COMMENTARY

Hydrostatic pressure: An understanding of its effects

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INTRODUCTION

The mechanical characteristics of composite materials can undergo major modifications as a result of hydrostatic pressure. The efficient design of composite structures for high-pressure applications requires a full understanding of these phenomena. This research reviews the literature on how hydrostatic pressure affects the mechanical properties of composite materials. This includes a thorough analysis of the experimental research that has been done on composite materials as well as a basic discussion of the effects of hydrostatic pressure on unreinforced polymers. Compressive, tensile, and shear testing are the three sections that make up the composites section. The test methods, materials, and outcomes both quantitative and physical for each sort of testing are discussed.

Hite was the first to document the impact of high-pressure processing on food systems. However, due to technological challenges and the high cost of HHP processing equipment and packaging materials, few research were published before the 1970s. Protein conformation can be impacted by high pressure up to 1000 MPa, which may cause denaturation, aggregation, or gelation. Protein susceptibility, applied pressure, temperature, and pressure treatment time all affect the outcome. Foods can be subjected to HHP treatment to obtain analog products with no impact on flavor, color, or nutritional content, or to develop new texturized products without heat degradation. Temperature is one of the variables that is most frequently used to analyze the thermodynamic, structural, and dynamic characteristics of biological membranes. A system's thermal energy and density are both affected by changes in temperature. A change in pressure only affects the system's density when it occurs under isothermal conditions. As a result, using pressure to study density-dependent processes can be quite useful without having to take into account thermally activated processes associated with temperature-dependent research.

It is noteworthy that there is a difference between how the HHP treatment affects whole meat and isolated myofibrils. In their study of the effects of high pressure (100 MPa to 300 MPa, 2°C to 4 °C, 5 min) on isolated myofibrils and whole meat discovered that the modifications were entirely different in each. However, at 200 MPa, Z-disks vanished and dense material accumulated on both sides of the missing M-lines, but only in whole meats. At a lower pressure (100 MPa), changes in the sarcomere structure occurred in both myofibrils and the entire meat system. Due to a reduction in the amount of proteins, meat from various animal species changes in texture the same way when exposed to HHP (Okamoto and others 1990).

The inherent volume of the atoms, the volume of the interior cavities, and the solvation of peptide bonds and amino acid side chains all contribute to the volume of a protein in solutions. A modified protein's volume reduces when high pressure is applied because the interior cavities are compressed. The main cause of high-pressure effects on proteins is the dissolution of noncovalent interactions (hydrophobic and electrostatic) within protein molecules, followed by the subsequent formation of intra- and intermolecular bonds within or between protein molecules. Using penetration experiments to examine the impact of hydrostatic pressure pretreatment on the thermal gelation of chicken myofibrils and hog meat patties, it was discovered that pressure treatment of the two types of myofibrils increased their texture and apparent elasticity. They postulated a mechanism of textural change caused by HHP treatment that comprised the dissociation of thick and thin filaments of the myofibrils based on the findings from various electron microscopic examinations. They suggested that the release of -actinin may have contributed to the breakdown of the Z-line caused by pressure. The M-line disappeared after HHP treatment at 200 MPa, each of the thin and thick filaments separated, and the Z-line (chicken myofibril) was destroyed in the presence of 0.2 M NaCl and hypothesized that the high apparent elasticity of a heat-induced myofibrillar gel following 200 MPa HHP treatment was caused by depolymerization of thin filaments. It was believed that the observed decreased apparent elasticity of a myofibrillar gel under 300 MPa pressure was due to myosin filament shortening brought on by pressure. Depolymerization of thin filaments, which in turn prevented head-to-head interaction between myosin filaments, may be to blame for this. However, HHP treatment enhanced the rheological characteristics of heat-induced gels. With a high-pressure optical cell installed in a multi-frequency cross correlation phase fluorometer, time-resolved fluorescence data were captured. The optical cell, inner cuvette, and pressure-generating mechanism of the high-pressure system were nearly identical to those of . By measuring the polarisation of a dilute solution of glycogen in water, corrections for strain birefringence of the quartz windows of the pressure optical cell at each pressure and temperature were made. As a light source, a mode-locked Nd-YAG laser was employed (green light of 532 nm, power 1.8 W). A Pyridine-I dye laser, whose output is cavity dumped at 3.81 MHz, was synchronously pumped by the system's picosecond optical pulse train. The dye laser is used for UV excitation was doubled in frequency at 345 nm. The typical UV power is 0.5 mW.

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