# A Study of Waste Management Strategies and Waste Generation Factors for Vegetable Oil Refining Sector

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Vegetable oil production is of vital importance in terms of the agriculture sector and human nutrition. The industry generates plentiful waste to be disposed of at a high cost; therefore, waste is a major issue of concern for this industry. Depending on the source of vegetable oil, the wastes produced in each step of the overall production process may change. The purpose of the present study is to develop waste management strategies for the vegetable oil industry through the identification of kinds and quantities of wastes produced. Sunflower oil production, natural and extra virgin olive oil production and refined olive oil production processes are described concerning waste generation, and the possible process and non-process wastes from each process step were identified.

The approach used in the study involved six major steps, namely, i) investigation of the processes used for sunflower oil production, natural and extra virgin olive oil production and refined olive oil production; ii) studying every process involved in each production process in detail, iii) identification of all potential process wastes and non-process wastes, iv) classification of each type of waste with the correct European Waste Catalogue codes (EWC codes) so that it can be disposed of at the correct disposal facility point, v) estimation of waste generation factors (WGFs) using the anonymous waste generation data gathered from the national waste declaration system (TABS) of the Ministry of Environment and Urbanization and analyzing it statistically, and vi) identification of management strategies for each of the waste types generated in each industrial activity.

*Sunflower Oil Production:* Figure 1 illustrates the general process scheme of sunflower oil production. In short, sunflower seeds are cleaned at first, and then ground and pressed for the extraction of crude oil from the seeds. At the extraction step, a volatile hydrocarbon is used as a solvent. The oils are then neutralized, bleached, and deodorized with bleaching earth and activated carbon to remove the color and residual matter.
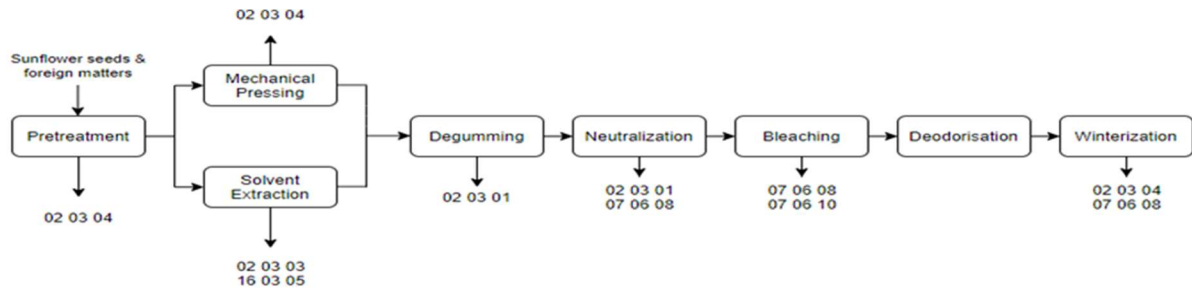


Figure 1. The production scheme of sunflower oil and waste points

The descriptions of the process wastes generated, their EWC codes and WGFs and reuse/recovery options for the wastes from the sunflower oil production are given in Table 1.

Table 1. Process wastes from the production of sunflower oil

| Waste Code | Definition | A/M/İ[1] | WGF (g/kg oil) | Recovery (R) and Disposal (D) Codes[2] |
|---|---|---|---|---|
| 02 03 01 | Sludges from washing, cleaning, peeling, centrifuging and separation | I | 0.4-14 | R1/R3/R9, R12/D9, D10, D1/D4/D5 |
| 02 03 03 | Waste from solvent extraction | I | 0.01-2 | R1/R2, R12/R13, D10 |
| 02 03 04 | Materials unsuitable for consumption or processing | I | 0.0035-30 | R1/R3/R5/R9, R12/R13, D10, D1/D5 |
| 07 06 08 | Other sill bottoms and reaction residues | A | 0.006-0.023 | R1, R12/R13, D10, D5/D15 |
| 07 06 10 | Other filter cakes and spent absorbents | A | 0.03-0.044 | R1/R11, R12/R13, D10 |
| 16 03 05 | Organic wastes containing dangerous substances | M | 0.004-0.045 | R1, R13, D10 |

[1]A: absolute hazardous, M: mirror hazardous, I: inert
[2] Recovery and Disposal Codes given in the EC's Waste Framework Directive.

