THE USE OF PERSIMMON PEEL EXTRACTS AS A NATURAL ANTIOXIDANT IN RAW GROUND MEAT AGAINST LIPID AND PROTEIN OXIDATION

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Abstract - In this study, effect of persimmon peel extracts (PPE) on lipid and protein oxidation in raw ground pork meat during chilled storage for 12 days. was evaluated. The addition of PPE, having amount of phenolic compounds, could more stable a* values than control and BHT-0.01 during chilled storage. PPE-0.2 and BHT-0.01 treatments had the lowest (p<0.05) conjugated dienes (CD) concentrations for all samples over the entire storage period. Control rapidly increased in thiobarbituric acid reaction substance (TBARS) values comparing other treatments. In meat samples added PPE, increase of carbonyl content had at low level as prolonged storage respectively. These results indicate that incorporation of PPE resulted in retard of lipid and protein oxidation of meat products as a natural lipid and protein.

Key Words – antioxidant activity, persimmon peel, ground pork

I. INTRODUCTION

Lipids of meats are extremely susceptible of oxidation by exposing on atmosphere for example grinding, cooking, storage in meat product processing. Also, protein oxidation happens through hydroxyl free radical chain reactions by formation of disulfide bonds and dityrosine, fragmentation of the peptide backbone results in modification of amino acid side chain, increase of carbonyl compounds, and amino acid composition during storage [1]. Due to these reasons it was needed antioxidant for preventing deterioration of meat quality by acting free radical scavenger. Natural antioxidant source of plants, plums, fruits, spices instead of synthetic antioxidants came to interest because of health benefits.

Persimmon is abundant bioactive substances such as phenol compounds, vitamin A, and C. In Korea persimmon peel is waste and use parts of persimmon peel as a food because of amount of dried persimmon product [2].

The objective of this study was to investigate the inhibition ability of lipid and protein oxidation of raw ground pork meat with persimmon peel extract (PPE) during 12 days of chilled storage.

II. MATERIALS AND METHODS

1. Preparation of persimmon peel extracts

The persimmon peel (PP) was cut into small pieces and dried by a hot air dryer (Enex-Co-600, Enex, Koyang, Korea) at 50 ℃ for 15 h, powdered (35 mesh). The dried goldnrod leaves powder (15 g) was extracted with 300 ml of 70% ethanol overnight in a shaker (VS-8480, Vison Scientific, Bucheon, Gyeonngi) at room temperature. The extract was filtered through Whatman No. 1 filter paper and the solvent was removed using a vacuum evaporator (CCA-1110, Rikakikai, Tokyo, Japan) at 45℃ to dryness. After evaporation of ethanol, persimmon peel ethanolic extracts were dissolved in 70% ethanol (5% v/w).

2. Preparation of meat samples

The ground meat samples were produced by the following formulation: 73.5% lean pork meat, 20% pork back fat, 5% Ice, and 1.5% salt. The lean pork meat and pork back fat were ground through a 3 mm grinding plate and then the ice and salt were added. The 70% ethanol extracts of persimmon peel were added (w/w) according to the following formulation: Control (without antioxidant), PPE-0.05 (with 0.05%

PP extract), PPE-0.1 (with 0.1% PP extract), PPE-0.2 (with 0.2% PP extract), As-0.05 addition (with 0.05% ascorbic acid) and BHT-0.01 (with 0.01% buthyl - hydroxytoluene (BHT)). These percentages were based on formula weight of minced meat samples without antioxidant extract. Samples were hand mixed for 3 min. Then, the mixed meat was anaerobically packed in PE/nylon film bags, spread to a thickness of 2.5 cm, stored at 4±1 ℃ during 12 days (1, 4, 7, 10, and 12 day).

3. Analytical methods

3.1. Color measurement

The color measurements were taken with a colori-meter (Chroma meter CR-210, Minolta, Japan; illuminate C). The color values (CIE L^*, a^*, and b^*) were measured on the sample surfaces and data were taken in triplicate for each sample.

