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MICROGRAVITY-INDUCED DOUBLE EMULSIONS: PIONEERING MULTIDISCIPLINARY
APPLICATIONS IN DRUG DELIVERY, FOOD TECHNOLOGY, AND COSMETICS

Abstract

This study delineates the innovative exploration of double emulsion generation under the unique conditions of space microgravity, undertaken by ResearchSat Pty Ltd aboard the ADI-Alpha mission. The microgravity environment, a characteristic unattainable on Earth, provided a distinctive setting to examine the formation and stability of water-in-oil-in-water (W/O/W) double emulsions, earmarked for multidisciplinary applications including drug encapsulation, probiotic encapsulation in food and beverages, and the enhancement of active ingredients in cosmetics.

Employing a bespoke satellite platform specifically designed for avant-garde research and development (RD) in space, this groundbreaking experiment was facilitated during the S1X-3/M15 SubOrbital Express mission. The Double Emulsion Experiment Module (DEEM), outfitted with state-of-the-art microfluidic technology, piezoelectric pumps, and sophisticated imaging capabilities, successfully demonstrated the generation of monodisperse emulsions. The experiment concentrated on manipulating fluid dynamics under microgravity to achieve emulsions with precise control over droplet size and encapsulation efficiency, a challenging feat under Earth's gravitational constraints.

The results indicate that microgravity significantly augments the stability and uniformity of double emulsions, heralding new pathways for advanced material science and fluid dynamics research. The ramifications of this research are vast, presenting novel solutions for controlled drug release systems, enhancing the bioavailability of nutrients in food products, and improving the efficacy of active ingredients in cosmetic formulations.

This paper underscores the potential of microgravity as an innovative tool for advancing fluid and materials science, laying the groundwork for future research and commercial applications that leverage the unique conditions of space to address complex challenges on Earth and beyond, thereby highlighting the synergistic potential of space technology in propelling forward multidisciplinary scientific endeavors and industrial applications.