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Research Article

ADSORPTION OF ANTIHYPERTENSIVE AS ANTI-DIABETIC DRUG ON CARBON NANOTUBE AND ACTIVATED CARBON

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ABSTRACT
In this laboratory study, we will examine the surface adsorption rate of several isotherms for antihypertensive drugs (Amelopress) on two activated carbon adsorbent and multi-walled nanotube carbon. It is also reported about the balance isotherms of Freundlich, Langmuir and Tmkin. In here, it is distinguished that Langmuir adsorption model is better than the other two. The amount of surface amelopress absorption in carbon nanotube is higher than activated carbon. It must be noted that with increasing the initial concentration of Amelopress, the absorption rate of both absorbents will be higher.

Keywords: *Surface Absorption, Multi-Walled Nanotube Carbon, Activated Carbon, Isotherm, Amelopress*

INTRODUCTION
Nano is a Greek word that it means small and it can be used it for evaluating very small amounts and sizes. Nanotechnology gives us this ability to access macromolecular structures and it has very high application in various science branches (chemistry, food Industries, Construction Industries and etc). Nanotube carbon is another form of carbon which has a tube-shape that in this study we use a multi-walled nanotube carbon.
Multi-walled nanotube carbons are capable to absorb many atoms and molecules on their surface, such as the absorption of metal elements. The surface absorption property of multi-walled nanotubes carbon plays the role of getting the air for surface absorption of gases such as hydrogen and other gases. All combinations that put on multi-walled nanotube carbon have covalent or non-covalent bond.
Carbon nanotubes exhibit several technologically important characteristics. Metallic (m) nanotubes can carry extremely large current densities (Dai *et al.*, 1996; Fischer *et al.*, 1997); semiconducting (s) nanotubes can be electrically switched on and off as field-effect transistors (FETs) (Tans *et al.*, 1998; Martel *et al.*, 1998). The two types may be joined covalently (Chico *et al.*, 1996; Metcalf & Eddy, 1991).
Applied quantum chemistry, specifically, orbital hybridization best describes chemical bonding in nanotubes. The chemical bonding of nanotubes is composed entirely of *sp*2 bonds, similar to those of graphite. These bonds, which are stronger than the *sp*3 bonds found in alkanes and diamond, provide nanotubes with their unique strength.

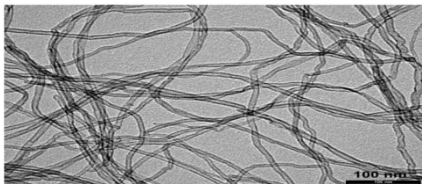

Figure 1: The microscopy form of nanotube

Activated Carbon Adsorption
An activated carbon is an absorbent that has a very high surface absorption; its form is crystalline that there are many pores in its internal structure.
Activated carbon has many applications including waters purification (drinking water, industrial waters, aquariums water). In terms of color and flavor, it can be used it in improvement of color and flavor in beverages and fruit juices (Tans *et al.*, 1998). The higher the porosity of activated carbon is, the more surface adsorption is also.

Sizes of activated carbon crystal have also inverse proportion with the amount of absorption level.
Adsorption is a process where a solid is used for removing a soluble substance from the water. In this process active carbon is the solid. Activated carbon is produced specifically so as to achieve a very big internal surface (between 500 - 1500 m2/g). This big internal surface makes active carbon ideal for adsorption. Active carbon comes in two variations: Powder Activated Carbon (PAC) and Granular Activated Carbon (GAC). The GAC version is mostly used in water treatment; it can adsorb the following soluble substances.
Adsorption of organic, non-polar substances such as:
O Mineral oil
O BTEX
O Poly aromatic hydrocarbons (PACs)
O (Chloride) phenol

- Adsorption of halogenated substance: I, Br, Cl, H en F
- Odor
- Taste
- Yeasts
- Various fermentation products
- Non-polar substances (Substances which are non soluble in water)

Process Description
Water is pumped in a column which contains active carbon; this water leaves the column through a draining system. The activity of an active carbon column depends on the temperature and the nature of the substances. Water goes through the column constantly, which gives an accumulation of substances in the filter. For that reason the filter needs to be replacing periodically. A used filter can be regenerated in different ways; granular carbon can be regenerated easily by oxidizing the organic matter. The efficiency of the active carbon decreases by 5 - 10% 1). A small part of the active carbon is destroyed during the regeneration process and must be replaced. If you work with different columns in series, you can assure that you will not have a total exhaustion of your purification system (Metcalf & Eddy, 1991).
Amlodipine: it is a drug from the blocking group of calcium channel that is offered as pill and it is blood pressure decreasing, anti-angina.

