MANAGEMENT ON ENVIRONMENTAL CONTAMINATION OF WATER FROM AGRICULTURAL SITES IN PATHEINGYI TOWNSHIP, MANDALAY REGION BY USING BIOSORBENTS (CORN COB POWDER AND ACTIVATED CORN COB CHARCOAL)

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Abstract

In this research, the paddy growing surrounding area in Patheingyi Township Mandalay Region was chosen to study the environmental contamination by water from agricultural sites. Some physicochemical parameters such as pH, temperature, conductivity and turbidity were directly measured by respective apparatus. The alkalinity of each water sample was determined by acid-base titration. The total hardness of water samples was determined by EDTA titrimetric method. Nitrogen content, phosphate content, chemical oxygen demand, biochemical oxygen demand, and dissolved oxygen were also determined. The compositions of the metals such as iron, lead, cadmium and copper which can cause pollution to water were investigated by Atomic Absorption Spectroscopy. To reduce the pollutants in water samples by adsorption, corn cob powder was chosen as adsorbent. In addition, corn cob sample was activated with H_3PO_4. The elemental compositions of adsorbent samples were examined by Energy Dispersive X-ray Fluorescence (EDXRF) analysis and the surface morphology of adsorbents was characterized by Scanning Electron Microscope (SEM). The collected water samples were treated by filtration using the prepared adsorbents to reduce the extent of contamination of water from agricultural sites.

Keywords: physicochemical parameters, corn cob powder, agricultural sites, elemental compositions

Introduction

Water is the most common or major substance on earth, covering more than 70 % of the planet's surface. All living things consist mostly of water (Kumar, 2006). Its usage for many purposes such as drinking, cooking, agricultural, transport, industry and recreation immediately show the extent to which it is integral part of our life. Water is also required in industries for power generations, navigations, irrigation of crops and disposal of sewage etc. There is no doubt that fertilizers increase yields of crops around the world. Fertilizers and pesticides both have definite advantages and disadvantages associated with their use. The main problems associated with agriculture are salinization, nitrate and pesticide contamination. Irrigation has enlarged the land area available for crop production but the resulting salinization which has occurred in some areas has caused the deterioration of previously fertile soils (Bartram and Balance, 1996). Natural fertilizers are more preferable than chemical fertilizers by plants. However different kinds of chemical fertilizers are usually used to give good yield depending on growing of crops. The major or macro-nutrients in inorganic fertilizers are nitrogen, phosphorus, and potassium. Nitrogen, phosphorus, and potassium are considered macronutrients, and boron, calcium, chlorine, copper, iron, magnesium manganese among others are micronutrients (Hegde, 2009). Though the plants require three essential elements, nitrogen, potassium and phosphorus, seed bearing plants such as paddy require good amount of phosphorus and also potassium.

Contamination of soil and water through human and industrial waste and agrochemicals is a universal problem and a major issue in developing countries. Unrestrained industrial and domestic waste in urban and rural situation and pollution of reservoirs caused by agrochemical runoff are an increasing concern (Wimalawansa and Wimalawansa, 2014). The excessive use of inorganic fertilizers causes serious environmental degradation, resulting in lower crop yields. Farmers were supplied with chemical fertilizers and pesticides at a subsidized price. Farmers

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increased the frequency of fertilizer applications to enhance yields. These practices are still used and have caused significant environmental degradation (Rahman and Zhang, 2018). The running water from agricultural sites can be rich with inorganic substances and hydrocarbons. Using chemical fertilizers can change the acidity or basicity of a soil and also can affect on the water of agricultural sites. Therefore this research was carried out to study the extent of pollution of water from agricultural sites in Patheingyi Township, Mandalay Region and to reduce the pollution by treatment with waste corn cob powder and activated waste corn cob powder.

Materials and Methods

Sample Collection

The sample was collected from agricultural sites in Gway-Gyi-Gon Village, Patheingyi Township, Mandalay Region. Seven water samples were collected once every two days within two weeks from the common drainage after using fertilizer.

