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Characterization of Natural Flavor Compounds of Five Commercial Anhydrous Milk Fats via GC-TOF-MS, Aroma Recombination, and Omission Models

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ABSTRACT

Aroma profiles are a significant factor determining the popularity of anhydrous milk fats. However, comprehensive characterization of the volatile flavor compounds in anhydrous milk fats and their recombination have been less reported. In this study, 30 aroma compounds were identified and quantified in different commercial anhydrous milk fat via HS-SPME-GC-TOF-MS analysis. Significant variations in free fatty acid profiles impacted the quality of flavor formation. Short-chain free fatty acids, particularly butanoic, hexanoic, and acetic acids, were the most aroma compounds in ID, EG, and PAK. The ratio of quantitative data to odor threshold confirmed the importance of odorants based on their OAVs ≥ 1. The ID sample had the highest concentrations and OAVs for 2-nonanone, 2-heptanone, and 2-undecanone, while esters, especially methyl decanoate, showed significant sensory contributions, with OAVs exceeding 200 in PAK, ID, and EG samples. Sensory reconstitution and omission models closely resembled the original samples in terms of buttery, fatty, and creamy odors, validating the identification of butanoic acid, octanoic acid, methyl decanoate, hexanoic acid, and 2-heptanone as key aroma compounds. The results found that AMF had a milder aroma than EG and ID samples, which was more acceptable to consumers. This characteristic can be utilized for quality control and industrial milk fat development.

1. Introduction

Anhydrous milk fat (AMF) is a key high-fat dairy product, consumed globally as a food additive under different names: "Samna" in Egypt, "ghee" in India, "anhydrous milk fat" in China, "butter oil" in Brazil, " Smen" in Morocco, and "maslee" in Iran (Elbarbary et al., 2024a; Kumbhare et al., 2021). Its popularity stems from its nutritional value, rich flavor, aromatic qualities, and health benefits, such as promoting weight loss, improving eyesight and digestion, strengthening immunity and bones, and relieving constipation (Kataria and Singh, 2024).

Milk fats are produced using different methods, namely indigenous (desi method, improved), direct cream (DC), creamery-butter (CB), pre-stratification (PS), and continuous modern method (Andrewes, 2012; Aneja et al., 2002). Heat clarification of fermented cream or butter at a temperature > 100 °C is one of the common processing steps for traditional DC, CB, and PS methods, which remove water and non-fat solids, causing browning and precipitates. Interestingly, AMF has recently been produced industrially using modern techniques in China. The aroma is a distinguishing characteristic of these fatty products. Microbial fermentation (lipolysis), degradation of substances through processing, lipid oxidation, and the Maillard reaction are the main pathways for distinguishing the flavor compounds in traditional ghee (Andrewes, 2012; Duhan et al., 2020; Xia et al., 2023). These processes generate various flavor fingerprints at different concentrations that are specific to each

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