LIFE-CYCLE ASSESSMENT OF OLIVE OIL ADDRESSING ALTERNATIVE PRODUCTION SYSTEMS: HOW TO DEAL WITH OLIVE POMACE VALORIZATION?

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Olive oil is an important product of the so-called “Mediterranean Diet”. In Portugal, about 90 000 tonnes of olive oil were produced yearly in the last agricultural campaigns. The main objective of this paper is to present a comparative life-cycle assessment (LCA) of olive oil produced from four types of cultivation systems (familiar, traditional, intensive and organic) and two olive oil extraction processes (three-phase and two-phase extraction), addressing the valorization of olive pomace. The most remarkable difference between three- and two-phase extraction is related to the co-products and residues produced: the three-phase process results in three fractions (olive oil, olive pomace and olive mill wastewater), whereas the two-phase extraction (a more recent and increasingly used process in order to avoid the production of olive mill wastewater) consumes less water and generates, together with olive oil, a suspension called olive wet pomace.

A life-cycle model and inventory was implemented for the entire olive oil chain, including olive cultivation and olive oil extraction (about 5-7 kg of olives are required to produce one liter of olive oil), as well as valorization of olive pomace (three-phase extraction) and olive wet pomace (two-phase) to produce olive pomace oil and extracted pomace. Two approaches for dealing with multifunctionality were analyzed: i) allocation based on market prices of coproducts (olive oil and olive pomace) and ii) substitution (“avoided burdens” approach) of extracted pomace (displacing conventional fuel in energy intensive processes) and olive pomace oil (displacing virgin oil in biodiesel production). The environmental impacts were calculated for four impact categories (ReCiPe method): greenhouse gas (GHG) intensity, terrestrial acidification, freshwater and marine eutrophication. The cumulative energy demand (CED) method was used to calculate non-renewable primary energy (NRPE).
The results (price based allocation) showed that olive cultivation was the life-cycle phase which contributed the most to the overall environmental impacts (55-95% to GHG intensity, 80-98% to acidification and 70-100% to eutrophication), except for the familiar cultivation system with no fertilizers and pesticides being applied. Fertilizers production and application contributed more than 43% to the environmental impacts of traditional, intensive and organic cultivation. Results calculated with the “avoided burdens” approach are highly dependent on the type of virgin oil displaced by olive pomace oil. This research shows the importance of olive cultivation practices and olive pomace valorization to reduce the life-cycle impacts of olive oil.

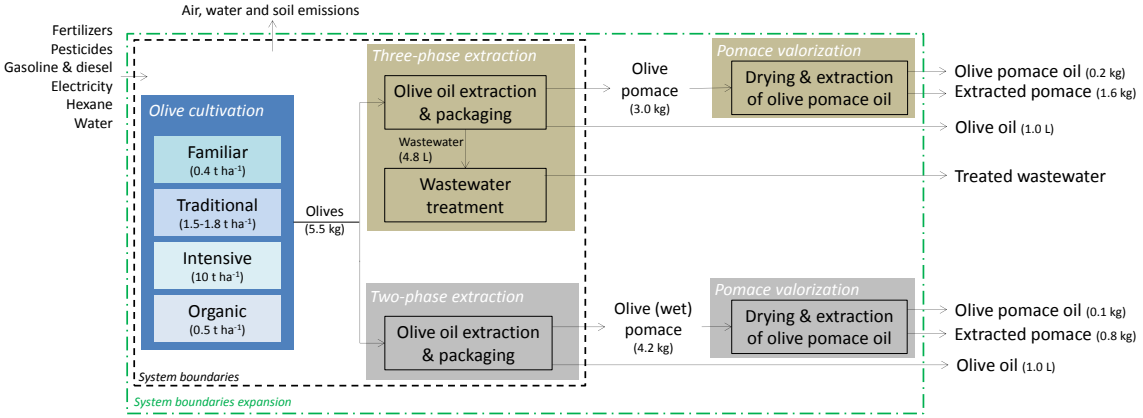

FIGURE 1 –SYSTEM BOUNDARIES FOR OLIVE OIL PRODUCTION AND POMACE VALORIZATION.