Determination of Some Physicochemical Parameters of Water Samples

Some Physicochemical parameters of water samples were determined by the respective procedures. pH was determined by a pH meter (KM 200, England), conductivity by conductivity meter, turbidity by nephelometric method and total dissolved solids by gravimetric method. Alkalinity and hardness of water samples were determined by titrimetric method. Ammonia nitrogen, nitrate nitrogen and phosphate were determined by spectrophotometric method.

Determination of Organic Pollutants in Collected Water Samples

The organic pollutants of water samples such as, Dissolved Oxygen (DO), Biochemical Oxygen Demand (BOD) and Chemical Oxygen Demand (COD) were determined according to the previously described in method (APHA, 2005).

Determination of Elemental Compositions in Water Samples by Atomic Absorption Spectroscopy

The content of metals such as iron, cadmium, lead, copper, and manganese in water samples were examined by Atomic Absorption Spectrophotometric method, at Department of Chemistry, Taunggyi University.

Preparation of Biosorbents, Corn Cob Powder and Activated Corn Cob Charcoal

The biomass corn cob was collected from local market, Monywa Township, Sagaing Region. Firstly, the collected samples were washed with water and immersed in boiling water for 3 h. Then the samples were allowed to dry and crushed into small pieces and then into a powder. The dried powder was sieved with a 120-mesh sieve. The resulting samples were used through the research work.

For preparation of activated corn cob the samples were pyrolyzed in a muffle furnace in absence of air at 500 to 600°C for 2 h. After pyrolysis, the activation was carried out by impregnation of the corn cob samples with phosphoric acid in a ratio of 1:2 (w/w) for 24 h, and then washed with distilled water several times until neutral. It was dried in oven at 100°C for 2 h.

Determination of Relative Abundance of Elements in Corn Cob Powder an Corn Cob Activated Charcoal by EDXRF

The elemental compositions of sample powders were examined by using Energy Dispersive X-ray Fluorescence (EDXRF) spectrophotometer.

Characterization of Corn Cob Powder and Corn Cob Activated Charcoal by Scanning Electron Microscope (SEM)

The sample was examined by scanning electron microscope (SEM) for a visual inspection of external porosity and morphology.

Treatment of Water Samples by Adsorption Using Corn Cob Powder and Corn Cob Activated Charcoal

The water samples collected from agricultural sites on September 2018 which was polluted by cadmium and lead were treated by adsorption using corn cob powder and activated corn cob as adsorbents.

The water samples were treated by using corn cob powder by column filtration method. 500 mL of each sample was added into the 1000 mL column. Before adding the water sample, the column was filled with cleaned and dried sand at the lower part at a height of about 20 cm and then corn cob powder with the height of 20 cm was placed above the sand. The water sample which had passed the corn cob powder was treated again by column filtration already filled with corn cob powder adsorbent. The filtration process was carried out totally three times.

In addition, the water samples were also treated by activated corn cob charcoal. Treatment process was carried out as the same procedure described in corn cob powder as shown in Figure 1.

Figure 1 Treatment of water sample by column filtration process

Results and Discussion

Table 1 shows the physicochemical parameters in water samples before treatment. By studying the results, most of the measured parameters were over the limit of EPA standard. pH of the water samples were found to be alkaline. Conductivity values were in the range of 340μScm^{-1} to 501μScm^{-1} and below the permissible limit. The water samples from agriculture sites were turbid with turbidity values of 25.00 NTU to 67.40 NTU. Total dissolved solids are in the range of 460 mg/L to 720 mg/L. The palatability of drinking water has been rated, by panels of tasters, according to TDS levels as follows: excellent, less than 300 mg/L, between 600 mg/L and 900 mg/L, poor and unacceptable, greater than 1200 mg/L (Bruvold and Ongerth, 1969). The TDS value were found to be within range of 460 mg/L and 720 mg/L and poor level according to literature. In the present study, the total alkalinity values of the water samples were between 180 mg/L and 400 mg/L. Hardness values were in the range of 100 mg/L to 380 mg/L and observed to be higher than the permissible limit. If the alkalinity is less than the hardness, then salts of calcium and magnesium are present in association with sulphate, chlorides, or nitrates. In the water samples from agriculture sites PO_4^{3-} contents were higher than the permissible limits. Conductivity, turbidity, TDS, alkalinity, hardness, concentration of NO_3-N, NH_3-N and PO_4^{3-} were found to gradually decrease during the study period of seven days.

