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The studies led to determine contacting time (40 minutes for 90% elimination of substrate methylene blue). However, this contacting time can vary with dye concentration. The optimization of parameter such as the temperature, agitation and initial concentration of dye has showed a sensitive improvement of the capacity and rate adsorption. Moreover, the adsorption of this compound is well described by both Langmuir and Freundlich isotherm models.

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I. Introduction

Intensive use of colors in everyday life has created a lot of problems both in the environment and in food [1]. It is important to mention that the water pollution is due to discharges of textile industries, and in feed, the toxicity is due to incorporation of several synthetic dyes [2] .

To address this situation, several decontamination methods have been developed, we cite as examples the adsorption [3,4], ion exchange [5,6], coagulation - flocculation [7] etc. In this work, we present the results for the adsorption blue methylene in banana peels powder. We determined successively contact time and the influence of parameters such as particle size, the initial concentration of substrate, the mass of the adsorbent and the temperature. These studies are needed to better understand the mechanisms governing the adsorption process.

II. Theoretical and Experimental Part

The adsorbent used in this work, banana peels powder was first washed with distilled water to remove impurities and then dried in air for 15 days , then ground in mortar and analyzed by size in order to obtain two different types of fractions, the first fraction is characterized by a diameter less than 80 microns (d < 80 microns), and the second fraction has a diameter of between 80 microns and 2 mm (80 microns < d < 2mm) .

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The measurements and spectral evolution of the optical density of the solutions of methylene blue at different reaction times were followed by UV/visible spectrometry (ShimadzuUV mini - 1240)

The experiments were conducted in "batch method" (100 ml Erlenmeyer flask) at an ambient temperature (22°C). It should be noted that the temperature control was made using a digital thermometer.

Moreover, to ensure good dispersion of solid particles Banana peels powder, we adopted the value of 1g/l (0.1g/100 ml) for solid/liquid ratio.

To investigate the adsorption power of our support, we applied models Langmuir and Freundlich. Due to their simplicity, the kinetic models the most commonly used are those of Langmuir and Freundlich.

a) *Adsorption Isotherms*

The adsorption data from experiments were fitted with:

i. *Langmuir isotherm [8]*

Langmuir adsorption isotherm sheds no light on the mechanistic aspects of adsorption. It provides information on uptake capabilities and also reflects the usual equilibrium process behaviour The Langmuir non linear equation is:

$$q_e = q_m \cdot \frac{b.C_e}{1 + b.C_e} \quad (1)$$

Where q_e is the amount of methylene blue sorbed per unit weight of biomass at equilibrium, C_e is the residual equilibrium Dye, q_m is the maximum possible amount of dye adsorbed per unit weight of biomass and b is the equilibrium constant related to the affinity of the binding sites for the methylene blue, lower is b more is the affinity of methylene blue to biomass.

Low values of parameter b indicate that banana peel powder have high affinity for methylene blue. The table 1 presents linear equations of Langmuir model.

The essential characteristic of a Langmuir isotherm can be expressed as a dimensionless constant, defined as the separation factor:

$$R_L = \frac{1}{1+b.C_0} (2)$$

b) Freundlich isotherm [9]

The Freundlich non linear equation is:

$$q_e = K_F C^n e (3)$$

Where, K_F and n are constants indicating adsorption capacity and adsorption intensity, respectively. The constants were obtained from the plots of the linearized equations:

$$\log q_e = \log K_F + n.\log C_e (4)$$

Another use of the results is to plot the variation of the distribution coefficient K_d as a function of q_e in logarithmic scale:

$$\log K_d = (\frac{1}{n}).\log K_F.+[\frac{(n-1)}{n})].(\log q_e)(5)$$

III. Results and Discussions

a) Optimization of methylene blue adsorption

i. *Determination of equilibrium time*

The study of the adsorption of methylene blue on banana peels powder (PBP), clearly implies the determination of contact time, time which corresponds to the adsorption equilibrium or a state of saturation of the support the substrate . In this case, the experimental procedure is simple " batch method" which involves 10 mg / l of methylene blue with 1g / l of powdered banana peels . Analysis by UV/visible allows us to determine the residual concentrations of the substrate at different reaction times.

Thus, the determination of the equilibrium time, allowed the establishment of adsorption isotherms that are essential for the calculation of the maximum adsorption capacity and to identify the type of adsorption to occur either in mono or multilayers. The results obtained at the end of these experiments showed that the contact time required for the elimination of 90 % of methylene blue is 40 minutes. Furthermore, the extension of the time to (90 minutes) does not lead to a significant improvement of the percentage removal. This justifies the inclusion of this contact time for other adsorption experiments (Figure 1).This result was obtained by the ratio :

$$q = V.\frac{C_0 - C_t}{m} (6)$$

q: Adsorption capacity of the support (mg/g).
C_0: Initial concentration of dye (mg/l).
C_t: Concentration of dye (mg/l) at time t of the adsorption process .
V: Volume of solution (substrate).
m: Mass of support (g).

