Science of the Total Environment 622–623 (2018) 942–953

Contents lists available at ScienceDirect

Science of the Total Environment

journal homepage: www.elsevier.com/locate/scitotenv

Review

A new framework proposal, towards a common EU agricultural policy, with the best sustainable practices for the re-use of olive mill wastewater

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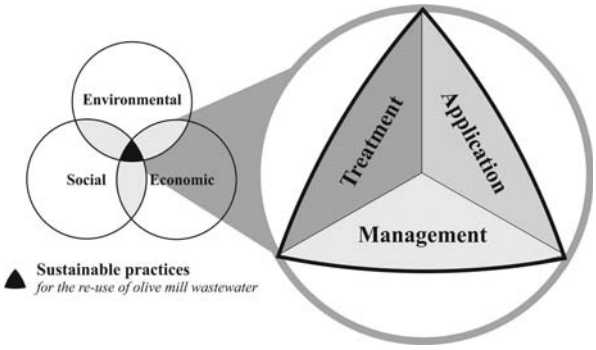
HIGHLIGHTS

- Sustainable practices can convert OMW from a pollutant to a valuable resource.
- OMW best practices can form a consensual framework for their re-use in agriculture.
- Sustainable practices grouped into treatment, application and management practices.
- A new framework environmentally acceptable, socially bearable and economically viable.

GRAPHICAL ABSTRACT



ARTICLE INFO

Article history:
Received 25 October 2017
Received in revised form 6 December 2017
Accepted 6 December 2017
Available online xxxx

Editor: D. Barcelo

Keywords:
Olive mill wastewater management
Environmental management
Sustainable agriculture
Sustainable crop management

ABSTRACT

The disposal of olive mill wastewater (OMW) is a serious environmental issue for the Mediterranean countries. However, there is still no common European legislation on the management and the re-use of OMW in agriculture, in the frame of sustainable crop management and the standards for the safe OMW disposal and re-use are left to be set by each EU country, individually. This review paper presents the most effective and sustainable practices for OMW, (treatment, application and management), which can maximize the benefits of OMW on crops and soils, while minimizing the potential hazards for public health, thus promoting environmental sustainability. The findings of this synthetic work suggest that there is enough information and proven sustainable practices to go ahead with the initial formulation of a new consensual framework, environmentally acceptable, socially bearable and economically viable, that could hopefully help to set the standards for the re-use of olive mil wastewater and can lead to a common EU policy on the management and re-use of OMW.

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https://doi.org/10.1016/j.scitotenv.2017.12.073
0048-9697/© 2017 Published by Elsevier B.V.

1. Introduction

In the European context, the three Mediterranean countries, Spain, Italy and Greece dominate the world olive production (FAOSTAT, 2015), but also they face the biggest environmental problems related to the disposal of the huge quantities of olive mill wastewater (OMW) produced every year, as expected (Di Serio et al., 2008; Barbera et al., 2013; Belaqziz et al., 2016). OMW is a mixture of olive oil and pulp, mucilage, pectin, soft tissues of the olive fruit, suspended in a relatively stable emulsion, and water used in the various stages of the oil extraction process, such as the water added during centrifugation, water derived from filtering disks, and from washing rooms and equipment (Tsagaraki et al., 2007). OMW could be temporarily stored in evaporation ponds or lagoons (Azbar et al., 2004; Rincón et al., 2012), and then it is distributed uniformly on agricultural lands (Paredes et al., 1999). However, in some Mediterranean countries, such as Greece (Greco et al., 2006), these treatments are difficult to be always implemented due to the excessive seasonal amounts of OMW produced, the high scarcity of olive mills, and the lack of central management (Tamimi, 2016).

