Re-waste
Recovery · Recycling · Resource

LIFE + Environment Policy and Governance

Olive oil mill wastewaters (OMWW) are very rich in phenolic compounds, which are the main responsible for their phytotoxicity and difficult biological degradation. Recovery of OMWW phenolic fraction would facilitate the waste disposal and, at the same time, produce a natural extract characterized by high antioxidant activity, which could be object of great attention by pharmaceutical, cosmetic and food industries.

Several methods have been proposed in order to recover OMWW phenolic fraction, but none of them proved at the same time technically and economically feasible.

We propose an OMWW treatment process based on the combination of membrane filtration technology, anaerobic digestion and chromatographic purification on adsorbent polymer, aimed at producing biogas and recovering antioxidant phenolic compounds and a high percentage of purified water.

The process has been tested at laboratory and pilot scale by Industria Olearia Biagio Mataluni srl within a three year research and development project, co-financed by Italian Ministry of University and Research.

A pilot membrane filtration plant (figure 1 and figure 2) has been installed near Industria Olearia Biagio Mataluni olive oil mill and used for the optimisation of the filtration process during the last three olive oil seasons.

Figure 1. Pilot plant for OMWW treatment: ceramic microfiltration section.

Figure 2. Pilot plant for OMWW treatment: polymeric ultrafiltration – nanofiltration – reverse osmosis section.

The treatment process foresees an initial pre-treatment of OMWW aimed at removing fats and suspended solids, in order to reduce membrane fouling and increase the permeability in the successive membrane filtration steps. The pre-treatment consists of addition of flocculants, centrifugation, oil flotation and filtration on filter press.
The pre-treated OMWW undergoes, then, successive membrane filtration steps with progressively lower molecular cut-off.
The first step is represented by microfiltration on ceramic membrane.

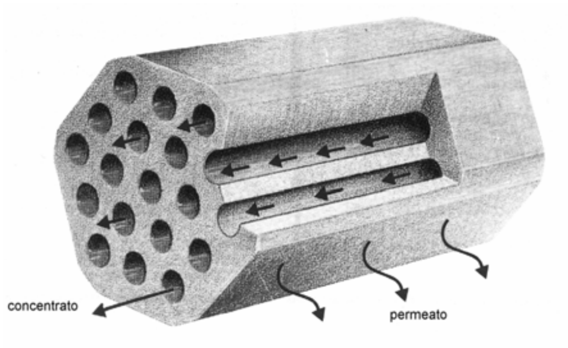


Figure 3. Ceramic microfiltration membrane.

In this type of cross-flow filtration, the liquid to be treated flows parallel to the filtration surface, while the permeate is extracted across the active membrane surface in a continuous mode (figure 3). The tangential flow allows keeping stable filtration efficiency for long time.
The successive steps (ultrafiltration, nanofiltration and reverse osmosis) are carried out on spiral wound polymeric membranes.

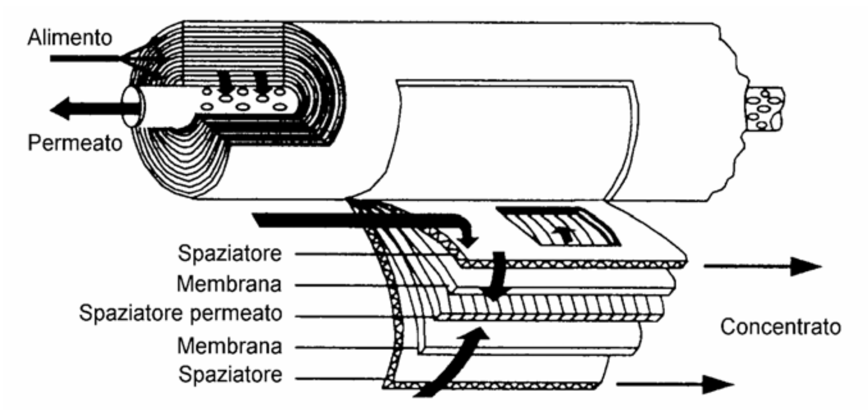


Figure 4. Spiral wound polymeric membrane.

