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Application of the technique of biosorption by a plant sorbent in the treatment of chemical releases from a hospital laboratory

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ABSTRACT

The present study aims to investigate the treatment of chemical releases of laboratories Bacteriology of the hospitals. Generally, the waste can be treated with thermal, chemical, biological, and physical processes, but these methods are expensive and sometimes can't be supported by the small industry sector thereby prohibits the use of these techniques and consequently leads the non-treatment of liquid waste from this sector. Thereby to reduce the cost of treatment of industrial effluents, more research is oriented towards the use of available and inexpensive products such as clays, products and agricultural by-products, forestry or food, hence the use of the bark of eucalyptus in this study.

Keywords: Chemical releases, organic matter, eucalyptus bark, BOD_5, COD.

INTRODUCTION

The wastewater generated from various industrial processes and public activities is of major concern in several countries due the harmful effects of organic and inorganic pollutants. The presence of these pollutants such as heavy metals and volatile organic compounds (VOC) in nature is severely controlled. To meet applicable environmental standards before being discharged to the environment, treatment is normally required. Conventional technologies employed for eliminating polluent from industrial effluents includes coagulation, chemical oxidation and biological treatment. However, these processes are very pricey. Among these techniques, biosorption is one of the most promising processes for removal of various water contaminants[1]. This process, which is a surface phenomenon, is performed using different conventional and nonconventional biosorbent. Extensive research has been directed to the investigation of low cost materials as viable substitutes for expensive sorbent. These materials include palm fruit bunch [2], cellulose based waste [3], compost adsorbent [4], orange peel [5].In the present study, as a natural plant material, eucalyptus bark was used for the elimination of organic matter from medicals laboratories effluents. There is no official definition of laboratory waste; they are considered part of DTQD (Toxic Waste Quantities in Dispersed)[6]. Effluents laboratory are liquid waste from controllers (liquid chromatography for example) or manipulations performed in the laboratory. These can include acids, bases, solvents, dyes, toxic products; solutions containing heavy metals...

MATERIALS AND METHODS

This part contains the experimental techniques used. Specifically, protocols and conditions of substrate preparation from the bark of Eucalyptus [7]and analysis methods that have allowed the characterization of the bacteriology laboratory discharges. The biosorption technical is operated by used columns for a treatment.

Experimental protocol

1.1 Physical and Chemical Preparation of the biosorbent

The biosorbentis produced from the bark of eucalyptus*. This material has been washed with tap water to remove suspended solids, dried in the open air, crushed and sieved.

The biosorbent is used after treated initially with sodium hydroxide (2M) and a second time with phosphoric acid (1,4M). Finally, the material biosorbent is washed several times with distilled water and oven-dried at 80°C for 12 h. The dried biosorbent was stored at ambient temperature until further use.

1.2Preparation of the biosorption column

Effluent treatment by the bark is performed in columns of 8 mm in diameter. The full height of the column depends on the mass of fastener material(Fig1).

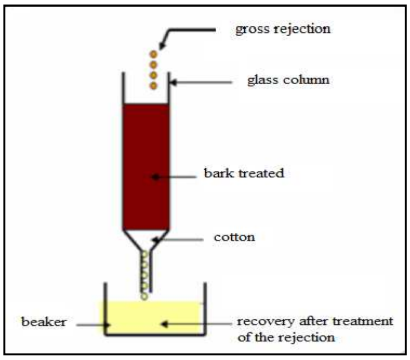

Fig 1- Schematic of the column used biosorbent for the treatment of discharges

1.3 Selecting the amount of applied substrate

Effluent treatment is performed by Eucalyptus bark masses that vary in area 3 -10g. The treatments are carried out on an aliquot of 100ml rejection. The flow rate is about 5 ml / min. The treated samples are kept at room temperature.

Performance calculation (R %)

The following relation gives the removal efficiency of organic materials R (%):

$$R = \frac{CODi - CODf}{CODi} \times 100$$

COD $_i$: Value of the chemical demand for oxygen before the treatment by substrate (mg O_2 /l); COD $_f$: Value of the chemical demand for oxygen after the treatment by substrate (mg O_2 / l).

