Food Chemistry 117 (2009) 106–113

Contents lists available at ScienceDirect

Food Chemistry

journal homepage: www.elsevier.com/locate/foodchem

Effect of various levels of rosemary or Chinese mahogany on the quality of fresh chicken sausage during refrigerated storage

Deng-Cheng Liu, Ruei-Tsz Tsau, Yen-Chih Lin, Shyh-Shyan Jan, Fa-Jui Tan *

Department of Animal Science, National Chung Hsing University, 250 Kuo Kuang Rd., Taichung 402, Taiwan

ARTICLE INFO

Article history:
Received 18 July 2008
Received in revised form 18 March 2009
Accepted 23 March 2009

Keywords:
Chinese mahogany
Rosemary
Fresh sausage
Volatile compound

ABSTRACT

The purpose of this study was to evaluate the effect of rosemary or Chinese mahogany, at levels of 500, 1000 and 1500 ppm, of the phenolic compounds, on the quality of fresh chicken sausage stored at 4 °C for 14 days. The results showed that sausages with addition of Chinese mahogany or rosemary underwent less pH value reduction. The intense colour of Chinese mahogany or rosemary resulted in samples with lower *L* values and higher *a* values. Samples with more Chinese mahogany or rosemary added had higher total phenolic compounds. Lower TBA (thiobarbituric acid) and VBN (volatile basic nitrogen) values, and lower total plate counts were observed for the samples with Chinese mahogany or rosemary added. Samples with Chinese mahogany added had higher overall acceptance than had samples with rosemary added. Some volatile compounds, including alcohols, acids, esters, aldehydes, ethers and phenolic compounds, were isolated from the samples and identified.

1. Introduction

Sausage is one of the oldest known forms of processed meat products and is very popular in many areas. Fresh sausages, e.g. fresh pork sausage, country-style pork sausage, fresh kielbasa (Polish), Korr (Swedish), Italian sausage, bratwurst, bockwusrt, chorizo (fresh) and thuringer (fresh), are some common examples (Romans, Costello, Carlson, Greaser, & Jones, 1994). The cited authors indicate that fresh sausage is a sausage "made from selected cuts of fresh meat (not cooked or cured) and must be stored in a refrigerated (or frozen) state prior to being consumed." Therefore, adding "curing agents" (mainly nitrites and nitrates) to a formula, or not, is the major criterion used to judge whether the product belongs to "fresh sausage" or cured sausage. Also, raw materials of fresh sausage should not be cooked. No typical thermal treatments, such as drying, smoking or cooking, should be applied when making fresh sausages.

Lipid oxidation, resulting in rancidity, is one of the most important quality defects of meat or meat product during storage. Antioxidants can retard lipid rancidity in foods and prolong product shelf life. Since consumers have concerns regarding synthetic antioxidants, such as butylated hydroxy anisole (BHA), butylated hydroxy toluene (BHT) and propyl gallate (PG), natural antioxidants may be applied in foods (Aruoma, Halliwell, Aeschbach, & Löligers, 1992). Many herbs and spices contain phenolic compounds, which have some antioxidative properties.

Rosemary (*Rosmarinus officinalis* L.), like other aromatic herbs and spices, which has been planted in many areas and used in Mediterranean and other cuisine, is not only used to improve or modify flavours of foods, but also to provide some functionality. For example, its extract has been widely used as an antioxidant in the food industries. Carnosol, carnosic acid and rosmarinic acid have been identified as major constituents that contribute to the antioxidant activity of rosemary (Aruoma et al., 1992). Utilising DPPH and ABTS radical-scavenging assays, and the ferric thiocyanate test, Erkan, Ayranci, and Ayranci (2008) pointed out that rosemary extract had a higher phenolic content than had blackseed (*Nigella sativa* L.) essential oil, thus leading to a higher antioxidant activity. Many reports have indicated that rosemary extracts can retard lipid oxidation and prolong the shelf life of meat products (Georgantelis, Ambrosiadis, Katikou, Blekas, & Georgakis, 2007; Georgantelis, Blekas, Katikou, Ambrosiadis, & Fletouris, 2007; Sebranek, Sewalt, Robbins, & Houser, 2005). In addition, rosemary extracts have been shown to have some antimicrobial effect (Angioni et al., 2004).

