Tomato Powder in Regular-fat Pork Sausages Suppressed Lipid Oxidation during Refrigerated Storage

Kim H.S. [1] and Chin K.B. [1]

[1] Department of Animal Science and Functional Food Research Center, Chonnam National University, Gwangju, South Korea

Abstract— **This study was performed to evaluate the effects of oven-dried tomato powder (TP) on the physico-chemical properties, and antioxidant and antimicrobial activities of emulsified pork sausages. The control (without TP), reference (butylated hydroxyltoluene, BHT 0.01%), and 2 levels (1 and 2%) of TP were prepared. pH values and Hunter L value of pork sausages formulated with TP were reduced, while Hunter a and b values were higher than those of the control and those effects were increased with increased levels of tomato powder. During storage at 10℃ under the wrap packaging for 28 days, pH and Hunter L values were slightly increased, however, no differences in proximate composition, expressible moisture content, textural and sensory evaluation, and total plate counts were observed among all treatments (p>0.05). However, thiobarbituric acid reactive substances (TBARS) values of pork sausages containing TP showed lower than that of the control and reference, regardless level of TP. These results indicated that TP could be used as a natural color agent and antioxidant in meat products without defects.**

Keywords— **tomato powder, lipid oxidation, regular-fat pork sausage**

I. INTRODUCTION

Lipid serves as a significant role in meat products to increase textural and functional properties such as cooking yield and water holding capacity (WHC) [1, 2]. However, lipid oxidation leads to a quality deterioration of meat and meat product, such as flavor, color, texture and nutritional value [3]. For these reasons, synthetic antioxidants such as butylated hydroxytoluene (BHT), butylated hydroxyanisole (BHA) and tert-butylhydroquinone (TBHQ) have been used in meat products to inhibit lipid oxidation. However, development of natural antioxidants is needed for substitute the synthetic antioxidant due to these are harmful to human health [4].

Tomato is one of the widely cultivated and extensively consumed vegetable crops worldwide. Tomato is the most important for both its large consumption and its richness in health-related food components. Continuous consumption of tomato and tomato product can reduce risk of cancer and heart disease [5]. Especially, tomato containing lycopene, which is the major carotenoid compound give the red color to the tomato. Lycopene is hydrophobic material that soluble in strong non-polar organic solvent such as chloroform and benzene [6], and has various anticancer effects [7]. Thermally processed tomato products showed an increased absorption of lycopene as compared to the raw ones [8].

Many researches have been conducted to improve the functional and antioxidant properties of meat products using tomato [9-13]. However, effects of tomato powder on the antioxidative activities in the meat products have not been investigated yet. Therefore, the aim of this study was to evaluate the effects of oven-dried tomato powder (TP) on physico-chemical properties, and antioxidant and antimicrobial activities of emulsified pork sausages.

II. MATERIALS AND METHODS

A. Preparation of tomato powder

Ripened fresh tomatoes were purchased from a local market. Prior to drying, fresh tomatoes were chopped and homogenized by mixer and then, dried at 60℃ oven. The obtained powder was used as the dried tomato powder (TP).

B. Preparation of regular-fat pork sausages

Four treatments of sausage were produced with different levels of TP using the procedure of Chin et al. [14]. Tomato powder was applied into pork sausage

which is formulated as shown in Table 1.There are control, reference, TRT1, and TRT2, which are those without tomato powder (CTL), adding BHT 0.01%, tomato powder 1 and 2 percents, respectively. Then all treatments were air packed and stored at 10℃ until analyzed.

Table 1. Formulation of pork model sausages with two levels of tomato powder (TP)

Ingredients	Treatments			
	CTL	REF	TRT1	TRT2
Raw meat (%)	55.0	55.0	55.0	55.0
Fat (%)	20.0	20.0	20.0	20.0
Water (%)	19.0	19.0	19.0	19.0
Non meat ingredients (%)	6.00	6.01	6.00	6.00
Salt (%)	1.30	1.30	1.30	1.30
STPP[1)] (%)	0.40	0.40	0.40	0.40
Cure blend (%)	0.25	0.25	0.25	0.25
Sodium erythorbate (%)	0.05	0.05	0.05	0.05
Sugar (%)	1.00	1.00	1.00	1.00
Spices (%)	1.00	1.00	1.00	1.00
Nonfat dry milk (%)	1.00	1.00	1.00	1.00
Corn syrup (%)	1.00	1.00	1.00	1.00
BHT[1)] (%)	-	0.01	-	-
Tomato powder (%)	-	-	1.00	2.00
Total (%)	100.00	100.01	101.00	102.00

[1)]STPP= sodium polyphosphate.
[2)]BHT= butylated hydroxyl toluene.

