The Influence of Spices on the Volatile Compounds of Cooked Beef Patty

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Abstract

The aim of this study is to examine the influences of spices on the amounts and compositions of volatile compounds released from cooked beef patty. Beef patty with 0.5% of spice (nutmeg, onion, garlic, or ginger powder, w/w) was cooked by electronic pan until they reached an internal temperature of 75°C. A total of 46 volatile compounds (6 alcohols, 6 aldehydes, 5 hydrocarbons, 6 ketones, 9 sulfur compounds, and 14 terpenes) from cooked beef patties were detected by using purge-and-trap GC/MS. The addition of nutmeg, onion, or ginger powder significantly reduced the production of the volatile compounds via lipid oxidation in cooked beef patty when compared to those from the control. Also, the addition of nutmeg and garlic powder to beef patty generated a lot of trepans or sulfur volatile compounds, respectively. From these results, the major proportion by chemical classes such as alcohols, aldehydes, hydrocarbons, ketones, sulfur compounds, and terpenes was different depending on the spice variations. The results indicate that addition of spices to the beef patty meaningfully changes the volatile compounds released from within. Therefore, it can be concluded that spices can interact with meat aroma significantly, and thus, the character of each spice should be considered before adding to the beef patty.

Key words: beef patty, aroma, volatile compounds, spice

Introduction

Aromas of cooked meat are important flavor attribute and the initial sensory trait with the appearance of cooked meat. It affects not only appetite but also the pleasure of eating. Aromas of cooked meat are predestined from volatile compounds (Resconi et al., 2013). When meat is cooked, various volatile compounds are released by heat-induced reactions, mainly Strecker and Maillard reaction, lipid oxidation and degradation, thiamin degradation, and interaction between lipid-oxidized products with Strecker and Maillard products (Resconi et al., 2013). Therefore, various factors such as fat content, fatty acid composition, amino acid content and composition, and reducing sugar content and composition of meat, which are affected by breed, sex, and maturity of animals, and aging time with proteolytic and lipolytic enzyme activities of meat, significantly influence the aromas of cooked meat (Gianelli et al., 2012; Golovnya et al., 1983; Lieske and Konrad, 1994; Mottram, 1998).

In the meat processing, spices are used to improve shelf life, appearance, or flavor of meat products (Brown, 2009). Spices have unique taste and odor. Therefore, the aromas of meat product could be mainly influenced by added spices. Previous studies reported that various volatile compounds in meat product were originated from spices (Demirok et al., 2013; Gianelli et al., 2012). In this sense, it is noteworthy to understand the change of volatile compounds by each spice in meat product for producing meat product with desirable aroma. However, the change in the amount and the composition of volatile compounds from
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meat product by adding each spice have not been reported. Therefore, this study was carried out to investigate the change in the amount and composition of the volatile compounds from cooked beef patty with added spice such as nutmeg, onion, garlic, or ginger, which are globally familiar spices used in meat products.

Materials and Methods

Sample preparation
Raw ground beef and spices (nutmeg, onion, garlic, and ginger powder) were purchased from local market. The ground beef was mixed with each spice (0.5%, w/w), and individually vacuum-packaged (~650 mmHg) in low-density polyethylene/nylon vacuum bags (oxygen permeability of 22.5 mL/m²/24h atm at 60% RH/25°C, water vapor permeability of 4.7 g/m²/24 h at 100% RH/25°C). The vacuum-packaged ground beef was stored at 4°C for 24 h. After storage, beef patty was made (200 g, 1 cm thickness). The beef patty was cooked for 2 min on a preheated electric pan until they reached an internal temperature of 75°C.

Volatile compounds
A purge-and-trap apparatus (Solatek 72 and Concentrator 3100; Tekmar-Dohrmann, USA) connected to a gas chromatograph/mass spectrometer (HP 6890/HP 5973; Hewlett-Packard Co., USA) was used to analyze the volatiles produced. The beef patty sample (3 g) was placed in a 40 mL sample vial, and the vial was flushed with helium gas (40 psi) for 5 s. The maximum waiting time of a sample in a refrigerated (4°C) holding tray was less than 4 h to minimize oxidative changes before analysis. The meat sample was purged with helium gas (40 mL/min) for 14 min at 40°C. Volatiles were trapped using a Tenax-charcoal-silica column (Tekmar-Dohrmann) and desorbed for 2 min at 225°C, focused in a cryofocusing module (-80°C), and then thermally desorbed into a capillary column for 60 s at 225°C.

An HP-624 column (8.5 m × 0.25 mm i.d., 1.4 μm nominal), an HP-1 column (60 m × 0.25 mm i.d., 0.25 μm nominal; Hewlett-Packard Co.), and an HP-Wax column (6.5 m × 0.25 mm i.d., 0.25 μm nominal) were connected using zero dead-volume column connectors (J&W Scientific, USA). Ramped oven temperature was used to improve volatile separation. The initial oven temperature of 30°C was held for 6 min. After that, the oven temperature was increased to 60°C at 5°C/min, increased to 180°C at 20°C/min, increased to 210°C at 15°C/min, and then held for 5 min at the temperature. Constant column pressure at 22.5 psi was maintained. The ionization potential of the mass selective detector (Model 5973; Hewlett-Packard Co.) was 70 eV, and the scan range was 19.1 to 400 m/z. Identification of volatiles was achieved by comparing the mass spectral data of the samples with those of the Wiley Library (Hewlett-Packard Co., USA). Standards were used to confirm the identification by the mass selective detector. The area of each peak was integrated using the ChemStation (Hewlett-Packard Co.), and the total peak area (pA*seconds × 10⁴) was reported as an indicator of volatiles generated from the sample.

Statistical methods
This study was performed in triplicate. The raw data of the total peak area (pA*seconds × 10⁴) was changed to Log₁₀ value. Analysis of variance was performed using the raw data, and the mean values and standard error of the means (SEM) were calculated by the Statistical Analysis System (SAS version 9.3, SAS Institute Inc., USA). Differences among the means were determined by Tukey’s multiple range test with p<0.05.

Results and Discussion
Totally 46 volatile compounds (6 alcohols, 6 aldehydes, 5 hydrocarbons, 6 ketones, 9 sulfur compounds, and 14 terpenes) were identified in cooked beef patties (Table 1). In the volatile compounds detected in the present study, alcohols could be generated by lipid oxidation and bacterial action in meat (Resconi et al., 2013). Aldehydes, hydrocarbons, and ketones are mainly originated from lipid oxidation in meat (Mottram, 1998). Aldehydes (2-methylbutanal, 3-methyl-butanal), ketone (2,3-butanedione), and sulfur compounds are originated from Strecker and Maillard reaction (Farmer, 1996; Resconi et al., 2013). Mottram (1998) reported that the volatile compounds originated from Strecker and Maillard reaction have more influence on aroma of meat than those from lipid oxidation. Also, since sulfur compounds have very low detection thresholds, their contribution to aroma of meat is very important (Mottram, 1994).

Most of the volatile compounds detected in the present study showed significant difference except for 2-propanol among treatments (p<0.05). The control, cooked beef patty without spice, released 18 volatile compounds including 4 alcohols (1-propanol, 2-propanol, 2-ethyl-1-hexanol, and ethanol), 5 aldehydes (2-methylbutanal, 3-methylbutanal, heptanal, hexanal, and pentanal), 4 hydrocarbons (decane,