# Nano-architecture of food ingredients: towards novel functionalities

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**Abstract**

Food structure consists of the spatial arrangements of food constituents (proteins, polysaccharides, lipids) at different length scales from nm to cm. In this context, food nanostructure refers to molecular organizations in the nanometric range, such as nanoemulsions, nanoparticles, nanofibrils, nanoporous networks etc. Nanostructures are pivotal in defining food functional attributes, including texture, taste, stability and nutritional value. The design of food nanostructures through a rational interplay of formulation and process strategies has been thus attracting large attention in the food sector. In particular, food nanotechnology can be exploited in engineering bioactive delivery systems and in driving the hierarchical organization of food constituents into structures providing tailored functionalities.

This presentation discusses nano-liposomes and aerogels as representative examples of food nanostructures, highlighting their potential as innovative food ingredients.

Liposomes are vesicles produced by exploiting the self-assembling properties of amphiphilic molecules, which, in aqueous environments, form a phospholipid bilayer. Soy-lecithin nano-liposomes loaded with quercetin, a bioactive compound with healthy properties, were prepared by high-pressure homogenization (HPH). The liposomes were characterized for their physicochemical properties by applying advanced analytical techniques and tested for antitumoral activity. The results demonstrate that HPH generates 30 nm-diameter liposomes, with high encapsulation efficacy. Quercetin-loaded liposomes showed a good antitumoral capacity against colon cancer cells, opening new opportunities in the preparation of novel foods enriched with healthy compounds.

Aerogels are solid nanostructured materials that can be prepared from food-grade biopolymers, including proteins. They are obtained by removing water from an aqueous gel using supercritical-$CO_2$ drying, which allows gel nano-architecture to be preserved. In this way, meso-porous materials (i.e., containing pores of 2-50 nm diameter), characterized by low density and extremely high surface area are obtained. Aerogels prepared from plant and animal proteins were exploited for structuring liquid oil into semi-solid materials which were characterized for physical properties, digestion behaviour, and suitability as fat replacers in cocoa spreads. Obtained results show the potentialities of aerogels in improving the lipid profile of foods while also modulating lipid digestibility.