Other factors such as the particle size, the initial concentration of the substrate, the mass of the adsorbent and the temperature may affect the adsorption capacity [10]. It finds its application in various adsorption models used.

b) Effect of particle size

To study the influence of the particle size of the adsorbent We choose two types of fraction, the first fraction having a particle size less than 80 microns, and the second fraction is between 80 microns and 2 mm, results is shown in fig 2, it is found that the adsorption is fast and relatively large for the fine particles (d <80 microns), this could be explained by the fact that the extent of adsorption depends on the external surfaces of the particles, More the particle size is small over the exchange surfaces are provided important promoting high speed transfer of dye to the adsorbent. On considering this, we will continue work with fine particle (d <80 microns).

c) Effect of mass of adsorbent

The influence of the mass of the adsorbent was studied in the range 0.1- 0.3 g. The figure 3 shows the variation of the adsorption amount depending on the time chosen for different masses ; 0.1 g, 0.2 g and 0.3 g, the mass 0.1g provides removal rate which can reach 96%. This effect, we chose the mass 0.1 g, as an optimal weight for the rest of our work.

d) Effect of initial concentration

Figure 4 shows the influence of the initial concentration of methylene blue on the dye adsorption capacity (the mass of the support being fixed), it shows that the adsorption capacity is better for the high initial concentration of methylene blue.

e) Effect of temperature

Figure 5 shows the influence of temperature on the adsorption of the dye. When we use different temperatures to 40 minutes of stirring, the adsorption capacity of powdered banana peels over time increases, the values obtained were Q = 8.8991 mg / g at 22°C.

The experimental results show that this parameter does not affect the adsorption retention of methylene blue on the support of the study process.

f) Adsorption Isotherm

Adsorption isotherms play an important role in determining the maximum capacity and in determining the type of adsorption front is produire.Elles are obtained first by the knowledge of the time and then the graphical presentation of Qe = f (Ce) and Qe These are respectively the amount of adsorbed dye per g of adsorbent and the equilibrium concentration of this colorant.les experimental results obtained show that the S-type is isothermal, which classification coorspond

Gilles[11]. This indicates the adsorption of growth when the concentration of the adsorbate augmante (FIG. 6)

The shape obtained shows that the adsorption of the dye process could occur in a monolayer.

g) Langmuir isotherm

The values of equilibrium relation parameter, RL were calculated. As shown in Table 1, RL values lie between 0 and 1 which indicate favourable sorption isotherm for methylene blue. Low values of parameter b indicate that banana peels powder have high affinity for methylene blue.

h) Freundlich isotherm

The values of equilibrium relation parameter, n were calculated for two Freundlich model's, the results is shown in table 1, n values is high than 1 so the methylene blue adsorption was not well fitted with Freundlich model and The low values of maximum adsorption capacities obtained from the Freundlich model, confirm that the molecule of Methylene Blue is not strongly adsorbed inside the pores because of its size.

The main parameters characterizing each model are summarized in Table 1. The results shown in Figures 7 and 8 show that the adsorption of Methylene blue on banana peels powder (PBP) follow the two linear models Freundlich and Langmuir.

Table1 : Valeur des paramétres d'adsorption Qm,K et Kf du BM sur les Pelures de Bananes en Poudre

Models	Equation	Q_m (mg/g)	K(l.mg^{-1})	K_f(mg/g)	R
Langmuir	$Q_e = \frac{Q_m\, KC_e}{1+KC_e}$ $\frac{1}{Q_e} = \frac{1+KC_e}{Q_m KC_e} = \frac{1}{Q_m KC_e} + \frac{1}{Q_m}$	111,111	0,310	-	0,972
Freundlich	$Q_e = KC_e^n$ $\ln(Q_e) = \ln K_f + n \ln(C_e)$	-	-	25,559	0,943

