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Removal of COD, polyphenols and color from olive mill wastewater using activated carbon

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Abstract— **Olive oil mill wastewater (OMW) constitutes a source of environmental problems in Tunisia due to its significantly high organic load, its phytotoxic properties and its relatively biodegradability. The aim of this work was to characterize these effluents and to examine the performance of activated carbon in treating OMW. These waters are sampled, treated under different conditions and then analyzed by chromatography. The results show a considerable retention rates for elimination of COD, polyphenols and color: 91% of polyphenols, 98 % of color and 74% of COD removal.**

Keywords— **OMW, polyphenols, color, COD, activated carbon.**

I. INTRODUCTION

The liquid effluent, left after removal of the olive oil, causes a serious environmental hazard in olive producing countries, especially around the Mediterranean basin. It has been estimated that 30.106 m3 are produced per year [1]. The problems mainly arise from the effluent's high level of pollutants leading to a high chemical oxygen demand (>200 g/l) [2].

The characteristic black-brownish color of this effluent is due to polymerization of low molecular weight phenolics compounds and is chemically related to lignin derivative [3]. Color removal is commonly applied in treatment of colored wastewaters [4]. Color can be removed by oxidation using hydrogen peroxide or sodium hypochlorite or can be removed by flocculants, biopolymers or adsorbents [5].
Phenolic compounds have been classified as high-priority pollutants by the USA EPA (Environmental Protection Agency) [6]. Phenolic compounds are usually present in wastewater generated from the paint, solvent, petrochemical, coal conversion, pharmaceutical, plastic, iron-steel and paper and pulp industries.

Several methods are currently used for the removal of phenol and its derivatives from wastewater, e.g. microbial degradation, chemical oxidation, incineration, solvent extraction and irradiation. However, by far the most frequently used technology is adsorption by a solid phase. Several different adsorbent solids such as silica [8], glass powder [9], polymeric resins [10, 11], kaolinite [12], zeolites [13, 14] and activated carbon [7] have all been proposed to remove phenolic pollutants from wastewater.

II. MATERIALS AND METHODS

A. Olive Mill Wastewater

The characterization of the OMW is presented in Table 1. Before starting experiments, the OMW are decanted, filtered and diluted.

TABLE1

PHYSICO-CHEMICAL CHARACTERIZATION OF OMW.

Parameter	Unit	Value
pH		4.87
Salinity	ms/cm	23
Conductivity	ms/cm	46
λ max	Nm	277
COD	g of O_2/l	37.2
polyphénols	g/l	5.367
BOD	g of O_2/l	32

B. Activated Carbon

The activated carbon used as adsorption support during this work is called ` Norit'.
The characterization of 'Norit' is presented in Table 2.

TABLE2

NORIT'S CHARACTERISTICS.

SpBET (m^2/g)	1370
Vpores (cm^3/g)	1.318
Vmicropores (cm^3/g)	0.97
Dmoy of pores(Å)	38.47

C. Adsorption Procedure

The adsorption of polyphenols, of color and chemical oxygen demand (COD) of OMW is carried out ' in batch' using activated carbon as adsorbent.

The studied parameters are: time contact, stirring velocity, masses of adsorbent and pH. The volume used during each experiment is 50 ml.

The rate of reduction is calculated with the following relation:

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$$R(\%) = \frac{x_{ini} - x_{fin}}{x_{fin}} \times 100 \quad (1)$$

With: R(%) : Rate of reduction, xini : initial Concentration and xfin : final Concentration.

III. RESULTS AND DISCUSSIONS

The studied parameters are: contact time, stirring velocity, mass of adsorbent and pH.

A. Effect of Contact Time

The results are showed in figure 1.

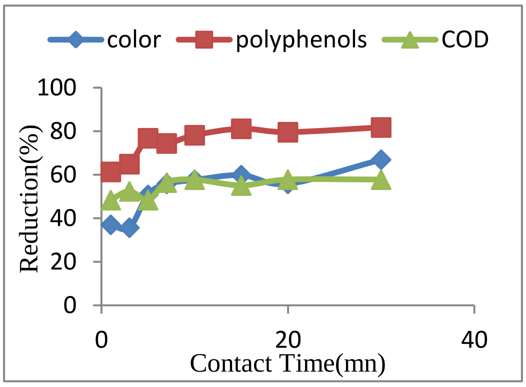

Fig1. Influence of contact time on the adsorption of pollutants.

