# OLIVES AND OLIVE OIL AS FUNCTIONAL FOODS

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# 9 Integrated olive mill waste (OMW) processing toward complete by-product recovery of functional components

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## 9.1 Introduction

Olive oil extraction is an ancient agricultural industry all over the Mediterranean area, and to date it is of much economic importance for many countries. This agro-industrial activity generates large amounts of highly offensive waste (olive mill waste, or OMW) that is usually unexploited and in most cases poses a severe threat to the environment.

There are two ways of extracting the oil: traditional pressing, which has been used for many centuries with only minor modifications; and centrifugation, which the olive oil industry has taken over in recent decades. There are also two centrifugation systems, called three-phase and two-phase systems, which are described in Figure 9.1. Even though traditional pressing is a relatively obsolete technology, it is still in use by some olive oil producers. After extraction by pressing, a solid fraction called "olive husk" is obtained as a by-product along with an emulsion containing the olive oil that is separated by decanting from the remaining olive mill wastewater (OMWW). The continuous three-phase extraction process, which is the predominant process in modern olive mills, generates two streams of waste: a wet solid cake (~30% of raw material weight) called "orujo" or "olive cake," and a watery liquid (50% of raw material weight) called "alpechin" or OMWW (Tsagaraki *et al.*, 2007). In spite of the clear advantages of this system compared to pressing (i.e., complete automation, better oil quality, and smaller area required), it also presents some negative aspects, such as greater water and energy consumption, higher wastewater production, and more expensive installations (Roig *et al.*, 2006). At the end of the 1991–1992 olive oil campaign, a new centrifugation system was developed that reduced the OMW by 75%. This system was launched to the market as "ecological" because of the reduction in water consumption, and as a "two-phase" system because it produced two fractions: a solid one called "alperujo" (also called "olive wet husk," "wet pomace," or "two-phase olive mill waste" [TPOMW]) and a liquid one (olive oil). The different by-products resulting from the olive oil extraction, depending on the extraction system utilized, are summarized in Table 9.1.

At present, olive cake is processed in seed oil factories in order to extract the small amount of oil remaining in the waste. Both crude and exhausted olive cake can be used as solid fuels, added to animal feed as a supplement, or returned to the olive grove as mulch. While economic concerns regarding the profitability of seed oil production now are being questioned, the problem of disposal of olive cake is adequately addressed by one of these three alternatives (Tsagaraki *et al.*, 2007). However, when TPOMW was intended to be treated similarly, great difficulties appeared because of its high moisture and carbohydrate concentration. Thus, the alperujo tends to stick to the furnace walls, blocking the gaseous stream and causing an explosion hazard (Arjona *et al.*, 1999). Besides, because of its high moisture, the drying process demands a lot of energy that significantly increases costs (Roig *et al.*, 2006).

As far as OMWW treatment and disposal are concerned, the situation is more complicated. Attempts to alleviate the problem started more than 50 years ago and as of yet there has been little success in finding an

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