

Supercritical CO₂ Extraction of Oil from Arctic Char Side Streams

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Abstract

The increasing global demand for fish products, leads to the need for more sustainable utilization of fish processing side-streams. Presently fish industry by-products are mainly used as animal feed or as organic fertilizers. As these by-products are rich in exploitable valuable compounds such as polyunsaturated fatty acids, proteins and minerals, novel, environmentally friendly processes should be investigated to optimize the recovery of these components. In this framework, supercritical fluid extraction (SFE), a green extraction technology without the use of conventional organic solvents, was explored. Fish by-products from filleting of arctic char (*Salvelinus alpinus*) were provided by a Swedish fish company (Umlax AB) and consisted of heads, skin, bones, frames and tails. The supercritical CO₂ extraction of the contained fish oil was carried out under different operating conditions of pressure (200-450 bar) and temperature (40-80 °C). The total extraction time was set at 2 h and the efficiency of the process was evaluated based on the yield of total extract (dry weight basis). Since the arctic char contains lipophilic antioxidants such as astaxanthin which are extracted together with the fish oil, the impact of the operating conditions on the antioxidant activity was also evaluated. Fish oils are prone to oxidation, therefore peroxide value was measured in order to estimate the oxidation level between the different samples. The recovery of fish oil ranged from 20-36% on dry basis under all the examined conditions, except for 200 bar and 80 °C where the fish oil yield was very low (0.6%). The yields at 350 bar and at 450 bar/40°C were at the same level (27-28%). Peroxide value was expressed with EC₅₀ value which is the efficient concentration of extract that reduce 50% the absorbance of the free radical DPPH. At 450 bar, the temperature increase led to 36% higher EC₅₀ value (lower antioxidant activity). At intermediate pressure levels, the extracts had similar EC₅₀ values (18.2 and 20.0 mg/mL respectively). In terms of peroxide value, increasing both temperature and pressure resulted in higher oxidation levels in oil except for 200 bar.

Under this condition, the oil showed higher peroxide value (1.83 meq O₂/kg_{oil}) than the other samples at 40 °C. SFE can effectively applied for the extraction of valuable compounds such as polyunsaturated fatty acids from fish industry by-products. The remaining defatted material after oil extraction can further be used for protein extraction for more effective valorization of fish side-streams.

Keywords: Supercritical CO₂ extraction, Salmonid by-products, fatty acids

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