The balance of adsorption is observed starting from 7mn. This time is the necessary time needed to fix molecules of phenolic and organic compounds on the surface of adsorbent to reach saturation.
The adsorption is maximum at a time equal to 7mn, which is a removal of 74.5% for polyphenols, 56.5% for COD and 56% for color.

B. Effect of mass of adsorbent

The results obtained are presented in figure 2.

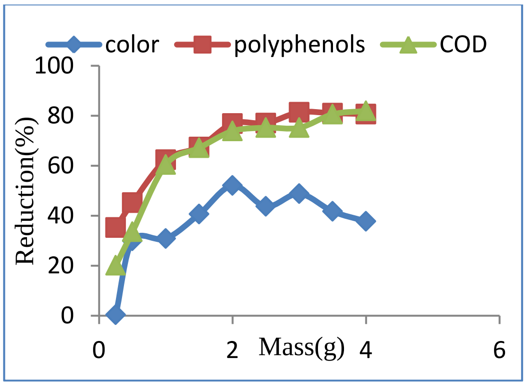

Fig2. Influence of mass on the adsorption of pollutants.

The adsorption output increases with the activated carbon mass until reaching a stage starting from a mass equal to 2g. The maximum of adsorption is obtained with 2g of adsorbent (either a reduction of 52 % of color, 77% of polyphenols and 74% of COD).

C. Effect of Stirring Velocity

The results obtained are given in figure 3.

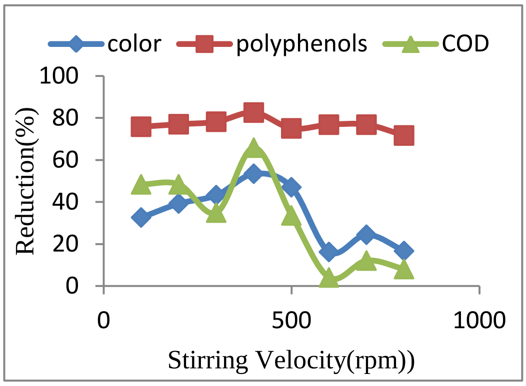

Fig3. Influence of stirring velocity on the adsorption of pollutants.

The output of adsorption increases slightly with the stirring velocity until obtaining a maximum. The best rate of adsorption is obtained for a speed of 400 rpm, i.e. 82.6% of polyphenols removal, 66% of COD and 53.5% of color.

D. Effect of pH

The results obtained are represented in figure 4.

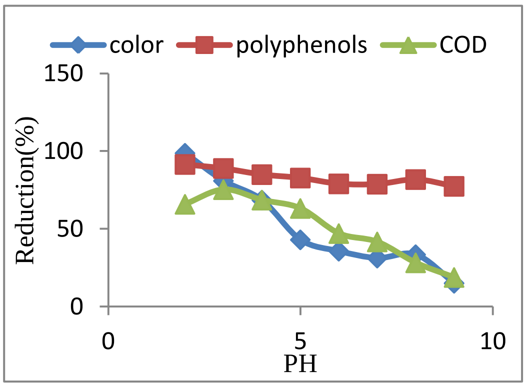

Fig4. Influence of pH on adsorption of pollutants.

Fig4 shows that adsorption output increases when the pH decreases for the three pollutants studied. The best rate of removal of these compounds (98% of the color, 91% of polyphenols and 66% of COD) is obtained at pH=2.

IV. CONCLUSIONS

The adsorption of OMW allowed the quasi-total elimination of pollutants, the best rate of reduction is 98% for the color, 91% for polyphenols and 74% for the COD, obtained under the following operating conditions: contact time = 7mn, stirring velocity = 400rpm, mass = 2g and pH = 2.

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