Semi-industrial subcritical water extraction: a step forward in green extraction

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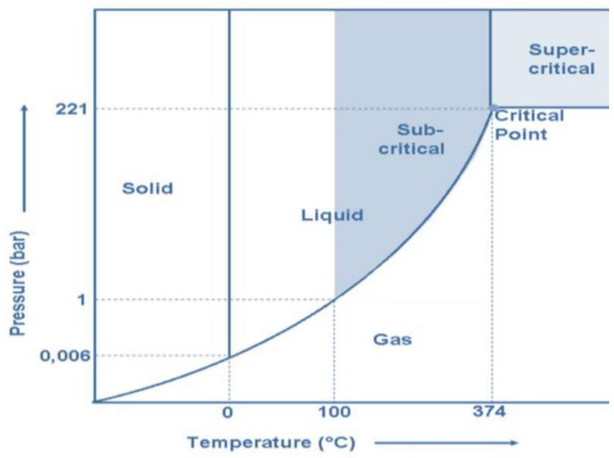
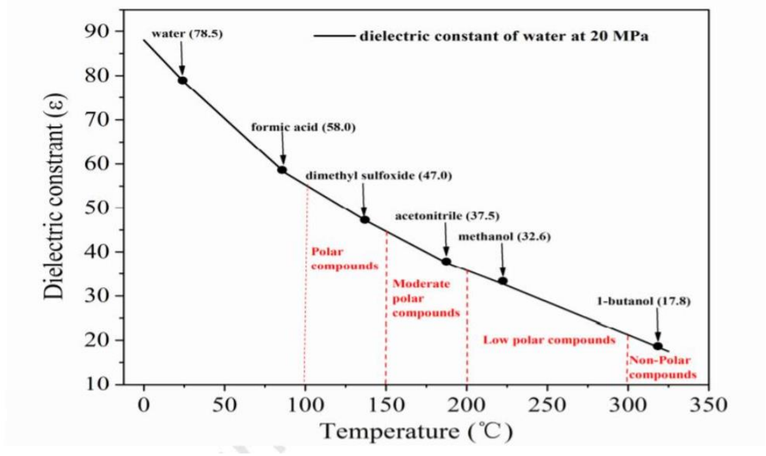
Subcritical water extraction (SWE) is an environmentally friendly approach that combining temperatures between 100 and 374°C and high pressures bring water in its subcritical phase. As the temperature and pressure increase, there is a marked and systematic decrease in permittivity, an increase in the diffusion rate, and a decrease in viscosity and surface tension. These changes favor the solubility of low polarity compounds in water, the mass transfer rates, and the water permeation in the matrix. This technique can be applied for the extraction of **proteins**, **polyphenols**, **polysaccharides**, **lipids** and other **phytochemicals**, which can be used as nutritional and bioactive **functional ingredients**.



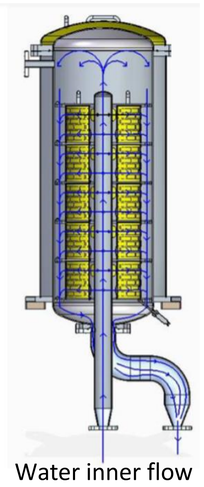
Water phase diagram



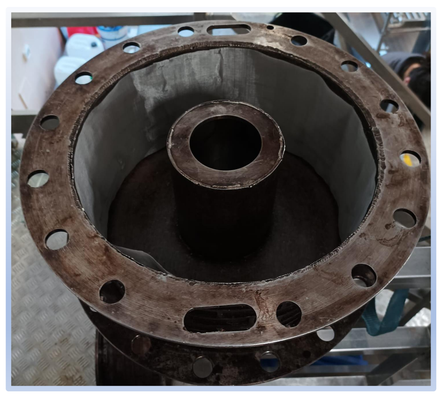
Dielectric constant modulation in SWE

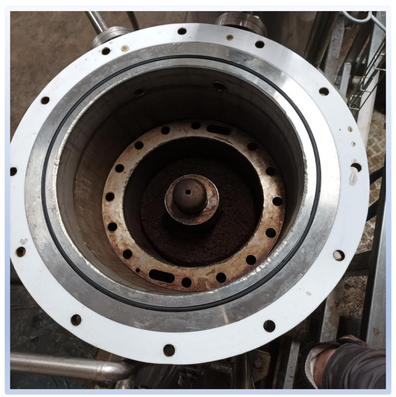
SynthWAVE° apparatus

Thanks to the collaboration with Tropical Food Machinery srl, we scaled up the lab-optimized protocols to **semi-industrial level** developing a new patented prototype extractor. The latter is equipped with **two 100-liter pressurized extraction tanks** with five metallic cylindric baskets where biomass can be placed and subjected to a radial and vertical flow of pressurized hot water. After 15 to 30 minutes, the solution is transferred to an **expansion tank** and subjected to flash evaporation with a rapid temperature drop.