Chinese mahogany, also known as *Toona sinensis* Roem, is a perennial tree that has become widely grown in Taiwan and China (Edmonds & Staniforth, 1998). Its leaves have a special aroma and are often consumed in Taiwan. Several reports regarding the medical uses of this plant, such as for treatment of enteritis, dysentery and itch (in the practice of oriental medicine) and for anticancer and hypoglycaemic effects have also appeared (Edmonds & Staniforth, 1998). Hseu et al. (2008) reported that *T. sinensis* aqueous extracts, at levels up to 100 μg/ml, showed some antioxidant activities, including the scavenging of free and superoxide anion

* Corresponding author. Tel.: +886 4 22870613x246; fax: +886 4 22860265.
E-mail address: tanfj@dragon.nchu.edu.tw (F.-J. Tan).

0308-8146/$ - see front matter © 2009 Elsevier Ltd. All rights reserved.
doi:10.1016/j.foodchem.2009.03.083

radicals, reducing power and metal chelation. Methanol extracts of *T. sinensis* also demonstrated strong DPPH radical-scavenging activities and inhibitory effects on lipid peroxidation Cho et al. (2003). Similarly, some potent antioxidative components in the young leaves and shoots of *T. sinensis* let to a promising healthy-promoting food (Wang, Yang, & Zhang, 2007). Even though, *T. sinensis* was reported to have some antimicrobial activity (Shi, 2003), limited information regarding the antimicrobial effect of this plant is available.

Therefore, the aim of this study was to compare the effects of rosemary or Chinese mahogany on the quality of fresh chicken sausage during refrigerated storage. We also wanted to identify the volatile compounds from Chinese mahogany, rosemary and sausages with rosemary or Chinese mahogany added.

2. Materials and methods

2.1. Rosemary and Chinese mahogany preparation

Rosemary, which was obtained from a local spice company in Taiwan, was comminuted with a grinder (DIAX 600, Heidolph, Germany) into approximately 2 mm lengths, and stored in a moisture-proof cabinet (BK236, Bossmen, Taiwan). Chinese mahogany leaves, which were obtained from a local farm in Pingtung, Taiwan, were dried in an oven at 60 °C for 8 h, ground with the same grinder to approximately 2 mm in length, and then stored in the moisture-proof cabinet.

A pre-measurement of the total phenol contents in rosemary and Chinese mahogany was first conducted according to the Folin–Ciocalteu method of Tsau (2006) and is described briefly as follows. Two grams of ground rosemary or Chinese mahogany were mixed with 100 ml of distilled water, boiled and extracted for 20 min, cooled rapidly, and filtered. The filtered liquid was combined with phenol reagent (Sigma) and saturated Na_2CO_3 (Union Chemical Works Ltd., Hsinchu, Taiwan), vortexed, and then held for 1 h. The optical density values were determined using a spectrophotometer (U3210, Hitachi, Japan) at 700 nm wavelength. A standard curve was prepared with gallic acid added and regression determined as $Y = 2.35X - 0.0472$, where Y represents OD (optic density) and X represents the concentration of the total phenol contents of the solution (mg/ml). Total phenol contents of rosemary or Chinese mahogany were determined according to the formula: Total phenol content (mg/g) = $(X \times 10 \times 100)/2 \times 1000$. Based on the preliminary test results, 395 and 82 mg/g total phenol contents were determined for the Chinese mahogany and rosemary, respectively, in this study. Therefore, amounts of 1.265, 2.530, or 3.795 g of ground Chinese mahogany were added to 1 kg of sausage mixtures, respectively, in order to have 500, 1000 or 1500 ppm of phenolic compounds, respectively. Similarly, amounts of 6.1, 12.2, or 18.3 g of ground rosemary were added to 1 kg of sausage mixtures, respectively, in order to have 500, 1000, or 1500 ppm of phenolic compounds, respectively.