C. Proximate analysis

Moisture, fat, protein, and ash contents of regular-fat pork sausages were measured by using AOAC methods [15].

D. Expressible moisture

Expressible moisture contents of sausage samples were determined by modified method of Jauregui et al. [16]. Expressible moisture contents were calculated as below:

Expressible moisture (EM, %)= (weight of expressed water in filter paper / weight of sample) ×100

E. Texture profile analysis

Inston Universal Testing Machine (Model 3344, Canton, MA, USA) was used for measuring textural properties of sausage samples. Textural properties of samples were expressed as hardness (gf), springiness (cm), and chewiness according to the method of Bourne [17

F. pH and Hunter color measurement

The pH values were measured using a digital pH-meter (Mettler-Toledo, 340, Schwarzenbach, Switzerland. Briefly, a 10 g sample of pork patties was homogenized with 90 mL of deionized water using a food mixer, after which the pH values were measured five times and then expressed as average values.

The Hunter L (lightness), a (redness) and b (yellowness) values were measured using a Color Reader (CR-10, Minolta Corp., LTD, Japan), after which they were expressed as mean values. The colorimeter was calibrated against a white board (L = 91.7, a = 1.90, b = 1.20) prior to use.

G. Thiobarbituric acid reactive substances (TBARS)

TBARS values of pork patties were determined following the method described by Sinnhuber and Yu [18]. The reactive substances were measured at 532 nm using a spectrophotometer (UV-Visible Spectro-photometer, UV-1601, Shimadzu, Australia). TBARS values were calculated as follows:

TBARS value (mg malonaldehyde/kg) = optical density (O.D.) × 9.48 / sample weight (g)

H. Microbial counts

The total plate counts (TPC) and violet red bile (VRB) agar were employed for the determination of total bacterial counts and *Enterobacteriaceae*, respectively. Sausage samples (10 g) were homogenized with 90 mL of sterile deionized water, and serial dilutions were made, then a 0.1 mL of each dilution was spread in TPC and VRB agars. They were incubated at 37℃ for 2 days, counted and expressed as log cfu/g.

I. Statistical analysis

The experiment was replicated twice, and the data were analysed by two-way analysis of variance (ANOVA) using SPSS 18.0 for Windows [19]. Significant differences among means were analysed by Duncan's multiple range test ($P<0.05$).

III. RESULTS AND DISCUSSION

According to the results from proximate analysis in table 2, all treatments did not show the different in moisture, crude fat, protein, ash and expressible moisture. This suggested that adding tomato powder did not affect chemical composition of the final products.

Table 2. Proximate analysis (%), expressible moisture (EM, %) of regular-fat pork sausages with TP

Parameters	Treatments[1)]			
	CTL	REF	TRT1	TRT2
Moisture (%)	62.0 [a]	63.2 [a]	61.6 [a]	61.1 [a]
Fat (%)	19.9 [a]	20.0 [a]	20.3 [a]	18.7 [a]
Protein (%)	12.3 [a]	12.6 [a]	12.4 [a]	12.5 [a]
Ash (%)	2.64 [a]	2.73 [a]	2.72 [a]	2.83 [a]
EM (%)	22.3 [a]	21.1 [a]	26.1 [a]	21.4 [a]

[a] Means with same superscript within same row is not different (p>0.05).
[1)] Treatments: As shown in Table 1.

In addition, textural parameters which are hardness, springiness, gumminess, chewiness, cohesiveness were not affected by any treatments.

