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European Journal of Advances in Engineering and Technology, 2019, 6(12):98-107

Research Article ISSN: 2394 - 658X

Utilization of Feather Hen and Egg Shell as Sorbents for Removal of Methyl Violet from Aqueous Solutions

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ABSTRACT

This study was made on the comparison of the effectiveness of the adsorption of Methyl Violet onto Eggshell and Hen Feather, using batch adsorption studies. Adsorption equilibrium studies using Langmuir, Freundlich and Temkin isotherms. The adsorption process mechanism was also studied employing the pseudo-first order, pseudo-second and intra-particle kinetic models. The operating parameters studied were: effects of initial dye solution, adsorbent dose, temperature, contact time and pH. The values of adsorbate removal by egg shell and hen feather were: Initial Dye Solution of 15 mg/l at 93.5% and 92.6% ; Adsorbent Dosage of 0.5 g at 96.0% and 95.5%, pH of 2 at 98.1% and 96.7% , Contact Time of 15 minutes at 97.9% and 99.4% and Temperature of 20℃ at 90.9% and 91.2% respectively. The Freundlich isotherm gave the best fit for Hen Feather, with a correlation coefficient of 0.9816. It was found that the adsorption kinetics followed the pseudo-second order kinetic model, with a correlation coefficient, R^2 of 0.992 for Eggshell and 0.987 for Hen Feather. In the overall analysis, Hen Feather proved to be a better absorbent than Eggshell in the removal of Methylene Violet from aqueous solutions.

Key words: Adsorption, Methylene Violet, Eggshell, Hen Feather isotherm, kinetics

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INTRODUCTION

Many industries and fields, such as ink, pulp, paper, cosmetics, plastics, textile, carpet, food technology, agricultural research and leather tanning use synthetic dyes in their processes. The wastewater from these industries contain large amount of harmful dyes [1]. These are emptied into the wastewater streams of these industries and pave their way into the aquatic system, causing a serious environmental challenge, worldwide [2]. Thus, polluting our waters making them unsafe for aquatic creatures, drinking, domestic and other general useful purposes. Ubani [3] noted that most Nigerian industries release their untreated wastes through their channels into the nearest water bodies, like streams, rivers and the sea.

A dye is a natural or synthetic substance used to add colour to a material. It has a chemical liking for the substrate it is applied on, which on binding to the material gives color to it. Methylene Violet (MV) also called Crystal Violet or Gentian Violet is a common industry dye. It is mostly used in textile industries as a purple dye, giving a deep violet color in the paint industry, in printing-inks and skin disinfectants..

Eggshell (ES) and Hen Feather (HF) are both obtained from the fowl. Eggshell is obtained from the egg of the female fowl, while feather is a general covering for both female and male fowl (hen). Eggs are regularly used in homes, food processing manufacturing companies, restaurants and eateries, and the shells are discarded as waste [1]. Previous studies have examined the useful application of eggshell. In such works, eggshell was used as livestock feed additive, fertilizer and was efficient for dye and heavy metals removal from aqueous solution [4-7].

Hen feather is a waste product from the livestock poultry. Hen feather are mainly composed of keratin (about 91%), 1% lipids and 8% water [8]. Feathers, generally, are well organized, hierarchical structures, being ranked among the most complex keratin structures in vertebrates [9].

Adsorption is a technique whereby a desired material is taken from fluid to solid phase. It is a surface phenomenon. Adsorption is good for separation, especially at low concentration. Researchers have studied adsorption extensively, labeling it an economical and efficient process in treating wastewater that contains dye [10-11].

Adsorbent is the solid that takes up the desired material (may be a gas or solute from a solution). Adsorbents include clay, charcoal and silica gel. The component (gas or solute) which adheres to the solid’s surface (or adsorbed) is termed adsorbate, while removal of adsorbed substances is termed desorption.

The decomposition of most dyes give out harmful products such as carbon monoxide (CO), carbon dioxide (CO_2), nitrogen oxides and hydrogen chlorides, and can also cause reduction in light penetration and photosynthesis [11]. Methyl violet (MV) causes heartbeat increase, vomiting, shock, jaundice and tissue necrosis in humans. Sometimes, it could lead to respiratory and kidney failures and permanent injury to the cornea and conjunctiva. Thus, it becomes necessary that MV is removed to prevent harmful effects on humans, plants, waters and environment.

Eggshell from egg is discarded to fill lands without any pretreatment because it had no useful application. But that kind of management of waste in not the optimal practice due to associated biodegradation odour from egg shell and this pollutes the air [12]. It is vital to avert this menace to breathe in fresh air in our surrounding environment. Hen feathers are generated and discarded yearly into lands and rivers and creating significant waste. They are dumped without prior treatment, creating bad odour problems due to attached remnant flesh. Also, the dumped site becomes a breeding spot for flies, which can further cause other diseases that are contagious [13].

This study compares potential of hen feather (HF) and eggshell (ES) as low cost and readily available sorbents, for removing Methylene Violet dye from wastewater.