*Natural and Extra Virgin Olive Oil Production*: Natural and extra virgin olive oil production can be summarized into five main steps, namely leaf separation, and washing, crushing, malaxation and separation, as shown in **Error! Reference source not found.**Figure 2. Olives must be cleaned from foreign matters in order to obtain high-quality oil and to eliminate the malfunctions that may occur in the machines. In the stage of crushing, the olive oil is extracted from olive tissues with stone mills and metal crushers. This process generates plant tissue waste and used filter cake and spent absorbent. Malaxation is for the oil droplets to become larger to form a continuous phase by breaking the oil/water emulsion. In the centrifugation step, the separation of oil, blackwater, and pomace oil occur simultaneously. Two-phase and three-phase centrifugation systems can be built in many sub-stages with different modifications and the waste code of 020303 is observed during oil extraction.

Table **2** lists the wastes generated by these processes with the related WGFs. As can be seen, for some waste streams, adequate WGFs could not be determined due to the limited amount of data available in TABS. This situation also caused an extremely wide range of WGFs for some wastes.
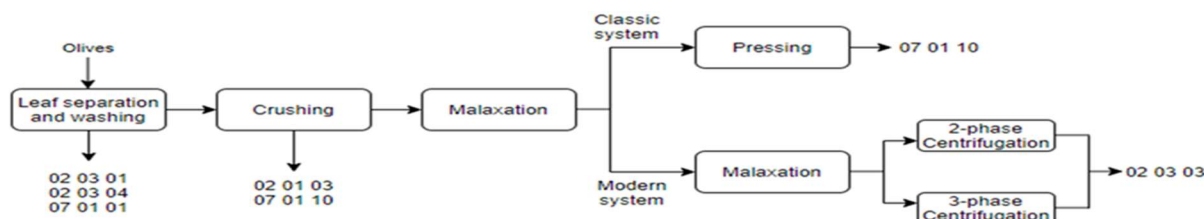


Figure 2. The production scheme of natural and extra virgin olive oil and waste points

Table 2. Process wastes from the production of natural and extra virgin oil

| Waste Code | Definition | T/M/İ* | WGF (g/kg oil) | Recovery (R) and Disposal (D) Codes |
|---|---|---|---|---|
| 02 01 03 | Plant-tissue waste | I | - | R1/R3, R12, D10, D5 |
| 02 03 01 | Sludges from washing, cleaning, peeling, centrifuging and separation | I | - | R1/R3/R9, R12/D9, D10, D1/D4/D5 |
| 02 03 03 | Waste from solvent extraction | I | 0.01-18 | R1/R2, R12/R13, D10 |
| 02 03 04 | Materials unsuitable for consumption or processing | I | 0.05-2 | R1/R3/R5/R9, R12/R13, D10, D1/D5 |
| 07 01 01 | Aqueous washing liquids and mother liquors | A | 0.02-3 | R1, R12/R13/D9, D10 |
| 07 01 10 | Other filter cakes and spent absorbents | A | - | R1/R5, R12/R13/D9, D10, D5 |

*Refined Olive Oil Production:* Raw olive oil is refined to allow the elimination of color, odor, or flavor of those oils that are unacceptable or to remove chemical compounds that might be toxic by the processes. The main processes are neutralization, bleaching with an adsorbent. Table 3 lists the wastes generated by these processes. As shown, WGFs could not be determined for this activity as there was insufficient data in TABS.

Table 3. Process wastes from the production of refined oil

| Waste Code | Definition | T/M/İ* | WGF (g/kg oil) | Recovery (R) and Disposal (D) Codes |
|---|---|---|---|---|
| 06 01 01 or 06 01 04 | Sulphuric acid and sulphurous acid or Phosphoric and phosphorous acid | A | - | R5/R6, R12/R13/D9 or R5/R10, R12/R13, D13 |
| 07 01 10 | Other filter cakes and spent absorbents | A | - | R1/R5, R12/R13/D9, D10, D5 |
| 16 08 07 | Spent catalysts contaminated with dangerous substances | M | - | R4/R7/R8, R13, D5 |

The identification of sector-specific process and non-process wastes and their WGFa is vital not only for the national authorities to implement correct management strategies but also for the waste producers to declare their wastes correctly. The use of the WGFs generated in the study and the future continuous update will enable the Ministry to obtain more accurate range of WGFs with better uncertainty and improve control mechanisms.