

# Safety and toxicological considerations of single-cell oils as future food ingredients: a critical review

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## Abstract

Single-cell oils (SCOs) are gaining traction as sustainable alternative lipids for future food applications as they are produced from oleaginous yeasts, fungi, algae and thraustochytrids via controlled fermentation systems with flexible feedstock substrates.<sup>1</sup> However, the safety evaluation of SCOs have not caught up with technological development. Existing assessments of SCOs emphasise strain identity, composition and conventional toxicology techniques, however, the link between lipid oxidation (LO) chemical hazards and mechanistic toxicology of SCOs still remains sparse.<sup>2</sup>

This critical review examines current food safety concerns of SCOs from a food chemical safety perspective, with a particular emphasis on oxidative stability, oxidation pathways and the generation of chemically reactive products, especially secondary products during processing, storage and digestion. These are critical as SCOs are predominantly rich in unsaturated fatty acids which are highly susceptible to oxidative deterioration, leading to the formation of oxidation products with potential toxicological risks.<sup>3, 4</sup>

Yet current evaluation of hazardous lipid oxidation (LO) products remains fragmented since existing studies use various oxidation markers, analytical platforms and toxicological endpoints which complicate hazard interpretation and limit direct comparison across food systems. In addition, conventional testing frameworks tend to provide limited mechanistic insight into how LO chemistry translates into adverse biological effects, especially for SCOs.<sup>5-7</sup>

Therefore, this review also evaluates how New Approach Methodologies (NAMs), including *in-vitro*, *in-chemico* and *in-silico* tools, can be integrated into targeted and untargeted analytical workflows to strengthen hazard identification and support the overall mechanism-informed safety assessment of SCOs.<sup>8</sup> Overall, this review positions LO-derived chemical hazards as a key but underexplored area in the safety assessment of SCOs and identifies NAM-enabled workflow as a promising direction for evaluating SCOs as emerging future food ingredients.

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