Qualitative and Quantitative Analyses of Volatile Compounds in Cream Cheese and Cholesterol–removed Cream Cheese Made from Whole Milk Powder

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Abstract
This study was to identify and quantify the flavor compounds in cream cheese and cholesterol-removed cream cheese made from whole milk powder stored at 7°C for 4 wk. Flavor compounds of cream cheese were identified using gas chromatography mass spectroscopy and quantified by gas chromatography. The tentatively identified flavor compounds were mainly eight from fatty acids in cream cheese made from whole milk powder (CCWMP) and nine from fatty acids in cholesterol-removed cream cheese made from whole milk powder (CRCCWMP). In quantitative analysis of the flavor compounds, most of the volatile compounds were slightly increased during storage. N-Decanoic acid was produced only in CCWMP. On the basis of the results, it was concluded that the quality and quantity of flavor compounds in CCWMP and CRCCWMP have almost no adverse effects in comparison with that of whole milk-made cream cheese.

Key words: flavor, whole milk powder, cream cheese, cholesterol removal

Introduction
Various efforts have been made to characterize the flavor profiles of hard and semi-hard cheeses (Rychlik and Bosset, 2001; Van Leuven et al., 2008) but very few efforts were taken in determining the flavor compounds of cream cheese. To our knowledge, no report has been published concerning the flavor profiles of cream cheese made from the whole milk powder. Further the development of cheese flavor is a complex combination of microbial and a biochemical activity throughout the storage period which leads to the formation of a heterogeneous mixture of volatile and non-volatile compounds (Adda, 1986; Molimard and Spinnler, 1996). In cream cheese most of the flavor derives from the lactic acid fermentation and from other rich nutrients such as protein and fat (Molimard and Spinnler, 1996). The fat reduction in cheeses leads to less acceptable than the full fat counterparts due to flavor defects (Kondyli et al., 2002). The lack of flavor is due to the precursors or solvent power lack from the fat that allows the release of essential volatile compounds (Urbach, 1997). However, cholesterol-reduced cream cheese flavor from whole milk powder is not yet reported. Additionally, whole milk powder is usually made by high heat treatment; the formation of cooked flavor could be possible. Therefore, whole milk powder has not been tried to use for cheese making. But nowadays vacuum system was developed to lower temperature for heat treatment; thereby cooked flavor could be possibly reduced from the whole milk powder.

The quantitative measurement is of prime importance. Among the techniques used headspace gas chromatography (GC) is very effective, least destructive which provides volatile profile similar to the flavor characteristics perceived by the nose (Chin et al., 1996). This technique has been widely used to evaluate the flavor components in various cheeses (Alewijn et al., 2003). Therefore, the main objectives of this study were 1) to identify the volatile flavor compounds that are in headspace gases of cream cheese and 2) to compare the changes in the composition and concentration flavor profiles of cream cheese and cholesterol-removed cream cheese made from whole milk powder during 4 wk storage.

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Materials and methods

Materials

Whole milk powder and cream (40% milk fat) were obtained from Seoul Dairy Co-op. (Korea). All solvents were of gas-chromatographic grade. Cholesterol and 5α-cholestane were purchased from Sigma Chemical Co. (USA), and all solvents were of gas-chromatographic grade.

Manufacture of cream cheese

Cream cheese from whole milk was produced according to the method of Kosikowski and Mistry (1997). For the preparation of cholesterol-removed cream cheese from whole milk powder (CRCCWMP), the whole milk powder was reconstituted to 87% water and blended with fresh cream (40% milk fat) to a fat content of 11% which was then pasteurized at 65°C for 30 min. The blended mixture of whole milk powder and cream was stirred with 3.6% crosslinked β-cyclodextrin (β-CD) at 800 rpm with a blender (Tops, Misung Co., Korea) in a temperature-controlled water bath at 20°C for 30 min. It was then centrifuged at 166×g for the β-CD removal. Cholesterol-removed whole milk powder mixture of cream was homogenized (680 psi at 50°C) and cooled to the incubation temperature of approximately 30°C. The mixture was then inoculated with a 0.05% lactic culture (CNN-22, Chr. Hansen’s Lab., Denmark) and incubated under gentle mixing. The curd was cut and ripened for 7 h to pH of 4.7. Then it was heated in a coil vats to about 45°C until a proper “break” is obtained between the curd and the whey. Whey was drained and the curd was cooled to 28°C for 4 h with continuous turning. The curd was drained in muslin bags and pressed until total solid was 45% and stored in plastic tubs at 7°C for 4 wk. The whole milk powder mixture of cream without treating with the β-CD was used as the cream cheese made from the whole milk powder (CCWMP). Both cheeses were made in duplicate.

Composition analyses

The samples of CCWMP and CRCCWMP were analyzed for moisture, protein and fat according to the methods of the Association of Official Analytical Chemists (AOAC, 1984). The cheese yield was determined in percentage as wt cheese×100/wt of reconstituted milk and cream. Cholesterol was extracted and determined using silica fused capillary column (HP-5, 30 m×0.32 mm I.D.×0.25 μm thickness) using a Hewlett-Packard 5890 A gas chromatograph (Hewlett-Packard, USA) equipped with a flame ionization detector. The quantification of cholesterol was done by comparing the peak areas with the response of internal standard. The percentage of cholesterol reduction was calculated as follows: cholesterol reduction (%) = 100 – (amount of cholesterol in β-CD-treated cream cheese×100/amount of cholesterol in cream cheese). Cholesterol determination for cream cheese was averaged with each batch of treatments.

Identification of volatile compound (solid phase microextraction GC-MS)

The volatile compounds in whole milk cream cheese, cholesterol removed whole milk cream cheese, CCWMP and CRCCWMP were extracted by solid phase microextraction. The cheese samples were grated and ten grams of each cheese were placed in a 50-mL vial contains 10 mL NaH₂PO₄ (25%, w/v) along with 7 mL of distilled water and 1mL of internal standard (IS) [5-nonenon (10 μg/mL in methanol)]. The sample was stirred at 60°C for 30 min to accelerate equilibrium of headspace flavor compounds between the cheese matrix and the headspace. Then, flavor compounds extraction was carried out by injecting a 50/30 μm divinylbenzene/carboxen/polydimethylsiloxane SPME fibre (Supelco, USA) into the vial and exposing it to the headspace at 50°C for 30 min. After extraction samples were then desorbed and identified by GC-MS according to the modified method of Lee et al. (2003). The analyses of flavor compounds were performed on a Hewlett-Packard gas chromatograph (HP-6890 GC) coupled to a Hewlett-Packard 5973 MS (Hewlett-Packard, USA). Flavor compounds were separated using a capillary column (DB-Wax; 30 m×0.33 mm I.D.×0.25 μm film thickness; J&W Scientific Inc., USA). The carrier gas was helium with a flow of 1.3 mL/min. The temperature programmed was isothermal at 40°C for 4 min, then raised at 5°C/min to 185°C and held for 20 min. The GC-MS transfer line temperature was at 230°C. The MS operated in electron impact mode with electron impact energy of 70 eV; and collected data at a rate of 0.7 scans/s over a range of m/z 40-650. The compounds were identified by comparison with commercial reference compounds provided by Wiley 275 Mass spectral database (Hewlett-Packard, USA). Quantitation of CCWMP and CRCCWMP was performed by integrating the peak areas of total ion chromatograms by the Agilent ChemStation software.

Analysis of short-chain free fatty acids (SCFFA)

SCFFA of each cheese samples were quantified using a