Indian Journal of Fundamental and Applied Life Sciences ISSN: 2231– 6345 (Online)
An Open Access, Online International Journal Available at www.cibtech.org/sp.ed/jls/2014/04/jls.htm
2014 Vol. 4 (S4), pp. 933-937/Rahimi et al.
Research Article

LANGMUIR, FREUNDLICH AND TEMKIN ADSORPTION ISOTHERM OF CAPTOPRIL AN ACE INHIBITOR (OR ANGIOTENSIN-CONVERTING-ENZYME INHIBITOR) IS A PHARMACEUTICAL DRUG USED FOR THE TREATMENT OF HYPERTENSION BY MULTI-WALL CARBON NANOTUBE

Mehdi Rahimi[1], Davood Wadi[2] and [*]Mehdi Vadi[2]
[1]*Department of Chemistry, Gachsaran Branch, Islamic Azad University,Gachsaran,Iran*
[2]*Department of Chemistry,Sarvestan Branch, Islamic Azad University, Sarvestan, Iran*
[*]*Author for Correspondence*

ABSTRACT
We have studied the adsorption of the isotherm of Captopril, on multi-wall carbon nanotube. The adsorption equilibrium isotherms were fitted by Freundlich, Langmuir, and Temkin models. It was found that the Freundlich model described the adsorption process better than other two isotherm models. The amount of Captopril adsorbed on carbon nanotube surface increased with the increase of the initial Captopril concentration.

Keywords: *Adsorption, Isotherm, Multi-wall Carbon Nanotube, Captopril*

INTRODUCTION
Adsorption of material depends on the adsorbate-adsorbent interaction and system condition and has been investigated for their suitable for application in drugs adsorption control (Elahe and Mahdi, 2014**;** Namavar *et al.,* 2014; Rahimi and Vadi, 2014; Dehmolaei and Vadi, 2014; Vadi and Namavar, 2014; Vadi, 2013; Vadi *et al*., 2013; Vadi *et al*., 2012; Vadi, 2012; Vadi, 2011; Wang *et al*., 2009).
Carbon nanotubes (CNTs) are allotropes of carbon with a cylindrical nanostructure. Nanotubes have been constructed with length-to-diameter ratio of up to 132,000,000:1 (Sheng *et al*., 2010), significantly larger than for any other material. These cylindrical carbon molecules have unusual properties, which are valuable for nanotechnology, electronics, optics and other fields of materials science and technology. In particular, owing to their extraordinary thermal conductivity and mechanical and electrical properties, carbon nanotubes may find applications as additives to various structural materials. Multi-walled carbon nanotubes (MWCNT's) can adsorb many atoms and molecules on their surface such as adsorption of metallic elements. Adsorption characteristic of MWCNTs is breather for adsorption of gases such as hydrogen and other gases. All of the compounds on the surface of MWCNTs adsorbed two main covalent bonds and non-covalent bonds (Zhao *et al*., 2006; Akif *et al*., 2010).
Non-steroidal drugs (NSAIDs) are drugs that inflammation, pain and reduce fever. Captopril is an angiotensin-converting enzyme (ACE) inhibitor used for the treatment of hypertension and some types of congestive heart failure. Captopril was the first ACE inhibitor developed and was considered a breakthrough both because of its novel mechanism of action and also because of the revolutionary development process (Attoub *et al*., 2008). Captopril's main uses are based on its vasodilation and inhibition of some renal function activities.
These benefits are most clearly seen in the following conditions: Hypertension, Cardiac conditions such as congestive heart failure and after myocardial infarction, Preservation of kidney function in diabetic nephropathy. It has also been investigated for use in the treatment of cancer (15). In this research, some non-steroidal anti-inflammation on multi walled carbon nanotube were studied and tried to find out how this drugs can be adsorbed by carbon nanotube.
We also want to find out if we can affect the inflammable molecules by putting these drugs on carbon nanotube without damaging the safe molecules. Systematic (IUPAC) name**:** (*2S*)-1-((*2S*)-2-methyl-3-sulfanylpropanoyl) pyrrolidine-2-carboxylic acid with this structure figure 1.

