P-08-04

Effects of lotus (*Nelumbo nucifera*) root and leaf extracts on pork patties as inhibitors of lipid oxidation, alone and in combination (#74)

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Introduction

Lipid oxidation in meat products can occur during its processing such as grinding, heating, and storage. It is one of the major reasons for the quality loss, including off-flavor, discoloration and other undesirable changes in sensorial value, reducing the shelf life of products.

Generally, synthetic antioxidants such as butylated hydroxytoluene (BHT) have been used to decrease lipid oxidation. However, their use has been limited due to its health risks, e.g., toxicity and carcinogenic effect. Accordingly, natural antioxidant sources were investigated to replace synthetic antioxidants. Also, studies on the combined effect of different natural antioxidants were partially reported revealing a combined effect from antioxidants could reduce the cost of expensive additive-free products.

Lotus (*Nelumbo nucifera*) roots and leaves contain abundant levels of the bioactive compounds. Despite functional and antioxidant activity of lotus roots and leaves have been individually studied, the effects of their combination were scarcely discussed. Thus in this study, I) the antioxidant mechanisms of ethanol extracts from lotus root and leaf at different ethanol concentrations were investigated. Subsequently, II) physicochemical and sensorial properties, and lipid oxidation stability of pork patties with the extracts individually or in combination were determined during 10 days of storage at 4 ± 1°C.

Methods

Experiment I

The dried lotus root and leaves were powdered then extracted with different levels of ethanol (50% and 75%). After filtration and removing of extract solvents, the filtrates were diluted to 10% using the same concentration of extracting ethanol. As a positive control, BHT diluted as the same concentration of the extracts was used. To compare antioxidant activities of lotus root and leaf extracts, extraction yield, diphenyl-1-picrylhydrazyl (DPPH) radical scavenging activity (Brand-Williams *et al*. 1995), chelating activity (Decker and Welch, 1990), and reducing power (Oyaizu et al., 1986) were determined.

Experiment II

The pork patties were used in the experiment II because it is susceptible to lipid oxidation. Pork patties with selected 10% extracts were prepared following formulation: 70% pork hind leg, 20% pork backfat, 10% ice water, and added 1.5% salt based on the total weight. The lotus root extract or lotus leaf extract was added to the patties at 1% (LRE or LLE, respectively) or together at 0.5% (LRE+LLE). As the negative and positive control, patties without any extract and those with 0.02% BHT were prepared. In addition, patties with varying levels of the extracts (0.1%, 0.5%, and 1%) were made to compare their effect on lipid oxidation. The patties were analyzed on cooking yield, proximate composition, pH value, peroxide value (POV, Horwitz, 2000) and 2-Thiobarbituric acid reactive substances (TBARS, Vyncke, 1970) value.

Results

Experiment I

The results of the antioxidant activity of lotus root extract and lotus leaf extract revealed different antioxidative mechanisms between them. The leaf extracts presented antioxidant activities comparable to BHT in DPPH radical scavenging assay (Table 1). Although it was lower than that of leaf extract in DPPH radical scavenging and reducing power assay (data not shown), the root extract provided higher chelating activities ($P < 0.05$) that may promote antioxidant effect against the initiation of lipid oxidation in meat products. Meanwhile, as extracts made by 50% solvent ethanol exhibit generally higher extraction yields than that by 75% ethanol, extracts by 50% ethanol were applied to pork patties in experiment II.

Experiment II

The TBARS values of pork patties containing individual root and leaf extracts in different levels (0.1, 0.5, and 1%, respectively) were decreased with increasing levels of extracts, indicating their concentration-dependent anti-lipid-oxidation activity on pork patties (data not shown). In case the extracts of lotus root and leaf were combined, both POV and TBARS values exhibited that the addition of LLE (1%) alone and combined LRE and LLE (0.5%, respectively) had the highest antioxidant effect among treatments ($P < 0.05$, Table 1, 2). The treatments maintained its TBARS values under the sensory threshold level (1.0 mg/kg) of pork. Even though LRE had a less antioxidant effect than LLE, patties treated with combined 0.5% LRE and 0.5% LLE maintained similar ($P > 0.05$) TBARS value with those treated with 1% LLE. It was considered as the combined effect of different antioxidation mechanisms of LRE and LLE.

