Comparative Bioprofiling of *Chlorella vulgaris* Powders: Links between Composition, Particle Size, and Physiological Activity

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Abstract

Chlorella vulgaris is a nutrient-rich microalga with proven antioxidant, anti inflammatory, and metabolic-regulatory properties, making it a promising ingredient for functional food formulations. This study compared two commercial *C. vulgaris* powders from India (Sample 1) and the UK (Sample 2) with respect to particle size, metabolite composition, and biological activity. Sample 1 exhibited finer particles, whereas Sample 2 was coarser. GC–MS profiling revealed distinct metabolite fingerprints: Sample 1 contained higher levels of saturated fatty acids, β-sitosterol, β-amyrin, and glucitol, while Sample 2 was enriched in unsaturated fatty acids, betulin, salicylic acid, and complex carbohydrates. In vitro assays showed stronger inhibition of albumin denaturation by Sample 1 compared with Sample 2 and prednisolone. Ex vivo experiments demonstrated that both samples induced tonic contraction of gastric smooth muscle through muscarinic acetylcholine receptors and L-type calcium channels, with a more pronounced response for Sample 1. Immunohistochemical analysis revealed broader IL-1β upregulation with Sample 1 and localized nNOS modulation with Sample 2. Overall, these results indicate that both composition and particle size critically determine the biological effects of *C. vulgaris*, supporting its targeted use in digestive, neuroimmune, and cardiometabolic health.

Keywords

Albumin denaturation, functional foods, gastric smooth muscle, GC–MS profiling, IL 1β, L-type calcium channels, microalgae, muscarinic acetylcholine receptors, nNOS, particle size.

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