2. MATERIALS AND METHODS

2.1. Preparation of Adsorbents

2.1.1. Physical Treatment of Eggshell

The eggshell used was obtained from the poultry farm at Delta State University (DELSU), Abraka, Delta State, Nigeria. The eggshells were washed with detergent, and then carefully rinsed with distilled water to remove dust and dirt. The eggshells were dried under sunlight for few days and then oven-dried at 80°C until it becomes crispy. Dried samples were pulverized by grinding in a mortar to increase surface area.

2.1.2. Carbonization of the Eggshell

The pulverized eggshells were carbonated in a muffle furnace (Muffle Furnace Digital Temperature Controller S/N 446601) at 800° C for 2 hours without air. They were then cooled to room temperature.

2.1.3. Chemical Treatment of Eggshell

The carbonized eggshells material were mixed with hydrochloric acid (HCl) of pH 2.5 overnight. This process further removes dirt and increases eggshell adsorption efficiency. Then they were washed with distilled water to get a neutral pH, mixed with NaOH, to remove any excess acid and rinsed with distilled water to remove dirt and air-dried for two days. It was passed through sieve of 1.18 mm mesh, in order to get a uniform particle size. After which it was stored in air-tight container.

2.2. Physical Treatment of Hen Feather (HF)

The hen feather that was used for this study was obtained from the poultry farm at Delta State University, Abraka, Delta State, Nigeria. They were first washed using detergent several times, and rinsed with distilled water repeatedly to remove adhered dirt, chicken dung and blood and were then air-dried for one week. They were cut into lengths of 3cm, using scissors and oven- dried for 2 hours at 40℃. They were then dried further in an oven at 80°C for 2 hours, so as achieve a better dryness that will improve feather adsorption capacity. Then, it was blended in an electric blender and stored in air-tight container for subsequent use.

2.2.1. Carbonization of the Hen Feather

The pulverized hen feather was heated in muffle furnace at 250°C for 2 hours without air. They were then cooled at room temperature at room temperature.

2.2.2. Chemical Treatment of Hen Feather

The pulverized carbonated hen heather was mixed with HCl at pH of 2.5 overnight, to improve adsorbent efficiency. They were then washed repeatedly using distilled water and treated with NaOH, so as to remove excess acid. Then it was rinsed using distilled water repeatedly for further cleansing to attain a neutral pH. The retained water was then drained through a 1.18 mm sieve, and air-dry for two days. When confirmed dried, they were then stored in an air-tight for subsequent use.

2.3. Preparation of Methylene Violet Dye Stock Solution

The Methylene Violet used is of commercial quality (Methylene Violet C. I. No. 42535). Stock solution was prepared with 1g of Methylene Violet in 1 L (1000 mL) of distilled water in a beaker. Thus, the solution's concentration was 1000 mg/L. From this standard solution, further dilutions were done, with standard volumes of distilled water to get desired concentrations.

2.4. Batch Adsorption Studies

For both the Eggshell and Hen Feather, experiments were done batch-wise. Operational parameters studied were Effects of Contact Time, Adsorbent Dosage, pH, Initial Dye Concentration and Temperature. Dye standard solutions were mixed with Eggshell and Hen Feather respectively and agitated at various rates using a mechanical shaker. Samples were collected at various time intervals. The residual dye suspensions were filtered using Whatman filter paper no. 1. The filtrate was examined through observance of changes in absorbance values at highest wavelength of 510 nm using

UV/Vis Spectrophotometer (Spectrophotometer 200, Techmel & Techmel, USA)
Amount of Dye adsorbed per unit of adsorbent (mg dye/g of adsorbent) was determined, gotten from the mass balance on dye concentration using:

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

Where:
C_o = initial dye concentration (mg/L)
C_e = Equilibrium dye concentration (mg/L) at time,
V = solution volume (L)
m = adsorbent mass (g)
Percentage removal (% Removal) was calculated thus:

$$\%\ \text{Removal} = \frac{(C_o - C_f)}{C_o} \times 100$$

C_o = initial dye concentration (mg/L)
C_f = final dye concentration (mg/L)

2.5. Batch Adsorption Experiments

Adsorption was performed under control using the UV/Vis Spectrophotometer (Spectrophotometer 200, Techmel & Techmel, USA). Samples were collected from the mechanical shaker at different time intervals. The dye solution was then separated from the adsorbent by centrifugation at 150 rpm for 30 minutes. The absorbance of the supernant solution was measured.

2.5.1. Effect of Adsorbent Dosage

The effect of adsorbent dosage for Eggshell (ES) and Hen Feather (HF) on Methylene Violet (MV) removal were examined at distinct adsorbent dosages of 0.5, 1.0, 1.5, 2.0 and 2.5 g, respectively with other parameters constant.

2.5.2. Effect of Initial Dye Concentration

This step examines MV concentration effect on adsorbent dye removal efficiency. Effect of initial dye concentration was investigated at various initial dye concentrations of 3, 6, 9, 12, and 15 mg/L, for ES and HF respectively, keeping other parameters constant.

