Utilization of Dried Garlic Powder and α-Tocopherol to Improve the Shelf-life of Emulsion-type Sausage during Refrigerated Storage

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Abstract

This study investigated the shelf life of emulsion-type sausages containing garlic powder and/or α-tocopherol during storage at 4°C for 0, 10, 20, and 30 d. Six groups of emulsion-type sausages were included: control (no additives), GP1 (1% garlic powder), GP3 (3% garlic powder), AT100 (100 IU of α-tocopherol/kg of sausage), AT200 (200 IU of α-tocopherol/kg of sausage), and GP1+AT100 (1% garlic powder+100 IU of α-tocopherol/kg of sausage). During storage, the pH, thiobarbituric acid reactive substances, and residual nitrite content were reduced by the addition of garlic powder and/or α-tocopherol relative to the control (p<0.05). In addition, emulsion-type sausages supplemented with garlic powder and/or α-tocopherol improved color stability (p<0.05). The results suggest that a higher amount of garlic powder and their different combinations could improve the shelf life of emulsion-type sausages and protect against lipid oxidation.

Key words: emulsion-type sausage, garlic powder, α-tocopherol, TBARS, residual nitrite, meat color

Introduction

Lipid oxidation and discoloration, which are the major causes of deterioration in meat quality during storage, are 2 of the greatest concerns in the meat industry (Fernández-López et al., 2005; Kanner, 1994). Lipid oxidation and discoloration reduce both the nutritional quality and consumer acceptability (Brewer et al., 2002; Buckley et al., 1995; Fernandez-Lopez et al., 2005; Ryu et al., 2005, 2006). This has led to great interest in the application of additives or antioxidants that prevent the oxidative deterioration of meat and meat products. Accordingly, the application of natural products with antioxidant activities in meat and meat products may be necessary to extend their storage shelf life and prevent diseases (Yin and Cheng, 2003). Many studies have demonstrated that various antioxidants such as nitrite, butylated hydroxyanisole (BHA), butylated hydroxytoluene (BHT), garlic, and α-tocopherol, are effective in food products (Fernández-López et al., 2005; Kahl and Kappus, 1993; Martinez-Tome et al., 2001; Sammet et al., 2006). However, use of the synthetic antioxidants nitrite, BHA, and BHT in the meat industry has begun to be restricted due to their toxic properties and potential health hazards (Kahl and Kappus, 1993; Luecke, 1999). Consequently, a number of consumers are concerned about the safety of synthetic food additives. Therefore, replacement of these synthetic antioxidants with natural antioxidative substances, such as garlic and α-tocopherol, that can prolong the shelf life of both processed and unprocessed meat products is being considered.

Garlic is commonly used as a flavor enhancement in sausage and is also appreciated for its medicinal properties (Sallam et al., 2004). It has long been known that garlic has beneficial effects in animals, including antioxidant, antiviral, and antifungal activities (Harris et al., 2001; Jackson et al., 2002). Previous research has suggested that these functions are mainly attributed to the bioactive components present in garlic, including sulfur-containing compounds, such as alliin, allicin, and diallyl sulfides (Amagase et al., 2001).

α-Tocopherol is the most effective chain breaking lipid antioxidant present in cell membranes, and it protects cellular structures against damage from oxygen free radicals and the reactive products of lipid peroxidation (Sodhi et al., 2008). In several studies, lipid stability was shown to be greater in meats and sausages when pork and lamb...
diets were supplemented with α-tocopherol (Harms et al., 2003; Lauzurica et al., 2005). In addition, the use of antioxidant blends in animal diets has a potential economic advantage for the meat industry because a combination of antioxidants will require lower production costs than single pure compounds (Shahidi, 1996). Therefore, determining the antioxidant activity of mixtures of garlic and α-tocopherol will provide fundamental information that may lead to new sausage formulations to gradually increase consumer acceptance.

