

Molecular Signature of Quebec Cheddar Cheeses Linked to Flavor Quality throughout Aging

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Abstract

Cheese quality is challenged by technological constraints, ingredient variability, and differences in starter cultures. These factors directly contribute to rancidity, bitterness, and inconsistent sensory properties, all of which are strongly influenced by aging conditions. Microbial metabolism and non-enzymatic reactions generate characteristic aroma compounds; however, excessive biochemical activity can lead to off-flavors and bitterness-associated peptides. This study aimed to establish aroma profiling and chemical fingerprinting of Quebec cheddar cheeses with varying sensory qualities to identify potential molecular markers associated with aging and bitterness. A total of 48 cheese products were sampled from the Quebec market in order to cover different productions and aging times. The samples were evaluated by a professional sensory panel and processed for physicochemical characterization. Volatile compounds were profiled using headspace gas chromatography–mass spectrometry (HS-GC-MS), while peptide fractions were extracted, purified via dialysis, and analyzed using HPLC–QTOF-MS to generate non-volatile peptide fingerprints. Multivariate statistical analysis, including principal component analysis (PCA), was then applied to correlate molecular profiles with maturation time and sensory attributes. HS-GC-MS confirmed the relevance of butanoic acid, acetic acid, hexanoic acid, 2-heptanone, and 2,3-butanedione as key aging markers. Notably, 2,3-butanedione correlated positively with desirable buttery notes, whereas 2-butanone was associated with less favorable sensory perception. LC-QTOF-MS further revealed multiple bitterness-associated peptides. Overall, this integrated volatile–peptide fingerprinting approach identifies candidate biomarkers to support quality control and optimized aging strategies for high-quality cheddar production.

References

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