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Study on Adsorption Activity of Activated Carbon Prepared from Groundnut Shell for Colour Removal of Cottage Textile Industrial Effluent

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Abstract
In this research, the adsorbent (activated groundnut shell carbon) was prepared from groundnut shells for the removal of colour in cottage textile industrial effluents. Activated groundnut shell carbon (AGC) was prepared by carbonization at 600˚C for 30 minutes and activation with 2N H_2SO_4. Physico-chemical properties of activated groundnut shell carbon was measured by SEM. Then, selected different process parameters like effect of pH, adsorbent dosage, contact time and initial effluent concentration were investigated for adsorption study to reduce colour in cottage textile industrial effluent. Colour removal efficiencies of activated groundnut shell carbon were determined by using UV spectrophotometer. Treated cottage industrial effluents were characterized by biochemical oxygen demand (BOD), chemical oxygen demand (COD). Heavy metal contents of treated cottage textile industrial effluents were analyzed by atomic absorption spectroscopy (AAS). Results indicated that AGC was strongly colour adsorbed at pH-4. Maximum colour removal efficiency (99.8 %) of AGC was obtained by treating with the amount of 1.2 g for the contact time of 2 hr. Results suggested that BOD and COD contents of cottage textile industrial effluents were efficiently reduced to (30.77%), and Cd to (44 %) by AGC.
Keywords: activated carbon, adsorbent, adsorption, colour, industrial effluent

Introduction

Weaving industry is one of the main professions of the Amarapura people and dyes are widely used in these cottage industries. (San Dar Win, 2015). In the process of washing and finishing coloured products, wastewater contaminated with dyes is generated (Visa, M., *et al.*, 2007). Discharge of hazardous wastewater without treatment can seriously damage the environment. (www.hsc.gov.uk/statistics/industry/ sic 2007.htm).

Wastewater contaminated with dyes cannot be easily removed by conventional wastewater treatment process due to their complex structure and synthetic origins.
The process of adsorption has an advantage over the other methods due to its sludge free clean operation and completely removed dyes, even from the diluted solution. The most common adsorbent materials are alumina, silica, metal hydroxide and activated carbon. Unfortunately, this effective adsorbent is expensive and has high regeneration cost. For these reasons, different studies have been carried out in order to find out inexpensive adsorbing materials (https://www.researchgate. net / publication/251289860. Adsorption of methylene blue onto treated activated carbon).

Some of the agricultural waste materials can be effectively used as low-cost adsorbents. Modification of agricultural by-product could enhance their natural adsorption capacity or add another additional value to the by-product (Aadil Abbas *et al.*, 2012). A number of non-conventional, low cost adsorbents such as rice hull, groundnut shell, ash, activated red mud have been used for the removal of dyes from aqueous solution (Aadil Abbas *et al.*, 2012). Conversion of groundnut shells into adsorbents will serve double purposes. First, unwanted agricultural wastes are converted to useful, value-added adsorbents and second, the use of agricultural by-products represents as a potential source of cheap adsorbents, which

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will contribute to solve the part of the wastewater treatment problem in Myanmar (Gimba, C.E., 2001).

In this research, groundnut shells were selected for making different adsorbents such as activated groundnut shell carbon and their colour removal efficiency of cottage textile industrial effluent was studied. The objectives of this research are to prepare the low cost bio-adsorbent such as activated groundnut shell carbon from abundantly available waste groundnut shells, to study various operating parameters such as pH of cottage textile industrial effluent, amount of prepared adsorbent, contact time for removal of colour from cottage textile industrial effluent, and to find out the optimum condition for colour removal.

Materials and Methods

Raw Materials

Groundnut shells were collected from groundnut dehulling machine at Tada U Township, Mandalay Region. Sulphuric acid, commercial activated carbon were purchased from Kemico Chemical Shop, 28th Street, Pabedan Township ,Yangon Region and cottage textile industrial effluent was collected from a cottage dyeing industry in Amarapura Township.

Preparation of Activated Groundnut Shell Carbon and Carbonization of Groundnut Shells

The collected groundnut shells were washed with tap water to remove soil and dust and sun-dried for a week. Then dried groundnut shells were crushed manually. 100 g of crushed groundnut shells were placed in a previously weighed crucible and carbonized in a muffle furnace at 600°C for 30 minutes. Carbonized carbon was ground into powder and sieved by 140 mesh (105 µm) screen and stored in an airtight screw capped bottle.

