Antioxidant Properties of Lotus Leaf (Nelumbo nucifera) Powder and Barley Leaf (Hordeum vulgare) Powder in Raw Minced Pork during Chilled Storage

Ju-Hui Choe, Ji-Hun Choi1, Yun-Sang Choi1, Doo-Jeong Han, Hack-Youn Kim, Mi-Ai Lee, Si-Young Kim, and Cheon-Jei Kim*

Department of Food Science and Biotechnology of Animal Resources, Konkuk University, Seoul 143-701, Korea
1Research Institute for Meat Science and Culture, Konkuk University, Seoul 143-701, Korea

Abstract

The effects of additions of lotus leaf (0.1 and 0.5%) and barley leaf powder (0.1 and 0.5%) on the lipid oxidation and microbiological analysis of raw minced pork were investigated after 1, 4, 7, and 10 d at chilled storage. Days of storage caused (p<0.05) decreases in pH values in samples with lotus leaf (LP) and barley leaf powder (BP). L* and a* values decreased, and b* values increased in the treatments with increasing lotus leaf and barley leaf powder contents, respectively. The decrease in a * values was lowest (p<0.05) in the treatment with 0.1% BP. Thiobarbituric acid reaction substance values and free fatty acids in 0.5% LP were lowest (p<0.05) on day 10. Thus, the addition of lotus leaf powder significantly improved lipid oxidative stability in the raw minced pork during chilled storage of 10 d. Furthermore, the raw minced pork treatments with LP and BP presented low peroxide values and total microbes as compared to control (-) (without LP and BP). These results indicate that LP and BP can be incorporated into raw minced pork as natural additives to retard oxidation.

Key words: lotus leaf, barley leaf, lipid oxidation, microbiological analysis, minced pork

Introduction

Minced pork has become an important food due to its convenience. Minced meat is markedly changed by exposing lipid membranes to metal ions. This process makes possible the generation of free radicals and propagation of oxidative reactions by interacting pro-oxidants and unsaturated fatty acids (Asghar et al., 1988). Oxidative reactions in meat during processing and storage result in deteriorations of color, sensory quality, and decreased shelf-life. Therefore, it is important for the meat food industry to inhibit lipid oxidation in minced meat.

Antioxidants that have oxidative stability and enhance the quality of meat can be classified into two groups: synthetic antioxidants and natural antioxidants (Huber et al., 1995). Synthetic antioxidants such as butylated hydroxytoluene (BHT), butylated hydroxyanisole (BHA), tert-butylhydroquinone (TBHQ), and propyl gallate have been used in raw and precooked meat products as strong oxidative inhibitors. However, negative health effects of synthetic antioxidants have decreased their use (Shahidi et al., 1992). For example, high concentrations of BHT can be toxic (De Oliveira et al., 2009). These negative effects of synthetic antioxidants have led to interest in natural antioxidants due to their safety (Han and Lee, 2005). Natural antioxidants obtained from natural sources such as seeds, rinds, leaves, nuts of plants, honey, fruits, and vegetables have been studied for their antioxidant activities in meat products (Devatkal and Naveena, 2010; Naveena et al., 2008). Several studies have documented the antioxidant effects of grape seed extracts in chicken thigh meat (Brannan, 2008), kinnow rind and pomegranate rind extracts in goat meat patties (Devatkal and Narsaiah, 2010), and green tea leaf extracts in turkey sausages (Bozkurt, 2006). In recent studies, Bastida et al. (2009) observed the antioxidant activities of carob fruit extracts in pork meats, and Ganhão et al. (2010) reported on antioxidant activities of fruit extracts in burger patties.

Plant extracts containing phenolic compounds retard lipid oxidation in meat products by radical scavenging and metal-chelating activities (Rice-Evans et al., 1996).
Lotus (*Nelumbo nucifera*) leaf has antioxidant compounds such as phenolic acids and flavonoids (Choe et al., 2010). Several studies have reported on the antioxidant effects (Choe et al., 2010; Lee et al., 2006a) and antimicrobial activities (Lee et al., 2006b) of lotus leaf extracts. In addition, lotus leaf has been used as a functional food because of its various biologically active components (Lee et al., 2006). For example, lotus leaf powder was added to sulgitteok (Yoon, 2007) and fish paste (Shin, 2007).