Table 3. Textural properties of regular-fat pork sausages with TP

Parameters	Treatments[1)]			
	CTL	REF	TRT1	TRT2
Hardness (gf)	2181 [a]	2291 [a]	2094 [a]	2013 [a]
Springiness (mm)	4.32 [a]	5.12 [a]	5.02 [a]	4.35 [a]
Gumminess	19.7 [a]	15.6 [a]	16.6 [a]	12.6 [a]
Chewiness	78.0 [a]	93.1 [a]	84.6 [a]	54.3 [a]
Cohesiveness	0.008 [a]	0.007 [a]	0.008 [a]	0.007 [a]

[a] Means with same superscript within same row is not different (p>0.05).
[1)] Treatments: As shown in Table 1

Results of pH, Hunter color values (L and b) and microbial counts were shown in Table 4. Since no interaction between treatments and storage time in pH, Hunter L, Hunter b, TPC, and VRB were observed, data were pooled. The pH values were reduced when tomato powder was added. Hunter L value was decreased, but Hunter b values increased when tomato powder was added. Microbial changes were not affected by any treatments. In addition, the pH, Hunter L, total bacterial counts and *Enterobacteriaceae* were increased with increasing the storage time up to 4 weeks.

Table 4. pH and Hunter color values (L and b) and microbiological changes in pork sausages with two levels of TP during storage at 10℃

	Parameters[1)]				
	pH	Hunter L	Hunter b	TPC	VRB
Treatments[2)]					
CTL	6.15 [a]	76.0 [b]	5.81 [c]	3.51 [a]	2.47 [a]
REF	6.16 [a]	76.3 [a]	5.87 [c]	3.69 [a]	2.66 [a]
TRT1	5.99 [b]	74.8 [c]	9.53 [b]	4.02 [a]	2.93 [a]
TRT2	5.86 [c]	72.3 [d]	12.0 [a]	3.97 [a]	3.07 [a]
Storage days					
0	6.00 [y]	74.3 [y]	8.34 [z]	2.21 [w]	<2.00 [x]
3	6.03 [yz]	74.9 [z]	8.42 [z]	2.31 [w]	<2.00 [x]
7	6.04 [yz]	75.0 [z]	8.34 [z]	2.28 [w]	<2.00 [x]
14	6.06 [z]	75.0 [z]	8.16 [z]	3.01 [x]	<2.00 [x]
21	6.05 [z]	75.0 [z]	8.21 [z]	5.81 [y]	3.25 [y]
28	6.06 [z]	75.0 [z]	8.41 [z]	7.16 [z]	5.44 [z]

[a-c]Means with same letter into same column (Treatments) are not different (p>0.05).
[w-z]Means with same letter into same column (Storage days) are not different (p>0.05)
1) Parameters: Hunter L= lightness; Hunter b= yellowness; TPC= total plate count agar for total bacteria; VRB= violet red bile agar for *Enterobacteriaceae*.

On the other hand, redness value was increased when the tomato powder was added (Fig. 1). Moreover, its effect was maintained until the last stage of storage time. Østerlie and Lerfall [13] evaluated the effect of tomato products on the storage quality and color of minced meat. They reported that adding tomato products to meat batter resulted in a red to brown hue. These results indicate that adding tomato power on the meat product, colorant maintained safely until end of storage.

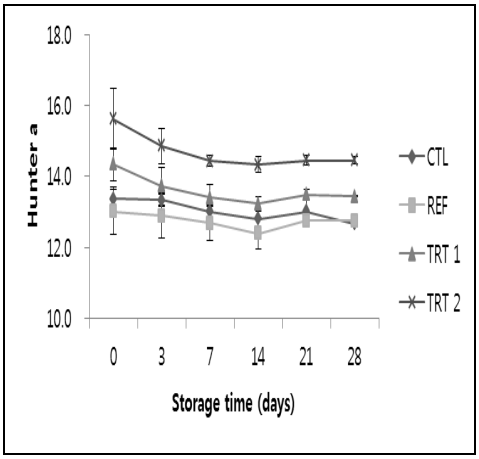

Fig. 1 Redness of pork sausages with TP during storage at 10℃

TBARS value of sausage with all tomato powders was lower than control and reference sausages (p<0.05). Therefore, the addition of tomato powder into pork sausages could inhibit lipid oxidation significantly during storage time (Fig. 2).