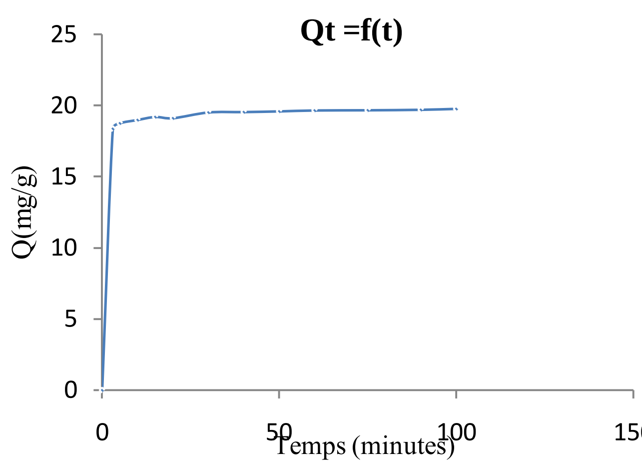

Fig. 1 : Adsorption kinetic of BM on banana peel powder, [BM]=20 mg/l ; m =1g/l ; T=22°C and d<80 μm

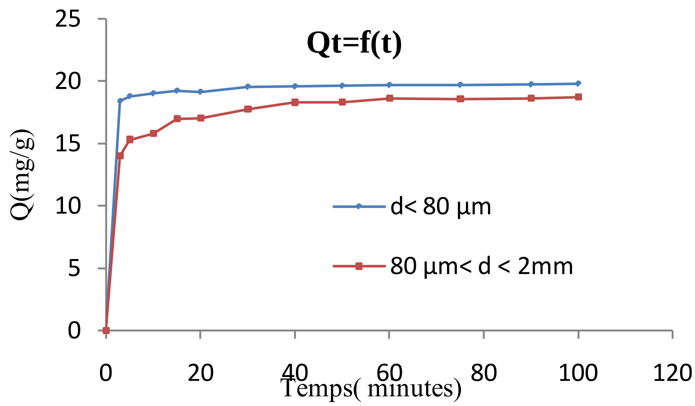

Fig. 2 : Effect of Granulometry banana peel powder, m=1g/l and T=22°C

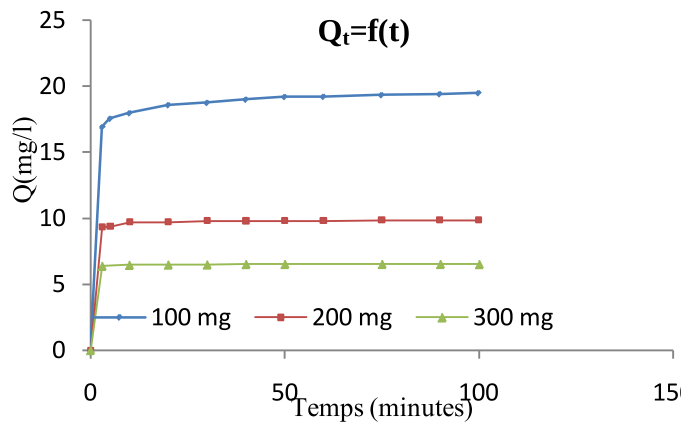

Fig. 3 : Effect of banana peel powder mass. [BM]=20 mg/l ; T=22°C and d<80 μm

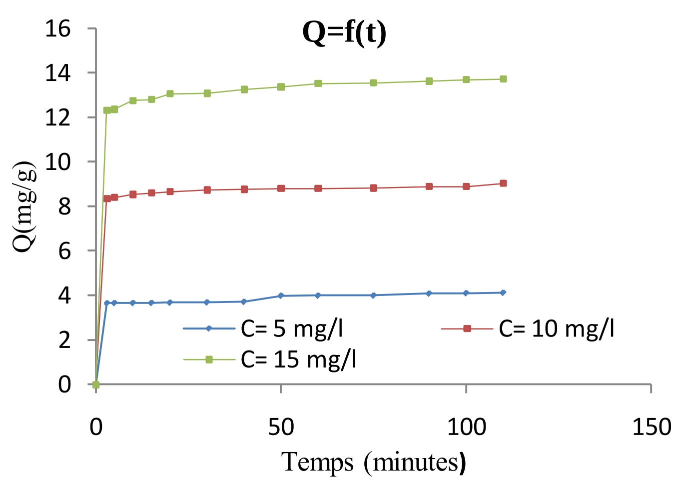

Fig. 4 : Effect of methylene blue initial Concentration, m =1g/l; T=22°C and d< 80μm

