ABSTRACT

Rice bran is a nutritionally rich by-product of rice milling operation and is a potential source of edible oil production. However, rapid rise in its free fatty acid content leads to utilisation of a very small fraction of its total potential for edible grade oil production. Also, the dispersed nature and prevalence of small capacity of rice mills in developing nations like India causes ineffective utilization of presently existing large scale solvent extraction plants used for rice bran oil (RBO) extraction. With a view to improving the process of RBO extraction which can be adopted for scale-up, the present study investigated the effect of various parameters viz., microwave (MW) power, MW exposure time and solvent to bran ratio (STBR) on RBO recovery in two step microwave assisted extraction (TSMAE) process. Observations indicated it to be a better process than the conventional solvent extraction (CSE) process where more than 95 % oil could be recovered in 10 min of total extraction time. Microwave power of 320 W, MW exposure time of 60 s and STBR of 2.3 mL/g per step were found to be optimum. Quality of oil obtained from TSMAE was found to be comparable with respect to wax content, colour, iodine value and oryzanol content while being superior in respect of antioxidant activity, tocopherol content and phospholipid content to the oil extracted by CSE. Extraction kinetics study gave an insight to understand the reason behind rapid extraction in MW treated bran and it was found that a significant increase in oil recovery in washing stage took place in MW pre-treated bran than the untreated bran. Conforming to this, the scanning electron micrographs further showed more cell rupture in MW treated bran than the untreated bran. The absorbed power density (APD) of 1.00 ± 0.15 W/g was found to be optimum for MAE of RBO. Numerical modelling of MW heating of rice bran was attempted using COMSOL Multiphysics software to predict its heating behaviour which can be further utilized for scaled-up studies and equipment development. The developed model was found to well predict the average temperature and APD of bran with root mean square error values of 5–8 °C and 0.16–1.28 W/g respectively. A percolation type microwave assisted extraction (PMAE) setup which can accommodate up to 600 g bran was also developed as a part of this study to perform semi continuous extraction of RBO and the experimental evaluation indicated 4 cm bran bed height as the optimum in terms of heating uniformity. It was found that 95% oil recovery was obtained from 400 g bran in 10 min of extraction time at 500 W MW power when solvent flow rate was maintained at 184 mL/min. Based on the experimental observations, market evaluation and theoretical considerations, the economic feasibility of installing a continuous PMAE unit with a processing capacity of 100 kg bran/hour integrated to a 2 Tonne/hour rice mill was analysed, which indicated it to be an economically viable proposition facilitating 15 per cent and 41 per cent yearly return on investment with undelayed utilization of rice bran currently being sold as edible and non-edible grade respectively. The developed process has a potential to curtail the national edible oil import by about 4.5 per cent.

Keywords: *Two step microwave assisted extraction; Rice bran; Dielectric properties; Numerical modelling; Percolation type microwave assisted extraction; Continuous solvent extraction*