To deal with the problem of waste management, Mediterranean countries have set individually the standards and limits, since there is no unified legislation or regulations and on the disposal amounts of OMW (Brunetti et al., 2007; Tamimi, 2016). Treatment, application and management practices have been proposed in the context of refunded programs, or independent research at each country, and they often provide valuable information towards the development of a common EU policy, in order to convert OMW from a serious environmental problem into a valuable source of water and nutrients, in the frame of sustainable crop management. Therefore, this review presents and thoroughly discusses the best practices for OMW management, which should be taken into account towards a common EU legislation.

2. The current situation on national legislations for OMW management

In all EU countries, the direct discharge of OMW into lakes and rivers is strictly forbidden, due to its detrimental effects on ecological balance. Nevertheless, in many cases, the illegal, direct disposal of OMW into nearby aquatic resources has been observed. Each Mediterranean country faced the problem of regulating OMW with a different approach. In Spain, around 1000 evaporation ponds were constructed to promote evaporation during summer, improving the water quality, but caused odor nuisance. In Italy, OMW should be treated before their disposal into the environment and their spreading of these treated effluents on agricultural lands should be done under controlled conditions (Barbera et al., 2014; Komnitsas, 2015). In Greece, no specific regulations have been set (Kapellakis et al., 2006; Tsagaraki et al., 2007). The main standards for OMW management are based on the Law 1650/86 “For the protection of the Environment”, according to which, olive mill owners are obliged to provide an environmental impact assessment study for the produced olive waste waters (Galanakis, 2017), and each Prefecture is responsible for the adoption of the proper management practices. However, in some Prefectures such as Messinia (Peloponnese), OMW was discharged onto ecosystems without treatment, while in Crete (Prefecture of Iraklio) the disposal of untreated effluents is forbidden (Kapellakis et al., 2006). The latest Join Ministrial Decision (KYA) 145,116/2011 defines the standards for the re-use of wastewater for several purposes, including irrigation (Galanakis, 2017).

Until now, there is still no common EU legislation for OMW management; standards, and therefore threshold, values for receptors, physicochemical parameters and limit values for safe disposal and use are left to be set by each country, individually. Italy, Spain, Portugal, Greece, and Cyprus have already put in force legislation for safe disposal of OMW on agricultural soils. Regulations of OMW re-use show several differences, depending on each special case. For example, according to the Italian law (574/96), the maximum tolerance limit for soils is set to 50 m^3 ha^{-1}/year for OMW deriving from traditional mills (discontinuous extraction systems) and 80 m^3 ha^{-1}/year for vegetable water deriving from centrifugal extraction (continuous extraction systems). However, in Greece there is still no limit set (legislation refers only to the water quality standards for the re-use of the treated effluents) and in Portugal the maximum limit for soils is set to 80 m^3 ha^{-1}/year for spreading OMW on agricultural lands (Law No. 626/2000).

3. Important aspects for olive mill wastewater disposal, treatment and management

3.1. Issues related to OMW characteristics

Characteristics of OMW such as the strong offensive smell, the extremely high degree of organic pollution (COD values up to 220 g l^{-1}), COD/BOD5 ratio between 2.5 and 5, pH between 3 and 5.9, high content of polyphenols (up to 80 g l^{-1}) and high content of solid matter (total solids up to 20 g l^{-1}), are the main reasons why OMW can be hardly degradable and toxic to most of the microorganisms and crops (Tsagaraki et al., 2007).

According to Davies et al. (2004), based on their work on OMW synthesis that covers published articles over 50 years, the typical OMW composition by weight consists of 83–94% water, 4–16% organic compounds (2–15% of phenolic compounds) and 0.4–2.5% mineral salts. The main concept of the re-use of OMW is that all the macronutrients (K, P, N), which have been removed from the soils during the cultivation, could be recycled by using the treated olive wastewater as a biological fertilizer, soil amendment and as a valuable water source of irrigation (Vlyssides et al., 2012; Nasini et al., 2013). Spreading OMW on crops has been proved to be a great solution for dealing with the disposal of these effluents, thus affect promoting environmental sustainability (Barbera et al., 2013; Nasini et al., 2013). However, direct application on several crops may inhibit the germination of different

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