EFFECT OF PURPLE SWEET POTATO (*Ipomea batatas*) AND PURPLE PERILLA (*Perilla frutescens*) ON OXIDATION SATIBLITY OF PORK PATTIES WITH Ω-3 FATTY ACIDS

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Abstract – The 1, 1-diphenyl-2-picrylhydrazyl (DPPH) radical scavenging activity of purple sweet potato (PSP) and purple perilla (PP) were 84.2 and 70.0%. Fe^{2+} chelating capacity of PSP were the highest. PP showed the strongest reducing power. The treatments of the PSP and PP experimental designs were: C+ (with pork back fat), C- (with pre-emulsified flaxseed oil), PSP (with 1.5% purple sweet potato) and PP (with 1.5% purple perilla). The raw pork patties were stored at 7±2 °C for 13 days. Color parameters, 2-thiobarbituric acid reactive substances (TBARS) value and carbonyls content were measured. The results were as follows: the lipid and protein oxidation of raw pork patties were inhibited, and a* value were stabilized by PSP and PP during refrigerated storage.

Key Words –antioxidant, pre-emulsified oil, purple vegetable

I. INTRODUCTION

Purple sweet potato and purple perilla were reported to have high antioxidant ability by their anthocyanin and other polyphenols which could considered as a potential antioxidant agent [1, 2]. However, the application of PSP and PP were limited.

In the composition of fatty acids, omega-3 (ω-3) fatty acids were good for human body. Ω-3 fatty acids could decrease thrombus formation and prevent hyperlipidemia [3]. However, ω-3 fatty acids were tended to oxidize and increased the formation of free radical. Moreover, the oxidation of protein by reactive oxygen substance (ROS) in meat product, which were affected on the functional characteristics of meat protein [4].

The *in vitro* antioxidant capacity of purple vegetable (purple sweet potato and purple perilla) and its effect on oxidation stability of pork patties with ω-3 fatty acids during the storage time were studied.

II. MATERIALS AND METHODS

Preparation of purple vegetable extracts

Fresh sweet potato and purple perilla powder were made as followed: steam blanched (100 ℃, 20 min), water chilling (0℃, 5 min), frozen (-18 ℃, overnight), slicing (5 mm), dried (24 hour) and grinded. The powder was packaged at vacuum condition and stored at -20 ℃ until extraction.

The extract procedures were as follows: 5 g of powder were soaked in 150 m L of 70% ethanol and mixed for 1 h. After standing for 10 min, the mixture was filtered (Advantec No. 2) and then collected the supernatant. This procedure was repeated two times and adjusted with 70% ethanol until total volume to be 500 mL.

Antioxidant capacity of purple vegetable extracts

Antioxidant capacity of PSP and PP extracts were investigated by DPPH radical scavenging activity, Fe^{2+} chelating ability and reducing power assay.

DPPH radical scavenging activity was according to the method described by Shimada *et al.* [5]. 4 mL of sample and blank (70% ethanol) were mixed with 1 mL of 1 mM DPPH methanol solution. After incubation in the dark at room temperature for 30 min, the absorbance was measured at 517 nm. 100 ppm gallic acid (GA) was used as a standard curve.

Scavenging activity (%) =
[1 - (Sample A_{517}) / Blank A_{517}] x100

Ferrous ion-chelating ability was according to the method proposed by Decker and Welch [6] 1 mL of sample and blank (70% ethanol) were mixed with 3.7 mL of 99.9% methanol and 2 mL of 2 mM $FeCl_2$. After reacting for 30 s, added 0.2 mL of 5 mM ferrozine and standed in the dark at room temperature for 10 min. The absorbance was measured at 562 nm. 100 ppm gallic acid (GA) was used as a reference standard.