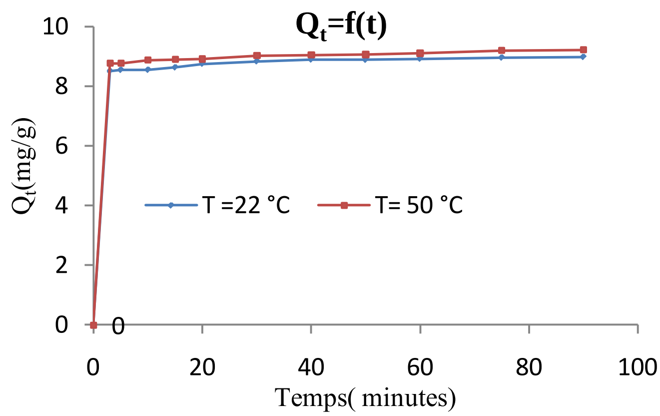

Fig. 5 : Effect of Temperature, [BM]= 20 mg/l. m 1g/l and< 80µm

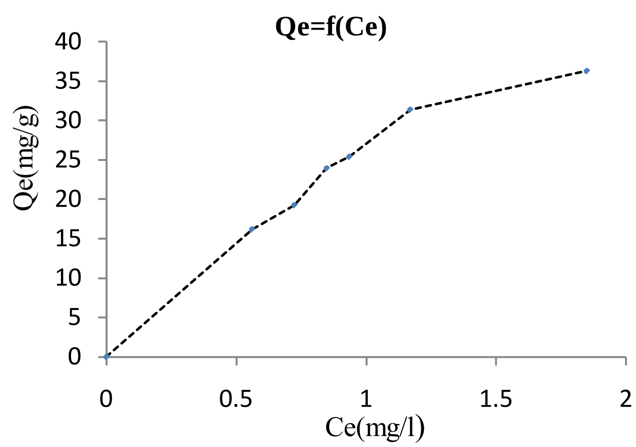

Fig. 6 : Isotherm of methylene blue adsorption. C0=20 mg/l; m =1g/l; T=22 °C and d <80 µm

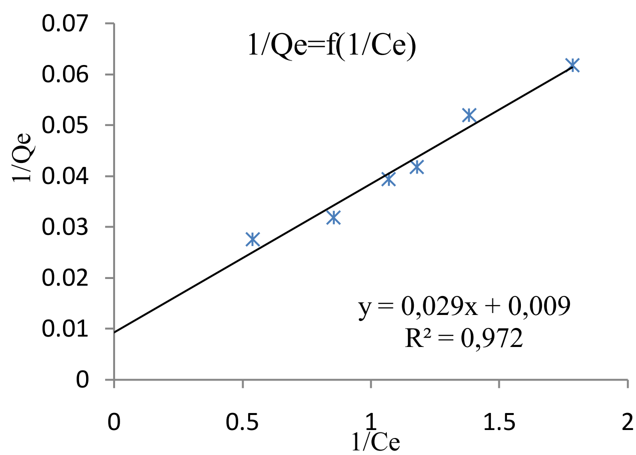

Fig. 7 : Langmuir linear Model of Methylene blue adsorption,T=22°C; d<80 µm

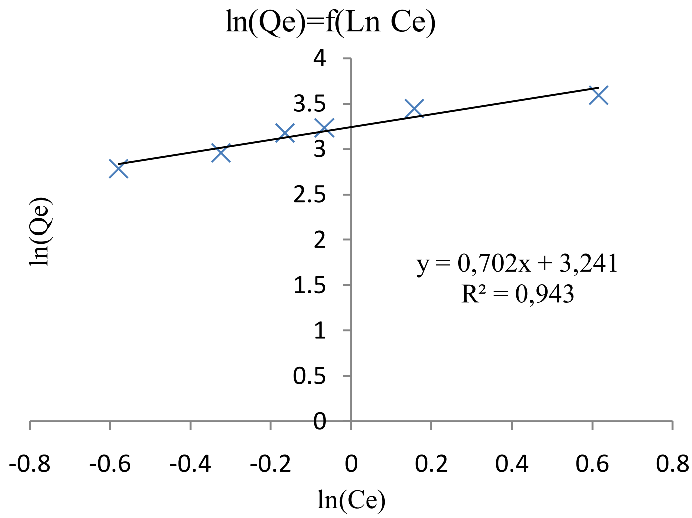

Fig. 8 : Freundlich Model of Methylene blue adsorption, T=22°C; d<80µm

IV. Conclusion

The results obtained in this work have to mount that :

- Methylene blue (20 mg/l) is adsorbed relatively well on this medium with a contact time of 40 minutes which corresponds to a removal rate of 90 %. Giving it a relatively large affinity with respect to peels Banana Powder (PBP).
- The effect of particle size, the mass of the adsorbent and the adsorbate concentration had a positive influence on the capacity and kinetics of retention Methylene Blue on our support study. Models of Langmuir - Freundlich and correctly describes the adsorption process.

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