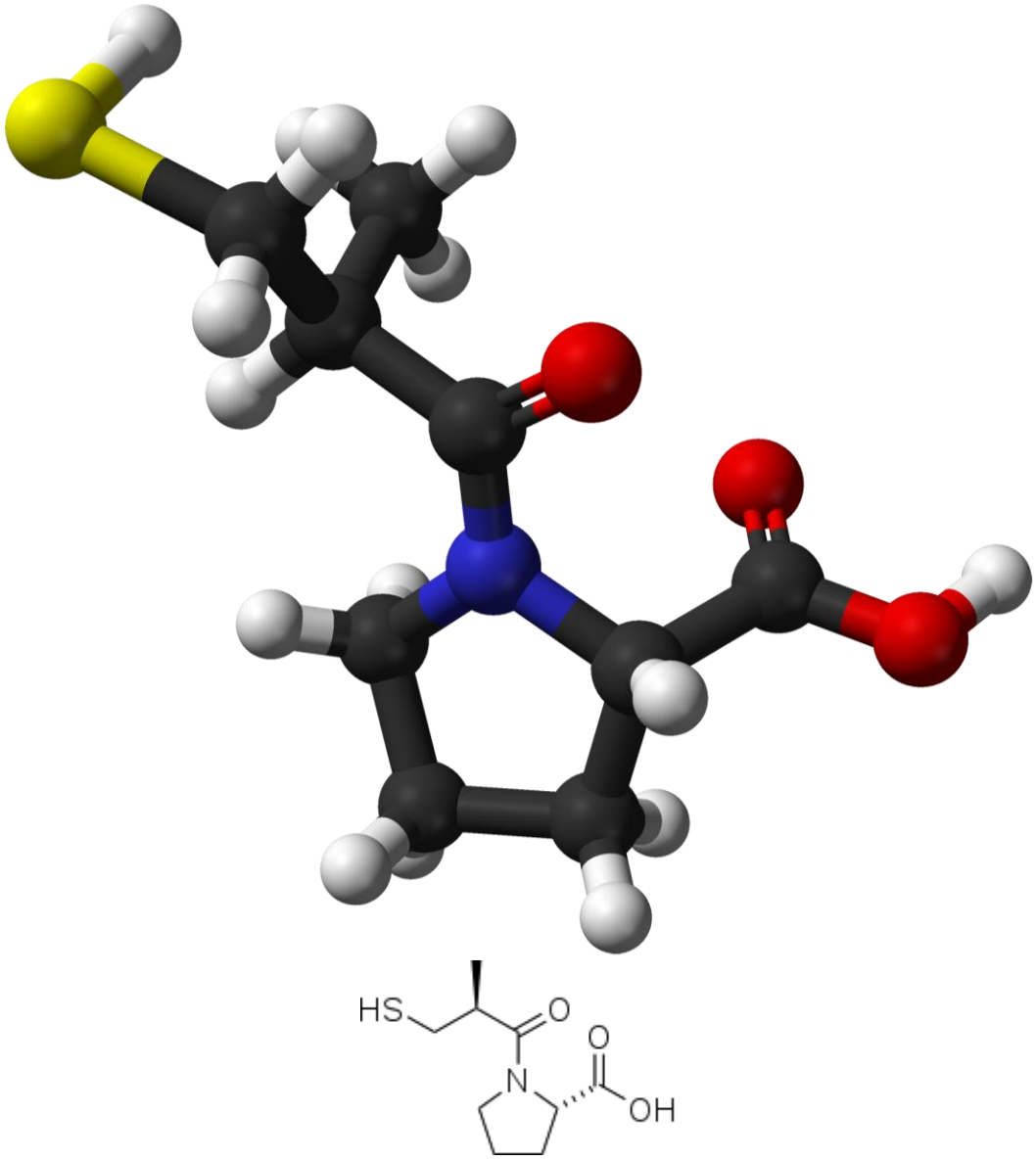

Figure 1: (*2S*)-1-((*2S*)-2-methyl-3-sulfanylpropanoyl) pyrrolidine-2-carboxylic acid

Experimental

At first we solved 0.01 g of Captopril in 100 ml of water and make (100 ppm) solution. After dilution of this solution the consistencies 10, 20, 30, 40 ppm were produced. 10 ml of each concentration was taken and 0.01 g of multi-walled carbon nanotube (MWCNT) was added to each part. This solution was mixed about 10 min with magnetic stirrer. Then amount of concentration was measured with spectrophotometry before and after adding carbon nanotube.

RESULTS AND DISCUSSION

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 analysis adsorption occurred in the experiment data of adsorption isotherms. The Freundlich, Langmuir and Temkin models are employed to analysis adsorption occurred in the experiment.

Langmuir Model

The Langmuir adsorption model is the most common model used to quantify the amount of adsorbate on an adsorbent as a function of partial pressure or concentration at a given temperature. This equation expressed by relation.

$C_e/q_e = 1/q_m + 1/q_m b\, C_e$ (1)

n this equation, q_e (mg. g^{-1}) is the solution was adsorbed the surface and q_e is equilibrium constant of adsorption and b is the capacity of adsorption in saturated single layer and C_e (mg. l^{-1}) is solution in equilibrium state (Figure 2) and its calculated parameters can be seen in table 1.