Chelating activity (%) =
[1 - (Sample A_{562}) / Blank A_{562}] x100

Reducing power assay was according to Oyaizu's [7] method in several modifications. Briefly, 2.5 mL of sample and blank (70% ethanol) were mixed with 2.5 mL of sodium phosphate buffer (0.2 M, pH 6.6) and 2.5 mL of 1% potassium ferricyanide. The mixture was reacted in 50 ˚C water bath for 20 min. After adding 2.5 mL of 10% trichloroacetic acid, centrifuged at 3000 rpm for 10 min. 5 mL of suspension was taken and mixed with 5 mL of distilled water and 0.1% ferric chloride. After vortexing and reacting for 10 min, the absorbance was measured at 700 nm. 100 ppm gallic acid (GA) was used as a reference standard.

Reducing power = Sample A_{700} - Blank A_{700}

Preparation of pork patties

Pre-emulsified flaxseed oil was prepared by homogenizing eight parts of water (at room temperature) with one part of ISP for 2 min and adding 10 parts of the oil for another 2 min.

Table 1 Formulation (g) of patties

Ingredients	C+	C-	PSP	PP
Pork Meat	685	655	655	655
Pork Backfat	200			
Flaxseed oil emulsion		345	345	345
Water	115			
PSP			1.5	
PP				1.5
NaCl	20	20	20	20

Table 1 were shown four different pork patties which fat content to be 20%; which procedures were made as follows: Raw ground meat was mixed with salt for 2 min. Fat or pre-emulsified oils and powder were added for another 2 min. Each patty weighed 60g, wrapped with plastic film and stored at 7±2 ℃. Analysis were carried out at 1, 5, 9 and 13 days.

Color measurement

Color changes were monitored with a colorimeter (SP 60 Portable Sphere Spectrophotometer, X-Rite, Grandville, Michigan). Color was expressed with L* (100 = white, 0 = black), a* (positive = redness, negative = greenness), and b* (positive = yellowness, negative = blueness) values, CIELAB color parameters. Color readings were measured on three randomly chosen spots on the patties.

Determination of TBARS values

TBARS were quantified using the method described by Faustman *et al.* [8].

Determination of Total Protein Carbonyls

Protein oxidation was measured according to the method outlined by Vuorela *et al.* [9].

Statistical analysis

All the statistical analyzes were carried out by SAS University Edition.

III. RESULTS AND DISCUSSION

Antioxidant capability of purple vegetable extracts

The result of DPPH scavenging activities, Fe^{2+} chelating capacity and reducing power of PSP and PP extracts were shown in Table 2.

The DPPH scavenging activity of GA was the highest and PSP was higher than PP ($p < 0.05$). The results were similar to Teow *et al.* [1]. The Fe^{2+} chelating capacity of PP and PSP were stronger ($p < 0.05$) than GA. ROS might be generated by transition metal (iron or copper) via Fenton reaction and consequently formed hydroxyl radical.

Table 2 DPPH scavenging activities, Fe^{2+} chelating capacity and reducing power of PSP and PP extracts.

	DPPH scavenging activity (%)	Fe^{2+} chelating capacity (%)	Reducing power (A_{700})
GA	93.26±0.10 ^{A}	40.17±3.05 ^{C}	2.78±0.05 ^{B}
PSP	84.16±0.12 ^{B}	84.45±0.66 ^{A}	2.67±0.07 ^{B}
PP	69.75±0.14 ^{C}	67.00±2.82 ^{B}	3.15±0.14 ^{A}

$^{A–D}$ 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 ($p < 0.05$).

Reducing power of purple perilla were the strongest ($p < 0.05$). Reducing power could consider as the electronics providing ability. When a substrate, like lipid or protein was attacked by ROS and formed an unpaired electron which was highly unstable and easily reacted with other substrates. Consequently, decayed the quality of meat. As electronics providers, they could inhibit the free radical chain reaction attacking the lipid and protein.

Effect of purple vegetables on pork patties

While the storage time, a* values of C+, C- and PSP were decreased (Fig. 1) might be due to the oxidation of myoglobin. Oxy-myoglobin (fresh redness) had Fe^{2+} in the central, after oxidized by ROS or peroxyl radical, Fe^{2+} lose electronic and transferred into brownish Fe^{3+} (met-myoglobin). Faustman *et al.* [10] recently reviewed the interaction between myoglobin and lipid and suggested that lipid oxidation could cause formation of metmyoglobin and lead to discoloration. Although PP observe having lowest a* values, PP stabilized a* value during 13 days ($p < 0.05$). PP was negative a* value because of greenish color of purple perilla powder.

