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Physicochemical Characterization of Olive Oil Mill Wastewaters in the eastern region of Morocco

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Abstract
The aim of this study is to achieve a complete physicochemical characterization of the samples of the olive oil mill wastewaters collected from five different prefectures in eastern Morocco (Oujda, Nador, Berkane, Taourirt and Jerada), A comparative study was investigated with several OOMW samples from three olive oil extraction processes (traditional, semi-modern and continuous) were compared. This research is one of the first studies investigating the physicochemical characterization of olive oil mill wastewaters oil mills crushing olives Oujda area. The composition of OOMW varies significantly for each mill. The results of the physicochemical analyzes showed that all the samples of olive oil mill wastewaters have an acidic pH, the average value is between (4.5 and 5.32); and the values of the conductivity are varied between: 23-41ms/ cm for the (PP and CP3P) but for the (CP2P) are varied between: 13-25 ms/cm, this high conductivity due to the addition of the salt during storage before their crushing olives. The OOMWs are rich in organic matter. This last parameter is expressed as BOD_5 and COD. The average of the total BOD_5, COD, biodegradability, of samples varied with oil extraction processes, for the (PP): (BOD_5: 17-25 g O_2/L; COD :108-120 g O_2/L; biodegradability: 0.11-0.25); for the (CP3P): (BOD5: 12.5- 23 gO2/L; COD :76-100; biodegradability: 0.16-0.23) and for the (CP2P): (BOD5: 8.5-19 gO2/L; COD :52-64 g O_2/L; biodegradability: 0.16-0.23). And the samples are riche of the Oxidizable matters (($COD+2BOD_5$)/3), therefore, the connecting this industrial facility to a municipal sewer system is impossible; because, any connection of the units trituration olives can lead to dysfunctional treatment plant wastewater; but which poses a great problem for these units trituration effluents is non-biodegradable material: polyphenols and tannins, the values(the samples of OOMW filtered) are varied: (polyphenols: 0.8-1.35 g/L and tannins :0.62-1.2 g/L) for the PP, for CP3P (polyphenols: 0.29-1.83 g/L and tannins :0.2-1.71 g/L), but for the (CP2P) are varied between (polyphenols: 0.24-0.67g/L and tannins :0.12-0.65 g/L). In this article, recent and older research studies for the physicochemical characterization of olive mill wastewaters performed by several authors were shown.

Key words: Acidity; Turbidity; Density; BOD5 ;COD; polyphenols; tannins ; Sugars; fats ; Heavy metals

1. Introduction

Olive oil industries are a fundamental economic and social importance for many Mediterranean countries such as Spain, Italy, Greece, Turkey, Tunisia and Morocco **[1-2]**. The olive oil production of these countries represents 94% of world production. In 2001, world production was reached 2.5 million Tones **[3]**; For 2003-2004, the estimated production of olives and olive oil in Morocco is 1.000.000 Tones and 100.000 tons respectively, for an area of 580.000 ha **[4].** Throughout the Mediterranean area, the production of olive oil generates about 30 million Tons of olive oil mill wastewaters yearly **[5]**. Olive production is very important in all regions of Oujda, this is due to large areas of planting olive reflects the great efforts of the State in terms of the Green Morocco.

The extraction of olive oil is achieved mainly by two processes: discontinuous (pressing) in the traditional mills or continuous (centrifuging) in modern units, Three extraction systems are now used **[6]**, Batch processes or Press system where the olives are crushed with millstones. Olive oil is extracted using mechanical presses, this process is traditional in small non-motorized units that use animal power or semi-modern in large power units. Along with the development of the olive sector, traditional batch systems (washing olives, mechanical grinding, mixing) are being replaced by modern equipment, This improvement is less expensive and allows extracting the oil continuously in successive phases by centrifuging and separation of oil of others by-products [7]. In continuous processes or systems centrifugation, it takes place either by a continuous process in three stages or in a continuous process in two phases (green method) [6]. The continuous process uses rotary hammers for crushing olives in which the oil is separated from the water using industrial centrifugation.

Olive oil extraction processes generate three phases: olive oil, solid residue and aqueous liquor which represents 20-50% of the total weight of the processed olives [8]. Whether the discontinue system or centrifugation system used, in addition to its main production is oil (extra virgin oil and pomace oil), the olive oil processing industry has two by-products waste are obtained, the one is solids resulting from the squeezed residue (pulp and olive stones), called "pomace", this product can be transformed in a product intended for animal feed or said oil: olive pomace after chemical extraction [9-10], the other is a dark red to black liquid effluent called "Olive Oil Mill Wastewater" (OOMW) [11-15]; this activity produces huge quantities of liquid and solid wastes during a short period of time (November–March) [16-17]; Pressing a ton of olives produced an average of 1.5 tones of OOMW with modern ways of production [18]. While processing olive oil, the olive fruit is pressed and an amount of water is added, this amount depends on the process used; In the discontinuous process, this quantity is relatively low (about 40%), but in the continuous system, it ranges from 70 to 110% [19]. The both continuous process (two-phases (CP2P) and three-phases (CP3P)) seem to produce larger quantities of OOMW per unit of processed olives compared with the traditional system (press process) [20]. By definition, the Olive oil Mill Wastewater (OMW) is the liquid by-product generated during olive oil production [21] of the three processes of olive oil extraction from olives; Effluent olive oil mills are brown to reddish brown, with cloudiness [22-23]; this black liquid wastewater is composed of the olive fruit vegetation water, the water used for washing and treatment, a portion of the olive pulp and residual oil [24]. They hold olive pulp, mucilage, pectin, oil, etc., suspended in a relatively stable emulsion [25].

In general, the olive oil mil wastewater contain a variety of organic and inorganic compounds of different nature and concentration; several factors can affect the quantity, the quality and physicochemical composition of the by-products extraction of olive, especially liquid waste "OOMW", during extraction and/or after their discharge into receiving medium, including: climate and soil conditions, olive cultivars, agronomic practices adopted in the field [26], cultivation practices such as fertilization [27], olive variety, the irrigation management [28], the ripeness of fruits, the place and age of growth, yearly changes, harvesting period, storage time and conditions of olive and the type oil extraction processes [29-44]; The volume of this liquid waste varies from: 40–60 L for pressing method, but, this volume is varied to 80–100 L for three-phase centrifugation technique per 100 kg of olives [45].

The uncontrolled disposal of olive oil mill wastewaters (OOMW) represents a major social, economic, and environmental problem in Mediterranean olive oil producing countries [46-48]; up to now, the principal destinies of (OOMW) are either direct spreading to agricultural soils, OMW spreading to agricultural soils could be a successful way of OMW valorization if spreading is done in controlled conditions with convenient doses[49-52], or constructing artificial big ponds into which OMW is stored, awaiting for its natural evaporation. However, this elimination method, besides being very slow, requires relatively large evaporation surfaces, with associated investment costs including permeability treatments, causes subsequent unpleasant environmental pollution linked to generation of bad odors due to anaerobic activity [53], infiltration and insect proliferation [37], and generating volatile malodorous compounds, threatening the groundwater and decreasing the surface of arable land because new ponds are dug each year to hold new (OOMW) [38]; its disposal into watercourses could lead to deterioration of natural water bodies, pollution and environmental degradation [54-55], with the dangerous effects, such as coloring of natural waters, threat to the aquatic life, causing surface and ground water pollution, changing soil quality and plant growth and causing odors; and caused dysfunctional of the wastewater treatment plant (WWTP) mainly by OOMW from crushing units installed in large agglomerations (city), which are discharged their effluents directly into equal conduits sewage stations. No chemical or biological effective treatments are available to deal with these olive oil mill wastewaters and mitigate their impact on receiving systems [56], the difficulties of treatment of olive mill effluents are mainly related to: high organic loading, the olive mill wastewaters are 100-400 times higher heavily loaded with pollutants than more than ordinary domestic wastewater [57-58], seasonal operation, high territorial scattering and presence of organic compounds which are hard to biodegrade, such as long-chain fatty acids and phenolic compounds [59], and the high cost of the treatment [16].

The objective of this study is to achieve a complete physicochemical characterization of the samples of the olive oil mill wastewaters collected from five different prefectures in eastern Morocco (Oujda, Nador, Berkene, Taourirt and Jerada), A comparative study was investigated with several OOMW samples from three olive oil extraction processes (traditional, semi-modern and continuous) were compared.

2. Material and methods

2.1. Samples and materials:

All samples of olive oil mills wastewater used in this study were obtained from five prefectures in the region of the Eastern of Morocco (Oujda, Berkane, Nador, Taourirt and Jerada) between November and December harvest season 2012–2013, Samples were taken from the storage tank of olive oil mill wastewaters in crushing units and they are homogeneous, OOMWs were collected from several olive oil mills operating with two, three phase and the traditional process, the choice of type of mills is based on the abundance of the pulping process in each region, Samples of OOMW were obtained from twenty-one different units in the area of Oujda: several samples from each process (four from the traditional press process(PP), twelve from the semi-modern press process (CP3P) and five from the continuous process (CP2P)), all samples are presented in **Table 1 and Fig.1**, the OMWW was collected in a closed plastic container, all samples were immediately analyzed for determination pH, conductivity, dissolved oxygen, turbidity and temperature, then were maintained at 4°C so prevent biodegradation.

