Cascading extraction: a way to simultaneously increase market value and decrease the environmental constraints of hydrocolloid recovery from red seaweeds

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Agarophyte seaweeds are industrially exploited for their hydrocolloids, but the residues are discarded by the tons. Moreover, there is barely available data regarding the extraction of proteins, lipids, phenolics and pigments from these biomasses prior to agar extraction, leaving a huge gap surrounding the influence of each step on the composition and function of the main product (agar). The aim of this work was to evaluate the effect of several extraction procedures (cold-water targeting protein recovery, ethanolic solvent targeting pigment recovery and moderate alkali targeting protein recovery), alone and in several combinations, on the agars from Gelidium sesquipedale and Gracilaria vermiculophyla. Yield, texturizing and rheological properties, and structure (FTIR, molecular weight) of the hydrocolloids were evaluated. For control purposes, a direct agar extraction was performed. Side-streams were analyzed for proximal composition, nutritional value and bioactivity (antioxidant activity).
For Gracilaria vermiculophyla, sequential use of cold water and ethanol proved to be the most beneficial approach, without any impact on the agar's quality. For Gelidium sesquipedale, sequential use of cold water, ethanol and moderate alkali extraction proved to be significantly helpful, due to an increase in gelling strength and rheological behaviour, without yield loss. Using this optimized procedure, per 100 g of original biomass, 22 g of agar with 1150 g/cm2 gelling strength, gelling temperature of 34 oC, melting temperature of 95 oC and a purification degree near 90 % are obtained. Alongside this industrially relevant product, 376 mg of phenolic compounds (as gallic acid equivalents), 4.4 g of solubilized proteins and 3.8 g of solubilized sugars are recovered in the initial extraction procedures, with antioxidant activities reaching 1 mM/L (Trolox equivalents), demonstrating the potential market value of these additional fractions.
Overall, the sequential extractions employed, when optimized, proved to be capable of providing additional highly desirable side products, without compromising the potential uses of the main product, being a good alternative for the beginning of a cascading biorefinery approach for red seaweeds.
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