Calculating the amount of fixing of the organic material (Cf) by biosorbent:

$$Cf = \frac{CODi - CODf}{m} \times V$$

Cf : Capacity of fixing the organic matter (g COD / g)
CODi: value of the DCO before treatment by substrate (g / l)
COD_f: COD value after substrate treatment (g / l)
V: volume elapsed (l)
m: mass of biosorbent (g)

1.4 Presentation of gross releases and analytical methods

The different physicochemical techniques used in the processing of releases Bacteriology Laboratory are summarized in Table 1.

Table 1-Analytical methods used for sample analysis.*Characterization of physicochemical parameters of the sample studied

Physicochemical parameters studied	Methods and Materials
pH	PH meter, conductivity meter and thermometer Type 2 ORION STAR.
Chemical Demand Oxygen: COD	Acidic, K2Cr2O7 + DCOmétre 6 Velp brand positions (PNM) [8]
Organic demand Oxygen during 5 days: BOD_5	Winkler method
Heavy metals (copper, zinc, chromium)	atomic absorption spectrometry[9]

2.2 pH measurement

Moreover, the importance of the physic-chemical reactions is sometimes related to the acidity of the aqueous media, the pH alters the growth and reproduction of microorganisms existing in given water. Thus, most of the bacteria can grow in aquatic environments, in a pH range between 5 and 9, but the optimum conditions corresponding to a pH acidity of between 6.5 and 8.5. According to the World Health Organization (WHO), the growth and survival of aquatic organisms can be affected when the pH is outside of this area acidity.

2.4 Analysis of copper, zinc and chromium

Heavy metals are micro in nature cause nuisance even when they are released in very small quantities (toxicity develops through bioaccumulation)[10].This is why our interest has focused on the analysis of some elements of this family, generally very used as reagents such as Cu, Zn and Cr (VI).

2.5 Analysis of the COD and BOD_5

The organic matters (OM) areoxidizable materials which require for their decomposition a certain amount of oxygen. This decomposition process then leads to oxygen depletion of the natural environment receiving these materials. Therefore, these organic materials are considered undesirable pollutants especially in water currents as they exceed a threshold defined by the standards. The organic content is evaluated by two parameters, namely the chemical oxygen demand (COD) and biological oxygen demand (BOD).

BOD5 is the quantity of oxygen necessary for the degradation of the biodegradable organic material to water by the development of microorganisms for 5 days at 20 ° C[11]. Analyzed by the Winkler method, it is expressed in mg /l [5]. COD is the amount of oxygen required to oxidize the organic material (biodegradable or not) of water using an oxidant, the bichromate of potassium. This parameter offers a more or less complete representation of oxidizablematerials present in the sample. It is expressed in mg / l. COD is generally 1.5 to 2 times BOD_5 in urban wastewater and 1 to 10 for all the whole industrial wastewater. The empirical relationship of the organic matter (OM) according to the COD and $BOD_5$is given by the following equation:

$$OM = \frac{2BOD_5 + COD}{3}$$

The ratio of BOD_5 / COD allows us to assess the biodegradability of the effluent.

RESULTS AND DISCUSSION

It must be remembered that the treatments are performed by bark masses equal to 3g, 6g and 10g. The diameter of columns is 8mm.

1 Measurement of the physic-chemical parameters

1-1pH

pH measurement is performed several times for the same sample .The Table 2 shows the average results. We indicate respectively by pHav and pHap pH before and after treatment.

Table2- pH measurement before and after treatment of the studied discharges

	Effluent
pH_{av}	10
pHap	6,2

It is clear from these results that the rejection of the biochemistry laboratory is alkaline and does not correspond to national and international standards (6.5 <pH <8.5). After treatment, the pH decreases.

1-2Heavy Metals Analysis

The results are summarized in Table 3.The values obtained are low and consistent with standards and are safe for the environment.

Table 3- Measurement of heavy metal pretreatment levels of discards.