Table.1. Different type samples of olive oil mill wastewaters obtained from the eastern of Morocco.

Type oil mill	Prefecture	City / companion	Name of oil mill	symbol	Amount of olive triturated (T/Day)	Debit of OOMW (T/Day)
Traditional units "maâsras" or Press Process [PP]	Taourirt	El Ayoune Mestergmer	Lakhmiss	AP	0,5	0.7
	Taourirt	El Ayoune Mestergmer	Atlahoualt	LP	0,5	0.8
	Taourirt	El Ayoune Mestergmer	Msamda	MP	0,5	1
	Taourirt	El Ayoune Mestergmer	Tizi zamour	TZP	0,5	0.8
Semi-Modern Oil Mills or Continuous Process Three-Phases [CP3P]	Taourirt	Taourirt	Ahl Oued Za	AOSM	3	4
	Oujda	Street Sidi Yahya	El Baraka	BSM	15	20
	Berkane	Aghbal	Charraa	CSM 1	10	13
	Berkane	Aghbal	Charraa	CSM 2	10	13
	Nador	Driouache	Driouache	DSM	3	4
	Nador	El Aroui	El Haj Bouzaan	HBASM	7	9
	Oujda	Industrial Area	El Jaouda Al Assria	JOSM	15	20
	Nador	Ain Zora Lamtalssa	El Nour	NNSM	10	14
	Oujda	Oujda-city	Haj Mhammed (CTM)	OSM 1	10	15
	Oujda	Oujda-city	Haj Mhammed (CTM)	OSM 2	10	15
	Jerada	Guenfouda	Tinzi	TSM	6	7.5
	Taourirt	Industrial Area	Zone Industrielle	ZISM	20	25
Modern oil mills or Continuous Process Two-Phases [CP2P]	Oujda	Street Bouchtat	Association Angad	AM	10	7
	Taourirt	Mestermer	Association Olivier	AOMM	15	10
	Berkane	Ain Regada	Investissement	ARM	15	10
	Taourirt	Melg El Ouedane	Lakrarma	LM	15	10
	Taourirt	Industrial Area	Moustaine	MM	15	10

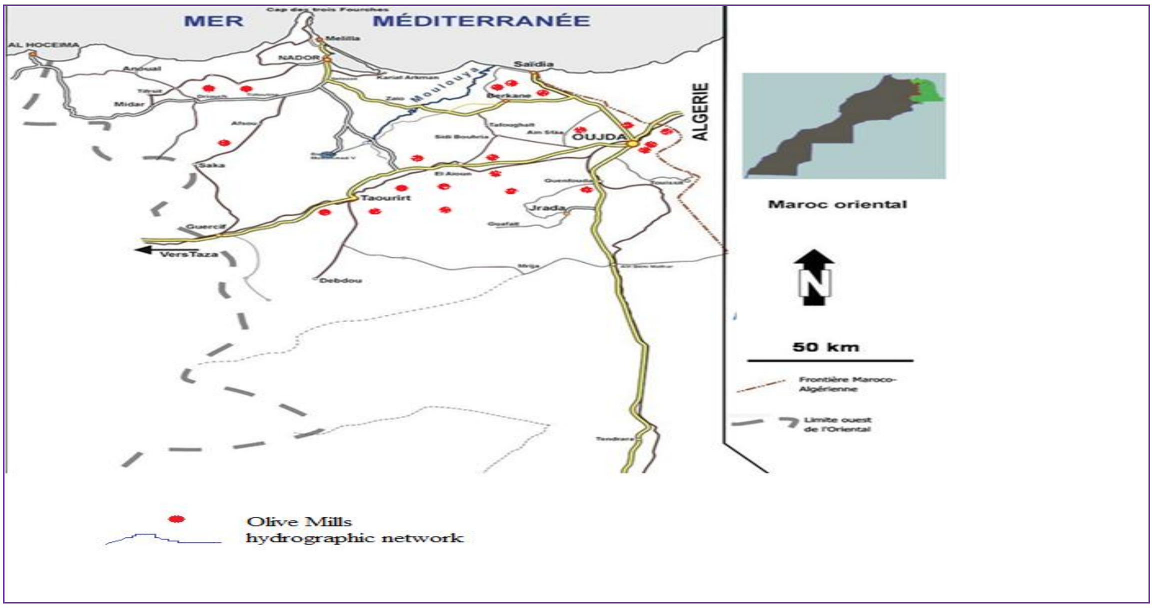

Fig.1. Location of the unity of trituration in the eastern Morocco.

1.1 Analytical methods

1.1.1 Physical and others parameters [60]:

pH: NF T 90-008. Water quality-Determination of pH. February, 2001.

was measured in a suspension of 50 ml of olive oil mill wastewaters at ambient temperature by a pH-meter instruments previously calibrated with buffer solutions pH 4, 7 and 10 immediately after sampling; pH measurement is done directly in the raw effluent olive oil mills at room temperature.

Acidity:

For the determination of acidity (percentage of oleic acid), 15 ml of olive oil mill wastewaters were transferred into three 50 ml beakers and dissolved in 10 mL of ethanol 97%. These fatty acids are titrated with NaOH solution (0.1 N) in the presence of phenolphthalein and continued up to pH8**.** A control test (without fat) was performed under the same conditions **[61]**.

Electrical conductivity (EC) and overall mineralization:

A digital calibrated conductivity-meter (Radiometer CDM 230) is used to measure the conductivity of the Olive oil mill wastewaters (OOMW) samples.

Dissolved oxygen (electrochemical method); Norm AFNOR NF T 90-032. Water quality - Determination of dissolved oxygen.

Measured using a device specific measure (oximetry Modèle DO700), the potentiometric method enables rapid, the dissolved oxygen concentration, at the measurement temperature, is expressed in mg /L

The turbidity: AFNOR NF EN ISO 7027 (March 2007). Water quality - Determination of turbidity (index: T-90-033).

Measured with a turbid-meter (Turbo 550IR), and expressed in NTU (Nephelometric Turbidity Units).

Density:

Determined by weighing an exactly measured volume of Olive Oil Mill Wastewaters using a Bench scale with protection type IP KERN FFNN.

Pouvoir Encrassant en % (P en %):

The only measure of turbidity does not appreciate the entire load carried by water, including plankton load of surface waters. This charge may, in some cases, lead to a rapid clogging of filters.

It may be interesting to know the clogging of water power. The method used is essentially designed to filter water on a stainless steel fine mesh fabric and measuring the volume likely to pass before complete blockage of the filter cloth water. Called reverse clogging limiting volume (expressed in liters) which fills 1 m2 of the device power.

Fouling Index:

The determination is based on the measurement of the rate in which a membrane having a pore diameter of 0.45 microns becomes clogged during a filtration continues at a constant pressure of 2.1 bar (30 psi) on a membrane acetate cellulose having a diameter of 47 mm.

1.1.2 Organic fraction of the olive oil mill wastewaters:

Total suspended solids (TSS) and the moisture: NF T 90-105-2 (January 1997).Water quality-Determination of suspended solids - Method by centrifugation.

The determination of suspended solids in the liquid samples is effected by filtration or centrifugation. The centrifugation method is especially reserved for effluent containing too much colloidal material to be filtered in good condition, especially if the filtration time exceeds one hour as effluents from mills. The TSS is determined by centrifugation a aliquot (50 ml) of crude samples of the olive oil mill wastewaters during 20 min at 4000 rpm, content (MES) is determined by weight difference before and the pellet after centrifugation and drying in an oven at 105°C for 2 h (AFNOR T 90-105). The total solids were determined according to the weight loss of the sample after being placed in an oven until reaching constant weight. The difference in weight with respect to the original sample, expressed in %, determined the moisture content. The total solids were calculated by subtracting between 100 and the moisture (humidity) **[62].**The ash content was determined after calcination of the dry sludge at 550 ◦C for 2 h in a muffle four. The difference between TSS and the ash content was defined as volatile suspended solids (VSS) **[63]**.

The biological oxygen demand (BOD_5): Respirometric method (manometric).

Biological oxygen demand (BOD5) signifies the biodegradable fraction of organic matter in olive oil mill wastewaters, involving bacteria and fungi, it is determined the manometric method with a respirometer (BSB-Controlled Model Oxi-Top (WTW), in a thermostat at 20°C for 5 days enclosure of olive oil mill wastewaters samples were previously diluted with water bi-distil**[64]**, the pH of the sample must be between 6 and 8, Otherwise, it will be brought into this range by using hydrochloric acid or sodium hydroxide solutions to about 0.5 mol / L.

The chemical oxygen demand (COD): NF T90-101 (February 2001). Water quality - Determination of the chemical oxygen demand (COD) (index: T90-101).