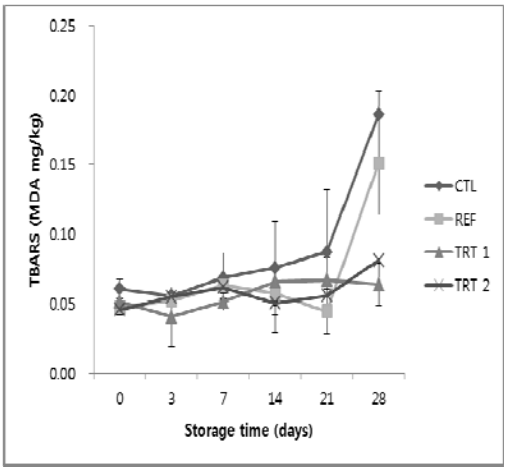

Fig. 2 TBARS of pork sausages with TP during storage at 10℃

IV. CONCLUSIONS

Addition of TP reduced pH and Hunter L values, however it increased Hunter a and b values. Especially, lipid oxidation of pork sausages was effectively retarded with the addition of TP. Thus, tomato powder could be used as an antioxidant and natural color agents in pork sausages.

ACKNOWLEDGMENT

This study was financially supported by Chonnam National University (2008), South Korea.

REFERENCES

1. Keeton JT (1994) Low-fat meat products: technological problems with processing. Meat Sci 36: 261-276.
2. Pietrasik Z (1999) Effect of content of protein, fat and modified starch on binding textural characteristics, and colour of comminuted scalded sausages. Meat Sci 51: 17-25.
3. Eriksson CE (1982) Oxidation of lipids. Food Chem 9: 3-20.
4. Branen AL (1975) Toxicology and biochemistry of butylated hydroxyanisole and butylated hydroxytoluene. J Amer Oil Chem Soc 52: 59-63.
5. Giovannucci E (1992) Tomatoes, tomato-based products, lycopene, and cancer: review of the epidemiological literature. J Natl Cancer Inst 97: 317-331.
6. Shi J (2002) Lycopene: biochemistry and functionality. Food Sci Biotechnol 11: 574-581.
7. Clinton SK (1998) Lycopene: chemistry, biology, and implications for human health and disease. Nutr Rev 56: 35-51.
8. Böhm V and Bitsch R (1999) Intestinal absorption of lycopene from different matrices and interactions to other carotenoids, the lipid status, and the antioxidant capacity of human plasma. Eur J Nutr 38: 118-125.
9. Candogan K (2002 The effect of tomato paste on some quality characteristics of beef patties during refrigerated storage. Eur Food Res Technol 215: 305-309.
10. Deda MS Bloukas JG and Fista GA (2007) Effect of tomato paste and nitrite level on processing and quality characteristics of frankfurters. Meat Sci 76: 501-508.
11. Garcia ML, Calvo MM and Selgas MD (2009) Beef hamburgers enriched in lycopene using dry tomato peel as an ingredient. Meat Sci 83: 45-49.
12. Kim IS, Jin SK, Nam SH, Nam YW, Yang MR, Min HS and Kim DH (2008) Effect of hot-air dried tomato powder on the quality properties of pork patties during cold storage. J Anim Sci Technol 50: 255-264.
13. Østerlie M and Lerfall J (2005) Lycopene from tomato products added minced meat: effect on storage quality and colour. Food Res Int 38: 925-929.
14. Chin KB, Keeton, JT, Longnecker MT, Lamkey JW (1998) Functional, textural and microstructural properties of low-fat bologna (model system) formulated with a konjac blend. J Food Sci 63:807-808.
15. AOAC (1995) Official Method of Analysis. 16th ed., Association of Official Analytical Chemists. Washington DC.
16. Jauregui CA, Regenstein JN and Baker RC (1981) A simple centrifugal method for measuring expressible moisture, a water binding property of muscle foods. J Food Sci 46: 1271-1273.
17. Bourne MC (1978) Texture profile analysis. Food Technol 32: 62-66, 72.
18. Shinnhuber RO and Yu TC (1977) The 2-thiobarbituric acid reaction, an objective measure of the oxidative deterioration occurring in fats and oils. J Japanese Oil Chem Soc 26: 259-267.
19. SPSS (2009) SPSS 18.0 program for Windows. SPSS Inc. USA.