ISSN: 0975-8585

Research Journal of Pharmaceutical, Biological and Chemical Sciences

Investigation of Langmuir, Freundlich and Temkin Isotherms of Letrozole by Single-Wall Carbon Nanotube and Multi-Wall Carbon Nanotube.

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ABSTRACT

This experimental studied aimed to compare the adsorption of Letrozole as anti-cancer drugs by two adsorbent: Single-wall carbon nanotube (SWCNT's) and Multi-wall carbon nanotube (MWCNT's) by use of UV-Vis spectrophotometer Jenway 6505 model. In this study, four different concentrations of B_{12} in the range of 212.nm were used. In all conducted experiments, the values of adsorbents, exposure time, temperature, and pH were assumed constant. Based on the results, under similar conditions the efficiency of adsorption of Letrozole by MWCNT's was more than SWCNT's. The results can be beneficial in pharmaceutical, biology and breast cancer treatment plant.

Keywords: Adsorption, Adsorbent, Letrozole, MWCNT's, SWCNT's

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INTRODUCTION

The first serious attempt to understand the structure of carbons produced by the pyrolysis of organic materials was made by Rosalind Franklin in the 1950s [1]. She showed that these carbons fall into two distinct classes, which she called graphitizing and non-graphitizing. . Carbon nanotubes are a new form of carbon with unique electrical and mechanical properties [2]. They can be considered as the result of folding graphite layers into carbon cylinders. Nanotube oxidation of the double tube begins that will open tube. Tubes have high capillarity and can solve liquids and gas in itself [3,4]. All compounds on the surface of carbon nano-tubes are adsorbed by two major covalent and non-covalent links [5,6]. They can be planted there without causing ulcers in the point and they can release the drugs slowly over the time in the point. The application part of carbon nano tube are: Precise photography of biological, chemical and biological sensors have a reliable and long life, gene therapy through gene transfer into cells by them, removing bacteria and [7] multi-wall nano-tubes discovered in 1991 would create incentives for broader research in engineering science based on entirely carbon nanotubes and their applications [8]. Multiwalled carbon nanotubes (MWCNTs) can adsorb many atoms and molecules on their surface such as adsorption of metallic elements like lithium [9], potassium [10], rubidium [11], cesium [12] and non-metallic such as hydrogen [13], oxygen [14], nitrogen [15] and methanol [16]. Adsorption characteristic of MWCNTs is breather for adsorption of gases such as hydrogen and other gases [15]. All of the compounds on the surface of MWCNTs adsorbed two main covalent bonds and non-covalent bonds [17-18].

Off-label uses of Letrozole

Letrozole has been used for ovarian stimulation by fertility doctors since 2001 because it has fewer side-effects than clomiphene (*Clomid*) and less chance of multiple gestation. A Canadian study presented at the American Society of Reproductive Medicine 2005 Conference suggests that letrozole may increase the risk of birth defects. A more detailed ovulation induction follow-up study found that letrozole, compared with a control group of clomiphene, had significantly lower congenital malformations and chromosomal abnormalities at an overall rate of 2.4% (1.2% major malformations) compared with clomiphene 4.8% (3.0% major malformations) [19]. Despite this, India banned the usage of letrozole in 2011, citing potential risks to infants. In 2012, an Indian parliamentary committee said that the drug controller office colluded with letrozole's makers to approve the drug for infertility in India and also stated that letrozole's use for infertility was illegal worldwide [20] however, such off-label uses are legal in many countries such as the US and UK [21-22]. The anti-estrogen action of letrozole has been shown to be useful in pretreatment for termination of pregnancy, in combination with misoprostol. It can be used in place of mifepristone, which is expensive and unavailable in many countries [23]. Letrozole is sometimes used as a treatment for gynecomastia, although it is probably most effective at this if caught in an early stage (such as in users of anabolic steroids) [24,25]. Some studies have shown that letrozole can be used to promote spermatogenesis in male patients suffering from nonobstructiveazoospermia [26].

Letrozole has also been shown to delay the fusing of the growth plates in mice [27]. When used in combination with growth hormone, letrozole has been shown effective in one adolescent boy with a short stature. Letrozole has also been used to treat endometriosis.

Mechanism of action

Estrogens are produced by the conversion of androgens through the activity of the aromatase enzyme. Estrogens then bind to an estrogen receptor, which causes cells to divide. Letrozole prevents the aromatase from producing estrogens by competitive, reversible binding to the heme of its cytochrome P450unit. The action is specific, and letrozole does not reduce production of mineral- or corticosteroids.

Adverse effects

The most common side effects are sweating, hot flashes, arthralgia (joint pain), and fatigue [28].

Generally, side effects include signs and symptoms of hypoestrogenism. There is concern that long term use may lead to osteoporosis, which is in certain patient populations such as post-menopausal women or osteoporotics, bisphosphonates may also be prescribed.

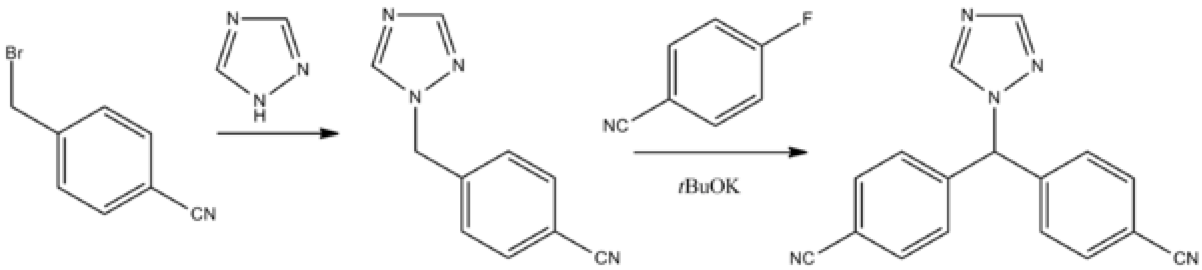
Comparison with Tamoxifen

Tamoxifen is also used to treat hormonally-responsive breast cancer, but it does so by interfering with the estrogen receptor. However, letrozole is effective only in post-menopausal women, in whom estrogen is produced predominantly in peripheral tissues (i.e. in adipose tissue, like that of the breast) and a number of sites in the brain [29]. In pre-menopausal women, the main source of estrogen is from the ovaries not the peripheral tissues, and letrozole is ineffective.