Metal**(µg/l)** Type de rejet	**copper**	**Zinc**	***Chrome***
Bacteriology releases	0,12	51	*< LD**

(: below the detectable limit)*

1-3 Analysis of the COD and BOD_5

The results of measurements of COD and $BOD_5$are shown in Table 4.Figure 2 illustrates the variation of the removal efficiency of the organic matter as a function of the mass of biosorbent.

Table 4 -Values of COD and BOD_5 rejection of bacteriology laboratory before and after biosorption and elimination efficiency rate of organic matter.

Parameters	Rejection before treatment	Rejection after treatment		
		Mass of biosorbent (g)		
		3	6	10
COD (mg /l)	2710	1000	450	180
Rendement R en %		63	83	93
BOD_5(mg /l)	1550	580	300	150
Rendement R en %		63	81	90

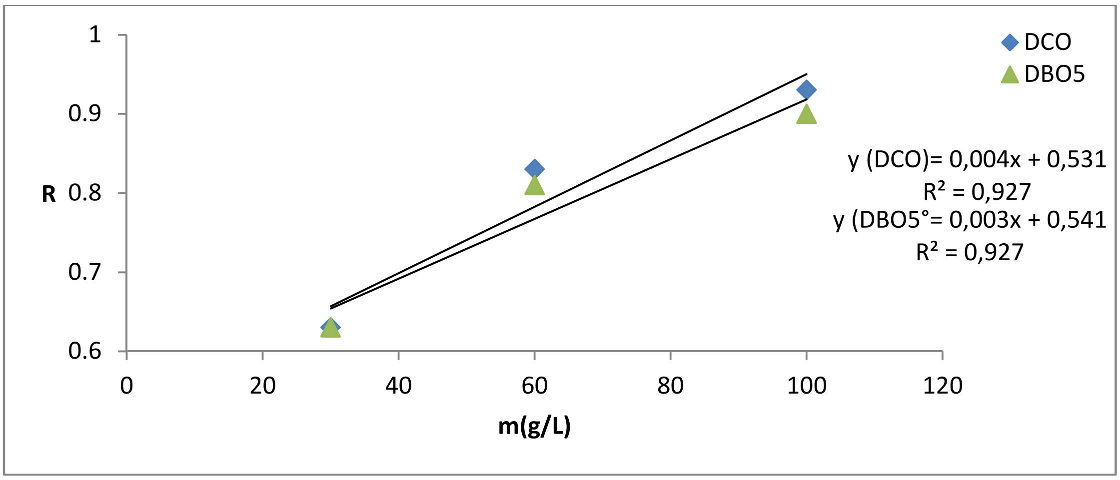

Fig 2-Elimination of the organic material rejection rate of Bacteriology by according of the mass of sorbent R = f (m)

These results indicate that this type of rejection gets loaded into oxidizable organic materials whose the COD is 2710 mg / l and BOD_5equal1550 mg / l.The elimination of the organic matter measured by the elimination efficiency denoted R is almost complete (93%) when the mass of the employed biosorbent is 100g / l. Variations R = f (m) are linear with a correlation coefficient between 90% <R^2 <99%.

2 **Study of the substrate fixation capacity depending on the volume of liquid waste**

To determine the maximum fixing capacity of the organic matter in the substrate considered, we examined the evolution of performance for removing a mass of 10g. To this effect, liquid waste of Bacteriology laboratory are processed by a fixation on a column of diameter equal to 10 mm. The COD analysis is performed in three steps after flowing 40ml of rejection with a 5ml / min flow rate for a total volume of 120 ml.Table5 shows the results obtained after flow of 120ml, the initial value of the COD is 2710mg/ l.The following results indicate that the removal efficiency obtained is in the range of 93%.

Table 5- Variation of the DCO, the rate of elimination and the quantity of fixation of the organic matter according to the volume sold by rejection, m (biosorbent) = 10g

	Rejection of bacteriology laboratory treated by 10g of biosorbent		
Volume elapsed (ml)	**40**	**80**	**120**
DCO (mg/l)	120	150	190
Elimination rate % (R)	95,57	94,46	92,98
$C_f$en (mg DCO/g of biosorbent)	10,36	20,48	30,24

Figures 3 and 4 respectively show the variations of the removal rate of organic matter expressed in (%) and the amount of fixing of the organic matter according to the volume disposed of rejection.