COD level was measured using the open reflux method in accordance with the standard methods for the examination of water and wastewater **[65]**, by oxidation of organic matter in the sample with an excess of potassium dichromate in acid medium and in the presence of sulfate silver, the role of the catalyst is to facilitate oxidation, but it is not, however, in the presence of total (aromatic pyridine derivatives, aliphatic long-chain compounds) stable organic compound, the mixture was then incubated for 120 min at 160°C in a COD reactor (Model 45600-Hach Company, USA). Subsequently, the remaining unreduced $K_2Cr_2O_7$ was titrated with ferrous ammonium sulfate (approximately 0.25 M) to determine the amount of potassium dichromate consumed and the oxidizable matter were calculated in terms of oxygen equivalent.

Biodegradability of olive oil mill wastewaters (Method using global parameters COD and BOD)

Is measured according to the ratio between the biochemical oxygen demand (BOD5) and the chemical oxygen demand (COD).

Oxidizable matters:

Oxidizable matter (MO) is a weighted average of the two global parameters COD and BOD5, both COD and BOD parameters were measured after 2 hours decanting effluent (DCOad2 and DBO5ad2), Since the COD and BOD, Oxidizable matters are expressed in g / L (or mg / L) of oxygen.

The total phenolic content:

The total phenol content of Olive Oil Mill Wastewaters was determined calorimetrically on a Shimadzu UV 1240 spectrophotometer using the Folin–Ciocalteu reagent (FCR) (Flucka, England), according to the procedures described and developed by several authers **[66-72];** In the presence of polyphenols, the mixture of phosphotungstic acid ($H_2PW_{12}O_{40}$) and Folin ($H_3PW_{12}O_{40}$) is reduced to tungsten blue oxide (W_8O_{23}), color has a maximum absorption at 760 nm. The selective reagent for polyphenols (FCR) was used at 1:10 dilution in distilled water. Aliquot of the sample of the Olive Oil Mill Wastewaters standard was diluted then mixed with the Folin–Ciocalteu reagent and 1 ml of a sodium carbonate saturated solution 20%. The final solution was left in the dark for 1 h, after which the absorbance of the solution was measured at 725 nm and compared against a blank prepared following the same protocol but without any sample. A range of Gallic acid concentrations from 0.0005 to 0.02 g/ml was used to prepare the calibration curves; the gallic acid was used as standard to quantify the concentration of phenols in OMW [73-74].The Results were expressed in terms of Gallic acid equivalent g/L.

Tannins determination:

The method used is based on the technique for the determination of phenolic compound in plants and is adapted by [75] for the determination of olive oil mill wastewaters tannins.

Total sugars:

Total sugar content of olive mill wastewater samples were analyzed by spectrophotometer, using the method of [76], 1 ml of the sample is mixed with 1 ml of phenol solution (5%) and 3 ml of concentrated sulfuric acid (97%), Acid hydrolysis (H_2SO_4 1N) for 4 hours at 100° C allows to transform polysaccharides on the free sugars, After stirring, the tubes are kept in the dark for 10 min then transferred to a water bath at 30°C for 30 min, sugars are reacted with phenol and concentrated sulfuric acid and give a yellow-orange coloring, the optical density is measured at 488 nm, The values obtained are converted into concentration by reference to the standard curve of D-glucose previously established.)

Residual oil:

Extraction of residual oil was performed on OOMW dry matter using only hexane as solvent [77].

1.1.3 Mineral fraction of the olive oil mill wastewaters:

$PO4^{3-}$: Dosages of orthophosphate (Method by molecular absorption spectrophotometry).

Orthophosphate (PO_4) is determined by the colorimetric method, by training middle of a phosphomolybdic acid complex, which is reduced by ascorbic acid in a complex of blue color whose intensity is determined by spectrophotometer at 700 nm [64].

NO3-: Determination of nitrate (sodium salicylate method).(quality limit "Drinking Water") method of molecular absorption spectrometry.

In the presence of sodium salicylate, nitrates paranitrosalicylate give the sodium yellow colored and capable of a spectrometric assay, perform readings spectrometer wavelength of 415 nm and reflect the value read to the witness, refer to the calibration curve. For a test sample of 10 mL, the curve directly gives the nitric nitrogen content in milligrams per liter of olive oil mill wastewaters. For the nitrate (NO_3^-), multiply the result by 4.43.

Cl-: Dosage chlorides: AFNOR NF ISO 9297 (February 2000) - Water quality - Determination of chloride - titration with silver nitrate with potassium chromate as indicator (Mohr method) index (T90-014 ranking).

Chlorides are determined according to the standard [78]; they were measured by the method of Mohr titration with silver nitrate and potassium chromate.

Major Elements and Trace Elements metallic (atomic absorption spectrometry with flame (FAAS)). NF T90-020. Examination of water - Determination of sodium and potassium Method by atomic absorption spectrometry. August 1984. And NF T90-112. Water quality - Determination of the eight metallic elements (Mn, Fe, Co, Ni, Cu, Zn, Pb) by atomic absorption flame. Direct assays and after complexation and extraction. July 1998.

The content of the olive oil mill wastewaters in Macro-and micro-elements (Sodium (Na^+), potassium (K^+), magnesium (Mg^{2+}) and calcium (Ca^{2+})) and metallic trace elements (Iron, copper, zinc, cobalt, nickel, cadmium, lead) were brought into solution by acidic digestion (HNO3 and HCl), then analyzed by an atomic absorption spectrophotometer.

Experiments were made at the center of Oriental Science and Technology of Water (COSTE), Faculty of Science, Oujda.

3. Results and discussion

Olive oil mill wastewaters characterisation:

All physicochemical analysis was repeated three times, the reported results are averaged.

1. *Physical and organoleptic properties parameters of olive oil mill wastewaters (OOMW).*

1.2 pH and the acidity:

The acidic pH is a fundamental characteristic effluent mill with values between (4.5 and 5.32) for different processes trituration of olive oil [Fig.2], these results are confirmed with the values obtained by several researches such as [79], also values acidity lie within the range between (1.19% and 1.56%) [Fig.2], same results are found by [61]; It is noticed that the acidity was higher in all the samples of olive oil mill wastewaters, this is explained by self-oxidation reactions and polymerization of phenolic compounds which convert during the storage olive oil mill wastewaters before measures the acidity of the samples [80]; these reactions occur by a change in the initial color of olive oil mill wastewaters with a very dark black color [81].

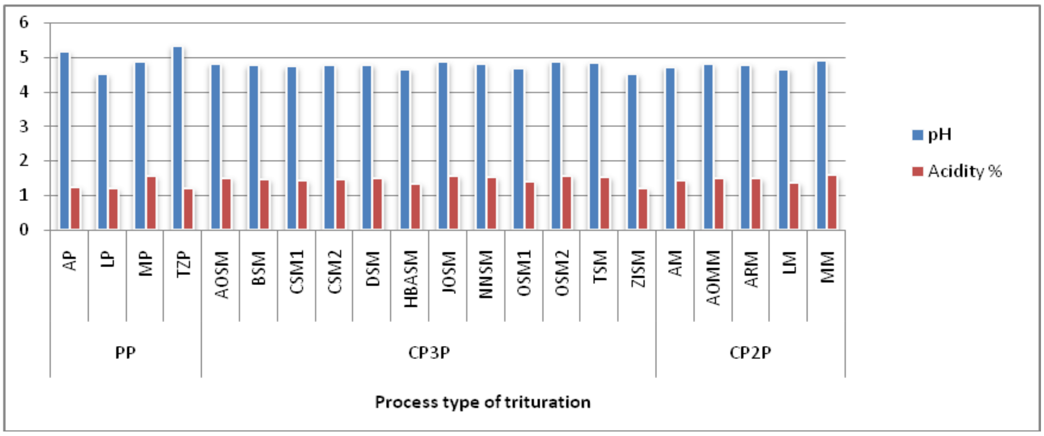

Fig.2. pH and acidity values of different of Olive Oil Mill Wastewaters of three extraction process of olive oil.

1.3 Electrical conductivity (EC):

The conductivity measurement is a good assessment of the degree of mineralization of olive oil mill wastewaters, where each ion is characterized by its concentration and specific conductivity, the electrical conductivity is strongly related to the concentration of dissolved substances and to their nature; in the case of olive oil mill wastewaters, the conductivity varies from one system of trituration to another, and it can take values ranging between 13 and 50 [38, 82].