Activation of Groundnut Shell Carbon with 2N Sulphuric Acid

Activated groundnut shell carbon was prepared by treating the 100 g of groundnut shell carbon powder with 200 ml of 2N sulphuric acid in 500 ml beaker and slowly stirred by magnetic stirrer for 30 minutes and then allowed to interact for 24 hr. After that, the flask contents were filtered through Whatmann filter paper No.41 and treated carbon residue was washed repeatedly till no more acid was left and then air dried for 2 days. It was weighed and stored in an airtight screw capped bottle.

Determination of Optimum Wavelength from Absorbance Values of Cottage Textile Industrial Effluent

Optimum wavelength value of cottage textile industrial effluent was determined from their absorbance values measured at various wavelengths using spectrophotometer. Measurements were conducted by Spectrophotometer at different wavelengths (460, 470, 480, 490, 500, 510, 520) nm respectively and the results are shown in Table (1) and Figure (3) respectively.

Determination of Calibration Curve for Diluted Cottage Textile Industrial Effluent

Cottage textile industrial effluent 1ml (1%) from fabric dyeing cottage industry was taken in a 1 cm cell of a spectrophotometer and then measured its absorbance. Nineteen 250 ml beakers were taken and 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 20, 30, 40, 50, 60, 70, 80, 90 ml of this sample were added into each of eighteen 250 ml beakers. The volume of each sample solution of 18 beakers was adjusted by addition of 99, 98, 97, 96, 95, 94, 93, 92, 91, 90, 80, 70, 60, 50, 40, 30, 20, 10 ml of distilled water to get the various dilution factors. 10 ml of distilled water was added into the remaining test tube. The dilution factors were calculated as follows. The data were recorded as shown in Tables (2), (3) and the calibration curve was drawn by plotting absorbance vs dilution factor (as concentration) of the sample as shown in Figures (4), (5).

Dilution factor, $DF = \frac{V_1}{V_2} = \frac{C_1}{C_2}$

where, V_1 = volume of 1 % stock solution used

V_2 = total volume of working solution produced

C_1 = solute concentration in 1 % stock solution

C_2 = solute concentration in working solution

Effect of pH on Removal of Colour from Cottage Textile Industrial Effluent

Diluted cottage textile industrial effluent 25 ml of each (pH-6.5) was placed in five 100 ml Erlenmeyer flasks and the pH in each flask was adjusted at pH 4, 5, 6, 7 and 8 respectively using 0.1N HCl. Then, 1 g of AGC was added to each flask and stirred by magnetic stirrer slowly for 30 minutes and allowed to interact for 6 hr with occasional stirring. After that, each of the flask contents were filtered through Whatmann filter paper No.41 and filtrates were analyzed for residual concentrations of colour from dye solutions. The absorbance of cottage textile industrial effluent before and after treatment was detected by using Spectrophotometer. Dilution factor (as concentration) in industrial effluent after absorption was estimated by using the calibration curve and colour removal efficiency was calculated as follows. Adsorbance values of these solutions before and after treatment with various adsorbents are shown in Table (4).

Colour removal efficiency = $\frac{C_1 - C_2}{C_1} \times 100$

Effect of the Amounts of AGC on Removal of Colour from Cottage Textile Industrial Effluent

pH of diluted cottage textile industrial effluent 200 ml were adjusted with HCl in 500 ml beaker to get optimum pH. Six 100 ml Erlenmeyer flasks were taken and then 25 ml of diluted cottage textile industrial effluent (at optimum pH) was added into each flask. Then various amounts of AGC (0.2 g, 0.4 g, 0.6 g, 0.8 g, 1.0 g, 1.2 g) were added to each flask and stirred slowly by magnetic stirrer for 30 minutes and allowed to interact for 6 hr. Then, each of the flask contents were filtered through Whatmann filter paper No.41 and filtrates were analyzed for residual colour concentration. The absorbance of cottage textile industrial effluent before and after treatment were detected by using Spectrophotometer. Concentration of colour in industrial effluent after adsorption was estimated by using the calibration curve. The results are shown in Table (5).

