21^{Ca}	6.43 ± 0.27^{Eb}	6.28 ± 0.33^{Db}
Yellowness (b*)	C	14.54 ± 0.55^{D}	13.92 ± 0.33^{D}	14.02 ± 0.73^{B}	13.72 ± 1.15^{B}
	T1	19.41 ± 0.79^{Aa}	14.20 ± 0.36^{Db}	13.85 ± 0.28^{Bb}	14.04 ± 0.36^{Bb}
	T2	18.16 ± 0.38^{Ba}	16.10 ± 0.17^{Cb}	15.95 ± 0.44^{Ab}	15.79 ± 0.54^{Ab}
	T3	15.77 ± 0.14^{Cb}	17.92 ± 0.06^{Ba}	16.29 ± 0.50^{Ab}	16.13 ± 0.30^{Ab}
	T4	19.68 ± 0.37^{Aa}	18.80 ± 0.75^{Aa}	16.28 ± 0.63^{Ab}	16.66 ± 0.53^{Ab}

Results are expressed as means±SD
[A,B,C,D,E]: Means with different superscript in the same column significantly differ at $P < 0.05$.
[a,b,c,d]: Means with different superscript in the same row significantly differ at $P < 0.05$.
[2)]Treatments are the same as described in Table 1.

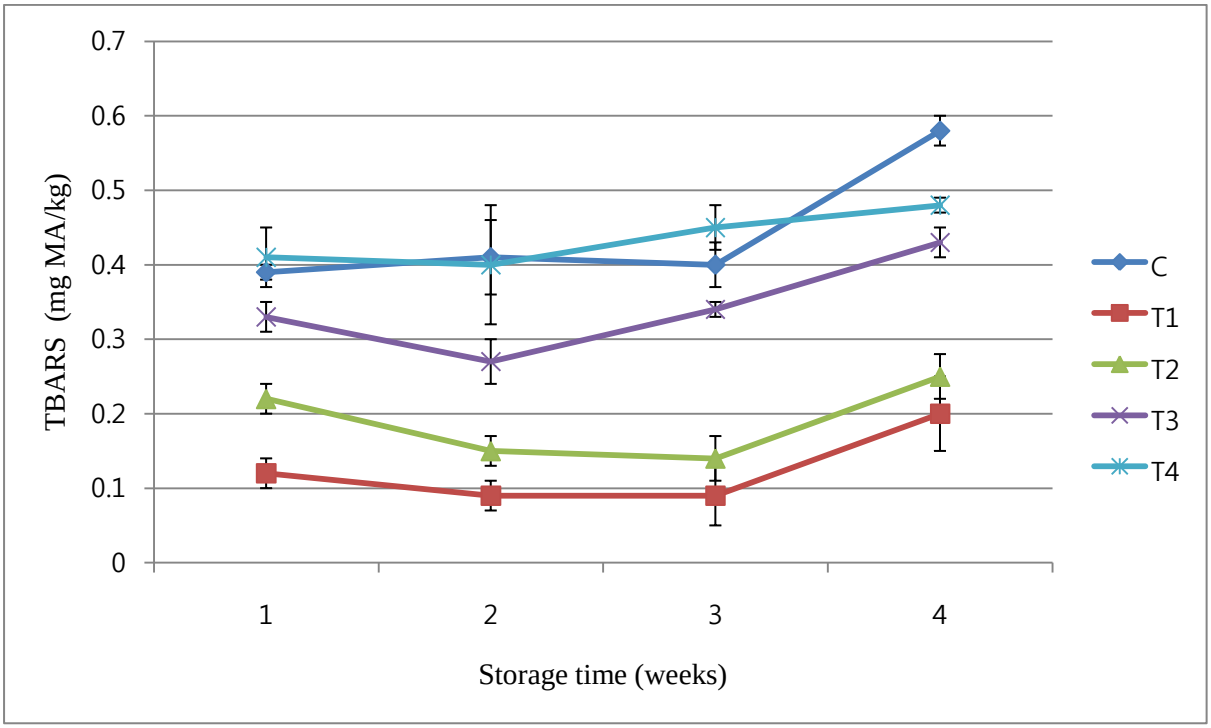

Fig. 1. Changes of TBARS in added *puerariae radix* extract of cooked emulsion-type pork sausage during storage time at 4℃. Treatments are the same as described in Table 1.

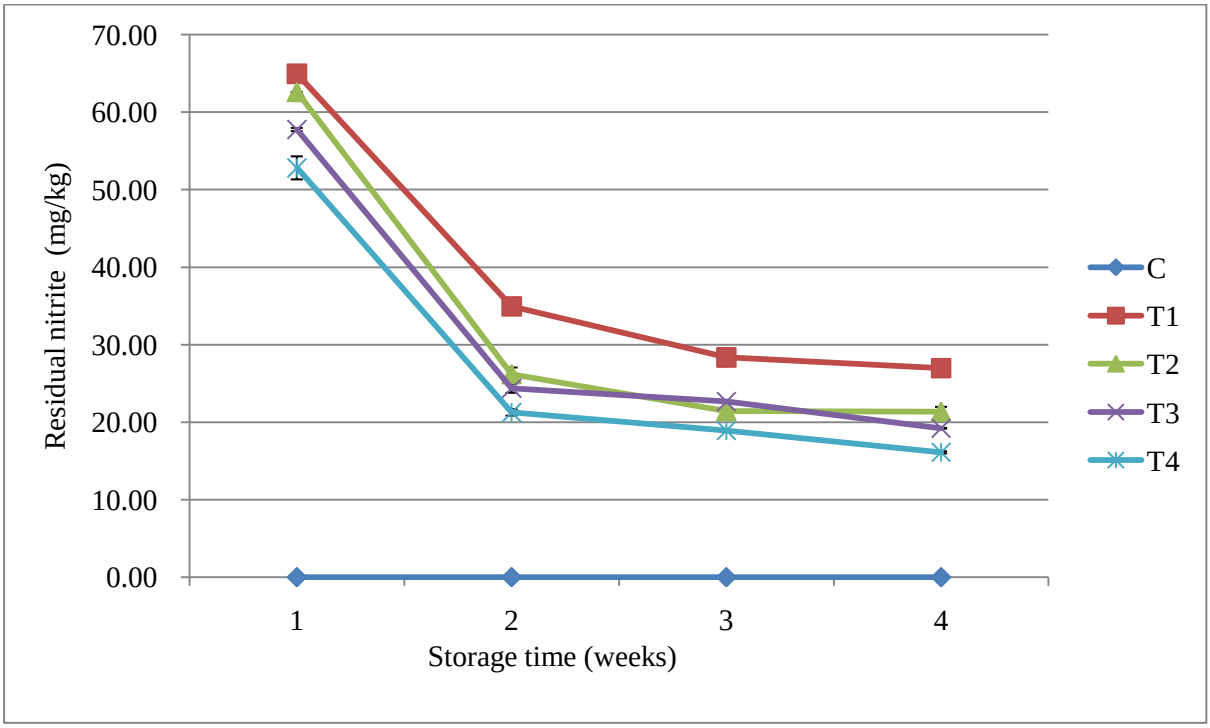

Fig. 2. Changes of residual nitrite in added *puerariae radix* extract of coked emulsion-type pork sausage during storage time at 4℃. Treatments are the same as described in Table 1.