2.2. Sausage preparation

Fresh chicken tenderloin, chicken skin, pork backfat and salted natural pork casing were purchased from local markets in Nantou, Taiwan. Chicken meat, chicken skin and pork backfat were first frozen at −20 °C and then ground. Chicken meat was ground through a 9 mm plate, whereas chicken skin and pork backfat were ground through a 6 mm plate. Ground chicken (75%) was mixed thoroughly with salt (1.8%) and polyphosphates (0.15%) with a mixer (DITO, BM10) for 1.5 min, and then other spices and seasonings were added, including 0.5% sugar, 0.3% monosodium glutamate, 0.1% white pepper powder, 0.075% nutmeg powder, 0.03% parsley powder, 0.03% thyme powder, 0.03% onion powder, pre-assigned amounts of ground Chinese mahogany leaves or rosemary and non-lean tissue (25%, in which the ground chicken skin:ground pork backfat ratio = 1:2), then mixed for another 1.5 min. The mixtures were cured at 4 °C for 16 h, and then stuffed (Stuffer, Dick D-73779, Germany) into pork casings which were soaked in water prior to use. Raw sausages were manually linked, packed in a tray with PVC film and stored at 4 °C.

2.3. Proximate composition and pH

Samples were first ground (with a grinder, 31BL91, Blender, USA). Proximate compositions of samples including moisture, crude fat, crude protein and ash contents, were measured according to the AOAC (1990) method. Crude fat was measured using a fat extractor (Sotec System HT 1043 Extraction Unit, Tecator Co. Sweden). Crude protein was measured using the Kjeldahl method using a digester (Model 2006, Foss tecator, Sweden) and a distillation unit (Model 2100, Foss tecator, Sweden). Ten gram samples were blended with 90 ml of distilled water in a polyethylene bag for 1 min using a stomacher (Stomacher 400, Seward Ltd., England) at high speed for 2 min, and then the pH of the mixture was measured using a pH meter (Micro-Computer pH meter, Model 6210, Taiwan).

2.4. Instrumental colour measurement

Ground samples were placed in a measuring container, and then the Hunter *L* (lightness), *a (redness)* and *b* (yellowness) values of samples were measured with a colour meter (Spectrophotometer, Model TC1, Tokyo Co., Ltd., Japan). A standard plate, with "*Y*" = 86.53, "*X*" = 82.45, and "*Z*" = 91.28, was used as a reference.

2.5. Total phenol contents in products

Fifty grams of ground sausage samples were mixed with 100 ml of distilled water, boiled and extracted for 20 min, cooled rapidly, filtered, and then put through the same method as described in Section 2.1 to determine the total phenol contents in products.

2.6. Thiobarbituric acid (TBA) values and volatile basic nitrogen (VBN)

TBA values of the samples were determined according the methods described by Faustman, Specht, Malkus, and Kinsman (1992). TBA value was expressed as mg malonaldehyde/kg of meat. Volatile basic nitrogen was determined according to CNS (1982) by the Conway micropipette diffusion method.

2.7. Microbial evaluation

At a specified sample time, sausages were aseptically removed from the bags. Ten gram samples were placed in a sterile bag containing 90 ml of sterile water and homogenised with a stomacher (Stomacher blender, Model 400, Seward) for 2 min. Serial dilutions were then made. Plate count agar (PCA, Merck) was used for enumeration of total plate count, and the pour plate method was used for enumeration of bacteria. Total microflora were incubated at 37 °C for 48 h. Microbial counts in this study were expressed as $\log_{10}$ colony forming units (CFU) per gram of sample.

2.8. Sensory evaluation

At days 0, 7 and 14, during storage, sausages were first cooked on a grill at 160 °C for 15 min, cooled at room temperature (approximately 25 °C), sliced (approximately 0.25–0.30 cm thickness), and then served to a sensory panel which consisted of 12