Effect of Contact Time on Removal of Colour from Cottage Textile Industrial Effluent

Diluted cottage textile industrial effluent (at optimum pH) 25 ml was added into each flask. The optimum amount of AGC was added to each flask and stirred slowly by magnetic stirrer for 30 minutes and allowed to interact for (1 hr, 2 hr, 3 hr, 4 hr, 5 hr, 6 hr) respectively. After which, each of the flask contents were filtered through Whatmann filter paper No.41 and filtrates were analyzed for residual colour concentrations. The absorbance of cottage textile industrial effluent before and after treatment were detected by using Spectrophotometer. Concentration of colour in industrial effluent after adsorption was estimated by using the calibration curve. The results are shown in Table (6).

Effect of Effluent Concentration on Removal of Colour from Cottage Textile Industrial Effluent

Diluted cottage textile industrial effluent 25ml was added into 250 ml Erlenmeyer flask. Then the effluent in each Erlenmeyer flask was adjusted the optimum pH with 0.1N HCl. (1.2) g of AGC was added to each flask and stirred slowly by magnetic stirrer for 30 minutes and allowed to interact for 2 hr. After which, each of the flask contents were filtered through Whatmann filter paper No.41 and filtrates were analyzed for residual colour concentrations. The absorbance of cottage textile industrial effluent before and after treatment were detected by using Spectrophotometer. Concentration of colour in industrial effluent after absorption was estimated by using the calibration curve. The above procedure was repeated by using 50 ml, 75 ml, 100 ml and 125 ml of diluted cottage textile industrial effluent. The results are shown in Table (7).

Physical and Chemical Characteristics of Cottage Textile Industrial Effluent before and after Treatment with AGC

Physical and chemical characteristics of cottage textile industrial effluent such as total dissolved solids, pH, biochemical oxygen demand (BOD) and chemical oxygen demand (COD) before and after treatment with AGC were determined by American Public Health Association (APHA) methods. The results are shown in Table (8).

Results and Discussion

In this research, groundnut shell based adsorbent was prepared and used for removal of colour from cottage textile industrial effluent. The present research focused on the preparation of low-cost adsorbents and investigation of its efficiency in treatment of cottage textile industrial effluent.

Figures (1) and (2) show SEM images of before and after activation of groundnut shell carbon. The results from these Figures showed significant differences in pore volume before and after activation of groundnut shell carbon. Small narrow pores were observed on the surface of the groundnut shell carbon before activation. Larger pores were observed on the external surface of the activated carbon indicating that it had a large surface area and pore volume, which allowed the removal of liquid phase contaminants, including organic pollutants, heavy metal ions and colours.

Cottage textile industrial effluents discharged from dyeing industries are highly coloured. Therefore, dilution of cottage textile industrial effluent was carried out with purified water to study the colour intensity of this effluent by using spectrophotometer. In analyzing unknown colour sample, measurements were conducted at (460, 470, 480, 490, 500, 510, 520) nm for textile industrial effluent. Table (1) and Figure (3) showed the absorbance values of diluted cottage textile industrial effluent at different wavelengths. Results indicated that maximum absorbance occurred at a wavelength of (490nm) for diluted cottage textile industrial effluent. Tables (2) and (3) showed the effect of dilution factor of cottage textile industrial effluent on absorbance at a wavelength 490 nm. It was observed that as the concentration of these cottage textile industrial effluent decreased, absorbance also decreased linearly. Calibration curves were plotted with absorbance Vs various concentration of these industrial effluent and shown in Figures (4) and (5). These were used for finding the colour removal efficiency of different process parameters.

Selected different process parameters like effect of pH, adsorbent dosage, contact time and effluent concentration were conducted to reduce colour in the cottage textile industrial effluent. The pH of an aqueous medium is an important factor that may affect the uptake of the adsorbate. The effect of pH on colour removal was investigated by varying the pH (4, 5, 6, 7 and 8) of diluted cottage textile industrial effluent. Results in Table (4) indicated that AGC was strongly adsorbed at pH-4.

Taking the most suitable pH of diluted cottage textile industrial effluent, experiments were conducted various amounts of AGC (0.2 g, 0.4 g, 0.6 g, 0.8 g, 1 g, 1.2 g) per 25 ml of cottage textile industrial effluent to find out optimum amount of dosage for colour removal. The results in Table (5) revealed that maximum colour removal efficiencies 99.5 % of cottage textile industrial effluent were obtained by treating with 1.2 g of AGC in treatment.

