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The WRC operates in terms of the Water Research Act (Act 34 of 1971) and its mandate is to support water research and development as well as the building of a sustainable water research capacity in South Africa.

TECHNICAL BRIEF

Industrial water treatment

Pilot-scale treatment of table olive brines

A WRC-funded pilot-scale study investigated the treatment of table olive brines as well as by-product beneficiation, purification and recovery of water for re-use.

Background

Olives are exceedingly bitter and need to be cured to make them palatable before consumption. The curing process involves placing the olives in a brine solution whereupon a spontaneous lactic acid and/or yeast fermentation takes place.

The brining process takes from 3 to 12 months, depending on cultivar and type and is associated with various washing and rinsing steps. This results in noxious, darkly coloured and acidic wastewaters with a high organic load, high phenolic content and high salinity (three times more than seawater). It is a water-intensive process, with up to 10 kilolitres of water being consumed per ton of olives processed.

The wastewaters generated present an environmental disposal problem, as they are not amenable to biological treatment, and cannot be disposed of in municipal sewage systems or the environment for toxicity reasons. They are generally disposed of in evaporation ponds.

The wastewater does, however, contain valuable components, in particular low molecular weight (monomeric) phenolic compounds with powerful antioxidant activity and numerous other beneficial effects on human health.

Of particular interest is recovery of the naturally occurring antioxidant hydroxytyrosol or HT, which has been shown to have antimicrobial and antiviral activity, among others. This antioxidant can be used in the pharmaceutical, personal care products, and cosmetic sectors as an active ingredient, or in the food and beverage industries as a natural alternative to currently used synthetic antioxidants and preservatives.

Pilot-scale plant

Based on previous laboratory research, a comprehensive treatment system was designed in order to recover the HT and simultaneously recover purified brine that can be re-used for table olive production, while minimising the amount of waste for disposal to the evaporation ponds. In this manner, the cost of wastewater treatment can be offset by the recovery of value-added products that can be commercially exploited.

In a project funded by the WRC and executed by the University of Cape Town, a modular, containerised wastewater treatment system was developed for piloting at an olive farm and processing factory. Wastewater batches from the factory were diverted into a holding tank for temporary storage. From there 1 kilolitre batches of the discharge were processed through two sequential unit processes.

Firstly, fine ultrafiltration was performed to remove lignins and tannins for disposal to waste, with the membrane permeate stream then containing antioxidants, salt, organic acids and some other minor components. Secondly, this permeate stream was passed through a chromatography column containing a selectively adsorbent resin. This allows a purified brine stream to exit the column while it retains the other substances in the water.

When the column becomes fully loaded and can adsorb no more, it is rinsed and an ethanol solution is then distilled to obtain a crude antioxidant extract and the ethanol is recovered for re-use. The ethanol also regenerates the column and, after rinsing, it is ready for the next loading cycle. The purified brine stream can be sent for recycling, while retaining the antioxidants for recovery.

The pilot-scale system was operated for six months during which data was collected and analysed, yields and productivity of the process were established, and the economics of the treatment process evaluated. Operation of the pilot plant has demonstrated that the technology is effective for treating such highly polluted brine wastewaters.

While relatively small-scale equipment was used for the pilot plant, it was possible, on average, to process a one kilolitre batch of wastewater per week. Up to 75% of this feed could be recovered as purified brine for recycling, while an additional 300 ℓ of freshwater was used for backwashing the membrane system and processing the chromatography column.

An average of 360 g of antioxidant was produced per kilolitre batch of wastewater processed. The operation cost of production at the current level was around R20 per gram of antioxidant in the form of a crude extract, with a corresponding zero cost for the treatment and recovery of the wastewater. With refinement and further modification these throughput, yield and productivity can be improved further.

Conclusion

A spin-out company is being formed to exploit the IP generated during the project and develop the process into a full-scale treatment system. Thereafter, it is intended to roll out the technology to other olive producers, and investigate other possible applications of the technology.

The process is only feasible if there are value-added products to be obtained from a waste stream; if wastewater treatment alone is considered, it is expensive due to the high cost of the speciality membranes and the chromatography resin used.

Further reading:
To order the report, ***Pilot-scale treatment of table olive brines: beneficiation, purification and water recovery for re-use*** (**Report No. 2010/1/12**) contact Publications at Tel: (012) 330-0340, Email: orders@wrc.org.za, or Visit: www.wrc.org.za to download a free copy.