2.5.3. Effect of Contact Time

This is a relevant study for the useful application of adsorption. This was done by shaking 0.25 mg/L of adsorbent at various contact times of 15, 30, 45, 60 and 75 minutes to determine quantity adsorbed by the ES and HF, respectively.

2.5.4. Effect of pH

Effect of pH on MV removal was examined over a pH range of 2- 10, with 0.25 g/mL of ES and HF respectively. Initial pH of 6 was used, with pH adjustment done using 0.1 M hydrochloric acid (HCl) and 0.1 M sodium hydroxide solution (NaOH).

2.5.5. Effect of Temperature

Temperature effect on MV removal was investigated over a temperature range of 20, 30, 40, 50 and 60℃ for both ES and HF respectively, while other conditions were constant.

3. RESULTS AND DISCUSSION

3.1. Batch Adsorption Studies

3.1.1. Effect of Initial Dye Concentration

Study was made of effect of initial dye concentration on Methylene Violet (MV) adsorption by Eggshell and Hen Feather respectively. Concentration was varied from 3.0 to 15.0 mg/L at initial with an initial concentration of 10.0 mg/l. The results are shown in figures 1a and 1b. This agrees with Chowdhury and Saha [14]. The removal of Methylene Violet by both adsorbents increased as concentration increases. The reason is attributed to the presence of more absorbents which caused increase in surface area. Optimal removal was 93.5 % for Eggshell and 92.6 % for Hen Feather at a concentration of 15.0 mg/L for both adsorbents. Thus, this approach may be applied on a larger scale to adsorb Methylene Violet from wastewater.

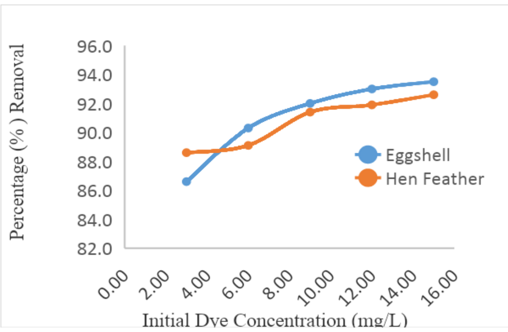

Fig. 1a Effect of Initial Dye Concentration on % Removal of MV by ES and HF from aqueous solution

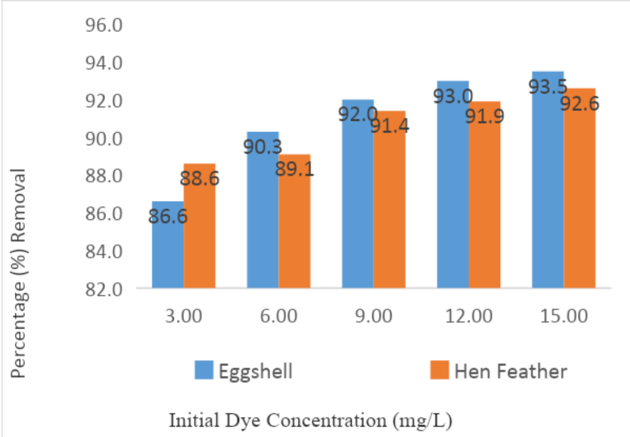

Fig. 1b Effect of Initial Dye Concentration on % Removal of MV by ES and HF from aqueous solution

3.1.2. Effect of Adsorbent Dose

To study effect of adsorbent dose, experiments were carried out by varying the dosages of both adsorbents from 0.5 to 2.5 g. The progress of adsorption process at respective dosages is shown in the Figures 2a and 2b, which reveals a fluctuation in Methylene Violet removal in ES and a continuous decrease in adsorption efficiency by HF, with increased adsorbent dose. This is because as the adsorbent dose increases, it gave room to overlapping sites of adsorption. A decline in the MV removal was noticed, after equilibrium was reached. The highest MV removal was achieved at 96.0%, for ES and 97.5% for HF, with corresponding dosages of 0.5 g for both ES and HF. Thus, optimal dosage is useful for real and large scale treatment of wastewater.

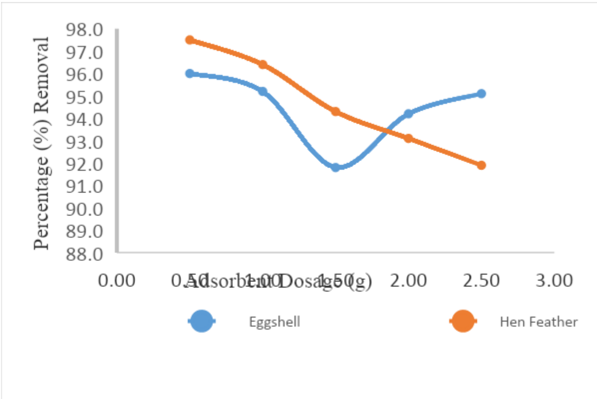

Fig. 2a Effect of Adsorbent Dosage on % Removal of MV by ES and HF from aqueous solution