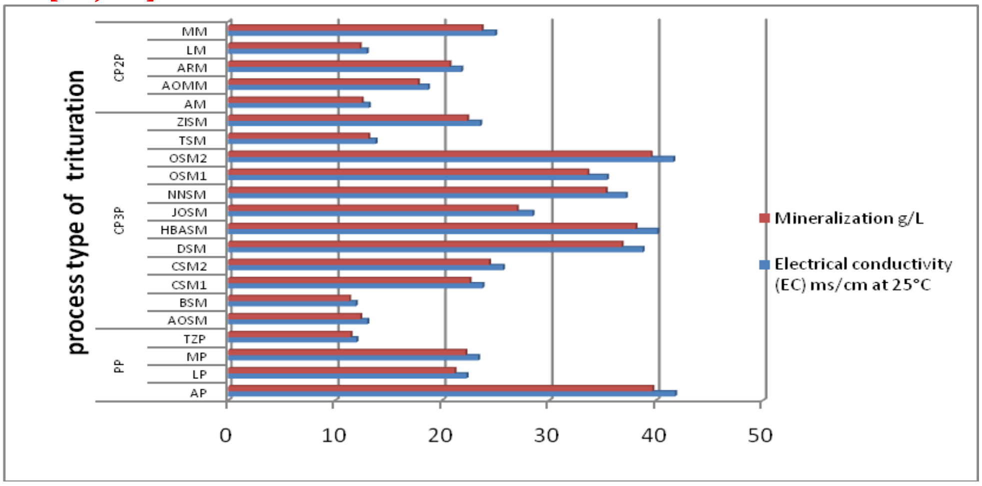

Fig. 3. Electrical conductivity and mineralization concentrations of different of Olive OMW of three extraction process of olive oil.

The results obtained in our study are comparable to those found in the literature, we found respectively for both press process (PP) and continuous process three-phases (CP3P) same resultants (23 to 41 ms/cm) but for the continuous process two-phases (CP2P), the values of the conductivity was varied between (13 and 25 ms/cm) [Fig.3]; this measure does not necessarily give an immediate idea of the mineral matter of the oil mills effluent [83]; the highest concentrations of the salt present in these effluents due to salting practices for the conservation of olives before crushing in addition to the natural wealth of olive oil mill wastewaters dissolved minerals.

1.4 Dissolved oxygen:

The study of dissolved oxygen parameter is very important because it provides information about the quality of the effluents studied, this is one of the most sensitive to pollution parameters, its value provides information on the degree of pollution and consequently the degree of self-purification in storage basin olive oil mill wastewater or in a stream; dissolved oxygen levels observed in all the samples of olive oil mill wastewaters of our study in three extraction process of olive oil present in the Oujda area was changed as follows, for press process [PP] between 0.15 to 0.17 mg/L, continuous process three-phases [CP3P] between 0.1 to 0.27 mg/L, but for the continuous process two-phases [CP2P] between 0.14 to 0.41 mg/L, (0.1 to 0.41 mg/L) **[Fig.4],** the low level of dissolved oxygen observed in the all samples of olive oil mill wastewaters are caused by their consumption by bacteria to decompose biodegradable organic matter releases of high crushing units olive **[84].** The results obtained in our study are in the interval several studies, between 0.2 to 3.4mg/L, such as **[38]**.

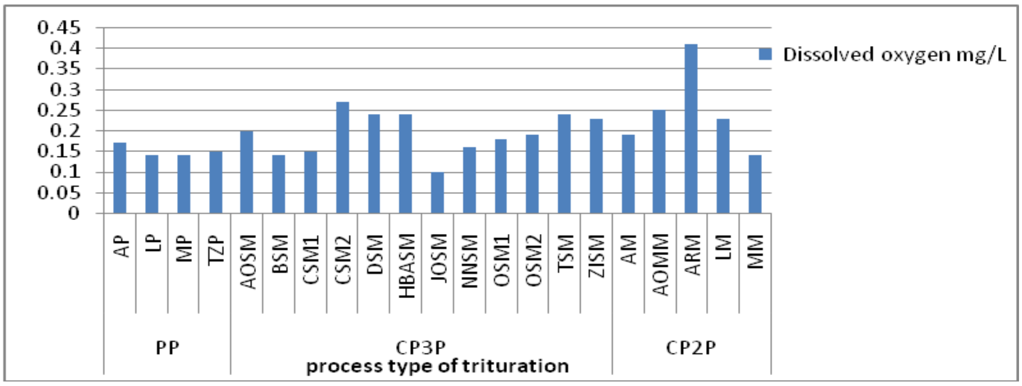

Fig.4. Dissolved oxygen concentrations of different of Olive Oil Mill Wastewaters of three extraction process of olive oil.

1.5. The turbidity:

The oil mill effluent turbidity is generally very high between 2654 and 2662 NTU **[Fig.5]**, The turbidity of the olive oil mill wastewaters is due to the presence of particles in suspension, including colloidal: organic materials, the results obtained in our study are similar as those **[85-86]** between 2249.3 and 2640 NTU).

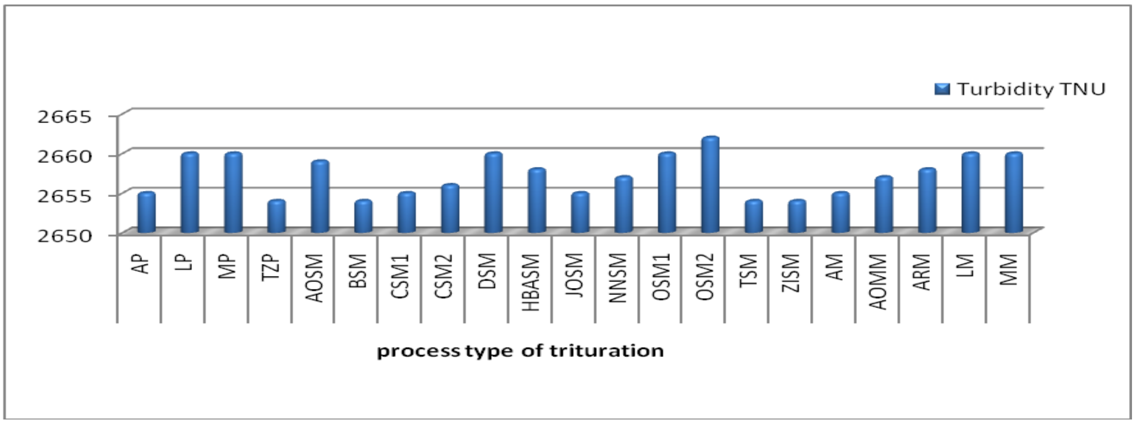

Fig.5. Turbidity values of different of Olive Oil Mill Wastewaters of three extraction process of olive oil.

1.6 Fouling Index:

Single measurement of turbidity is not possible to assess the content of olive oil mill wastewaters matter clogging; each clogging substance in the solution participates in the filter blocking the pores, the porous surface therefore decreases in proportion to the volume of olive oil mill wastewaters filtered until complete blockage of the membrane pores to form a cake. The clogging results from the accumulation of material on the surface of membranes and a wide spectrum of species present in the olive oil mill wastewaters can contribute to clogging, such as organic macromolecules (humic substances, polysaccharides, proteins ...), various organic or inorganic substances dissolved, colloidal substances, suspended particles or microorganisms. Clogging induced decreases in permeation flux and it is also the source of significant decreases lives membranes, all values obtained in our study of clogging are varied between 4.3 and 6.3 **[Fig.6].**

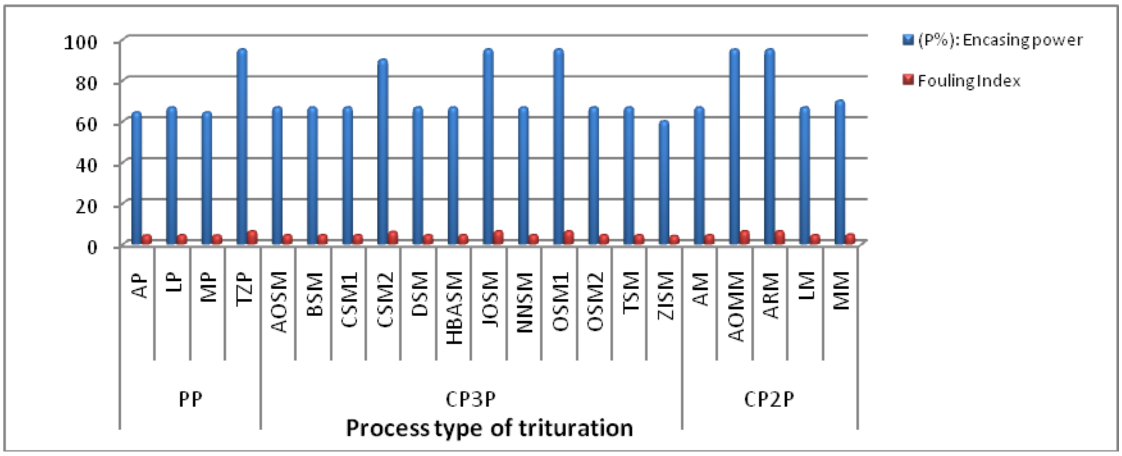

Fig.6. Encasing power and Fouling Index values of different of Olive Oil Mill Wastewaters of three extraction process of olive oil.