This type of membrane is made of several sheets wound round a central pipe (permeate collector). Between two adjacent membrane sheets, a space is interposed, which allows the feed flow (figure 4).

The treatment scheme is reported in figure 5. The pre-treated OMWW undergoes successive steps of microfiltration (cut-off 0.2 μm), ultrafiltration (cut-off 6 kDa), nanofiltration (cut-off 200-300 Da) and reverse osmosis.

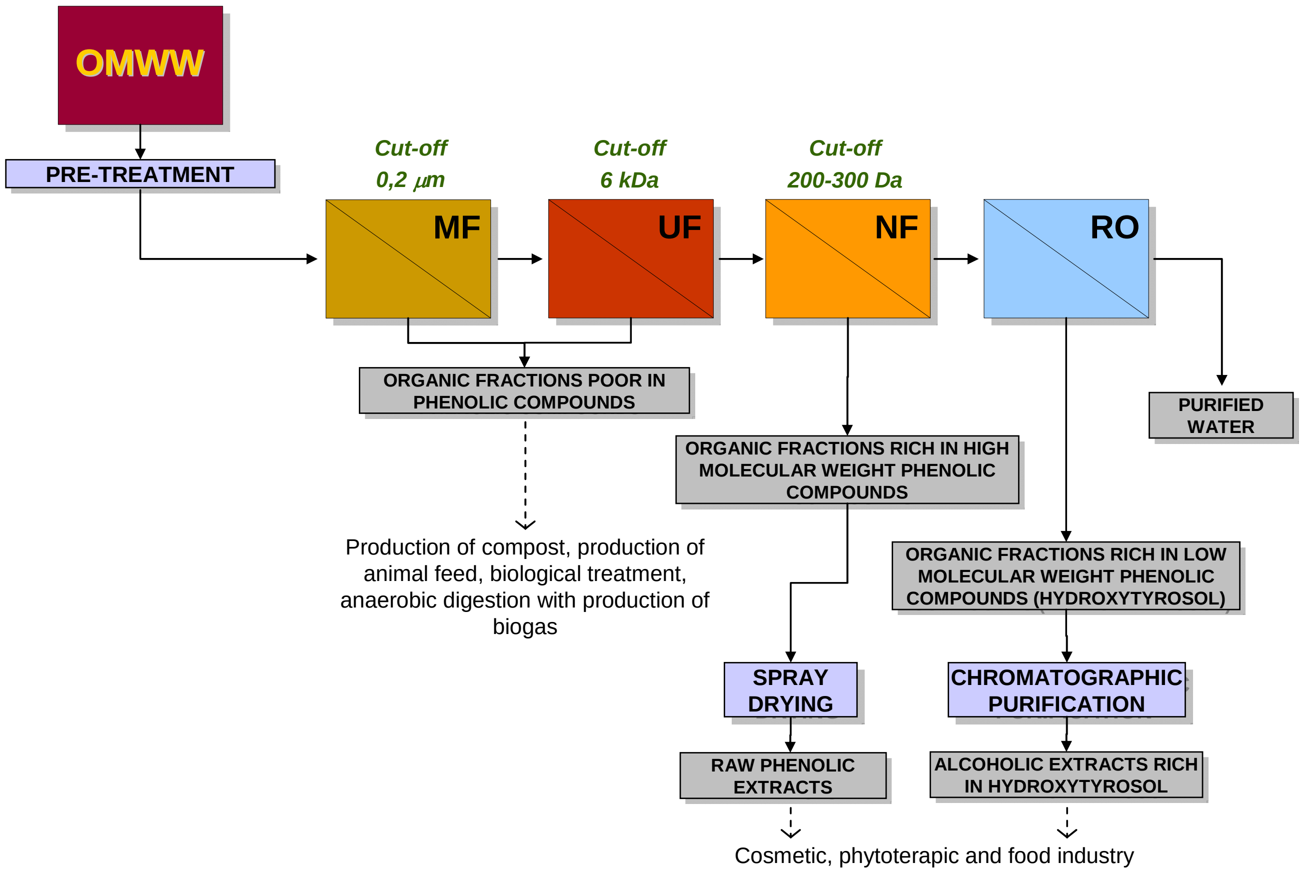
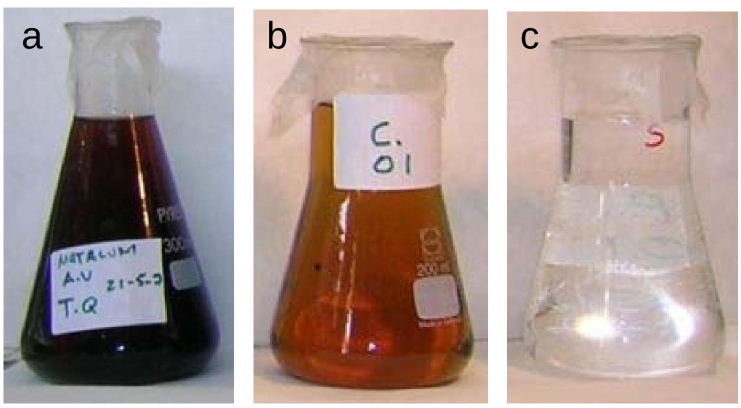