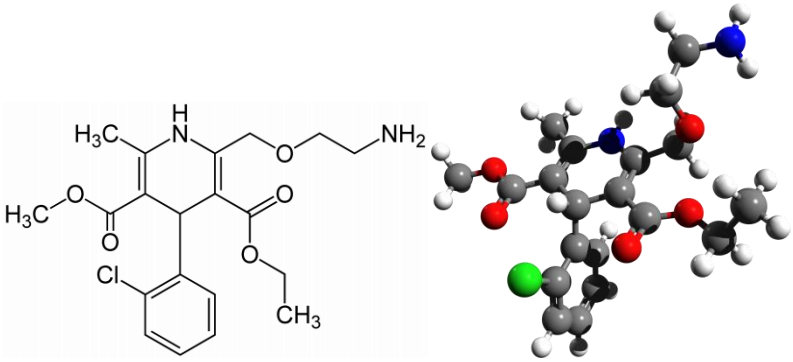

Figure 2: Molecular structures of amlodipine

A group of drugs are that inhibit calcium influx into the cell and calcium departure from cell reserves. These drugs reduce the conduction velocity of atrial-ventricular and sinus-atrial and relax smooth muscles of cardiovascular wall.
It is necessary Calcium connection to myosin for the smooth muscles contraction of vessels wall. These drugs are used in the treatment of coronary arteries diseases, such as angina, cardiac arrhythmia, high blood pressure and final vascular diseases. One of these drugs is Amlodipine.
Its IUPAC naming is as follows:

(*RS*)-3-ethyl 5-methyl 2-[(2-aminoethoxy)methyl]-4-(2-chlorophenyl)-6-methyl-1,4-dihydropyridine-3,5-dicarboxylate

MATERIALS AND METHODS

Multi-walled carbon nanotubes (MWCNTs) are produced by outer diameter of 10 to 20 nm, surface space of 250 of 280 m2 /g and high purity of 99%, and were purchased from Aldrich.
First we make powder Amlopress tablets then we use the water as a solvent and we prepare solutions with a concentration of 5 ppm, 10ppm, 20ppm, 30ppm, 50ppm and 80ppm prepared. Then we read their absorption at the highest wavelength by uv / visible machines.
After that, we solve the amount of 0.01 gram of nanotube carbon absorbent in the solutions and in the same way we measure its absorption with uv / visible machine (the amount of Amolpress powder is effective in our absorption rate).
In this experiment, it has been used nanotube carbon with the following characteristics.

Table 1: The Characteristics of used nanotube carbon

PROPERTY	UNIT	VALUE
Average diameter	nanometers	9.5
Average length	microns	1.5
Carbon purity	%	99
Metal oxide	%	10
Surface area		250-300

We also perform thistestforactivated carbonadsorbent.

Modeling of the Adsorption Isotherms

Equilibrium study on adsorption provides information on the capacity of the adsorbent. An adsorption isotherm is characterized by certain constant values, which express the surface properties and affinity of the adsorbent and can also be used to compare the adsorptive capacities of the adsorbent for different pollutants.
Equilibrium data can be analyzed using commonly known adsorption systems. Several mathematical models can be used to describe experimental data of adsorption isotherms. The Freundlich, Langmuir and Temkin models are employed to analyze the adsorption that occurred in the experiment.