1.7. Density:

The density is the weight of the olive oil mill wastewaters per its unit volume (mL), which depends on the temperature of the effluents; the results of the density of different samples of olive oil mill wastewaters are superior to the density of water (0.99707 g/cm^3 at 25°C), the results obtained in our study are varied between 1.001 and 1.05g/cm^3 **[Fig.7]**, similar values (1.1g/cm^3) was found by **[4]** and (1.01 g/cm^3) by **[79].**

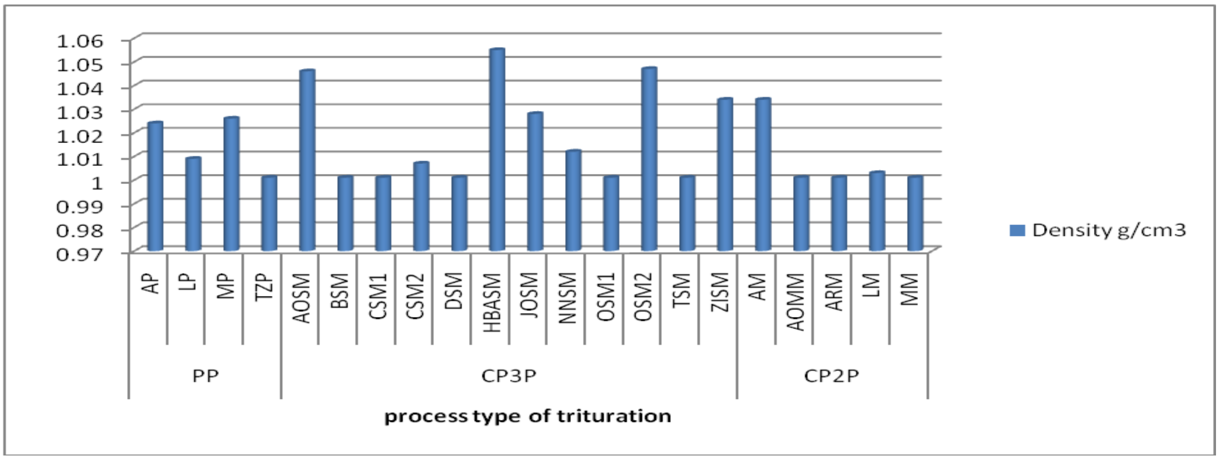

Fig.7. Density values of different of Olive Oil Mill Wastewaters of three extraction process of olive oil.

The dark color intensity:

Since the first overview of olive oil mill wastewaters, were found to represent a brown color to reddish-brown, which becomes darker during storage, with a cloudy appearance and a strong smell that reminds one of olive oil.

2. Organic fraction of olive oil mill wastewaters: (OOMW).

The organic matter olive oil mill wastewaters comprise two fractions: a fraction insoluble consisting essentially of olive pulp material which is suspended and colloidal **[80]**, and a fraction soluble in the aqueous phase which contains sugars, fats, nitrogen compounds, organic acids and phenolic compounds **[80, 87].**

2.1 The biological oxygen demand (BOD5) and the chemical oxygen demand (COD):

The olive oil mill wastewaters are rich in organic matter expressed in terms of BOD_5 (biological oxygen demand) and COD (chemical oxygen demand). From the **[Fig.8],** the values obtained for the process press(PP) are about (BOD_5 :17 to 25 g/L) and (COD: 108-120 g/l), for continuous process three-phase(CP3P) we found for (BOD_5 :12.5 to 23 g/l) and (COD: 76 to 100 g/l) and for continuous process two-phases (CP2P) a value of about (BOD_5 :8.5 to 24 g/l and (COD:52 to 64 g/l). The obtained values are almost comparable to those obtained with several authors presented in the **[Table.2];** carbon oxidation of organic matter of olive oil mill wastewaters can schematically be written using the following equation: organic matter + oxygen + microorganism nutrient will give biodegradation byproducts (CO2, H2O, NH3 ...) + bacterial biomass. Certain reducing bodies as sulfides, sulfites, ferrous iron, that may be encountered in industrial effluents react also on the oxygen consumption.

2.2 Biodegradability:

Evaluating the ability of the olive oil mill wastewaters to biodegrade has a vital interest for the treatment. This effect is more or less the ability to biodegradation that will determine the choice of method of treatment (treatment of biological or physicochemical). Both global pollution parameters COD and BOD5 allows a good approach biodegradability, COD representing organic matter in its entirety and BOD only biodegradable fraction,
If all the organic matter of olive oil mill wastewaters sample were biodegradable should have: BOD= COD.
Many organic molecules present in the olive oil mill wastewaters are not biodegradable such as the polyphenolic compounds or however very slowly. In this case we observe: BOD < COD. BOD_5/COD allows getting a realistic idea of the biodegradability of an effluent such as OOMW.
For industrial effluents, which may contain a significant fraction of non-biodegradable compounds can be considered as the BOD5/ COD report that the ability to biodegradation is not conducive to biological treatment, the following rules are generally used:

- BOD_5/ COD> 0.33 effluent readily biodegradable
- 0.2 < BOD_5/ COD <0.33 effluent medium biodegradable
- BOD_5/ COD > 0.2 effluent readily biodegradable or non-biodegradable

For samples of our study are readily biodegradable or non-biodegradable **[Fig.8].**

2.3 Oxidizable matters:

In urban effluents, Oxidizable matters represent a significant pollutant load and are taken into account in the definition of a population equivalent, but this setting is also very useful for assessing the pollution load of industrial establishments, according to the industry; it helps to explore the possibilities of connecting this industrial facility to a municipal sewer system; Therefore, any connection of the units trituration olives can lead to dysfunctional treatment plant wastewater (TPWW) **[Fig.8]**.

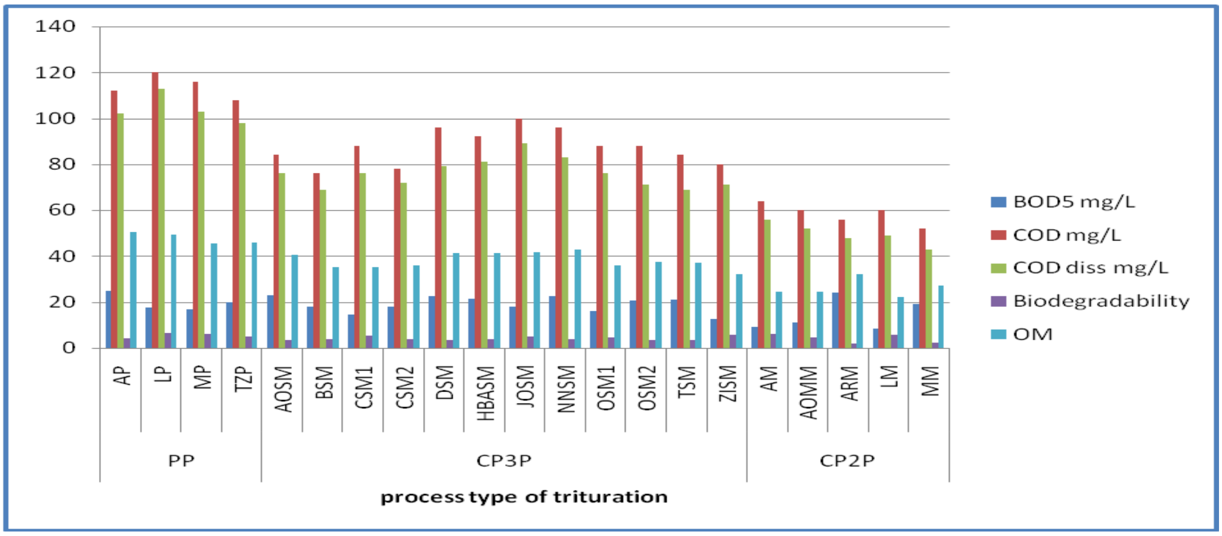

Fig.8. Organic load biodegradable and non-biodegradable of different of Olive Oil Mill Wastewaters.

2.4 Total suspended solids (TSS) and the moisture:

Suspended solids represent all mineral and organic particles in the olive oil mill wastewaters; high suspended solids concentrations can be regarded as a form of pollution.

The OOMW studied in this research are moderately loaded suspended solids, from the mean results obtained, the values of TSS are: 27.4, 18.7 and 19 mg/L) for press process, continuous process three-phases and continuous process two-phases, respectively **[Fig.9]**.

Table.2. Main Organic matter (COD and BOD) characteristics of olive oil mill wastewaters (OOMW) given by several authors.

Process type	COD Total	COD dissous	BOD_5	BOD_5/COD	(COD+2BOD_5)/3	AUTHORS
PP	108-120	98-113	17-25	0.11-0.25	47.3-56.7	our study
	57.8	n.d.	n.d.	n.d.	n.d.	**[14]**
	76.18-104.31	n.d.	25.35	0.24-0.33	42.3-51.7	**[61]**
	60.5	n.d.	10.2	0.17	27	**[98]**
	117.1	n.d.	38	0.32	64.4	**[99]**
	48.5	n.d.	15.3	0.32	26.4	**[100]**
CP3P	76-100	69-89	12.5-23	0.16-0.23	31.3-45	[our study]
	120	n.d.	67.5	0.5625	85	**[16]**
	130	n.d.	55	0.42	80	**[30]**
	52.1	n.d.	23.8	0.46	33.2	**[79]**
	36.9	n.d.	12.5	0.34	20.6	**[101]**
	0.03924	n.d.	0.01503	0.38	n.d.	**[102]**
	20	n.d.	n.d.	n.d.	n.d.	**[103]**
	93	n.d.	46	0.49	61.7	**[104]**
	177	n.d.	94	0.53	121.7	**[105]**
	65.3	n.d.	n.d.	n.d.	n.d.	**[106]**
	78	n.d.	49.08	0.63	58.7	**[120]**
CP2P	52-64	43-56	8.5-19	0.16-0.23	23-34	[our study]
	73.87	41.4	44.53	0.6	54.3	**[4]**
	112.5	n.d.	19.25	0.17	50.3	**[85]**
	29.36	18.11	n.d.	n.d.	n.d.	**[107]**
	5.5843-17.2785	n.d.	0.5-9.5	0.55-0.9	2.2-12.1	**[108]**

n.d. not determined.