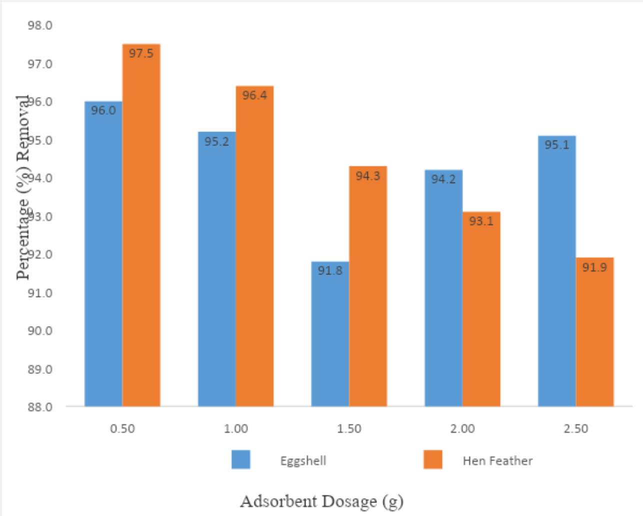

Fig. 2b Effect of Adsorbent Dosage on % Removal of MV by ES and HF from aqueous solution

3.1.3. Effect of Contact Time

Effect of contact time on MV adsorption by ES and HF were studied respectively. Contact time was varied from 15 to 75 minutes with results shown in Figures 3a and 3b. Removal efficiency was higher in HF (99.4 %) than in ES (97.9 %). Equilibrium time was 15 minutes at a pH of 6 and 10 mg/L adsorbent dosage. MV removal efficiency decreased after equilibrium was reached. The reason being that at first, free adsorption sites were available, but became diffused after equilibrium was attained. But as time progresses, the left over sites may have become worn out due to forces of repulsion between the adsorbent and counter ion-binding at adsorbent surface.

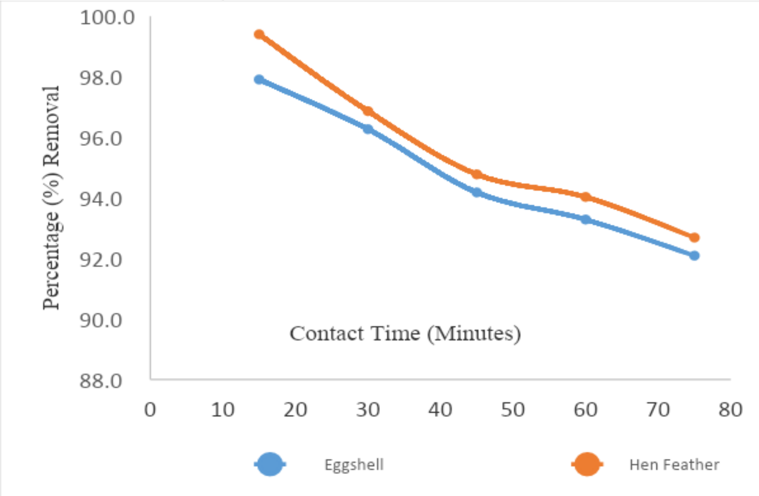

Fig. 3a Effect of Contact Time on % Removal of MV by ES and HF from aqueous solution

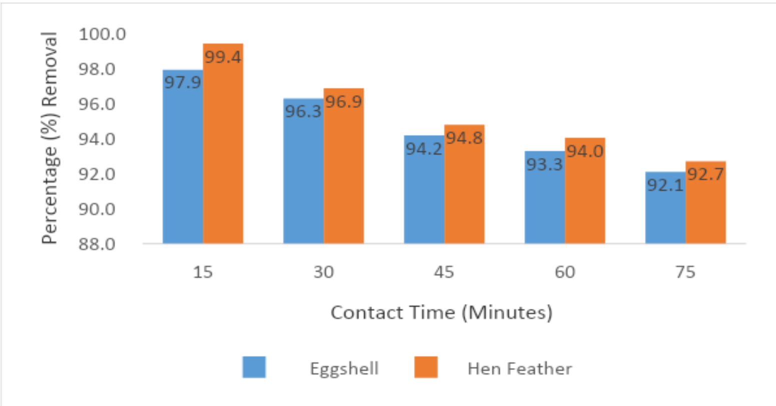

Fig. 3b Effect of Contact Time% Removal of MV by ES and HF from aqueous solution

3.1.4. Effect of pH

To study pH effect on the uptake of MV by ES and HF respectively, pH was varied from a range of 2 – 10. Adjustments in pH were done, using 0.1 M HCl and 0.1 M NaOH. Results which are shown in Figures 3.4a and 3.4b, reveal that highest adsorption of MV occurred at pH of 2, with a removal efficiency of 98.1 % for ES and 96.7 % for HF. When pH was increased from 2 to 10, MV removal was decreased from 98.1% to 95.1 % for ES while it decreased from 96.7 % to 92.8 %. This agrees with Yari et al. [15], who reported that with an increase from a pH 3 to 11, removal efficiency of acid orange 2 dye decreased from 74 % to 40 %. As pH increases, number of positively-charged adsorbent sites was decreased, and number of negatively-charged sites were increased, which caused a decrease in dye removal. Though egg shell carbon shows more increasing percentage removal than the feather when compared at the various pH studied.