Contact time is a crucial adsorption parameter that gives useful information on the optimum adsorption time. Taking the most suitable pH and amount of adsorbent, experiments were conducted at various contact time (1 hr, 2 hr, 3 hr, 4 hr, 5 hr, 6 hr) per 25 ml of cottage textile industrial effluent to find out optimum contact time for colour removal. The results from Table (6) revealed that maximum colour removal efficiencies 99.8 % of diluted cottage textile industrial effluent were obtained after 2 hr contact time of AGC.

By taking the most suitable condition, treatment of various effluent concentrations (25 ml, 50 ml, 75 ml, 100 ml, 125 ml) of diluted cottage textile industrial effluent per 1.2 g of AGC were carried out for each treatment and the results are shown in Table (7). The percentage of colour removal efficiency decreases with increasing dye concentration. This indicated that there is a reduction in adsorption, due to the lack of available active sites required for the initial concentration of the coloured solution.

Table (8) showed pH, BOD, COD and TDS contents of before and after treatment of cottage textile industrial effluent. Results showed that AGC could reduce 30.77 % of BOD and COD in cottage textile industrial effluent. However, amount of total dissolved solids in treated cottage textile industrial effluent were increased due to soluble solids in AGC. Therefore, long term washing of AGC with water is needed before treatment with cottage textile industrial effluent i.e, necessary to reduce soluble solids.

Table (9) showed heavy metal contents of before and after treatment of cottage textile industrial effluent. Table (10) showed efficiencies of activated groundnut shell carbon (AGC). Removal percent of heavy metals (Cd, Cr, Pb) in cottage textile industrial effluent (44, 14.79 and 24.05 %) were obtained for AGC.

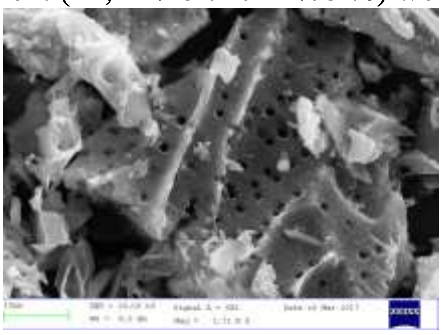

Figure (1) SEM Image of Groundnut Shell Carbon

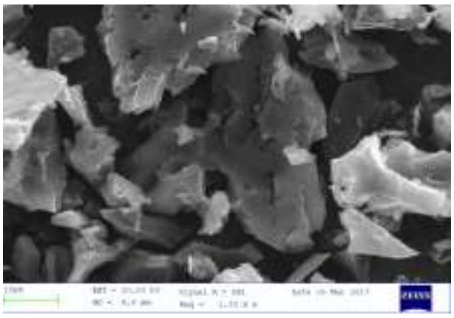

Figure (2) SEM Image of Activated Groundnut Shell Carbon

SEM diagram were obtained from Analysis Department, Defence Service Science and Technology Research Center, Pyin Oo Lwin

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Table (1) Absorbance Values of Diluted Cottage Textile Industrial Effluent at Different Wavelengths

Wavelength, (nm)	Absorbance
460	1.090
470	1.183
480	1.279
490*	1.407
500	1.320
510	1.249
520	1.113

*The most suitable wavelength

Data were measured by Spectrophotometer at the Laboratory of Industrial Chemistry Department, Yadanabon University.

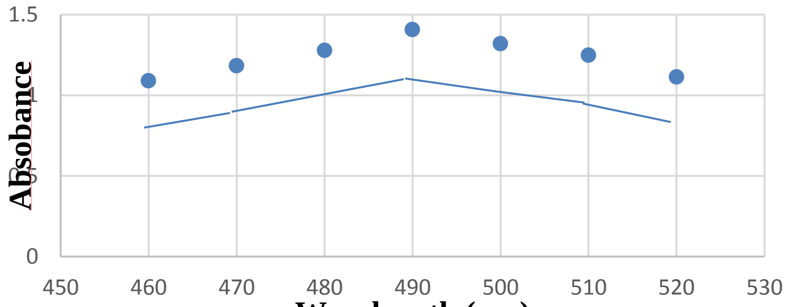

Figure (3) Absorbance Curve for Diluted Cottage Textile Industrial Effluent at Different Wavelengths