Conclusion

The application of 50% ethanol extracts of lotus root and leaf in pork patties effectively retarded lipid oxidation, by possessing different antioxidative mechanisms. Though the synergistic effect of lotus root and leaf was uncertain in pork patties, lotus root and lotus leaf alone or together could be used

Notes

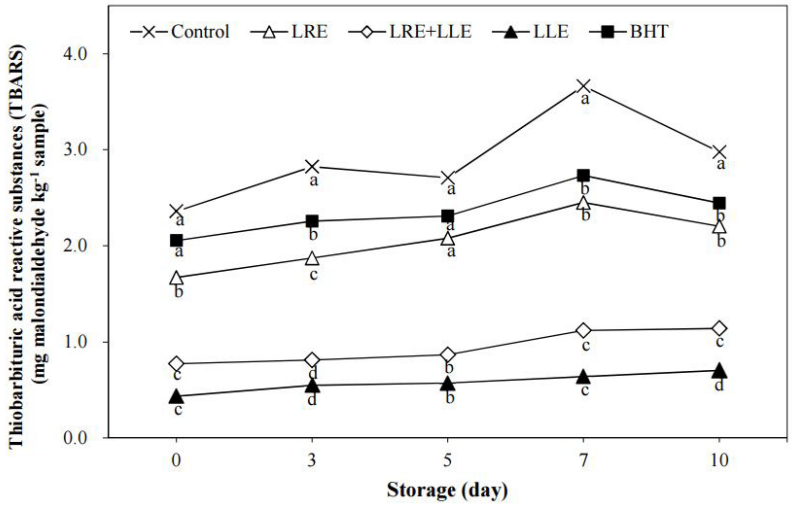

Figure 2. Changes in thiobarbituric acid reactive substances (TBARS) of pork patties
(×) Control, no ingredient added; (△) patties with 1% lotus root extract; (◇) patties with 0.5% lotus root extract and 0.5% lotus leaf extract; (▲) patties with 1% lotus leaf extract; (■) patties with 0.02% butylated hydroxytoluene (BHT). a-d means that column with different letters are significantly different (P < 0.05).

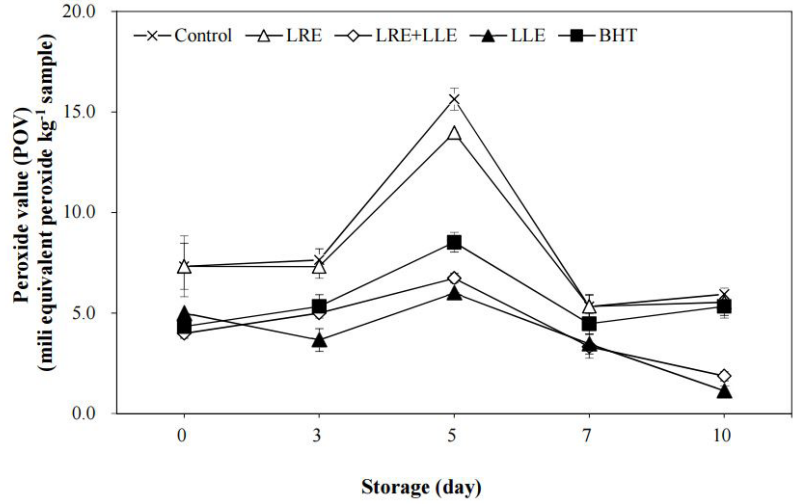

Figure 1. Changes in peroxide value (POV) of pork patties containing lotus loot and leaf extracts
(×) Control, no ingredient added; (△) patties with 1% lotus root extract; (◇) patties with 0.5% lotus root extract and 0.5% lotus leaf extract; (▲) patties with 1% lotus leaf extract; (■) patties with 0.02% butylated hydroxytoluene (BHT). Error bars show the standard deviation.

Properties	Lotus root-50% EtOH[1)]	Lotus root-75% EtOH	Lotus leaf-50% EtOH	Lotus leaf-75% EtOH	BHT
Extraction yield (%)	19.42±1.61[a]	14.05±2.34[b]	17.29±1.64[ab]	15.65±1.08[b]	-
IC_{50} on DPPH radical (g/L)[2)]	0.52±0.01[b]	0.71±0.03[a]	0.17±0.01[c]	0.13±0.01[cd]	0.09±0.02[d]
IC_{50} on chelating activity (g/L)	0.32±0.03[b]	0.31±0.08[b]	0.84±0.02[a]	0.85±0.11[a]	-
Reducing power (Absorbance at 700nm)	1.85±0.15[b]	1.53±0.11[c]	0.06±0.02[d]	0.08±0.13[d]	2.58±0.39[a]

Table 1. Extraction yield and antioxidant properties of lotus root and leaf extracts All values are the mean ± standard deviation. [a-d]Means within a row with different letters are significantly different (P < 0.05). [1)]Lotus root- 50% EtOH, lotus root extract using 50% solvent ethanol; Lotus root-75% EtOH, lotus root extract using 75% solvent ethanol; lotus leaf-50% EtOH, lotus leaf extract using 50% solvent ethanol; lotus leaf- 75% EtOH, lotus leaf extract using 75% solvent ethanol; BHT, butylated hydroxytoluene. [2)]IC50, concentration of extracts (g/L) to inhibit 50% DPPH radical or chelate metal ions.

Notes