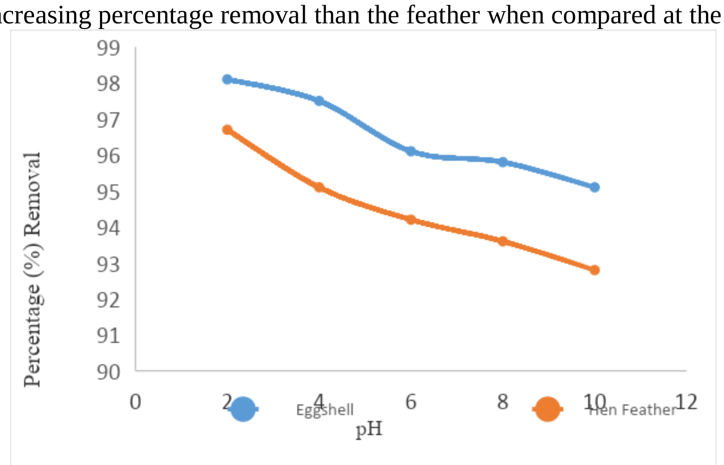

Fig. 4a Effect of pH on % Removal of MV by ES and HF from aqueous solution

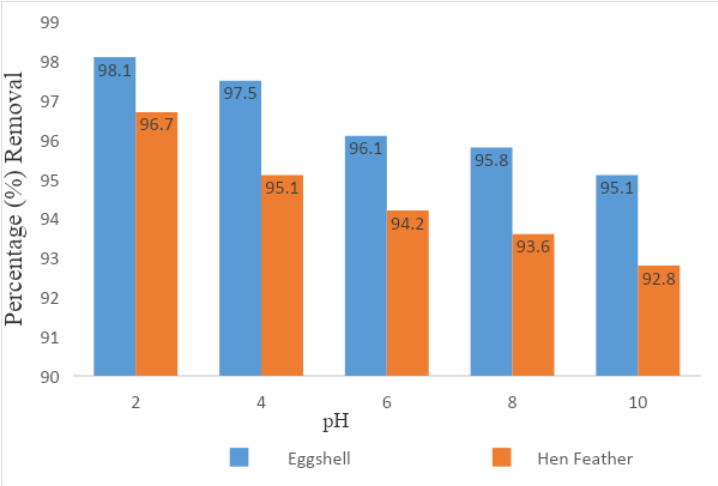

Fig. 4b Effect of pH on % Removal of MV by ES and HF from aqueous solution

3.1.5. Effect of Temperature

Effect of temperature on MV uptake by ES and HF was studied, respectively, from of 20 to 60°C and results were presented in Figures 5a and 5b. The results don't show a clear cut relationship between adsorption parameters and temperature. Nevertheless, peak values of percentage removal were 90.9 % at 20°C for Eggshell and 91.2 % at 40°C for Hen Feather. Thus, it is obvious that MV removal was not temperature-dependent. This follows the pattern of Pramanpol and Nitayapat [16] who studied adsorption of reactive yellow 205 dye by eggshell and it's Membrane and reveals that optimal adsorption occurred at 35°C and that temperature seems not to have effect on adsorption.

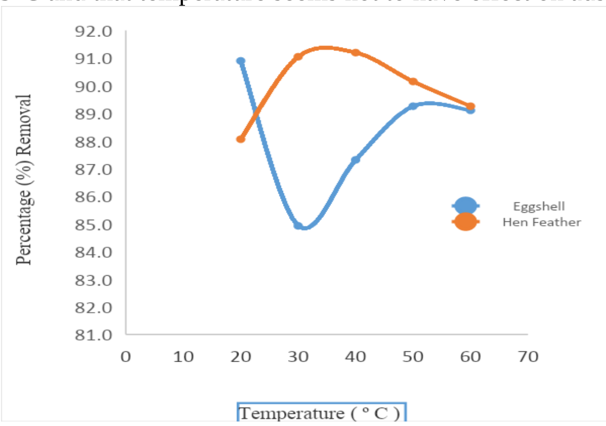

Fig. 5a Effect of Temperature on % Removal of MV by ES and HF from aqueous solution

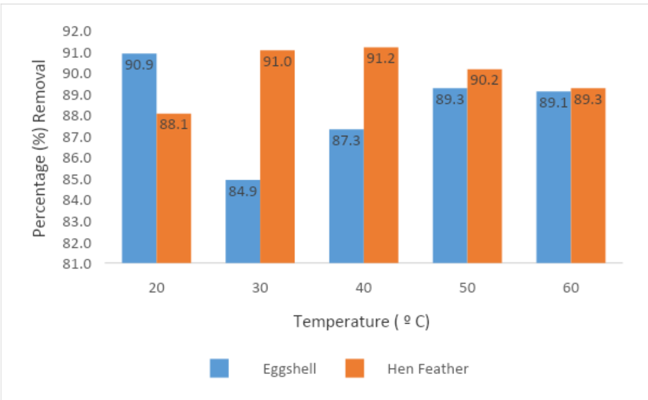

Fig. 5b Effect of Temperature on % Removal of MV by ES and HF from aqueous solution

3.2. Adsorption Isotherm Studies

The Langmuir, Freundlich and Temkin isotherms were utilized in studying adsorption of MV onto Eggshell and Hen Feather.

