Optimized extraction, characterization and microencapsulation of hydrolysable tannin from pomegranate (P*unica granatum*) peel and its application in food formulation

ABSTRACT

The present study focuses on valorisation of pomegranate peel by extraction and encapsulation of hydrolysable tannins and its application in food formulation. Response surface methodology (RSM) and artificial neural network coupled with multi-objective genetic algorithm (ANN-MOGA) was used to determine the optimum pulsed ultrasonic assisted extraction condition viz. solvent volume, amplitude, time and duty cycle. The optimized condition predicted by ANN-MOGA (35 mL solvent, 45% amplitude, 20 min and 100% duty cycle), yielded 5.97% and 7.54% higher punicalagin and hydrolysable tannin extraction, respectively, than RSM predicted values. The phytochemical characterization revealed the presence of 15 different hydrolysable tannin in the extract obtained under optimized condition. Pomegranate peel hydrolysable tannin (PPHT) was purified from the extract by eluting in Amberlite XAD column. The combination of eluting solvents was studied to yield highest hydrolysable tannin. Double emulsion was fabricated with PPHT in the internal aqueous phase of double emulsion. Span 80-to-lecithin ratio of 1:1 and 4% gum Arabic in formulating double emulsion increased the storage stability up to 60 days at ambient condition and exhibited 3.47 times increase in the bioaccessibility than crude PPHT. Physical stability was observed for the double emulsion throughout the storage at pH 3.0 – 8.0 and at time-temperature combination of 63 °C for 30 min and 72 °C for 15 s. Further, the shortdough biscuits with encapsulated PPHT showed no astringency. The fat replacement of up to 40% was found to produce best overall acceptance as evaluated by sensory evaluation. The shelf life of the biscuits was obtained as 98 days considering moisture adsorption to be the limiting factor for safe storage. The degradation of hydrolysable tannins was modelled into zero order (R^2_{adj} = 0.969) and first order kinetics (R^2_{adj} = 0.995) that exhibited good fit with the experimental data. Thus, these results facilitated the formulation of PPHT encapsulated double emulsion with enhanced bioaccessibility and stability. Also, the developed fat reduced shortdough biscuits are healthier alternatives, possessing functional properties, without imparting undesirable flavour from hydrolysable tannin.

Keyword: Response surface methodology, artificial neural network, multi-objective genetic algorithm, hydrolysable tannin, double emulsion, in-vitro digestibility, release kinetics, bioaccessibility and physical stability