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Relating sensory and chemical properties of sour cream to consumer acceptance

L. Shepard, R. E. Miracle, P. Leksrisompong, and M. A. Drake[1]
Department of Food, Bioprocessing and Nutrition Sciences, Southeast Dairy Foods Research Center, North Carolina State University, Raleigh 27695

ABSTRACT

Sour cream is a widely popular acidified dairy product. Volatile compounds and organic acids and their specific contributions to flavor or acceptance have not been established, nor has a comprehensive study been conducted to characterize drivers of liking for sour cream. The objective of this study was to characterize chemical and sensory properties of sour cream and to determine the drivers of liking for sour cream. Descriptive sensory and instrumental analyses followed by consumer testing were conducted. Flavor and texture attributes of 32 (22 full-fat, 6 reduced-fat, and 4 fat-free) commercial sour creams were evaluated by a trained descriptive sensory panel. Percent solids, percent fat, pH, titratable acidity, and colorimetric measurements were conducted to characterize physical properties of sour creams. Organic acids were evaluated by HPLC and volatile aroma active compounds were evaluated by gas chromatography-mass spectrometry with gas chromatography-olfactometry. Consumer acceptance testing (n = 201) was conducted on selected sour creams, followed by external preference mapping. Full-fat sour creams were characterized by the lack of surface gloss and chalky textural attributes, whereas reduced-fat and fat-free samples displayed high intensities of these attributes. Full-fat sour creams were higher in cooked/milky and milk fat flavors than the reduced-fat and fat-free samples. Reduced-fat and fat-free sour creams were characterized by cardboard, acetaldehyde/green, and potato flavors, bitter taste, and astringency. Lactic acid was the prominent organic acid in all sour creams, followed by acetic and citric acids. High aroma-impact volatile compounds in sour creams were 2,3-butanedione, acetic acid, butyric acid, octanal, 2-methyl-3-furanthiol, 1-octene-3-one, and acetaldehyde. Positive drivers of liking for sour cream were milk fat, cooked/milky and sweet aromatic flavors, opacity, color intensity, and adhesiveness. This comprehensive study established sensory and instrumental properties of sour creams and their relationship to consumer acceptance.
Key words: sour cream, flavor, preference mapping

INTRODUCTION

In 2010, over 500 million kilograms of sour cream were produced in the United States (USDA-NASS, 2010). Sour cream is a fermented dairy product that is defined as the souring of pasteurized cream by lactic acid-producing bacteria (US FDA, 2011). In sour cream, the microorganisms used are *Lactococcus lactis* ssp. *lactis*, *Lactococcus lactis* ssp. *cremoris*, *Cit* + *Lc. lactis* ssp. *lactis*, and *Leuconostoc citrovorum* (Meunier-Goddik, 2004). Different types of sour creams exist that are defined based on fat content. Full-fat sour creams must have at least 18% milk fat and not less than 14.4% milk fat (USDA-AMS, 2005). Reduced-fat sour cream has a minimum fat reduction of 25% (USDA-AMS, 2005). Light or lite sour cream has a minimum of 50% fat reduction (USDA-AMS, 2005). Low-fat sour cream must contain 3 g or less fat per 50 g and 6% or less total fat (USDA-AMS, 2005). Nonfat sour cream must have less than 0.5 g of fat per 50 g of product and less than 1% total fat (USDA-AMS, 2005).

Lactic acid and other organic acids found in fermented dairy products are usually produced by one of the following: direct addition of an acidulant, normal bovine biochemical metabolism, hydrolysis of milk fat, or bacterial growth (Marsili et al., 1981). Acetic, butyric, citric, formic, hippuric, lactic, orotic, propionic, pyruvic, and uric are the most common organic acids in fermented dairy products. Many studies have been conducted to examine the concentrations of these organic acids in fermented dairy products, including cheese (Izco et al., 2002; Tormo and Izco, 2004), yogurt (Marsili et al., 1981; Bevilacqua and Califano, 1989; Fernandez-Garcia and McGregor, 1994), kefir (Marsili et al., 1981), and sour cream (Marsili et al., 1981). Most of these organic acids are not volatile and as such are not aroma active, but they do display distinct taste profiles (Marsili et al., 1981). Their specific contributions to sour cream flavor or acceptance are not known.