Table (2) Relationship between Dilution Factor (0-1) of Cottage Textile Industrial Effluent and Absorbance

Sample No.	Diluted Industrial Effluent (V_1) (ml)	H_2O (ml)	Total Volume (V_2) (ml)	Dilution Factor** (Concentration)	Absorbance (at 490nm)*
1	100	0	100	1.0	1.407
2	90	10	100	0.9	1.247
3	80	20	100	0.8	1.122
4	70	30	100	0.7	1.011
5	60	40	100	0.6	0.880
6	50	50	100	0.5	0.732
7	40	60	100	0.4	0.599
8	30	70	100	0.3	0.380
9	20	80	100	0.2	0.308
10	10	90	100	0.1	0.153
11	0	100	100	0.0	0

Experiments were conducted at the Laboratory of Industrial Chemistry Department, Yadanabon University.

* Absorbances were measured by Spectrophotometer at the Laboratory of Industrial Chemistry Department, Yadanabon University.

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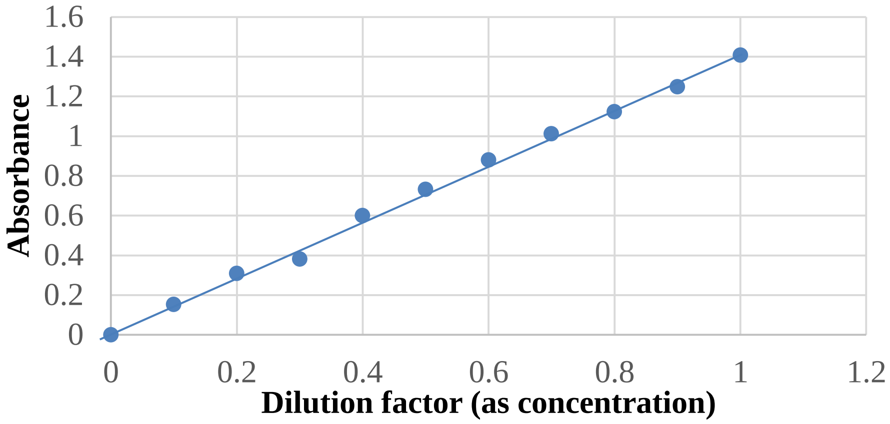

Figure (4) Calibration Curve for Diluted Cottage Textile Industrial Effluent at Dilution Factor (0-1) and Absorbance 490 nm

Table (3) Relationship between Dilution Factor (0.01-0.1) of Cottage Textile Industrial Effluent and Absorbance

Sample No.	Diluted Industrial Effluent (V_1) (ml)	H_2O (ml)	Total Volume (V_2) (ml)	Dilution Factor** (Concentration)	Absorbance (at 490 nm) *
1	10	90	100	0.1	0.153
2	9	91	100	0.09	0.141
3	8	92	100	0.08	0.127
4	7	93	100	0.07	0.108
5	6	94	100	0.06	0.094
6	5	95	100	0.05	0.077
7	4	96	100	0.04	0.064
8	3	97	100	0.03	0.048
9	2	98	100	0.02	0.032
10	1	99	100	0.01	0.013

Experiments were conducted at the Laboratory of Industrial Chemistry Department, Yadanabon University.

* Absorbances were measured by Spectrophotometer at the Laboratory of Industrial Chemistry Department, Yadanabon University.

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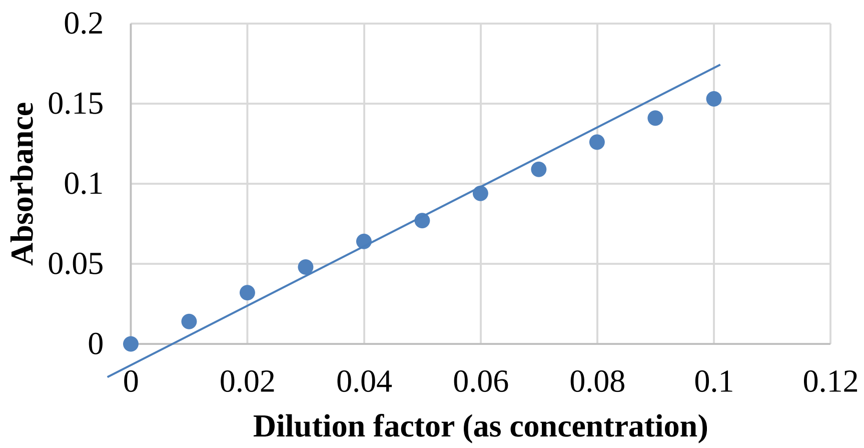

