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Some Langmuir and Freundlich Parameters of Adsorption Studies of Chlorpheniramine Maleate

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Abstract: The *in-vitro* adsorption of chlorpheniramine maleate on activated charcoal, magnesium trisilicate, talc powder and magnesium carbonate have been studied at 37°C and pH = 5.0 using the Batch method. Both the Langmuir and Freundlich parameters were determined for each adsorbent and their values used in determination of adsorption capacities of each. The results show that the adsorption capacities increased in the order Activated carbon > Magnesium trisilicate > magnesium stearate > Talc power. This in-vitro study indicates that some chlorpheniramine maleate may be lost when it is administered concomitantly with pharmaceutical adsorbents.

Key words: *In-vitro* adsorption, Chlorpheniramine Maleate, adsorbents Langmuir and Freundlich parameters, adsorption capacities

INTRODUCTION

The drug adsorption phenomenon exhibit Langmuir and Freundlich adsorption isotherm under general *in-vitro* experimental condition. These principles of surface adsorption have found clinical usefulness in the management of acute toxicity in drug overdose in patients. Numerous pharmaceutical adsorbents used in drug preparations have been discovered to have a substantial affinity for the drug (Aidoje *et al*., 1998). Studies of drug adsorption is important in the sense that adsorbent is given to patients after acute drug ingestion (drug overdose) in an attempt to adsorb some ingested drug and thereby decrease the duration of the comma or the incidence of drug-induced morbidity. Poisoning is another very common clinical problem and many drugs used in the treatment of variety of diseases do not have specific antidote for the management of accidental poisoning by the drug (Von-Ottingmen, 1993). Also the interference in the systematic availability of drug is brought about by its adsorption on the activated surface of the solid adsorbent, thus preventing the adsorbed fraction of the drug from permeating through the gastro-intestinal mucosa into the blood stream (Guay *et al*., 1984). In the past decades, the abuse of drugs has increased considerably (Safarikova and Safarik, 2002). Many drugs used in the treatment of many tropical diseases have been implicated in various intentional and accidental poisoning (Orisakwe and Akintonwa, 1990). Many adsorption studies on drugs have been carried out, some of these include the work of Ganjian *et al*. (1980) on the *in-vitro* adsorption studies of cimetidine on selected pharmaceuticals, Sanvordeker also studied the *in-vitro* adsorption of diphenoxylate hydrochloride on activated charcoal and its relationship to pharmacological effects *in-vivo*. Adsorption of benzoic acid on sulfamethiazine particles was found to be pH dependent (Nasipuri and Saleh, 1974). To the best of our knowledge, no reports have been documented on the adsorption studies of chlorpeniramine maleate. Chlorpheniramine maleate with the structural formula 3-(4-chlorphenyl) 13(2-pyrify propyl-N, -N-dimethyl -ammonium hydrogen maleate, is an antistamine which relieve red, itchy and watery eyes, running nose, sneezing caused by allergies and common cold. It is also administered on patients with hay fever and itching resulting from insect bites. When taken in overdose, it may cause side effects such as dry mouth, nose and throat, stomach upset, headache, chest congestion and vision problem. Considering these effects the need to study their adsorptions becomes imperative. The adsorption study of chlorpheniramine maleate is therefore undertaken to investigate the effectiveness of some pharmaceutical adsorbents in controlling and reducing the effect of using it in overdose.

MATERIALS AND METHODS

Activated carbon (BDH Chemicals), magnesium trisilicate, talc powder and magnesium stearate were all commercial products. Chlorpheniramine maleate was

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obtained from Evans PLC, Lagos, Nigeria. All other chemicals were analytical reagent grade and were used as received. The reagent solutions were always prepared using doubly distilled water.

Procedure: The adsorbents were washed according the procedure described by Ganjian *et al.* (1980) the activated charcoal, magnesium trisilicate, magnesium stearate and talcum powder were washed repeatedly with distilled water followed by methanol until the wavelength of maximum chlorpheniramine maleate absorption). The adsorbents were passed through a 20-mesh sieve while still wet and allowed to dry in an oven at approximately 45°C for 1 h. The dried materials obtained were further passed trough a 100-mesh sieve to ensure that the particle sizes of all the adsorbents were 100-mesh or smaller (Ganjian *et al.*, 1980).

The modified procedure described by Orisakwe was used for the preparation of sample solution (Orasakwe *et al.*, 2001). A weighed amount of 0.5 g of each adsorbent was placed in 100 mL conical flask. The various concentrations of chlorpheniramine maleate, 5.0, 7.5, 12.5, 15.0, 20.0 and 30.0 mg L^{-1} were prepared in distilled water and 25 mL of each solution was added to each adsorbent in conical flask. The resulting mixture was mixed for 60 sec, incubated in water bath shaken for 30 min at a temperature of 37°C. The mixtures were allowed to stand for 20 min. The supernatants were then immediately filtered. The absorbance of clear supernatant fluid containing the free drug was then read using a UV-SP 1800 Spectrophotometer at 358 nm. The corresponding concentration of each measured absorbance was determined from a calibration graph and recorded as residual concentration, C_e. A blank experiment was also carried out following the same procedure as described above without the adsorbent.