In the BIG 1–98 Study, of post-menopausal women with hormonally-responsive breast cancer, letrozole reduced the recurrence of cancer, but did not change survival rate, compared to tamoxifen.

Synthesis

Letrozole can by synthesized from 4-cyanobenzyl bromide, triazole, and 4-fluorobenzonitrile [29]:



EXPERIMENTAL

Chemicals materials

We used the carbon nanotube single wall with 95% and multi wall nanotube with 97% pure degree, production of neutrino Company. Water is distilled twice to prepare Letrozole solution.

Method

At first solutions used was prepared by solving Letrozole and distilled water is used twice. Then 50ppm of Letrozole was provided using this sample, some solutions with different concentrations of (8.10.12.14) mg/lit of pure Letrozole were prepared.

Absorbance of four standard solutions was measured by spectrophotometer and calibration curve was plotted. 10 ml of four standard solutions were added separately to 0.005 grams of carbon nanotube single wall and carbon nanotube multi wall as adsorbent and after 60 minutes mixing by magnetic mixer solutions. Then liquid and solid phase were separated by means of a filter paper. The concentration of Letrozole was measured by using on spectrophotometer tool adsorption rate gained for Letrozole. All tests have been performed at the lab with the temperature of (293 ± 1°C).

Adsorption isotherms

The adsorption isotherm described the relationship between the equilibrium concentrations of adsorbate in the solution and the amount of adsorbate on adsorbent. Which indicates how adsorbate molecules are distributed between the Liquid phase and solid phase when the adsorption Process reaches equilibrium [30,31]. In this study, three isotherms were used for describing the experimental results, namely the Freundlich isotherm, the Langmuir isotherm and the Temkin isotherm.

Langmuir isotherm

The Langmuir model assumes that the ideal monolayer adsorption takes place at specific homogeneous sites within the adsorbent, i.e. once a molecule occupies a sit and no further adsorption takes place [32]. The Langmuir equation may be Written as

$$\frac{c_e}{q_e} = \frac{1}{q_m} + \frac{1}{q_m b} c_e \qquad (1)$$

Where *qe* is the amount of solute adsorbed per unit weight of adsorbent at equilibrium ($mg.\,g^{-1}$), *C*e the equilibrium concentration of the solute in the bulk solution ($mg.L^{-1}$).

Freundlich isotherm

The Freundlich isotherm was broadly used to describe adsorption phenomenon in liquid and for adsorption on heterogeneous surface with multi layer adsorption. This isotherm assumes that as the adsorbate concentration increases, the concentration of adsorbate on the adsorbent surface also increase [33,34]. The Freundlich isotherm is expressed by the following empirical equation:

$$q_e = k_f c_e^{1/n} \qquad \ln q_e = \ln k_f + \frac{1}{n} \ln c_e \qquad (2)$$

where q_e and Ce are the equilibrated concentration of the adsorbate in sorbent and solution, respectively, where K_F is a constant indicative of the relative adsorption capacity of the adsorbent ($mg^{1-(1/n)}\ L^{1/n}\ g^{-1}$), and n is adsorption intensity related to the surface heterogeneity.

Temkin isotherms

The Temkin isotherm equation assumes that the heat of adsorption of all the molecules in the layer decreases linearly with coverage due to adsorbent–adsorbate interactions, and that the adsorption is characterized by a uniform distribution of the binding energies, up to some maximum binding energy [35,36]. It is expressed by the relation:

$$q_e = B1 \ln kT + B1 \ln Ce \qquad (3)$$

where constant B=RT/b is related to the heat of adsorption, *R* the universal gas constant($Jmol^{-1}\ K^{-1}$), *T* the temperature(K), *b* the variation of adsorption energy ($J\ mol^{-1}$) and KT is the equilibrium binding constant (Lmg^{-1}) corresponding to the maximum binding energy.

RESULTS AND DISCUSSION

Table 1. The value of correlation coefficient (293°K) for Freundlich equation (R^2 = 0.9994) is higher than Langmuir (R^2= 0.9342) and Temkin (R^2 = 0.989) suggesting that equilibrium data are well described by Freundlich isotherm.

Table 1: Parameters of Langmuir, Freundlich and Temkin isotherms of the of Letrozole on MWCNT's and SWCNT's

	Langmuir			Freundlich			Temkin		
	b	q	R^2	n	$k(l.g^{-1})$	R^2	$A(l.mg^{-1})$	B	R^2
MWCNT's	0.0	40.9	0.934	0.9	2.20	0.9	2.71	4.0	0.98
SWCNT's	0.1	11.9	0.740	1.8	2.30	0.8	1.282	2.9	0.79

CONCLUSION

In this study we compare the adsorption isotherms of Letrozole by multi wall carbon nanotube and single wall. Base on obtained results we conclude that MWCNT's has more efficiency in removal of Letrozole rather than SWCNT's. Therefore, in total, it is concluded that correlation coefficient, (n and Kf) in Freundlich isotherm model for MWCNT were higher and it's efficiency in the removal of Letrozole is better than SWCNT.

The results indicate that the Freundlich adsorption isotherm fits the data better than the other two models which suggest heterogeneity in the sorption sites.

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