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Next-Generation Plant-Based Lipid Systems: Process-Structure-Function Insights into Thermally Accelerated Recovery of Intact Groundnut Oleosomes

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Abstract
Oilseed-derived oleosomes are becoming an active area of research as natural lipid nanoparticles, emulsifiers and fat substitutes. But their effectiveness relies on their extraction yield and the preservation of their structure during processing. Enhancements in these areas are critical to provide consistent, functional oleosome ingredients. Here, we investigated the effect of pre-treatment conditions on the properties of oleosomes extracted from groundnut seeds. We treated the seeds with controlled time and temperature conditions. It includes soaking in water, moderate heating (60 ℃ and 80 ℃ for 5, 10, & 15 min), higher-temperature treatment (100 ℃ for 5, 10, & 15 min), and high-pressure heating (121 ℃ at 15 psi for 5, 10 & 15 min). The study found heat pre-treatment is critical. Specifically, pretreatment at 80 ℃ (15 min) and 100 ℃ (5 min) notably increased the oleosome yield & protein content. It also resulted in smaller, more stable droplets, a key requirement for an emulsion to be stable. Microscopy and FTIR studies showed that the oleosome structure was unaffected at these conditions. This was also confirmed by dynamic rheological analysis, which exhibited stronger viscoelastic networks than those observed under untreated, soaking, and high-pressure treatments. However, higher temperature and pressure levels were detrimental, as they lowered oleosome yield, increased the average droplet size, & led to poor emulsion stability. The study shows that controlled heat pre-treatment can address challenges of conventional soaking methods. Enables a stable, structurally intact & functional oleosome for plant-based milk applications.

References

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