3.2.1. Langmuir Isotherm

A linear plot of log q_e against log C_e gives a slope of 1/n and intercept of log K_f. When adsorption is conducive, then, 1/n < 1 or n > 1 [17]. The value of 1/n being below 1.0 or n > 1.0, this implies a normal adsorption. But if 1/n is above 1.0 or n < 1.0, it shows cooperative adsorption. For favourable adsorption, 1/n lies between 0 and 1.0.

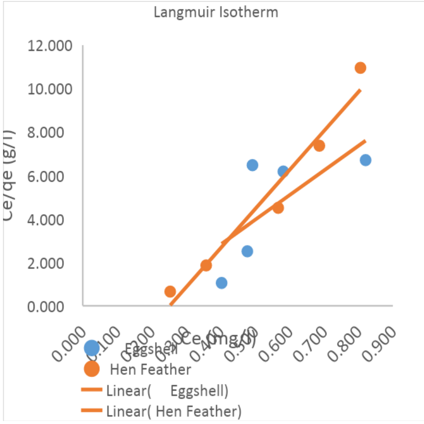

Fig. 6 Langmuir Isotherm Adsorption of Methylene Violet onto ES and HF

For Eggshell, q_e (experimental) was 0.196 mg/g, but from calculations, q_{max} was 0.0879 mg/g, correlation coefficient was $R^2 = 0.4922$, separation factor, R_L was – 0.0154. For Hen Feather, q_e (experimental) was 0.199 mg/g, but q_{max} was 0.0566 mg/g, correlation coefficient was $R^2 = 0.9584$, the separation factor, R_L was – 0.0264. $R^2 = 0.9584$ suggests that adsorption data fit well into Langmuir adsorption isotherm for Hen Feather. Related results were reported in crystal violet adsorption using eggshell by Chowdhury et al [18].

3.2.2. Freundlich Isotherm

The value of n for Eggshell was – 4.5620, k_f was 0.3526 mg/g and R^2 was 0.2738. For Hen Feather, n was -0.7323, k_f was 0.0550 mg/g and R^2 was 0.9816. R^2 of 0.9816 for Hen Feather shows a good fit for Freundlich isotherm. Identical results were reported in acid orange 2 dye adsorption using eggshell by Yari et al [15].

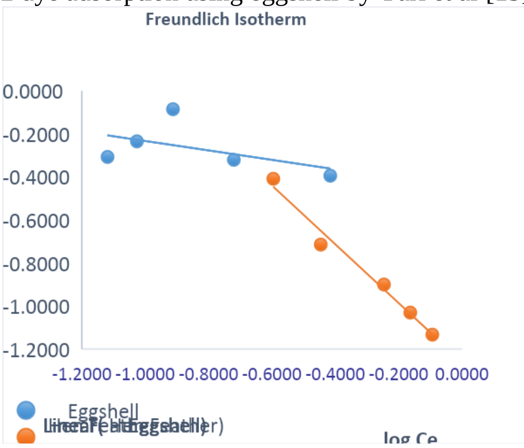

Fig. 7 Freundlich Isotherm Adsorption of Methylene Violet onto Eggshell and Hen Feather

3.2.3. Temkin Isotherm

The plot of q_e versus ln C_e, Temkin's isotherm is shown in Figure 4, from which k_T and B_T is determined. B_T is slope while intercept is equal to B_T ln K_T.

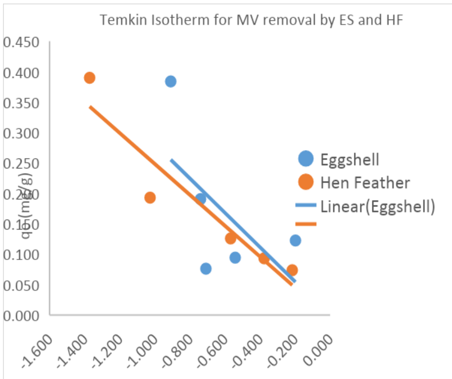

Fig. 8 Temkin Isotherm for Adsorption of Methylene Violet onto Eggshell and Hen Feather

For Eggshell, the constant relating to adsorption heat, B_T was 0.2827 J/mole, equilibrium binding constant, k_T was 0.9943 L/mg and R^2 was 0.3685, while for Hen Feather, B_T was 0.2541 J/mole, k_T was 0.9775 L/mg and R^2 was 0.8958. Adsorption data for Hen Feather fitted more satisfactorily well into the Temkin isotherm model, with R^2 of 0.8958.

