

High Pressure Processing as a Green Alternative to Thermal Pasteurization: Impact on Soy Milk Quality and Bioactive Retention

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Abstract

Conventional thermal pasteurization (CTP) is widely used for plant-based milk physical preservation but may degrade heat-sensitive bioactive compounds, alter physicochemical properties, and require high energy input [1, 2]. This study evaluated high pressure processing (HPP) as a non-thermal, greener alternative for soy milk pasteurization, emphasizing product quality and functionality. Soy milk processed from whole soybeans was subjected to HPP at varying pressure levels (200, 400, and 600 MPa) and process durations (4 and 8 min), and its quality were evaluated against those of thermally pasteurized soy milk (immersion method, 75°, 15 min). The pasteurized milk samples were evaluated for microbiological quality (total plate count, *TPC*), rheological properties (flow consistency index, *K*, and flow behavior index, *n*), sensory acceptability (hedonic rating and ranking), and bioactive characteristics, including radical scavenging activity and total phenolic content (TPhC). The results showed that HPP effectively reduced microbial load to levels comparable to CTP, except at 200 MPa (4 and 8 min, contain 1.4×10^7 and 1.4×10^7 CFU/mL, respectively), and resulted in improved retention of bioactive compounds. HPP did not affect the flow behavior of soy milk, which remained pseudoplastic ($n = 0.05 - 0.25$). However, HPP was observed to significantly affect the physical structure of the system, as indicated by increased viscosity with higher pressure levels and longer treatment duration. At lower pressures, the viscosity of HPP-pasteurized soy milk was lower than that of thermally pasteurized milk. HPP-treated soy milk exhibited higher antioxidant activity and TPhC compared to CTP-treated soy milk (0.026-0.034 mg GAE/mL vs. 0.017 mg GAE/mL), indicating enhanced retention of bioactive compounds. Further, sensory evaluation indicated comparable or improved consumer acceptance relative to thermally processed soy milk. This study demonstrates that HPP is able to be non-thermal processing strategy that ensures microbial safety while preserving soy milk quality, supporting more sustainable processing.

References

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