

Abstract

Olive oil consumption and production has increased worldwide over the last 25 years; this trend is especially true in the United States. The U.S. is the largest olive oil consumer outside of the EU, which has led to an increase in domestic olive oil production. Modern olive oil production methods, significantly advanced from the rudimentary methods used in 3,000 BC, rely on continuous processing equipment. While they reduce manual labor, modern production methods require heavy utilities, investment in capital, and additional costs to manage waste. A major problem with large scale olive oil operations is the increase of waste called olive oil mill wastewater (OMW), which is made up of wash water to remove debris from olives, process water to aid separation of the oil from the fruit, and vegetable water that is separated from the fruit. OMW is highly phenolic with concentrations up to 24,000 mg/L, which is orders of magnitude greater than the EPA's allowable limit of phenolic wastewater concentration of 3.4 mg/L; therefore, it is highly phytotoxic and should be treated before release. However, the vegetable water is the most significant fraction of the wastewater and must be rejected as OMW. Additionally, waste treatment is expensive enough that the profitability of the mill can be significantly impacted; this creates a need for process designs which are both economical and effective at treating OMW.

In my thesis, I study and compare the economics and environmental impacts of four alternative treatment solutions: spreading OMW, adsorption using activated carbon, biodegradation, and membrane separation and valorization. The most commonly used method currently are evaporation ponds, which are problematic due to the risk of spills and odor nuisances. From a model we developed to optimize the operating revenue of a self-supplied olive oil mill, we first show that modern production methods make the most sense for larger scale orchards. Most of the treatment alternatives are also more practical at a larger scale; however, there is no "silver bullet" treatment method as some were cost prohibitive (membrane separation and activated carbon treatment) and some, environmentally impactful (biodegradation). While spreading seems to be the best short-term solution, its environmental impacts can increase over a longer period of time and its cost-effectiveness is limited to orchards that already have an existing irrigation system.