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[1]Corresponding author: mdrake@unity.ncsu.edu

Flavor plays a critical role in the acceptance of any product. Therefore, flavor is often investigated by descriptive analysis and consumer acceptance testing. Preference mapping is a collection of multivariate techniques used to establish relationships between instrumental and descriptive results and consumer acceptance data (Meilgaard et al., 2007). Preference mapping has been applied to examine the drivers of liking for many dairy products, including drinkable strawberry yogurt (Thompson et al., 2007), Cheddar cheese (Drake et al., 2008, 2009), Gouda cheese (Yates and Drake, 2007), and cottage cheese (Drake et al., 2009). Meunier-Goddik (2004) described sour cream as a heavy, viscous, glossy product that has a delicate lactic acid taste with a balanced, pleasant, buttery-like (diacetyl) aroma, but a complete sensory understanding of this important cultured dairy product has not been established. Volatile compounds and organic acids and their specific contributions to flavor or acceptance have not been established, nor has a comprehensive study been conducted to characterize drivers of liking. Such information would provide insight and direction for manufacturers and product developers. The objective of this study was to characterize sensory and chemical properties of sour cream and to determine the drivers of liking for sour cream. Descriptive analysis and instrumental analyses followed by consumer testing were conducted.

MATERIALS AND METHODS

Sour Creams

Commercial sour creams (n = 32) were collected from across the United States. Sour creams were collected based on market share as well as fat content (full fat = 22, light = 6, and fat free = 4). National, regional, and store brands were included. Regular, all-natural (no stabilizers), and organic products were included. Samples were received by overnight carrier on ice packs and were examined for damage and discarded if necessary. Products were stored in the dark at 4°C. Each product was analyzed no later than 21 d before the expiration date. Duplicate lots of each brand were obtained approximately 1 mo apart.

Composition Analysis

Proximate analysis and color measurements were conducted on all sour creams. Sour creams were analyzed for TS and fat using the SMART Trac system (CEM Microwave Technology, Matthews, NC). Hunter L*a*b* color scale analysis (where L* = lightness, a* = position between red/magenta and green, and b* = position between yellow and blue) was conducted using a Minolta Chroma meter (CR-410; Minolta, Ramsey, NJ). Ten grams of sour cream was placed into a 60- × 15-mm polystyrene Petri dish (Becton Dickinson, Franklin Lakes, NJ); each Petri dish was measured in duplicate. A method from Wehr and Frank (2004) was used to measure titratable acidity. Measurements for pH were conducted with a pH meter (Mettler-Toledo GmbH, Schwerzenbach, Switzerland) with a combination electrode probe (BNC; Corning Inc., Corning, NY) at 4°C. All compositional analyses were conducted in duplicate.

Descriptive Analysis

Sensory testing was conducted in compliance with the North Carolina State University Institutional Review Board for Human Subjects (Raleigh) approval. Sour creams (30 g) were scooped (size 30 scoop) into lidded 60-g soufflé cups with 3-digit codes and tempered to 15°C. Each sample was served monadically with room-temperature deionized water and unsalted crackers.

A trained descriptive sensory panel (n = 8; 8 females, ages 23 to 47 yr) evaluated the flavor, texture, and appearance attributes of sour creams using a 0- to 15-point universal intensity (flavor) or product-specific (visual and texture) scale (Meilgaard et al., 1999). Each panelist had more than 200 h of experience with descriptive analysis of flavor and approximately 100 h of experience with descriptive analysis of texture with various dairy products, including cheese and yogurt. Sour cream attributes were generated across four 2-h sessions where panelists tasted an array of sour creams as well as other cultured dairy products (yogurt and buttermilk) and discussed and generated terms and definitions. The lexicon generated for sour creams included 4 appearance, 11 flavor, 4 basic taste, 2 chemical feeling factor, and 6 texture attributes (Tables 1 and 2). Following lexicon generation, seven 3-h sessions were held to refine the lexicon and to allow the panel to calibrate and consistently identify and score the attributes. Each sample from each lot (32 samples, with duplicate lots of each sample) was evaluated in duplicate by each panelist. Compusense Five (version 5.2; Compusense, Guelph, ON, Canada) or paper ballots were used for data collection (Swaney-Stueve and Heymann, 2002).

Organic Acid Extraction and Separation

A modified method from Marsili et al. (1981) was used for organic acid extraction of sour creams. Four grams was weighed into a 25-mL volumetric flask. The sample was diluted with 0.01 *N* sulfuric acid (2.0 *N*; Mallinckrodt Baker Inc., Phillipsburg, NJ) and shaken