ABSTRACT

Ultrasound-assisted supercritical extraction (US-SC) was investigated to enhance carotenoid recovery from Gac fruit, with a focus on its engineering properties and extraction optimization. The engineering properties of Gac fruit, including physical, thermal, textural and frictional characteristics, were evaluated. The pulp exhibited a thermal conductivity of 0.5856 W/m°C and a specific heat of 3.89 kJ/kg°C, suitable for heat-absorbing processes, while the peel showed lower thermal properties. Mass modelling using a power model effectively predicted mass with high accuracy (R^2 = 0.976, standard error = 0.074). The Gac fruit aril, rich in β-carotene (355.97 mg/100 g), lycopene (298.4 mg/100 g) and antioxidants, highlighted its potential for health-oriented food applications.

Ultrasound pretreatment was optimized using Response Surface Methodology (RSM) with 13 experimental treatments, exploring ultrasound amplitudes (50 to 100%) and durations (5 to 30 min). The optimized conditions of 80% amplitude and 30 min significantly enhanced carotenoid recovery (68.16 to 82.83%) and antioxidant activity (39.07 to 56.06%), promoting cellular disintegration for improved compound release. Supercritical extraction conducted at 30 MPa, 328.15 K and 15 g CO_2/min achieved a carotenoid recovery of 0.476 μg/mL, increasing to 0.481 μg/mL with US-SC, reflecting improved bioactive retention. The combined US-SC approach achieved a maximum antioxidant activity of 71.60% and a β-carotene concentration of 84.49 mg/100 g dry sample. Characterization of the extracted oil involved Scanning Electron Microscopy (SEM) for surface morphology analysis and Fourier Transform Infrared Spectroscopy (FTIR) for functional group identification.

These findings highlight the effectiveness of US-SC in enhancing carotenoid extraction and its potential application in developing nutritionally enriched products, offering valuable insights for food and pharmaceutical industries.