RESULTS AND DISCUSSION

The results of the in-vitro adsorption of chlorpheniramine maleate unto various adsorbents were subjected to sellers' version of the Freundlich adsorption equation (Sellers *et al.*, 1980) as

$$\text{Log } Q_e = \log k_{f+} 1/n \log C_e$$

Where k_f is Freundlich constant indicating adsorption capacity, n is a constant usually greater than unity, C_e is the equilibrium concentration of the drug in mg/L and Q_e is the amount of drug adsorbed per amount of adsorbent given by

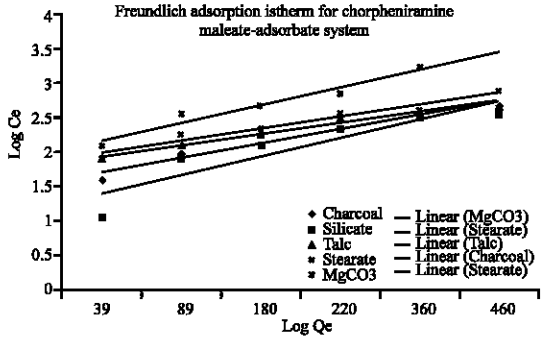

Fig. 1: Plot of $\log Q_e$ against $\log C_e$

Table 1: Freundlich adsorption parameters

Adsorbents	1/n	$k_{f\,x\,10^{-3}}$ mg g^{-1}	R^2
Activated charcoal	0.65	4.68	0.98
$MgSiO_3$	0.66	4.47	0.98
Magnesium stearate	0.77	3.80	0.96
Talc powder	0.99	1.91	0.87

$$\frac{Q_e = (C_o - C_e)\,V}{m}$$

Where C_o and C_e are the initial and equilibrium concentrations of the drug solutions in mgL^{-1} respectively. V is the volume of the drug solutions in L while m is the mass of adsorbent used in gram. Plots of log Q_e against log C_e were linear (Fig. 1), from these plots, values of Freundlich exponent 1/n and adsorption capacities k_f were determined.

The results are recorded in Table 1.

The results were also fitted into the Langmuir adsorption isotherm equation of the form

$$1/Q_e = 1/Q_o b.\ 1/C_e + 1/Q_o$$

Where Q_e is the amount of solute adsorbed per amount of adsorbent, Q_o and b are Langmuir constants indicating adsorption capacity and energy of adsorption.

The value of Q_o for each adsorbent was determined from the slope and intercept of the linear graph obtained from the plot of $1/Q_e$ against $1/C_e$ (Fig. 2). These values are 2.5, 2.0, 1.56 and 0.83 for Activated Charcoal, Magnesium trisilicate, Magnesium stearate and Talcum powder respectively. The linearity of this plot is an indication of the applicability of the Langmuir adsorption isotherm equation and formation of monolayer coverage of the adsorbate on the surface of the adsorbent in the concentration range studied.

The variation of log Q_e against log C_e in the Freundlich Isotherm plot and $1/Q_e$ against $1/C_e$ in the Langmuir isotherm plots were treated with statistical regression analysis. The experimental data fitted well

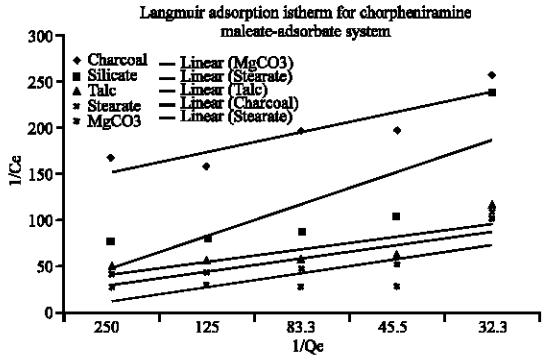

Fig. 2: Plot of $1/Q_e$ against $1/C_e$

with the regression data and the R^2 values ranged from 0.87-0.99 (Table 1) indicating that the experimental data fit strongly into the individual regression (John *et al*., 1985).

The low value of Freundlich exponent 1/n as recorded in Table 1 indicates that these adsorbents are effective at low concentration of chlorpheniramine maleate. The values fell between 0.65 and 0.99 and agreed with the literature report (Ganjian *et al*., 1980). The values are less than unity which indicates favourable adsorption mechanism and formation of relatively stronger bonds between the adsorbents (Nagernaik *et al*., 2002). The Freundlich parameter k_f are 4.68, 4.47, 3.80 and 1.91 for activated charcoal, magnesium trisilicate, magnesium stearate and talcum powder, respectively. This shows that the adsorbents have ability to adsorb or remove chlorpheniramine maleate from solution at 3.0-5.0 mg L^{-1} adsorbate. The drug was mostly adsorbed by the activated charcoal and least adsorbed by talcum powder. The differences in the surface characteristics and chemical structure of the adsorbents may be responsible for the observed variation in their adsorption abilities. The high adsorption capacity of activated charcoal as determined has been attributed to the organic nature of the adsorbent and the presence of phenolics and carboxyl moieties (Cooney, 1978; Guay *et al*., 1984). It was also observed that magnesium trilicate adsorbed better than magnesium stearate and talcum powder adsorbed less than magnesium stearate. This may be due to the presence of small amount of oleate molecules in magnesium stearate, this result agreed with the reports by Ginity and Lach who reported that for a given adsorbate, organic adsorbents generally adsorbed organic molecules strongly than inorganic adsorbents (Ginity and Lach, 1976).

The analysis of the experimental data using the Langmuir adsorption Isotherm followed the same pattern as the Freundlich Isotherm discussed above.

CONCLUSION

The results revealed that concurrent administration of these pharmaceutical adsorbents and chlorpheniramine maleate might induce interference between them. Also that these adsorbents can serve as well an antidote in case of chlorpheniramine maleate overdose or poisoning.

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