Water inner flow

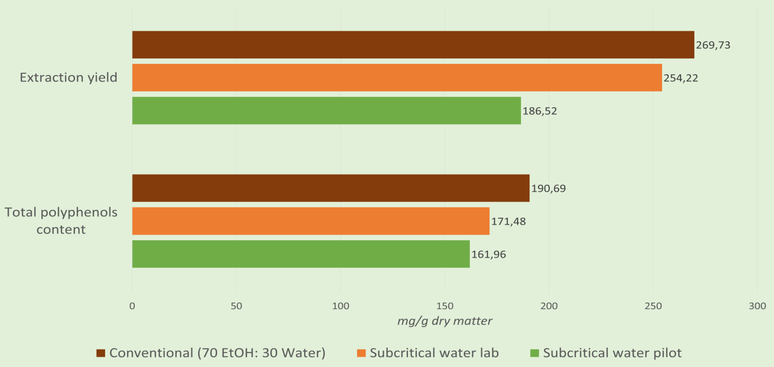

Semi-industrial plant for subcritical water extraction


Metallic cylindric basket


Extractor tank

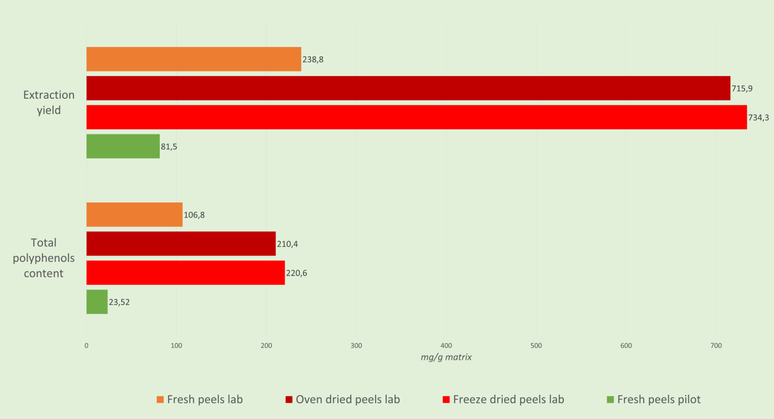

Expansion tank


Hazelnut pericarps



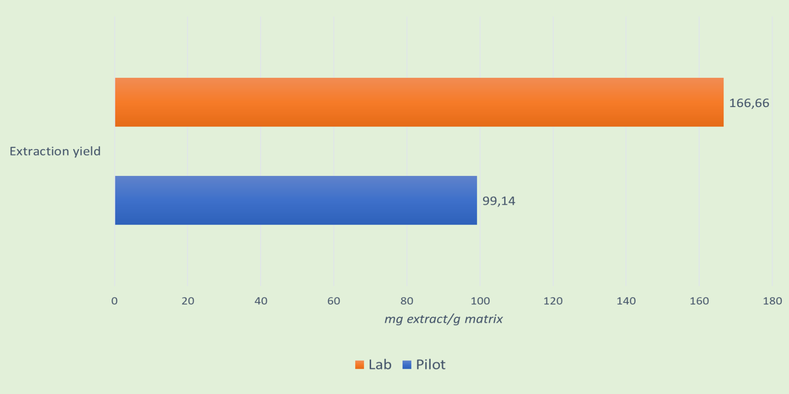
Hazelnut pericarps, by-products of the roasting process of hazelnuts, were subjected to subcritical water extraction for the recovery of **polyphenolic fraction**. The optimized operating condition, 150°C and 30 minutes, in a lab scale were reproduced on a pilot plan processing **9,2 kg in 150 L of water per batch**. The extracts obtained with this technology, given their high level of polyphenols, could be used industrially for the formulation of pharmaceuticals, cosmetics and nutraceuticals products.


Pomegranate fresh peels



Pomegranate peels are rich in bioactive phenolic and flavonoid compounds, **polyphenols**, which can be used as antimicrobial agents. Optimized conditions were 150°C for 20 minutes, short extraction times preserved the thermolabile bioactive compounds in pomegranate. The process was **scaled up from 60 g in 600 mL to 25 kg in 150 L of water**. The scaled-up trials were performed on fresh peels; future investigations will evaluate the effectiveness of subcritical water extraction on a pilot scale on dried peels.


Slaughterhouse by-products



Slaughterhouse by-products, including also insects, provide an excellent starting biomass for **high quality protein** extraction. Our research group investigated the possibility of protein recover through subcritical water extraction from meat by-products (shredded bones and cartilage). The lab optimized conditions 180°C and 30 minutes, were replicated in the pilot reactor extracting **23,5 kg per batch**. The scale-up procedure led to promising preliminary results, laying the foundation for future process optimization on industrial level.