Although many studies have focused on the supplementation of feed with garlic powder and α-tocopherol to improve lipid and color stability in chicken, pork, and beef, scientific literature on the shelf life properties of emulsion-type sausage supplemented with garlic powder, α-tocopherol, or both, is still scarce. Therefore, the aim of the present study was to evaluate the effect of garlic powder, α-tocopherol, or both, on the pH, thiobarbituric acid reactive substances (TBARS), residual nitrite (RN), and color properties of emulsion-type sausage during storage.

**Materials and Methods**

**Materials**

About 20 kg of fresh garlic samples produced in May or June were purchased from a local market (Eui-Sung local National Agriculture Co-operation Federation, Korea). Fresh garlic was prepared following the procedure previously described by Kim et al. (2010). Briefly, fresh garlic was peeled, cut into slices, and subsequently thinly spread on a mat in direct sunlight at 30 to 35°C to make garlic powder. The drying process continued for 8-10 h to ensure the appropriate consistency of the garlic. After drying, the garlic was further dried in an oven at 50°C for 8 h, ground to a fine powder, and stored immediately at 4°C until use. The dried garlic powder used in this study contained 905 g dry matter/kg, 128 g crude protein/kg, 38 g crude fat/kg, and 57 g crude ash/kg. α-Tocopherol (all-rac-α-tocopheryl acetate) was purchased from Sigma (USA).

**Sausage Making**

To produce emulsion-type sausages, fresh boneless pork, purchased from a local market, was trimmed of visible fat and connective tissue. Pork was ground through a 4 mm grinder plate (Super grinder-MK-G3, Matsushita Electric Industrial, Japan) before sausage manufacture. The ground meat was used to produce 6 different groups of emulsion-type sausages: control (no additives), GP1 (1% garlic powder), GP3 (3% garlic powder), AT100 (100 IU of α-tocopherol/kg of sausage), AT200 (200 IU of α-tocopherol/kg of sausage), and GP1+AT100 (1% garlic powder+100 IU of α-tocopherol/kg of sausage). The percentages of the basic components in the sausages were as follows: ground pork meat (60%), fat (20%), cornstarch (6%), sausage seasoning (3%, Taewon Food Industry CO., Ansan, South Korea), salt (1.5%), polyphosphate (0.25%), and ice water (10%). Emulsion-type sausages were manufactured as described by Kim et al. (2010). Briefly, all other ingredients were thoroughly mixed with the various formulations of sausage meat in the cutting chopper. While the emulsification was processing, ice water was added to absorb the generated heat and ensure that the emulsion held. The meat was cut to a very fine particle size, which encouraged protein extraction while chopping. When the emulsions were sufficiently formed by solubilizing the meat protein, fat was added. Then, the batter was mixed in an emulsifier (Model FP800, Kenwood Ltd., UK) for 5 min. The sausage mixture was tightly stuffed into polyvinylidene chloride casings 50 mm in diameter (Viskase Corporation, USA) that were divided into food-casing lengths of about 10 or 12 cm per unit. The sausage unit was heated at 75°C for 70 min in a cooking chamber, cooled immediately in ice water, and kept at 4°C for 0, 10, 20, and 30 d.

**Measurements**

**pH**

The pH was determined according to the method described by Sallam et al. (2004). A 10 g sausage sample was cut into small pieces and homogenized in 90 mL of distilled water. A slurry was then made using a homogenizer and the pH was measured with a digital pH meter (Model 520A, Orion, USA).

**Thiobarbituric-acid reactive substances (TBARS)**

The presence of TBARS was assessed using the method of Witte et al. (1970) and was expressed as milligrams of malonaldehyde (MA) per kilogram of sausage. A 20 g sausage sample was added to 50 mL of 20% trichloroacetic acid (in 2 M phosphate solution) and homogenized in a blender. The solution was added to 50 mL of distilled water and then filtered through Whatman No. 1 filter paper. After adding 5 mL of the filtrate to 5 mL of 2-TBA reagent (0.005 M in water) in a test tube (50 mL), the test tubes were kept at room temperature in the dark for 15 h and the absorbance at 532 nm was measured with a Uvitek Violet/Visible (UV/VIS) spectrophotometer (UV-24D1 (PC))