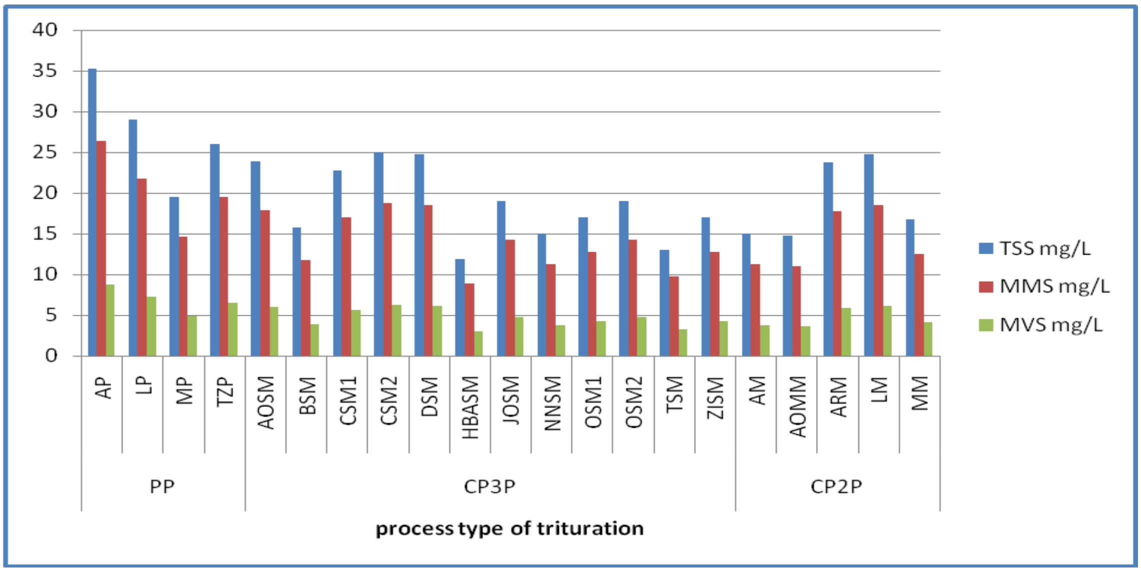

Fig.9. TSS, MMS and MVS concentrations of different of Olive Oil Mill Wastewaters of three extraction process of olive oil.

The mean values of the humidity are varied from 72.5% to 80% for process press, 75.5 to 84% for the continuous process three-phases, and from 69 to 76% for the continuous process two-phases **[Fig.10]**; same results of humidity are referred by several authors such as **[88]** and other research, it is about 82.18% ± 0.05.

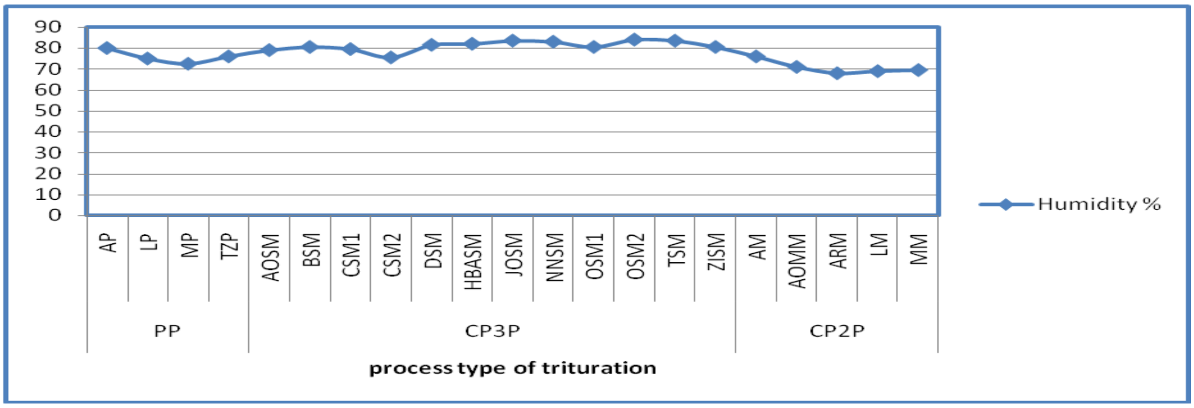

Fig.10. Humidity values of different of Olive Oil Mill Wastewaters of three extraction process of olive oil.

2.5 The total phenolic content and tannins:

The contents of phenolic compounds and tannins in olive oil mill wastewaters are lower than those reported by most authors **[Fig.11 and Table.3]**; this is due, on the one hand that the samples of olive oil mill wastewaters are centrifuged and filtered before the determination of polyphenols and tannins concentrations, and on the other hand, to the nature of the olive oil mill wastewaters. These last are not fresh olive oil mill wastewaters; they come from storage basins after the trituration process, phenolic compounds were degraded during storage and thus reducing their content which explains our results.

The phenolic composition of olive oil mill wastewaters depends not only on the variety, fruit maturity and climatic conditions, but also technological processes used to separate the aqueous phase (olive oil mill wastewaters) of the oil phase.

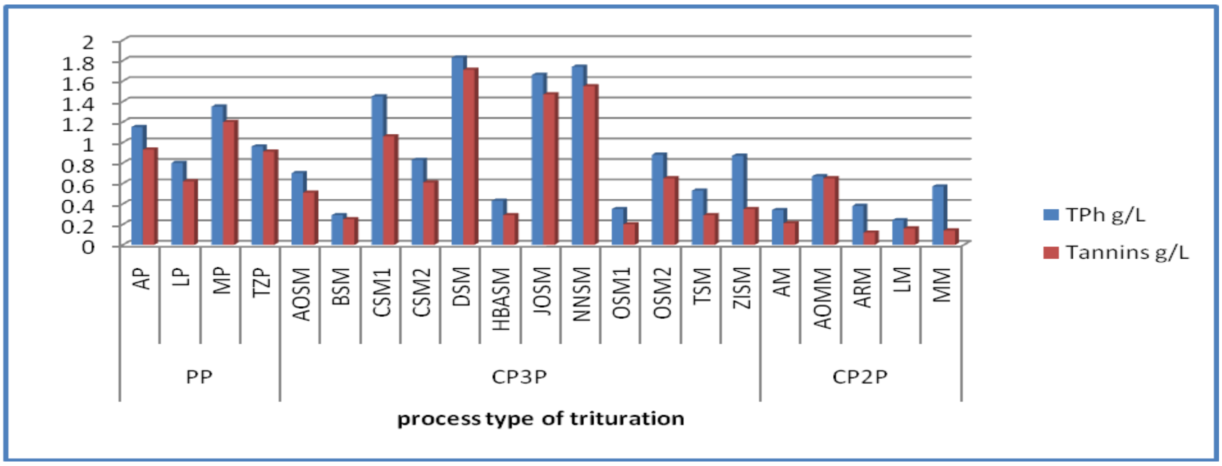

Fig.11. Phenolic compounds concentrations of different of Olive Oil Mill Wastewaters of three extraction process of olive oil.

2.6 Total sugars:

Carbohydrates are primarily represented by the parietal components, in particular cellulose and pectin, the latter play an important role in texture olives where they account for approximately 0.6% of the weight of the fresh pulp **[87, 89],** and recently, many studies have shown that the OOMW are very rich in simple sugars **[90-92].** The most common olive oil mill wastewaters in simple sugars are, in particular, raffinose, sucrose, arabinose, xylose, glucose, mannose, and fructose, the concentrations of sugars found in this search comparing with other research **are shown in [Fig.12 and Table.3].**

2.7 Residual oil:

Tenure residual fat present in OOMW depends on the system of olive oil extraction, the centrifugation process provides low rates compared to traditional processes **[93]**. **[Fig.12]** shows that the tenures obtained in this case have become viscous due to the presence of the oily fraction which is presented for different samples of olive oil mill wastewaters, these values are almost comparable to those obtained by several authors **[Table.3].**

The oily fraction form a lipid layer on the surface of evaporation ponds olive oil mill wastewaters, which may limit their natural evaporation.