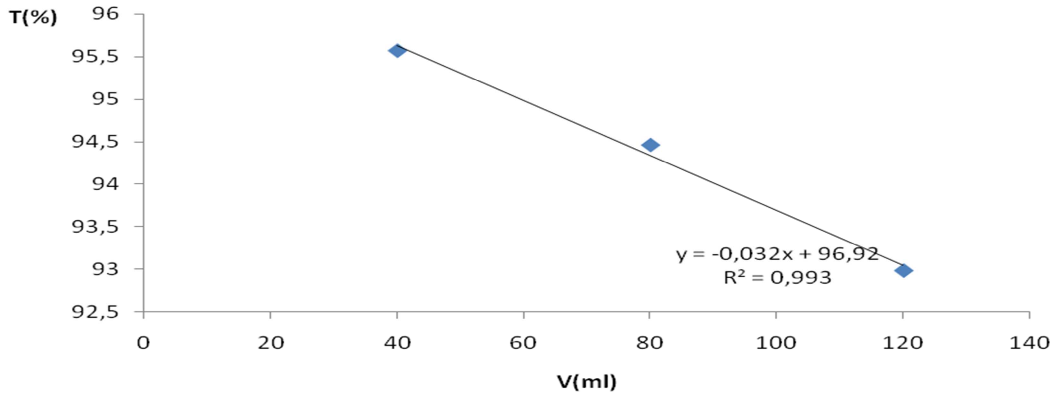

Fig 3- Removal rate of organic matter rejection studied m (sorbent) = 10g

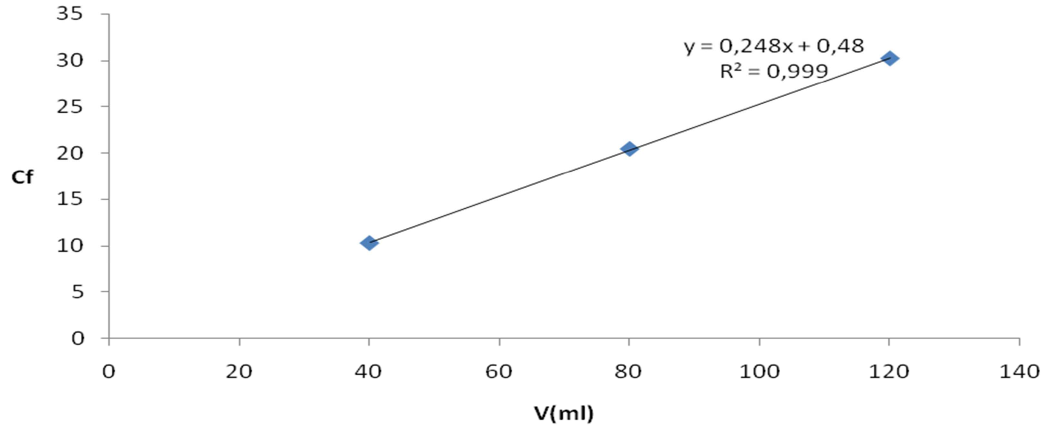

Fig.4 -Modification of the quantity of organic matter fixed (Cf) by sorption according to the volume of the laboratory of bacteriology rejection(discharge), m (sorbent) = 10g.

It is noted that the variation T = f (V) is linear. The equation of the line allows to achieve the maximum fixing capacity which is equal to 0.82 g / g of sorbent, It is apparent from these results that the binding capacity varies linearly with the volume of treated waste liquid, this indicating no saturation of the active sites of the sorbent material used.The maximum capacity given by the equation of the straight line T = f (V) allows to obtain Cf = 0.75 g / g.

CONCLUSION

The physicochemical analysis shows that these discharges are characterized by high pollution load that could be purified with the application of the substrate eucalyptus bark at significant rates, which reach 93%.This study's main objective is the proposal of liquid waste treatment methods of hospital laboratories using natural substrates not expensive, practical, and can't be after use harmful waste for the environment.

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