ANTIOXIDATIVE POTENTIAL AND ACTIVITY OF JUICE CONCENTRATE OF *PERILLA FRUTESCENS* VAR. *ACUTA* KUDO LEAVES

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Abstract – This study investigated antioxidative potential such as total flavonoids and phenolic content, DPPH radical scavenging activity, metal chelating activity, and reducing power of juice concentrate of *Perilla frutescens* var. *acuta* Kudo leaves (JCP) and antioxidative activity of JCP in meat batter. JCP contained flavonoids and phenolic as much as 14.89 mg quercetin equivalent/g and 97.71 mg gallic acid equivalent/g, respectively. The EC_{50} value of JCP for DPPH radical scavenging was 0.501 mg/mL. JCP showed no ferrous iron chelation activity. The malondialdehyde content in cooked meat batter was significantly lower in meat batter with 1g or 5 g of JCP kg^{-1} than meat batter without JCP. We concluded that JCP could be used as a natural antioxidant for processed meat product.

Key Words – *Perilla frutescens* var. *acuta* Kudo, antioxidant, lipid oxidation, meat batter.

I. INTRODUCTION

Lipid oxidation is one of factors to deteriorate the quality of processed meat product because processed meat product is generally heated in a manufacturing process. Lipid oxidation results in the undesirable flavor and the loss of nutritional value. In addition, the malondialdehyde, an abundant secondary product of lipid oxidation, have been reported as toxic compound for human [1]. Synthetic antioxidants such as butylated hydroxyl toluene, butylated hydroxyl anisole were generally used in food industry. However, toxicity was verified in several studies [2]. Therefore, the development of safe and effective natural antioxidants have been required

The development of natural antioxidant is generally conducted with extraction by hot water or organic solvent such as ethanol and methanol. However, extraction methods with water or organic solvent have some disadvantages in terms of low yield, complex process, and high production cost of production. On the other hand, the process for juice concentration is relatively simple and to get a high yield.

Perilla frutescens var. *acuta* Kudo is an edible plant usually consumed in various Asian countries. Lee et al. [3] reported that hot water extract of *Perilla frutescens var. acuta* Kudo was an effective natural antioxidant for beef patty.

Therefore, the objective of this study was to investigate the antioxidative potential of juice concentrate of *Perilla frutescens* var. *acuta* Kudo leaves (JCP) and compared with that of hot water extract of *Perilla frutescens var. acuta* Kudo leaves (WEP). And, the effect of JCP addition on the lipid oxidation of meat batter was investigated.

II. MATERIALS AND METHODS

Manufacture of JCP and WEP

Dried leaves of *Perilla frutescens* var. *acuta* Kudo was purchased in a local market. To manufacture JCP, the dried leaves of *Perilla frutescens* var. *acuta* Kudo was mixed with distilled water (1:9, v/v) and blended by electronic vacuum blender (HB300, Hanssem Co., Ltd., Seoul, Korea) for 40 s at maximum speed. The particle in blended solution was removed by filter paper. The filtrate was lyophilized and stored until use in a -70°C deep freezer. WEP was manufactured according to the method described by Lee et al. [3].

Antioxidative potential of JCP and WEP

Total phenolic content of JCP and WEP were estimated according to the method described by the Jung et al. [4], respectively.

DPPH radical scavenging activity, reducing power, and metal chelating activity of JCP and WEP were determined as the method described by Jung et al [4, 5]. The half maximal effective concentration (EC50) of JCP and WEP for DPPH radical scavenging and metal chelating activities was calculated by interpolation from the data.

Manufacture of meat batter

Pork hind leg meat was obtained from a commercial butcher. Visible fat and connective tissue were trimmed off and the meat was ground in a grinder with 6 mm plate. Ground meat was mixed with sodium chloride 10 g kg^{-1} and cold water 100 mL kg^{-1}. The meat batter was divided into 3 treatment groups: (1) control, meat batter without JCP; (2) JCP 1, meat batter with 1 g of JCP kg^{-1}; JCP 5, meat batter with 5 g of JCP kg^{-1}. Meat batter was vacuum-packaged and stored for 24 h at 4°C. After storage, the vacuum-packaged meat batters were cooked in a water-bath at 80°C for 30 min, until internal temperature of cooked meat batter reached 75°C.

Measurement of malondialdehyde content in cooked meat batter

Malondialdehyde (MDA) content in cooked meat batter was measured according to the method described by Jung et al. [6]. Briefly, MDA was extracted from cooked meat batter with acetonitrile. MDA in extracted solution was detected by HPLC.