Langmuir Model

The Langmuir model assumes uniform energies of adsorption onto the surface and no transmigration of adsorbate in the plane of the surface. The Langmuir equation may be written as:

$$Ce/qe = 1/qmb + 1/qm * Ce \quad (1)$$

Where qe is the amount of solute adsorbed per unit weight of adsorbent (mg/g), Ce the equilibrium concentration (mg/L), qmis the monolayer adsorption capacity (mg/g) and b is the constant related to the free energy of adsorption.
The Langmuir model considers several assumptions: the adsorption is localized, all the active sites on the surface have similar energies, none interaction between adsorbed molecules exist, and the limiting reaction step is the surface reaction as in the heterogeneous catalytic reaction.
The Freundlich model is an empirical equation based on sorption on heterogeneous surface through a multilayer adsorption mechanism. It is given as:

$$Qe = kfCe^{1/n} \quad (2)$$

where qe is the amount of solute adsorbed per unit weight of adsorbent (mg/g), Ce is the equilibrium concentration (mol/L), kf is the constant indicative of the relative adsorption capacity of the adsorbent (mg/g(mg/L) and 1/n is the constant, indicative of the intensity of the adsorption. The linearized form of the Freundlich equation is:

$$Lnqe = Lnkf + 1/nLnCe \quad (3)$$

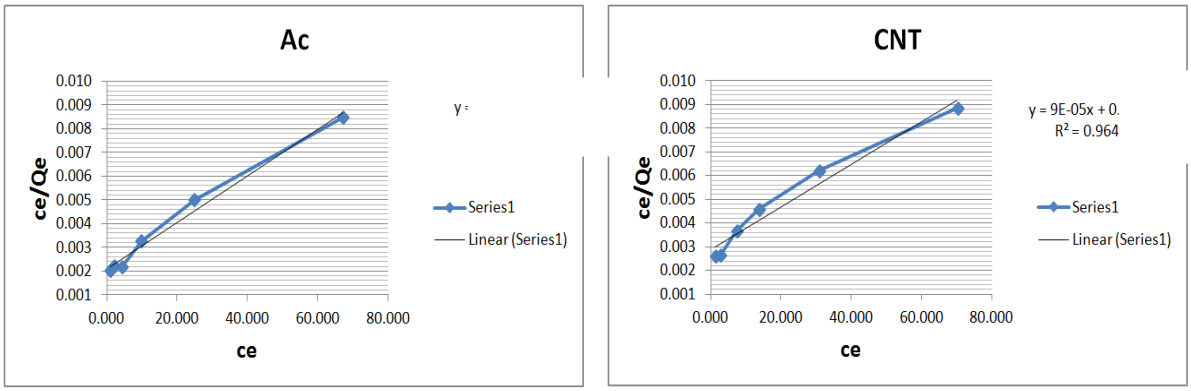

Figure 3: Diagram of Langmuir model adsorption of Amlodipin on AC and CNT

Freundlich Model

The value of kf and n can be calculated by plotting lnqe versus lnCe figure 5.

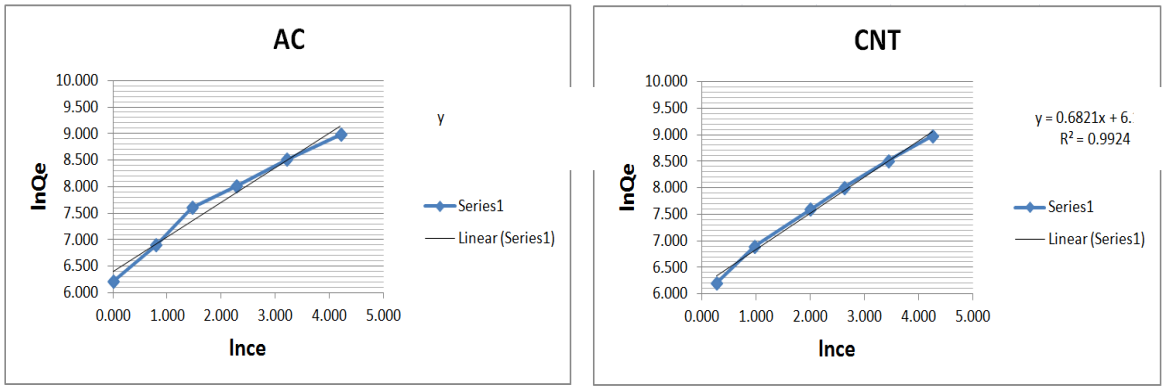

Figure 4: Diagram of Freundlich model adsorption of Amlodipin on AC and CNT

Temkin Model

Temkin suggested that, because of the existence of adsorbent-adsorbate interactions, the heat of adsorption should decrease linearly with the surface coverage. The Temkin isotherm equation assumes that the adsorption is characterized by a uniform distribution of the binding energies, up to some maximum binding energy. The corresponding adsorption isotherm can thus be adjusted by the following equation:

$$Q=B\ln A+B\ln C \quad (4)$$

Where B is related to the heat of adsorption (L/g) and A is the dimensionless Temkin isotherm constant. The Temkin parameters (B and A) can be determined from the linear plots of qe and lnCe figure 6.