Of all the adsorption isotherm models examined for Methylene Violet adsorption onto Eggshell and Hen Feather, the Freundlich isotherm gave a better fit for Hen Feather data, with R^2 of 0.982 than Langmuir isotherm. This agrees with

Tsai et al. [12] in characterization and adsorption properties of eggshells and eggshell membrane and Tizo et al. [19] in the removal of cadmium from aqueous solution using calcium carbonate from eggshell. The Langmuir isotherm gave slightly better fit (R^2 = 0.958) for Hen Feather than Temkin isotherm model (R^2 = 0.8958) for Hen Feather.

Table -1 Isotherm Constants for Adsorption of MV onto Eggshell and Hen Feather

		Eggshell	**Hen Feather**
Model	Parameters	Values	Values
Langmuir	q_{max} (mg/g)	0.088	0.057
	K_L (L/mg)	-6.578	-3.891
	R_L	-0.0154	-0.0264
	R^2	0.4922	0.9584
Freundlich	K_f (mg/g)	0.353	0.055
	N	- 4.562	- 0.732
	R^2	0.274	0.982
Temkin	B_T	0.2827	0.2541
	k_T	0.9430	0.9775
	R^2	0.3685	0.8958

3.3. Adsorption Kinetic Study

The kinetic study is important since it describes adsorbate uptake rate and controls the residual time of the whole process. Several models have been investigated to examine the mechanisms controlling the process of adsorption [2]. In this investigation, pseudo-first order, pseudo-second order and intra-particle diffusion model kinetics models were studied to assess MV adsorption onto Eggshell and Hen Feather, respectively, for closeness of fit to data of the experiment. Table 2 gives a summary of kinetic parameters of these models, including the correlation coefficient, R^2.

3.3.1. Pseudo-first Order Kinetic Model

Plot of log ($q_e - q_t$) against t is a straight line. Values of k_1 and q_e are obtained from slope and intercept of the graph respectively. Plot of log (q_e - q_t) against t.

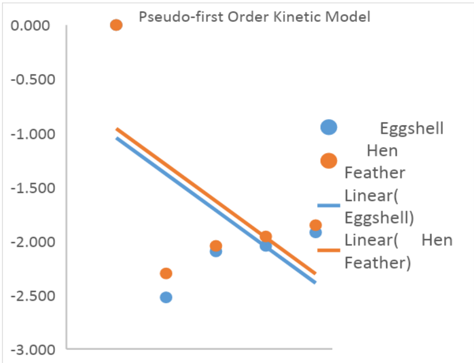

Fig. 9 Pseudo-first Order Kinetics for Adsorption of Methylene Violet onto Eggshell and Hen Feather

For Eggshell, k_1 was -0.0516 min^{-1}, and R^2 was 0.2909. q_e (calculated) was 0.1959 mg/g while the experimental value of q_e (experimental) was 0.196 mg/g. For Hen Feather, k_1 was -0.0516 min^{-1}, and R^2 was 0.3294. q_e (calculated) was 0.2386 mg/g, while q_e (experimental) was 0.199 mg/g. For both adsorbents, there was a deviation from linearity as seen from the low values of R^2 (less than 0.900). This shows that this was not a good fit for pseudo-first order kinetic model. This agrees with Gao et al. [20], who investigated Methylene Blue adsorption using Feather Keratin as bio-sorbent. They got a calculated q_e of 91.5 mg/g and an experimental q_e of 153.8 mg/g with R^2 of 0.885.

3.3.2. Pseudo-second Order Kinetic Model

A graph of t/q_t against t, gives a linear relationship from which k_2 and q_e (calculated) are obtained from slope and intercept of the plot.The calculated values of k_2, R^2, and q_e (calculated) for pseudo-second order model is given below.

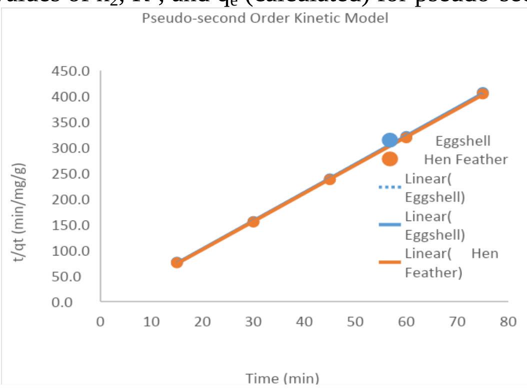

Fig. 10 Pseudo-second Order Kinetic Fit for adsorption of Methylene Violet onto Eggshell and Hen Feather

For Eggshell, the value of k_2 was -3.7632 g $mg^{-1}min^{-1}$ and correlation coefficient, R^2 was 0.9998. The value for q_e (experimental) was 0.196 mg/g and that for q_e (calculated) was 0.181 mg/g. For Hen Feather, k_2 was -3.5424 g $mg^{-1}min^{-1}$ and R^2 was 0.9998. The value for q_e (experimental) was 0.199 mg/g and that for q_e (calculated) was 0.182 mg/g. R^2 for pseudo-second order kinetic model was a high value of 0.998 for Eggshell and Hen Feather.