3.2. Conjugated dienes (CD)

Lipids from the meat samples were extracted by the method of Folch (Floch, Lee, & Stanley, 1957) using the chloroform:methanol solvent system (2:1). The CD concentration was calculated using a molar extinction coefficient of 25,200 M^{-1} cm^{-1} and expressed as μmol mg^{-1} meat lipid sample.

3.3. Thiobarbituric acid reaction substance (TBARS) values

Lipid oxidation was measured by a modified 2-thiobarbituric acid extraction method of Witte, Krause, and Bailey (1970). TBARS were calculated a standard curve (8-50 nmol) of malondialdehyde (MDA), freshly prepared by acidification of TEP (1,1,3,3-tetraethoxypropane). TBARS values were calculated as follows and expressed as MDA mg/kg meats.

3.4. Protein oxidation measurement

The measurement of protein carbonyls following their reaction with 2,4-dinitrophenylhydrazine (DNPH) was modified method by Mercier, Gatellier, Viau, Remignon, and Renerre (1998). The total carbonyl content, expressed as nmol / mg protein, was quantified by a spectrophotometric assay at 370 nm.

4. Statistical analysis

Three batches of samples for each treatment and storage days were prepared. All experiments were analyzed using two-way analysis of variance (ANOVA) with treatments and storage days. An analysis of variance was performed on all the variables measured using the General Linear Model (GLM) procedure of the SAS statistical package (SAS Institute, Inc., 2010). Duncan's multiple range test ($p<0.05$) was used to determine the differences among means of treatments.

III. RESULTS AND DICSUSSION

The meat samples with PE had higher L^* values ($p<0.05$) until day 7 then lower ($p<0.05$) than that of control (Table 1). The ground pork meat with PE had darker and redder color because of deep orange color of PE as increasing of PE concentration. The b* values of PE, As-0.05, and BHT-0.01 increased until day 4 and decreased thereafter. Fig. 1. shows the effect of PE on formation of CD (0.419-0.855 μM/mg meats) in raw ground pork during chilled storage for 12 days. The PE-0.2 had the lowest ($p<0.05$) peak and reduced CD formation around 23% as compared to the control on day 10, respectively.

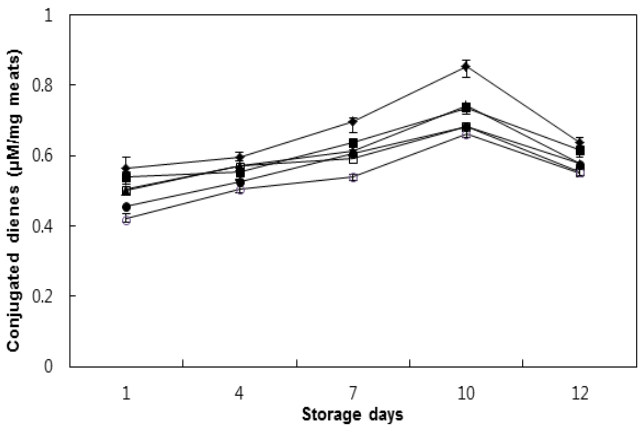

Fig. 1. Conjugated dienes (μM/mg meats) in raw ground pork containing various levels of persimmon peel extract (PPE) during chilled storage for 12 days. (◆) Control:ground pork without antioxidant, (▲) PE-0.05: ground pork with 0.05% persimmon peel extract, (□) PE-0.1: ground pork with 0.1% persimmon peel extract, (○) PE-0.2: ground pork with 0.2% persimmon peel extract, (■) As-0.05: ground pork with 0.05% ascorbic acid, (●) BHT-0.01: ground pork with 0.01% butylhydroxytoluene (BHT).