TBARS of patties were shown in Fig. 2. TBARS of PSP and PP were lower ($p < 0.05$) than the other. TBARS of C+ and C- were intensely increased ($p < 0.05$) during 13 days storage. Addition of PP and PSP could successfully inhibit lipid oxidation.

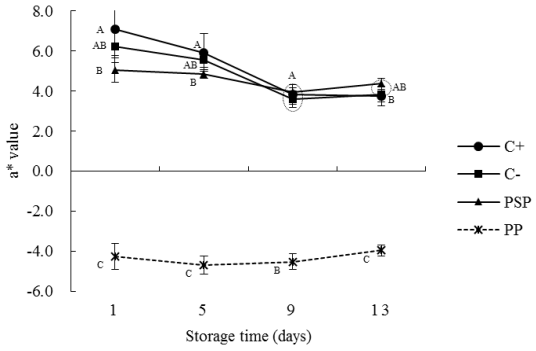

Fig. 1 Effect of purple vegetable on a* values of pork patties enriched in ω-3 fatty acids
$^{A–D}$ Within a column, different superscripts indicate significant differences ($p < 0.05$).

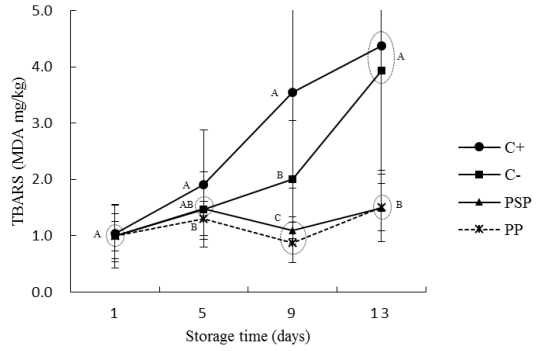

Fig. 2 Effect of purple vegetable on lipid oxidation (TBARS) of pork patties enriched in ω-3 fatty acids
$^{A–D}$ Within a column, different superscripts indicate significant differences ($p < 0.05$).

Carbonyls content of all treatments were shown in Fig. 3. Carbonyls content of C+ and C- were higher than the other ($p < 0.05$). According to the review of Estévez [4], lipid-derived reactive oxygen species, such as peroxyl radicals (ROO•) were potential initiators of protein carbonylation. PP could prevent the formation of carbonyls during the storage. C+ and C- had same trend of carbonyls content during the storage. The formation of cross-link products leaded to the decreasing of carbonyls content. The increasing at 13th day was caused by the oxidation of cysteines and methionine after the firstly formation of carbonyls content [4].

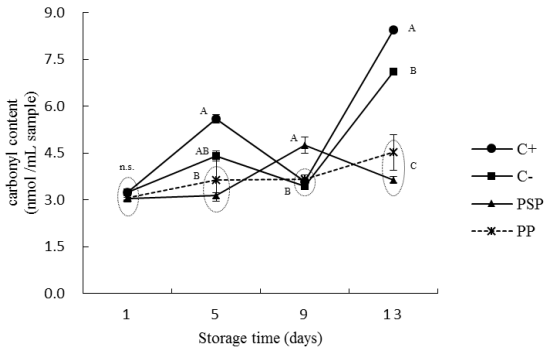

Fig. 3 Effect of purple vegetable on protein oxidation (carbonyls contents) of pork patties enriched in ω-3 fatty acids

[A–D] Within a column, different superscripts indicate significant differences ($p < 0.05$).

IV. CONCLUSION

Purple sweet potato and purple perilla could improve the oxidation stability of meat products with high ω-3 fatty acid. However, *in vivo* mechanism of antioxidant ability of purple vegetables on meat products was still need to study.

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