Figure 5. Scheme of the treatment process.

The permeate of each filtration step undergoes the successive filtration step, up to the reverse osmosis, which permeate is purified water, that can be re-used in the industrial process, for example in the olive washing phase.



The microfiltration concentrate and the ultrafiltration concentrate are organic fractions poor in phenolic compounds, which could be subjected to biological treatment and disposed of, or more conveniently can be used for the production of compost, for the production of animal feed, or for the production of biogas by means of anaerobic digestion.
The nanofiltration concentrate is rich in high molecular weight phenolic compounds, while the reverse osmosis concentrate is rich in low molecular weight phenolic compounds, mainly hydroxytyrosol. NF and RO concentrates can be used in cosmetic, phytoterapic or food industry as antioxidant extracts, after drying or purification.
Spray drying has been tested on NF and RO concentrates, adding dextran as thickening agent at a concentration of 2.5%, obtaining an antioxidant powder (figure 6).

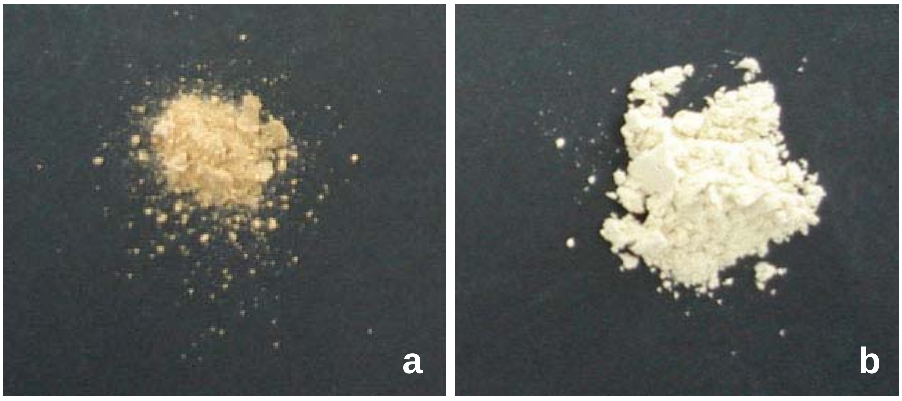


Figure 6. Antioxidant powder obtained from NF concentrate (a) and RO concentrate (b) by spray drying.