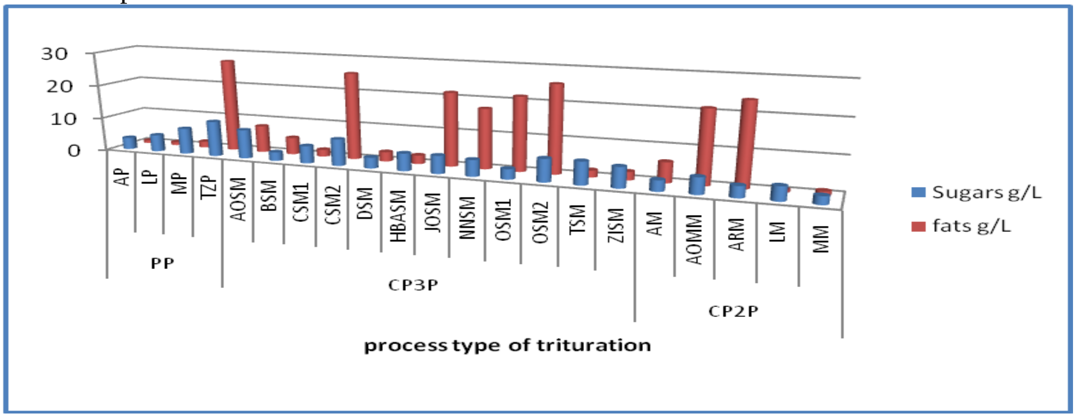

Fig.12. Sugars and fats concentrations of different of Olive Oil Mill Wastewaters of three extraction process of olive oil.

3. Mineral fraction of olive oil mill wastewaters (OOMW).

Very significant amounts of mineral salts are present in the olive oil mill wastewaters **[94]**; either as soluble (phosphates, chlorides and sulfates) of around 80%, the rest as 20% is insoluble (carbonates and silicates), the most representative elements are potassium (47%), carbonates (21%), phosphate (14%) and sodium (7%) **[95-96],** all the results of the mineral fraction are presented in the **[Table.8].**

3.1 PO_4^{3-}: Orthophosphates

Phosphorus can exist in OOMW under dissolved or suspended form, total dissolved phosphorus includes organic phosphorus and inorganic phosphorus, which itself includes orthophosphates and polyphosphates. In the wastewater as the Olive oil Mill Wastewaters, phosphorus can occur in the form of inorganic salts (orthophosphates, polyphosphates) but also in the form of organic compounds, these various compounds are either dissolved or attached to suspended solids, they can therefore be measured on the total sample and the soluble phase after separation of insoluble phosphorus by membrane filtration 0.45 microns.

Phosphorus is a biogenic element essential to the growth of algae. High levels of this element in olive oil mill wastewaters effluents can cause eutrophication in storage ponds. However, they have a beneficial effect by playing a regulatory role: they promote all the phenomena of fertilization, fruit and mature vegetative organs **[97],** the orthophosphates concentrations are varied with process type of trituration of olive, for the press process, it is 3.83 to 5.75ppm, the continuous process three-phases, it is 1.43 to 5.08 ppm, and for the continuous process two-phases, it is 0.93 to 4.12 ppm, all our results and other researchers are presented in the **[Table.5, 8].**

3.2 NO_3^-: nitrates.

Nitrates (or nitric nitrogen) represent nitrogen form most often present in OOMW (inorganic N) or mineral, including himself mainly in the global nitrogen (NGL) and total nitrogen (TN) with another component, the organic nitrogen (organic-N).Another classification of the forms of nitrogen is to differentiate the oxidized forms (N-NO3 - and N-NO2 -) reduced forms (N-NH4 + and organic N).

Inorganic-N = $N\text{-}NH^{+}4 + N\text{-}NO_3^- + N\text{-}NO_2^-$ = EN – organic-N

The nitrates concentrations are varied with process type of trituration of olive, for the press process, it is 0.36 to 1.39 ppm, the continuous process three-phases, it is 0.25 to 1.34 ppm, and for the continuous process two-phases, it is 0.06 to 0.95 ppm, all our results and other researchers are presented in the **[Table.5, 8].**

Table.3. Main polyphenols, sugars and fats characteristics of olive oil mill wastewaters (OOMW) given by several authors.

Process type	Polyphenols	Tanins	Sugars	fats	AUTHORS
PP	0.8-1.35g/L	0.62-1.2 g/L	3.52-10.48g/L	0.8-27.4g/L	our study
	2.42g/L	n.d.	n.d.	n.d.	[14]
	9.86-11.54	n.d.	n.d.	n.d.	[38]
	0.27-0.39g/L	n.d.	n.d.	1-2.5%	[61]
	n.d.	n.d.	n.d.	20mg/L	[86]
	0.56g/L	n.d.	n.d.	n.d.	[98]
	2.7g/L	n.d.	n.d.	n.d.	[99]
	Sample filted:1.74g/ L sample non filtred: 0.96g/L	n.d.	n.d.	n.d.	[100]
CP3P	0.29-1.83g/L	0.2-1.71g/L	2.55-8.59g/L	2-25.6g/L	[our study]
	7.30 g/L	n.d.	n.d.	2.60%	[16]
	1.6g/L	n.d.	8.79 g/L	3.1 g/L	[25]
	3.8g/L	n.d.	4.7 g/L	12.2 g/L	[33]
	8.26-10.14	n.d.	n.d.	n.d.	[38]
	12.2 g/L	n.d.	15.1g/L	n.d.	[79]
	3.57g/L	n.d.	n.d.	n.d.	[85]
	0.26g/L	n.d.	n.d.	n.d.	[103]
	10.7g/L	n.d.	16.1g/L	1.64g/L	[104]
	7.8g/L	n.d.	1.4 g/L	n.d.	[105]
	2.61g/L	n.d.	n.d.	n.d.	[106]
	Filtration(0.45) 1.098g/L	n.d.	n.d.	n.d.	[108]
	0.98g/L	n.d.	4.8g/L	8.6g/L	[109]
	OOMW original:9.1 g/L ; Centrifuged 4.4g/L; Centrifuged and filtred: 4.2g/L	n.d.	n.d.	n.d.	[115]
CP2P	0.24-0.67g/L	0.12-0.65g/L	2.39-4.8g/L	0.8-21.24g/L	[our study]
	1.42g/L	n.d.	0.24	n.d.	[4]
	7.32-8.61	n.d.	n.d.	n.d.	[38]
	5.69g/L	n.d.	n.d.	25.1g/L	[44]
	11.75g/L	n.d.	n.d.	12g/L	[85]
	2.40%	n.d.	19.40%	10.90%	[104]
	0.027-1.051g/L	n.d.	n.d.	2.47-62.3g/L	[108]
	0.54%	n.d.	n.d.	3.76%	[110]
	1.40%	n.d.	9.60%	12.10%	[111]
	1.20%	n.d.	9.60%	18%	[112]
	0.50%	n.d.	10.40%	12.70%	[113]

3.3 Cl^-: Chlorides

The chlorides concentrations are varied with process type of trituration of olive, for the press process, it is 52.33 to 123.68 ppm, the continuous process three-phases, it is 33.3 to 142.71 ppm, and for the continuous process two-phases, it is 23.79 to 71.36 ppm, all our results and other researchers are presented in the **[Table.5, 8].** This high chloride content is due to the practice of salting (adding salt in large quantities) for the conservation of olives before the extraction process, chlorides are important inorganic anions contained in varying concentrations in the olive oil mill wastewaters, generally as salts of sodium (NaCl) or potassium (KCl), they are often used as an indicator of pollution, they have an influence on the aquatic fauna and flora as well as plant growth.

3.4 SO_4^{2-} : sulfates.

The sulfates concentrations are varied with process type of trituration of olive, for the press process, it is 0.52 to 12.36 ppm, the continuous process three-phases, it is 1.56 to 12.36 ppm, and for the continuous process two-phases, it is 1.8 to 20.6 ppm, ensemble our results and other researchers are presented in the **[Table.5, 8].**

Table.4. Main values of (PO_4^{3-}, NO_3^-, Cl^- and SO_4^-) in the olive oil mill wastewaters (OOMW) given by several authors.

Process type	PO_4^{3-}	NO_3^-	Cl^-	SO_4^{2-}	Authors
PP	3.83-5.75 ppm	0.36-1.39 ppm	52.33-123.68 ppm	0.52-12.36 ppm	our study
	n.d.	n.d.	5-5.8 g/L	n.d.	[61]
	n.d.	OOMW non filtred:0.39g/L	OOMW non filtred:0.85g/L	OOMW non filtred:0.12g/L	[100]
	n.d.	OOMW filtred:0.35g/L	OOMW filtred:0.8g/L	filtred:0.1g/L	[100]
CP3P	1.43-5.08 ppm	0.25-1.34 ppm	33.3-142.71 ppm	1.56- 12.36 ppm	our study
	TP:1.6g/L;Po4-:0.8mg/L	Not detected at significate	n.d.	n.d.	[102]
	0.022g/L	n.d.	1.16g/L	0.465g/L	[103]
CP2P	0.93-4.12 ppm	0.06-0.95 ppm	23.79-71.36 ppm	1.8-20.6 ppm	Our study

3.5 K^+, Na^+, Ca^{2+} and Mg^{2+}.

The K+, Na+, Ca2+ and Mg2+ concentrations are varied with process type of trituration of olive, ensemble our results and other researchers are presented in the **[Table.6, 8].**

The OMW has a high potassium concentration and notable levels of nitrogen, phosphorus, calcium, magnesium, and iron **[25]**. The reused of OMW have enabling at the same time some of their primary components to be recovered (organic matter, nutrients, etc.).