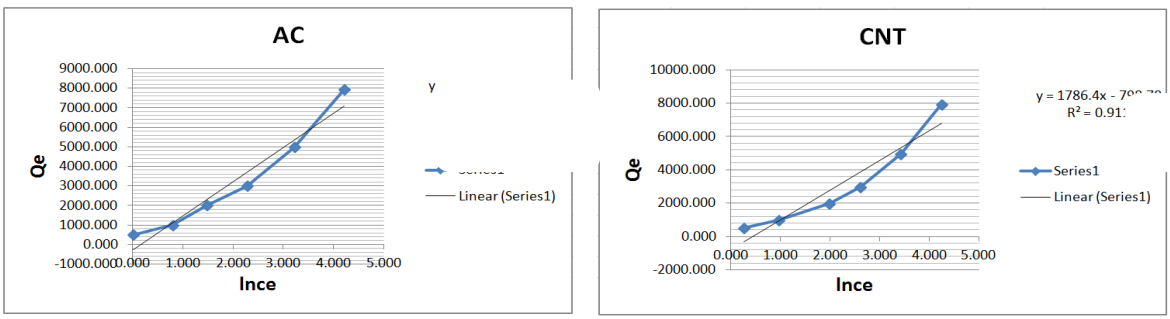

Figure 5: Diagram of Temkin model adsorption of Amlodipin on AC and CNT

RESULTS AND DISCUSSION

Adsorption of The Langmuir, Temkin and Freundlich isotherms of the adsorption process of Amilodipinon MWCNTs are as shown in Figures 4 to 6. It was observed that the experimental data were well represented by Langmuir, Freundlich and Temkin models. The values of the constants of the isotherms of Langmuir, q and b, and of Freundlich, k and n, and of Temkin, B, A and b, are as shown in Table 1. The results of Figures 4 to 6 show that in order to adsorb Amilodipin on carbon nanotube in the temperature range of 295 to 305 K, the Freundlich model is followed because they have more R2.

Conclusion

In this study we compare the adsorption isotherms of Amilodipin by activated carbon and carbon nanotube. Base on obtained results we conclude that nanotube has more efficiency in removal of Amilodipin rather than activated carbon. Results of isothermic experiments showed that the correlation coefficient of Freundlich model isothermic's equation for carbon nanotube was more than activated carbon. Also, the values of n and Kf for carbon nanotube were higher than activated carbon and indicating that the energy of adsorption is higher than carbon nanotube. Therefore, in total, it is concluded that correlation coefficient (n and Kf) in Freundlich isotherm's models for carbon nanotube were higher and it's efficiency in the removal of Amilodipin is better than activated carbon.

Considering that adsorption onto a solid surface due to attractive forces between functional groups on the solid surface and molecules material is absorbed. According to the results obtained on carbon nanotube (CNT) and activated carbon (AC) investigated in this study, Freundlich model for adsorption Amilodipin by carbon nanotubes and freundlich model for adsorption Amilodipin by activated carbon is consistent. freundlich model represents ions adsorption onto heterogeneous surfaces with multi-layer adsorption and adsorbed amount increases with increasing concentration.

Table 2: Parameters and correlation coefficients of isotherm model

Adsorption	**Langmuir model**			**Freundlich model**			**Temkin Model**		
	q_m(mg/g)	**R^2**	**b(L/mg)**	**K_f(mg/g)**	**N**	**R^2**	**B**	**R^2**	**A(L/mg)**
Adsorption of Metformin on Activated carbon	90	0.9653	0.21	47.4	1.54	0.9740	17.6	0.9473	1.65
Adsorption of Metformin on Carbon nanotubes	95	0.9841	0.261	60.7	1.56	0.9924	17.8	0.9810	1.76

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