Interest in the functionality of barley leaf, which contains the natural antioxidant enzyme superoxide dismutase (SOD), vitamin C, vitamin E, β-carotene, and flavonoids, has increased (Arimoto et al., 2000). Lee et al. (1994) studied the antioxidant activity of barley leaf extract and Jang et al. (2007) reported that barley leaf tea had antioxidant effects due to high DPPH radical scavenging activity.

The objective of this study was to evaluate the effects of lotus leaf powder and barley leaf powder in raw minced pork during chilled storage (4±1°C) for 10 d.

**Materials and Methods**

**Preparation of meat and samples**

Fresh pork hams, weighing 6.5-7.0 kg each, were purchased from a pilot plant at Konkuk University, Korea at 48 h postmortem. The pork back fat was also collected from the slaughter house. All subcutaneous and intermuscular fat and visible connective tissues were removed from the fresh ham muscles.

The raw minced pork was prepared by the following formulation and process: 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 plate and then the ice and salt were added. The lotus leaf powder and hot-air-dried barley leaf powder was added at levels of 0% (Control (-), 0.1% (LP1 and BP1), and 0.5% (LP2 and BP2), and added 0.01% BHT (Control (+)). These percentages were based on the control formula weight. Samples were hand mixed for 10 min. Then, the raw minced pork meat was anaerobically packed in PE/nylon film bags and stored for maximum of 10 d at 4±1°C.

**pH values**

The pH values of samples were determined with a pH meter (Model 340, Mettler-Toledo GmbH, Switzerland). The pH of the raw minced pork was measured after blending 5 g of sample with 20 mL of distilled water for 60 s in a homogenizer (Ultra-Turrax SK15, Janke & Kunkel, Germany).

**Instrumental color evaluations**

The instrumental color analyses of the raw pork patties were conducted as follows. The color measurements were taken with a colorimeter (Chroma meter CR-210, Minolta, Japan; illuminate C, calibrated with a white standard plate CIE L’ = 97.83, CIE a’ = -0.43, CIE b’ = +1.98), consisting of an 8 mm diameter measuring area and a 50 mm diameter illumination area. The color values (CIE L’, a’, and b’) were measured on the sample surfaces and data were taken in triplicate for each sample.

**Thiobarbituric acid reaction substance (TBARS) values**

Lipid oxidation was assessed in triplicate by the 2-thiobarbituric acid (TBA) method of Tarladgis et al. (1960) with minor modifications. Fifty mL of distilled water was added to 10 g sample prior to homogenizing with a homogenizer (AM-7, Nihonseiki Kaisha Ltd., Japan) at 10,000 rpm for 2 min. The cup used for blending was washed with an additional 47.5 mL of distilled water, which was added to the same distillation flask with 2.5 mL 4 N HCl and a few drops of an antifoam agent, silicone o/w (KMK-73, Shin-Etsu Silicone Co., Ltd., Korea). The mixture was distilled and 50 mL distillate was collected. Five mL of 0.02 M 2-thioibarbituric acid in 90% acetic acid (TBA reagent) was added to a vial containing 5 mL of the distillate and mixed well. The vials were capped and heated in a boiling water bath for 30 min to develop the chromogen and cooled to room temperature. The absorbance was measured at 538 nm, against a blank prepared with distilled water (5 mL) and TBA reagent (5 mL), using a UV/VIS spectrophotometer (Libra S22, Biochrom Ltd., England). TBARS values were calculated by multiplying the absorbance by 73%, the recovery of the standard from meat, resulting in a K value of 7.8. The TBA values were calculated as mg malonaldehyde (MA)/kg sample.

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\text{TBA (mg MA/sample kg) } = \text{OD value } \times 7.8
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**Peroxide values (PV) and free fatty acids (FFA)**

Lipids from the samples were extracted by the method of Folch (Floch et al., 1957) using the chloroform:methanol solvent system (2:1). The lipid extracts were evaporated and concentrated with a rotary evaporator (Rotary evaporator N-1000, EYELA, Japan). The peroxide val-