Figure (5) Calibration Curve for Diluted Cottage Textile Industrial Effluent at Dilution Factor (0.01- 0.1) and Absorbance 490 nm

Table (4) Effect of pH on Colour Removal Efficiency of Activated Groundnut Shell Carbon (AGC)

Effluent Concentration - (1:99) (v/v)
Volume of Industrial Effluent - 25 ml
Contact Time - 6 hours
Amount of AGC - 1 g
Stirring Time - 30 minutes

Sample No.	pH of Industrial Effluent	Before Treatment		After Treatment		Colour Removal Efficiency (%w/w)
		Absor-bance*	Dilution Factor** (Concentr-ation), (c_1)	Absor-bance*	Dilution Factor** (Concentra-tion), (c_2)	
1	3	1.407	1.0	0.014	0.009	99.1
2	4***	1.407	1.0	0.022	0.014	98.6
3	5	1.407	1.0	0.201	0.14	86
4	6	1.407	1.0	0.207	0.15	85
5	7	1.407	1.0	0.319	0.23	77
6	8	1.407	1.0	0.707	0.51	49

* Absorbances at the wavelength of 490 nm were measured by Spectrophotometer at the Laboratory of Industrial Chemistry Department, Yadanabon University.

** Data were obtained from calibration curve of diluted industrial effluent of Dyeing Cottage Industry.

***The most suitable condition

Table (5) Effect of Amount of Activated Groundnut Shell Carbon (AGC) on Colour Removal Efficiency

Effluent Concentration - (1:99) (v/v) pH - 4
Volume of Industrial Effluent - 25 ml Stirring Time - 30 minutes
Contact Time - 6 hours

Sample No.	Amount of AGC (g)	Before Treatment		After Treatment		Colour Removal Efficiency (%w/w)
		Absor-bance*	Dilution Factor** (Concentr-ation), (c_1)	Absor-bance*	Dilution Factor** (Concentra-tion), (c_2)	
1	0.2	1.407	1.0	0.173	0.13	87
2	0.4	1.407	1.0	0.150	0.11	89
3	0.6	1.407	1.0	0.063	0.041	95.9
4	0.8	1.407	1.0	0.040	0.026	97.4
5	1.0	1.407	1.0	0.022	0.014	98.6
6	1.2***	1.407	1.0	0.008	0.005	99.5

* The data were measured at the Laboratory of Industrial Chemistry Department, Yadanabon University.
** Data were obtained from calibration curve of diluted industrial effluent of Textile Mill.
***The most suitable condition

Table (6) Effect of Contact Time on Colour Removal Efficiency of Activated Groundnut Shell Carbon

Effluent Concentration - (1:99) (v/v) Amount of AGC - 1.2 g
Volume of Industrial Effluent - 25 ml Stirring Time - 30 minutes
pH - 4

Sample No.	Contact Time (hr)	Before Treatment		After Treatment		Colour Removal Efficiency (%w/w)
		Absor-bance*	Dilution Factor** (Concentr-ation), (c_1)	Absor-bance *	Dilution Factor** (Concentra-tion), (c_2)	
1	1	1.407	1.0	0.007	0.004	99.6
2	2***	1.407	1.0	0.003	0.002	99.8
3	3	1.407	1.0	0.004	0.003	99.7
4	4	1.407	1.0	0.005	0.003	99.7
5	5	1.407	1.0	0.008	0.005	99.5
6	6	1.407	1.0	0.008	0.005	99.5

*The data were measured at the Laboratory of Industrial Chemistry Department, Yadanabon University.
** Data were obtained from calibration curve of diluted industrial effluent of Textile Mill.
***The most suitable condition

Table (7) Effect of Effluent Concentration on Colour Removal Efficiency of Activated Groundnut Shell Carbon (AGC)

Effluent Concentration - (1:99) (v/v) Amount of AGC - 1.2 g
Contact Time - 2 hr Stirring Time - 30 minutes
pH - 4

