

Pressurized Gas eXpanded liquid (PGX) drying of egg white

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An approach, which is receiving increasing attention to enable the incorporation of bioactive components in foods, is the use of food-grade delivery systems for their protection and controlled release behavior. As food biopolymers, carbohydrates and proteins are commonly used for the encapsulation of bioactive components. The chemical and structural versatility of proteins makes them appropriate candidates for the delivery of bioactive components, offering the possibility of delivering both hydrophobic and hydrophilic bioactive compounds.

The protein microparticles, targeting bioactive delivery systems, are mainly fabricated by conventional methods such as spray-drying, coacervation, and cold gelation. The use of high temperatures and organic solvents, minimal control on particle characteristics, low bioactive loading, and difficulties in scale-up are some of the disadvantages associated with these conventional methods.

Pressurized Gas eXpanded liquid (PGX) technology is a novel technique that allows drying of high molecular weight water-soluble biopolymers and generates sub-micron and nano-scale particles with high porosities and high specific surface areas. It utilizes a mixture of CO₂ and ethanol at the gas-expanded liquid conditions (100 bar, 40°C) to dry aqueous biopolymer solutions.

This study aimed to investigate the applicability of the PGX technology to micronize and dry egg white (EW) proteins as a potential carrier for bioactive delivery systems. The specific objectives of the study were to evaluate the effects of the solids content of EW (1%, 6% and 12% w/w) and drying time (DT) (45, 30, 15, 10, and 5 min) at a flow rate ratio of EW:EtOH:CO₂ (20:30:10 g/min) on the morphology, specific surface area, lysozyme activity and structural conformation of the protein powder obtained by PGX drying performed at 100 bar and 40°C. The egg white was separated from the yolk manually prior to each experiment performed in duplicate. It was used as is with 12% w/w solids content or diluted with deionized water to adjust the solids content to 6% and 1%.

Dried EW powder was obtained at all the experimental conditions tested. Helium ion microscopy (HiM) was used to analyze the morphology of PGX-dried EW samples, showing delicate agglomerates of submicron particles at all the conditions tested (Fig. 1) which is preferable for delivery systems compared to spray dried materials which are typically in the micron range. FTIR analysis showed no formation or disappearance of peaks after PGX processing, indicating that the structural conformation of the protein was not affected. The specific surface area (BET method) of PGX-dried EW samples with initial concentrations of 1%, 6% and 12% w/w were 72.33 ± 5.53 m²/g, 50.64 ± 3.35 m²/g, 34.38 ± 4.14 m²/g, respectively which is much higher than what typically obtained using a spray drier. To determine moisture content (any residual liquids), PGX samples were dried in an oven at 106 °C overnight and percent weight losses were measured. The resulting moisture contents were 7.62 ± 1.10, 9.49 ± 1.19, 19.16 ± 2.62, 17.02 ± 1.39, and 31.12 ± 5.13 (%w/w) for the tested drying times of 45, 30, 15, 10, and 5 min, respectively. The PGX process was able to preserve 45 – 85% of the specific lysozyme activity depending on the drying time. The PGX technology is a suitable scalable technology to generate egg white protein powders with submicron particles, increased and adjustable specific surface area, adjustable moisture content, preserved protein conformation and lysozyme activity; thereby providing desirable characteristics as a potential carrier for bioactive delivery systems.

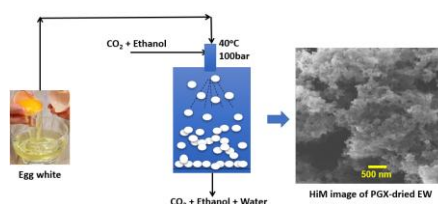


Figure 1. Formation of egg white powder using PGX technology and its HiM image.