On first day, no differences were observed in The TBARS significantly low (p<0.05) in raw meat samples incorporated with PE and BHT on each day of chilled storage. Control had the highest (p<0.05) TBARS values during the entire storage period (Table 2). Carbonyl content of control, PE-0.05, and As-0.05 in raw meat samples (Fig. 2). The PE-0.05 was significantly higher (p<0.05) reduction in formation of carbonyl comparative to control in raw ground pork samples after day 1. The control had the highest carbonyl content indicating the highest development of protein oxidation among the treatments and PE-0.05, PE-0.1, PE-0.2, As-0.05, and BHT-0.01 had inhibition at values of 38.2%, 44.8%, 53.9%, 27.1% and 51.3% against protein oxidation on end of storage comparing to control in raw meat samples on end of storage day.

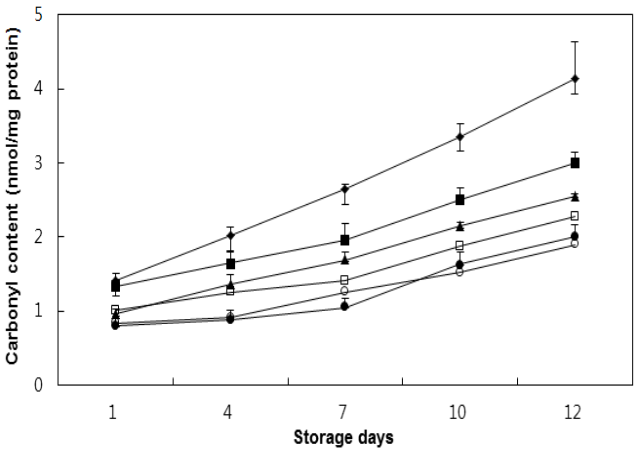

Fig. 2. Carbonyl content (nmol/mg protein) in raw ground pork containing various levels of persimmon peel extract (PPE) during chilled storage for 12 days. For sample denomination see Fig. 1.

Table 1
The color values of raw ground pork meats containing various level of persimmon peel extract (PPE) during chilled storage for 12 days

Traits	Treatment[1)]	Storage days				
		1	4	7	10	12
L^*	Control	57.89±1.07^{Cc}	62.05±0.92^{Da}	59.81±1.31^{Cb}	61.78±0.92^{Aa}	61.79±1.27^{Aa}
	PPE-0.05	60.98±1.62^{Bc}	66.15±0.66^{Ba}	62.61±1.20^{Bb}	59.40±1.35^{BCd}	61.23±1.19^{ABbc}
	PPE-0.1	60.76±1.33^{Bb}	64.44±1.25^{Ca}	62.05±0.97^{Bb}	58.01±1.60^{Cc}	61.07±1.06^{ABb}
	PPE-0.2	60.05±0.63^{Ac}	64.44±1.49^{Ca}	61.99±1.41^{Bb}	55.68±1.40^{Dd}	60.24±1.45^{Bc}
	As-0.05	58.11±1.45^{Cc}	62.92±1.31^{Da}	60.68±1.30^{Cb}	59.99±1.20^{ABc}	61.39±1.29^{ABb}
	BHT-0.01	63.76±1.69^{Ac}	68.88±1.42^{Aa}	65.91±0.37^{Ab}	60.45±0.64^{ABd}	61.65±1.10^{ABd}
a^*	Control	6.39±0.75^{Ba}	5.83±0.48^{Bab}	5.52±0.53^{Bb}	4.86±0.49^{Dc}	3.84±0.65^{Dd}
	PPE-0.05	6.23±1.29^{Bc}	8.62±0.77^{Aab}	8.34±1.18^{Aab}	6.13 ±0.75^{Bc}	7.69±0.83^{Bbc}
	PPE-0.1	6.34±0.65^{Bc}	8.31±1.54^{Ab}	8.26±0.59^{Ab}	6.49±0.83^{Bc}	7.73±0.45^{Abc}
	PPE-0.2	6.38±0.38^{Bc}	8.63±0.44^{Ab}	8.42±0.88^{Aab}	6.68±0.39^{Bc}	7.89±0.87^{Abc}
	As-0.05	8.49±1.22^{A}	9.34±0.96^{A}	9.21±0.49^{A}	9. 84±0.46^{A}	9.40±0.45^{A}
	BHT-0.01	7.11±1.23^{Ba}	6.73±1.03^{Ba}	6.25±0.81^{Bab}	5.91±0.73^{Cb}	5.63±0.31^{Cb}
b^*	Control	10.67±0.78^{c}	11.67±0.42^{Bb}	11.89±0.69^{Aab}	12.56±0.62^{Aa}	12.29±0.42^{Aab}
	PPE-0.05	11.23±0.88^{b}	12.91±0.68^{Aa}	10.95±0.78^{BCb}	11.18±0.63^{Bb}	11.34±0.62^{Bb}
	PPE-0.1	11.65±1.70^{ab}	12.27±1.26^{ABa}	10.73±0.53^{BDb}	11.13±0.62^{Bab}	11.40±0.35^{Bab}
	PPE-0.2	11.35±1.06^{b}	12.88±0.61^{Aa}	10.07±0.42^{Dc}	11.17±0.31^{Bb}	11.32±1.06^{Bb}
	As-0.05	10.52±0.93^{b}	13.09±1.12^{Aa}	10.36±0.54^{CDb}	11.22±0.55^{Bb}	11.13±0.48^{Bb}
	BHT-0.01	11.51±0.97^{b}	13.22±1.58^{Aa}	11.08±0.47^{Bb}	11.42±0.59^{Bb}	11.82±0.55^{ABb}