Table 5 : Mean values of (K^+, Na^+, Ca^{2+} and Mg^{2+}) in the olive oil mill wastewaters given by several authors.

Process type	K+	Na+	Ca2+	Mg2+	Authors
PP	4.13-5.56 ppm	0.29-0.58ppm	0.21-0.45 ppm	0.14-0.31 ppm	our study
CP3P	0.59-4.11 ppm	0.26-0.49 ppm	0.03-0.47 ppm	0.08-0.18 ppm	our study
	2.68g/L	0.57g/L	0.13g/L	0.09g/L	[79]
	0.639g/L	n.d.	n.d.	n.d.	[103]
	2.37g/L	0.3g/L	0.27g/L	0.044g/L	[104]
	2.9g/L	0.2g/L	0.2g/L	0.092g/L	[116]
	10.8g/L	0.42g/L	0.6g/L	0.22g/L	[117]
CP2P	0.48-2.56 ppm	0.21-0.38 ppm	0.05-0.1 ppm	0.07-0.1 ppm	**Our study**
	2.97g/L	0.37	0.6	n.d.	[4]
	0.1684-2.2105g/L	n.d.	n.d.	n.d.	[108]
	19.8 g/L	0.8	4.5	1.7	[111]
	29g/L	0.2	12	1	[118]
	17.1g/L	1	4	0.5	[119]

3.6 Metallic trace elements.

The load olive oil mill wastewaters trace metal is very important especially for iron, zinc, lead and magnesium, but for other elements are presented as a traces, the difference of concentrations of these elements in such amounts soil and type of irrigation and method of cultivation of olive trees, ensemble our results and other researchers are presented in the **[Table.7, 8].**

Table.6. Main heavy metal characteristics of olive oil mill wastewaters (OOMW) given by several authors.

Process type	Fe ppm	Cu ppm	Zn ppm	Pb ppm	Mn ppm	Ni ppm	Co ppm	cd ppm	AUTEURS
PP	39.5-45.4	1.02-1.24	19.5-25.8	6-8	3.15-5.15	<0.002	0.01-0.2	<0.001	our study
	40.28-42.50	5.21-6.32	30.82-32.00	10.31-12.85	4.02-6.20	n.d.	n.d.	0.03-0.06	[38]
CP3P	31.7-39.2	1.59-4.15	10.8-16.4	3.5-6.5	0.65-3.35	<.002	0.01-0.15	<0.001	our study
	68.5mg/L	1.5mg/L	4.1mg/L	n.d.	1.1mg/L	n.d.	n.d.	n.d.	[25]
	40.25-41.46	4.64-5.7	12.90-15.66	9.06-11.23	2.5-3.07	n.d.	n.d.	0.02-0.05	[38]
	13.5mg/L	0.34mg/L	2.01mg/L	n.d.	1.09mg/L	0.10mg/L	0	0	[79]
	13.8		3.69	0.2	0.26	n.d.	n.d.	n.d.	[103]
	120mg/L	6mg/L	12mg/L	n.d.	12mg/L	n.d.	n.d.	n.d.	[111]
	18.3mg/L	2.1mg/L	2.4mg/L	n.d.	1.5mg/L	n.d.	n.d.	n.d.	[116]
	120mg/L	3mg/L	6mg/L	n.d.	6mg/L	n.d.	n.d.	n.d.	[117]
CP2P	19.4-22.6	1.05-1.6	4.6-7.1	2.5-4.1	0.05-1.25	<0.002	0.07-0.25	<0.001	our study
	22.38-25.25	1.42-1.69	8.86-10.13	3.11-6.34	0.93-1.6	n.d.	n.d.	0.02-0.03	[38]
	614mg/L	17mg/L	21mg/L	n.d.	16mg/L	n.d.	n.d.	n.d.	[111]
	526mg/L	17mg/L	18mg/L	n.d.	13mg/L	n.d.	n.d.	n.d.	[112]
	769mg/L	21mg/L	27mg/L	n.d.	20mg/L	n.d.	n.d.	n.d.	[113]
	2600mg/L	13mg/L	10mg/L	n.d.	67mg/L	n.d.	n.d.	n.d.	[118]
	1030mg/L	138mg/L	22mg/L	n.d.	13mg/L	n.d.	n.d.	n.d.	[119]

Table. 7. Main mineral fraction characteristics of olive oil mill wastewaters (OOMW).

Process type	Parameters	$PO4^{3-}$	NO_3^-	Cl^-	SO4	K^+	Na^+	Ca^{2+}	Mg^{2+}	Fe	Cu	Zn	Pb	Mn	Ni	Co	Cd
Units		ppm	ppm	ppm	Ppm	g/L	g/L	g/L	g/L	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
PP	AP	4.13	1.39	52.33	6.36	5.56	0.58	0.35	0.31	45.4	1.02	25.8	8	5.15	<0.002	0.204	<0.001
	LP	3.83	0.41	61.84	12.36	4.25	0.46	0.29	0.25	41.1	1.03	22.9	7	4.15	<0.002	0.01	<0.001
	MP	4.21	0.52	80.87	8.64	4.13	0.29	0.45	0.17	39.5	1.24	21.4	6	3.15	<0.002	0.019	<0.001
	TZP	5.75	0.36	123.68	0.52	4.23	0.37	0.21	0.14	42.8	1.3	19.5	8	5.15	<0.002	0.01	<0.001
CP3P	AOSM	4.76	0.84	142.71	6.76	1.03	0.36	0.2	0.1	37.5	1.59	14.8	6	3.15	<0.002	0.019	<0.005
	BSM	1.43	0.63	52.33	5.96	1.75	0.49	0.13	0.1	39.2	1.89	16.4	4	1.15	<0.007	0.058	<0.001
	CSM1	3.19	0.45	47.57	3.96	1.62	0.38	0.47	0.18	37.1	3.58	12.8	5	2.15	<0.002	0.107	<0.001
	CSM2	3.99	0.58	80.87	7.04	1.23	0.41	0.14	0.09	37.2	3.45	11.9	4.5	1.65	<0.002	0.029	<0.001
	DSM	2.82	0.36	57.08	7.52	3.25	0.43	0.19	0.08	38.5	2.45	10.8	5.6	2.75	<0.002	0.156	<0.001
	HBASM	5.5	0.25	109.41	5.88	2.09	0.3	0.15	0.12	39.1	2.3	15.8	6.5	3.65	<0.002	0.107	<0.001
	JOSM	4.21	1.34	61.84	4.52	4.11	0.36	0.16	0.11	34.8	3.14	16.4	6.2	3.35	<0.001	0.117	0.003
	NNSM	5.08	1.16	104.65	3.44	1.74	0.28	0.03	0.12	35.9	3.26	13.5	5.5	2.65	<0.003	0.039	<0.001
	OSM1	3.32	0.57	104.65	5.84	1.87	0.37	0.17	0.08	34.5	4.15	11.5	5.4	2.55	<0.002	0.097	<0.001
	OSM2	3.44	0.72	114.17	12.36	4.09	0.32	0.15	0.12	36.8	4.05	14.2	6.1	3.25	<0.002	0.136	<0.001
	TSM	2.34	0.21	33.3	3.04	1.02	0.28	0.12	0.14	32.8	3.12	13.4	3.5	0.65	<0.002	0.01	<0.001
	ZISM	4.46	1.19	85.63	1.56	0.59	0.26	0.26	0.14	31.7	3.54	14.1	4.7	1.85	<0.002	0.029	<0.001
CP2P	AM	0.93	0.17	47.57	20.6	1.98	0.37	0.06	0.08	21.8	1.05	6.5	2.5	0.35	<0.002	0.078	<0.003
	AOMM	0.94	0.49	33.3	4.2	0.48	0.21	0.08	0.07	20.9	1.6	6.1	2.9	0.05	<0.005	0.078	<0.001
	ARM	4.12	0.54	47.57	3.4	1.75	0.28	0.1	0.07	19.8	1.3	4.6	3.01	0.16	<0.002	0.253	<0.001
	LM	1.11	0.06	23.79	2.8	2.08	0.38	0.07	0.07	19.4	1.09	5.1	3.7	0.85	<0.002	0.214	<0.001
	MM	3.64	0.95	71.36	1.8	2.56	0.35	0.05	0.1	22.6	1.07	7.1	4.1	1.25	<0.002	0.233	<0.001

Conclusion

The samples of the olive oil mill wastewaters collected from the eastern Morocco have very complex and heterogeneous physicochemical composition. They contain a variety of organic and inorganic compounds of very different nature and concentration. The diversity of results is due This variation is mainly due to the following factors: Stage ripening olives, climatic conditions, variety of olive cultivation system, geographic location, and time of storage before crushing olives, techniques and storage space, nature conservation olives, process for extracting olive oil which is the most important element.

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