Statistical analysis

The experiment was performed in triplicate. Data of antioxidative potential and activity were analyzed using T-test and analysis of variance (ANOVA) in SAS software, respectively (version 9.3, SAS Institute Inc., Cary, NC, USA). Differences among the means were assessed by Tukey's multiple comparison test. The results are reported as mean ± SD. Statistical significance was assumed at $p < 0.05$.

III. RESULTS AND DISCUSSION

Antioxidative potential of JCP

Total phenolic content of JCP was 97.70 mg gallic acid equivalents/g, respectively (Table 1). Total phenolic content of JCP was significantly higher than that of WEP.

The half-maximal effective concentration (EC_{50}) of JCP for scavenging DPPH radicals was compared with that of WEP (Table 2). The EC_{50} values of JCP and WEP was 0.349 and 0.418 mg/ml, respectively. The EC_{50} values of JCP was significantly lower than that of WEP.

Table 1. Total phenolic content (mg gallic acid equivalents/g) of JCP[1] and WEP[2]

	Total phenolic content
WEP	87.13±4.596[b]
JCP	97.70±2.981[a]

[1]JCP; juice concentrate of *Perilla frutescens* var. *acuta* Kudo leaves
[2]WEP; water extract of *Perilla frutescens* var. *acuta* Kudo leaves
[a,b]Values with different letters within the same column differ significantly ($p < 0.05$).

There was no metal chelating activity of JCP, WEP, and L-ascorbic acid. Previous study reported that plant extract and phenolic compounds showed metal chelating activity [7]. However, gallic acid and quercetin had no metal chelating activity in the present study (data not shown).

The high absorbance in reducing power test means high reducing power and higher value than 1.0 of absorbance means 100% reducing power [8]. In the present study, the reducing power of JCP and WEP was significantly increased with the increase of concentration from 0.1 mg/mL to 1 mg/mL (Figure 1). JCP had significantly higher reducing power than WEP in all concentration.

Lipid oxidation of meat batter

To determine the lipid oxidation of cooked meat batter, the malondialdehyde (MDA) content in cooked meat batter was detected. MDA content in cooked meat batter was the highest in control. Group JCP 5000 had the significantly low MDA content compared with control and group JCP 1000.

Table 2. EC_{50}[1] value (mg/mL) for scavenging of DPPH radical and metal (ferrous iron) chelation of JCP[2] and WEP[3]

	EC_{50} value of scavenging	
	DPPH	Metal chelation
WEP	0.418±0.0027[a 2]	-
JCP	0.349±0.0021[b]	-

[1] Half maximal effective concentration
[2]JCP; juice concentrate of *Perilla frutescens* var. *acuta* Kudo leaves
[3]WEP; water extract of *Perilla frutescens* var. *acuta* Kudo leaves

[a,b]Values with different letters within the same column differ significantly ($p < 0.05$).

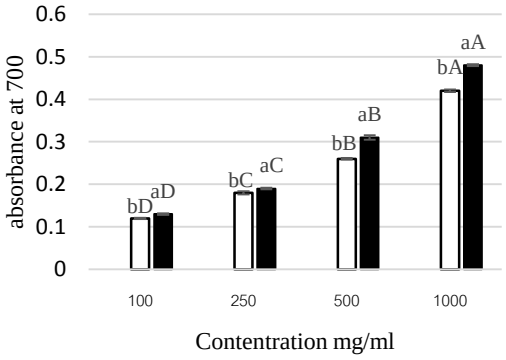

Figure 1. Reducing power of JCP (■) and WEP (□)
[a,b]Values with different letters differ significantly between treatments at same concentration ($p < 0.05$).
[A-D]Values with different letters differ significantly among concentrations in each treatment ($p<0.05$).

This result was similar with previous study. Lee et al. [3] found that the inhibition effect of WEP on the lipid oxidation of beef patty. In addition, previous studies found that plant extract containing phenolic compounds had antioxidant activity in meat product [9, 10].

Table 3. Malondialdehyde (MDA) content (mg/kg) in cooked meat batter

	MDA
Control	0.13±0.0044[a 3]
JCP 1000[1]	0.10±0.0032[b]
JCP 5000[2]	0.06±0.0030[c]

[1]JCP 1000; meat batter with 1000 mg of JCP kg^{-1}
[2] JCP 5000: meat batter with 5000 mg of JCP kg^{-1}
[3] Standard deviation
[a-c]Values with different letters within the same column differ significantly ($p < 0.05$).

IV. CONCLUSION

The JCP produced in this study had high antioxidative potential compared with WEP. In addition, JCP showed inhibition effect on lipid oxidation in meat batter. In conclusion, JCP could be used as a natural antioxidant for processed meat product. However, for increase of availability, the further study should be required related to the effect of JCP on sensorial quality and shelf life of processed meat product.

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