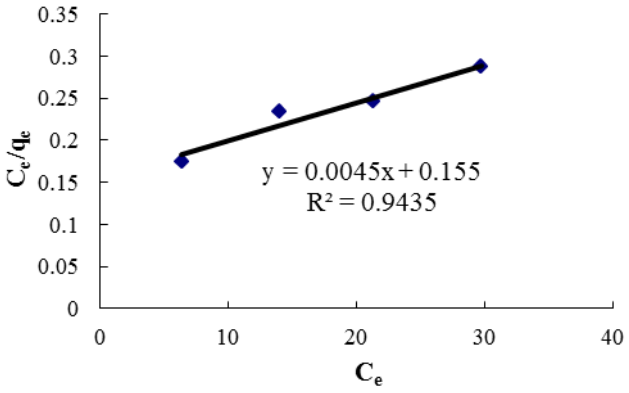

Figure 2: Langmuir isotherm of Captopril on CNT nanotube nnananotube

Freundlich Model

The Freundlich equation or Freundlich adsorption isotherm is an adsorption isotherm, which is a curve relating the concentration of a solute on the surface of an adsorbent, to the concentration of the solute in the liquid with which it is in contact.

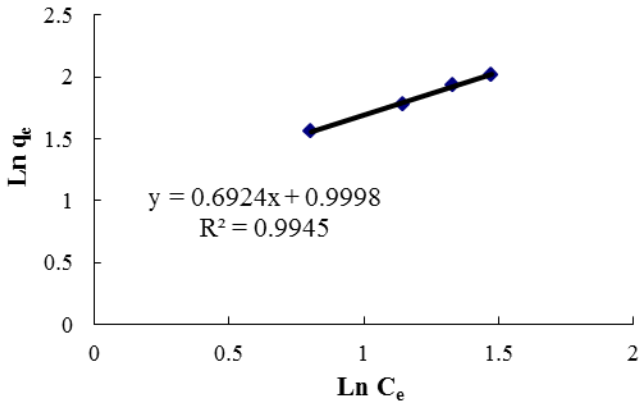

Figure 3: Freundlich isotherm of Captopril on carbon nanotube

Freundlich (1909) gave an empirical expression representing the isothermal variation of Adsorption of a quantity of gas adsorbed by unit mass of solid adsorbent with pressure. This equation is known as

Freundlich Adsorption Isotherm or Freundlich Adsorption equation. This model is specified with equation.

$q_e=k_f C_e^{1/n} \rightarrow \quad lnq_e= lnk_f + 1/n\ ln\ C_e$ (2)

In this equation, q_e ($mg.g^{-1}$) is amount of absorbed material in absorbent surface, K, n in arrangement are adsorption capacity adsorption intensification (Figure 3) and its calculated parameters can be seen in table 1.

Temkin Model

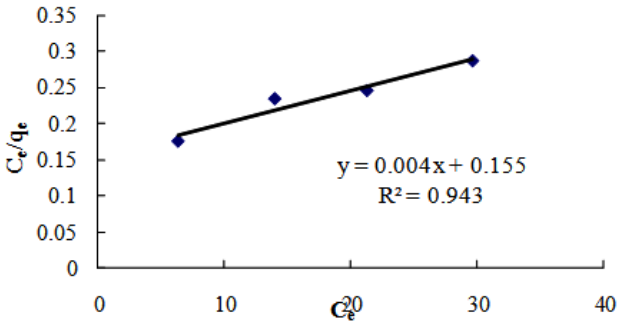

Figure 4: Temkin isotherm of Captopril on carbon nanotube

Table 1: Parameters and Correlation coefficient of Langmuer, Frendlicn and Temkin Captopril on carbon nanotuble

Langmuir			**Freundlich**			**Temkin**		
K_a(L/mg)	Q_m(mg/g)	R^2	n	K_f(mg/g)	R^2	K_t(L/mg)	B	R^2
0.0290	222.22	0.9435	1.4445	9.9953	0.9945	0.3337	43.67	0.9693

The Temkin model is linearly represented as equation (3) and generally applied in the form:

$q_e=B\ ln\ A + B\ ln\ C_e$ (3)

Where A and B are the Temkin isotherm constant (L/g) and heat of sorption (J/mol) respectively. R is the gas constant (J/mol/k), b is the Temkin isotherm constant linked to the energy parameter, B, as shown on equation:

f

$b = RT/B$ (4)

T is the absolute temperature in kelvin (Figure 4) and its calculated parameters can be seen in table 1.

Conclusion

The results of this survey show the correlation coefficient of Freundlich isotherm equation has the best accordance and its adsorption energy is high. The result of parameters shows the suitable efficiency of multi-wall carbon nanotube in adsorption of captopril.

ACKNWLEDGEMENT

The authors gratefully acknowledge partial support of this work by Islamic Azad University, Gachsaran Branch.

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