Agar recovery from agarophytes using combined subcritical water and moderate electric fields processing

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Agarophytes are red seaweeds industrially recognized for its agar content, a sulfated polysaccharide present in the cell-wall with technological applications. Subcritical water extraction is based on water's subcritical properties, consisting in the application of high temperature and pressure to increase extraction yields. Ohmic heating results from the application of moderate electric fields (MEF) and both thermal and electrical effects can enhance cell membrane permeabilization. Both processes are valorized due to their eco-friendliness and efficiency being an interesting alternative to the traditional processes.
The objective of this research was to assess the efficiency of subcritical water extraction under application of MEF on the agar recovery from two red seaweeds (*Gracilaria vermiculophylla* and *Gelidium sesquipedale*). The effects of MEF on different properties of the extracted agars were also addressed. Assessed parameters included total extraction and agar yields, structure, monosaccharide composition and molecular weight, gelling ability and rheological behaviour.
Extraction experiments were made using two types of pressurized reactors for each technology (conventional and MEF-assisted), with a solid:solvent ratio of 1:30 for a final volume of 400 mL, without stirring, with a conductivity of 3.5 mS/cm, where distilled water was used as solvent. A frequency of 20 kHz and an electric field ranging from 1-12 V/cm were used only for subcritical water extraction combined with MEF. For *G. sesquipedale*, temperatures and times ranged from 95 (control) to 140 °C and 180 min to 1 s (holding times after reaching the target temperature), respectively, and for *G. vermiculophylla* ranged from 85 (control) to 125 °C and 120 to 1 min, respectively, maintaining the same severity factor.
Combined subcritical water and MEF improved by up to 30 % the agar extraction efficiency, specifically for the 1 s process at 140 °C for *G. sesquipedale*. Gelling ability, rheological behaviour, structure, 3,6-AG content and molecular weight distribution of the agars extracted were not impaired by different treatments and extraction technologies.
Therefore, the combined use of subcritical water and MEF as a novel and innovative extraction technology may be an excellent alternative, improving extraction performances (with reduced processing time and increased extraction yield) to recover agar from agarophytes.