Sample No.	Effluent Concent r-ation) (ml)	Before Treatment		After Treatment		Colour Removal Efficiency (%w/w)
		Absor-bance*	Dilution Factor** (Concentr-ation), (c_1)	Absor - bance *	Dilution Factor** (Concentra-tion), (c_2)	
1	25***	1.407	1.0	0.004	0.002	99.8
2	50	1.407	1.0	0.082	0.053	94.7
3	75	1.407	1.0	0.092	0.06	94.0
4	100	1.407	1.0	0.149	0.096	90.4
5	125	1.407	1.0	0.211	0.15	85.0

*The data were measured at the Laboratory of Industrial Chemistry Department, Yadanabon University.
** Data were obtained from calibration curve of diluted industrial effluent of Textile Mill.
***The most suitable condition

Table (8) Characteristics of Textile Industrial Effluents before and after Treatment

Amount of Adsorbent (AGC) = 48 g , Contact Time = 2 hr,
Amount of Effluent = 1 liter

Parameter	*Before Treatment	*After treatment	**Effluent Standard (PCC)
pH	6.5	7.1	6.5-9
BOD (mg/l)	650	450	50
COD (mg/l)	1625	1125	250
TDS (mg/l)	596	712	500

*Data were obtained from Water and Sanitation Department, Mandalay City Development Committee. **PCC = Pollution Control Committee, http://pcd.go.th/info-serv/en-reg-std

Table (9) Heavy Metal Contents of Cottage Textile Industrial Effluents before and after Treatment

Amount of Adsorbent (AGC) = 48 g, Contact Time = 2 hr
Amount of Effluent = 1 liter

Heavy Metal Contents	*Before Treatment	*After Treatment	**Effluent Standard (PPC)
Cd (mg/l)	0.025	0.014	0.1
Cr (mg/l)	0.196	0.167	0.1
Pb (mg/l)	0.237	0.18	0.1

*Data were obtained from Chemical Technology at Defense Services Science and Technology Research Center, Pyin Oo Lwin City
**PCC = Pollution Control Committee, http://pcd.go.th/info-serv/en-reg-std

Conclusion

The present investigation was to study the colour removal efficiencies of prepared adsorbent (activated groundnut shell carbon). Colour removal efficiency of activated groundnut shell carbon (1.2 g) was 99.8 % at pH-4 for contact time 2 hr. These results indicated that activated groundnut shell carbon (AGC) could be used as cheap adsorbent for removal of colour in cottage textile industrial effluent. In addition to highly removal of colour, AGC could reduce TDS, BOD, and COD to some extent. However, TDS, BOD, and COD of textile industrial effluent treated by this adsorbent were not in acceptable range for safe disposal into lake. Further treatment method such as selective precipitation of dissolved solids and filtration should be carried out to reduce TDS, BOD and COD of treated textile industrial effluent.

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References

Aadil Abbas, Shahzad Murtaza, Kashif Shahid *et al.,* (2012). "Comparative Study of Adsorptive Removal of Congo Red and Brilliant Green Dyes from Water Using Peanut Shell"., *Middle-East Journal of Scientific Research* 11 (6): 828-832.

Dr Sandar Win, (2015). International Conference on Burma/Myanmar Studies Burma/Myanmar in Transition: Connectivity, Changes and Challenges University Academic Service Centre (UNISERV), Chiang Mai University, Thailand, 24---25 July, Socio---economic Changes in Livelihood of Htantaw Village Amarapura Township, Mandalay Region.

Gimba, C.E., (2001). *Preparation and Adsorption Characteristics of Activated Carbon from Coconut Shell*, Ph.D Thesis, Ahmadu Bello University, Zaria, Nigeria.

Visa, M., M. Vittorio Zanetti, A. Pereira, E. Eşturk and M.A. Sancho, (2007): *Clean Water an Invaluable Asset.* Ed. Univ. Transilvania, Braşov, ISBN: 978-973-598-031-3.

Websites

1. http://www.researchgate.net/publication/251289860.Adsorption of methylene blue onto treated activated carbon
2. http://www.hsc.gov.uk/statistics/ industry/ sic 2007.ht
3. http://www.bio.classes.ucsc.edu/bio 20L/MANUAL/Lab% 201.pdf