All values are mean ± standard deviation of three replicates.
[A-D] Means within columns with different superscript letters are significantly different (p<0.05).
[a-d] Means within rows with different superscript letters are significantly different (p<0.05).
[1)]For sample denomination see Table 1.

IV. CONCLUSION

According to this study, incorporation of persimmon peel extracts (PPE) highly inhibition activity on lipid and protein oxidation of raw ground pork during chilled storage as acting quencher from free radical. The results suggest that addition of PPE can play a role as a natural and safe antioxidant against lipid and protein oxidation of meat products.

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Table 2
Thiobarbituric acid reaction substances (TBARS) values (mg of MDA/kg meats) in raw ground pork containing various level of persimmon peel extract (PPE) during chilled storage for 12 days

Treatment[1)]	Storage days				
	1	4	7	10	12
Control	0.19±0.02^{Ae}	0.24±0.01^{Ad}	0.41±0.03^{Ac}	0.59±0.02^{Ab}	0.84±0.06^{Aa}
PPE-0.05	0.15±0.02^{Bd}	0.17±0.02^{Bd}	0.33±0.01^{Bc}	0.44±0.03^{Cb}	0.67±0.02^{Ba}
PPE-0.1	0.13±0.01^{CDd}	0.16±0.01^{BCd}	0.27±0.03^{CDc}	0.34±0.02^{Db}	0.60±0.05^{Ca}
PPE-0.2	0.10±0.01^{Ee}	0.14±0.02^{Cd}	0.25±0.01^{Dc}	0.32±0.01^{Db}	0.48±0.03^{Da}
As-0.05	0.13±0.01^{BCe}	0.17±0.01^{Bd}	0.29±0.01^{Cc}	0.47±0.02^{Bb}	0.66±0.01^{Ba}
BHT-0.01	0.11±0.01^{DEe}	0.16±0.01^{BCd}	0.25±0.02^{Cc}	0.32±0.02^{Db}	0.51±0.02^{Da}

All values are mean ± standard deviation of three replicates.
$^{A-E}$ Means within columns with different superscript letters are significantly different (p<0.05).
$^{a-e}$ Means within rows with different superscript letters are significantly different (p<0.05).
[1)]For sample denomination see Table 1.