Still for both Eggshell and Hen Feather, the q_e (calculated) agrees with q_e (experimental), affirming MV adsorption onto Eggshell and Hen Feather fits into the pseudo-second order kinetic model. This also indicates MV adsorption onto Eggshell and Hen Feather, respectively, is chemisorption, which involves adherence of MV onto adsorbent surface by chemical bond. An identical result was previously recorded for Crystal Violet adsorption using Eggshell by Chowdhury et al. 2012 and bio-sorption of Methylene Blue using Hen Feather by Chowdhury and Saha (2012). Table 2: gives a summary of rate constants, the corresponding correlation coefficients, R^2, q_e (calculated), and q_e (experimental).

3.3.3. Intra-Particle Diffusion Model

The prospect of intra-particle diffusion was investigated using intra-particle diffusion model.

A graph of q_t against $t^{0.5}$ was plotted as depicted in Figure 11 below.

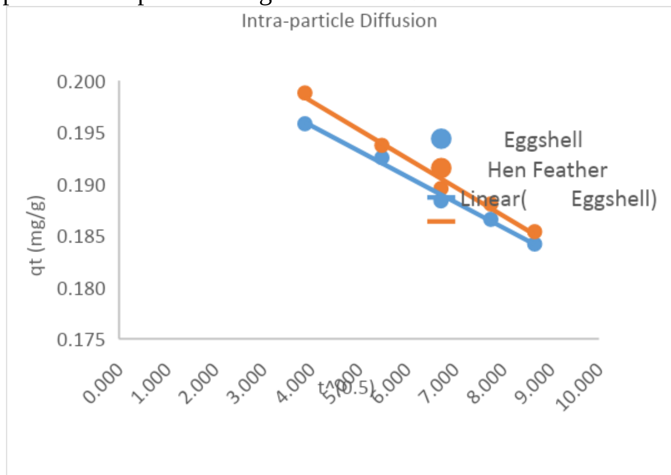

Fig. 11 Intra-Particle Diffusion for Adsorption of MV onto Eggshell and Hen Feather

In accordance with this model, if plot of q_t against $t^{0.5}$ gives a straight line, then intra-particle diffusion can explain the process. And also, if the line passes through the origin, it indicates that intra-particle diffusion is rate-controlling step [21]. But if the line does not pass through the origin, it indicates that there are other kinetic models that control adsorption process. And all these may be taking place simultaneously [22]. The intercept, C, gives a clue about boundary layer thickness. The larger the intercept, the higher the boundary layer effect.

For both Eggshell and Hen Feather, experimental q_e values (0.196 and 0.199 mg/g) are in harmony with calculated q_e, from the graph, C, (0.206 and 0.209 mg/g). Plot of q_t against $t^{0.5}$ gave a straight line, which suggests that intra-particle diffusion is involved in the process. But the line did not pass through the origin, indicating that it is not the only rate-limiting step, but that there are other kinetic models that control the adsorption and all these may be taking place simultaneously [22].

Table -2 Kinetic parameters for adsorption of Methylene Violet onto Eggshell and Hen Feather

	Pseudo-first order				**Pseudo-second order**				**Intra-particle diffusion**			
Kinetic Parameter	**k_1 (min^{-1})**	**qe (exp) (mg/g)**	**qe (cal) (mg/g)**	**R^2**	**k_2 (g/mg min)**	**qe (exp) (mg/g)**	**qe (cal) (mg/g)**	**R^2**	**k_i (mg/g min^{-2})**	**qe (exp) (mg/g)**	**C (mg/g)**	**R^2**
Eggshell	-0.0516	0.196	0.196	0.2909	-3.7632	0.196	0.181	0.9998	-0.0025	0.196	0.206	0.9920
Hen Feather	-0.0516	0.199	0.239	0.3294	-3.5424	0.199	0.182	0.9998	-0.0028	0.199	0.209	0.9873

4. CONCLUSION

This investigation concludes that Eggshell and Hen Feather are both good adsorbents of Methyl Violet from aqueous solution, but Hen Feather proved to a better adsorbent than Eggshell. Hen Feather showed highest in two parameters – Contact Time and pH. Hen Feather gave the most optimum value of 99.4 % at Contact Time of 15 minutes. The reason is that Hen Feather contains high keratin (about 90% by weight). Also, hen feather surface area (1170.0 m^2/g) was higher than that of Eggshell (1000.3 m^2/g), which gave it a better adsorptive characteristics than Eggshell. A higher surface area provides a higher adsorptive property [23]. Thus, Hen Feather is a better adsorbent than Eggshell. This study provides a means for realizing two of the seventeen sustainable goals - (number 3 and number 6: enabling the availability of Good Health and Well-being, Provision of Clean Water and Sanitation) of the United Nations by the year 2030.This research work, thus, establishes that hen feather is more efficient in Methylene violet adsorption from aqueous solution than eggshell.

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