Table 1 Some Physicochemical Parameters in Water Samples before Treatment

Parameter	Unit	Samples							WHO* (2011)	EPA** (2003)
		Day I	Day II	Day III	Day IV	Day V	Day VI	Day VII		
pH	-	7.8	7.9	8.0	7.8	7.7	7.9	7.8	8.2-8.8	6.5-8.5
Temperature	-	28.9	28.6	28.6	28.7	28.7	28.9	28.6	-	-
Conductivity	μScm^{-1}	501	447	402	380	347	340	388	600	-
Turbidity	NTU	67.40	60.00	58.00	49.01	38.11	33.00	25.00	10	-
TDS	mg/L	720	706	680	630	510	500	460	500	500
Alkalinity	mg/L	400	300	400	380	180	200	260	500	30-150
Hardness	mg/L	380	260	220	100	120	140	160	200	90-100
NO_3-N	mg/L	23.2	24.0	2.6	8.2	21.6	9.5	7.5	50	1.0
NH_3-N	mg/L	0.35	0.29	0.29	0.26	0.24	0.22	0.22	0.5	0.5
PO_4^{3-}	mg/L	0.33	0.26	0.24	0.21	0.18	0.10	0.10	0.02	0.12

* Maximum permissible limit of drinking water quality (WHO, 2011)
** United States Environmental Protection Agency for domestic water (USEPA, 2005)
Day I to Day VII = Water samples after using fertilizers

By observation of the results shown in Table 2, it can be seen that the dissolved oxygen level of water sample (Day I) was 1.7 mg/L and was the lowest among samples collected on other days. The DO levels of all water samples were lower than standard values. BOD values were 6.2 mg/L on the Day I and gradually decreased to 2.0 mg/L on Day VII. BOD values except that of Day 1 sample was lower than WHO and EPA standard values. Furthermore, chemical oxygen demand was in the range of 10.06 mg/L and 4.9 mg/L. All COD values except Day VII were higher than EPA standard.

Table 2 Results of Some Organic Pollutants in Water Samples after Using Fertilizers in September 2018

Parameter	Unit	Samples							WHO* (2011)	EPA** (2003)
		Day I	Day II	Day III	Day IV	Day V	Day VI	Day VII		
DO	mg/L	1.7	2.4	2.6	2.6	3.0	3.8	4.0	-	4-6
BOD	mg/L	6.2	4.3	2.1	2.1	2.0	1.9	2.0	6	5
COD	mg/L	10.6	9.3	7.8	7.6	7.0	6.8	4.9	10	5

* Maximum permissible limit of drinking water quality (WHO, 2011)
**United States Environmental Protection Agency for domestic water (USEPA, 2005)
Day I to Day VII = Water samples after using fertilizers

Table 3 shows the elemental compositions of water samples determined by AAS after using fertilizers. The elements determined were iron, copper, lead and cadmium. It was observed that the elements which can cause pollution to water were present in all tested water samples collected. However, these elements were below the permissible limit of EPA standard.

Table 3 Elemental Compositions of Water Samples after Using Fertilizers by Atomic Absorption Spectroscopy before Treatment

Element	Unit	Samples							WHO* (2011)	EPA** (2003)
		Day I	Day II	Day III	Day IV	Day V	Day VI	Day VII		
Fe	mg/L	0.002	0.020	0.010	0.021	0.023	0.009	0.010	2.0	0.30
Cu	mg/L	0.095	0.011	0.092	0.011	0.018	0.001	0.015	0.05	1.00
Pb	mg/L	0.003	0.015	0.010	0.001	0.002	0.010	0.011	0.01	0.05
Cd	mg/L	0.001	0.013	0.011	0.002	0.012	0.002	0.012	0.003	0.01
K	mg/L	0.003	0.001	0.002	0.002	0.003	0.001	0.092	0.05	0.05

* Maximum permissible limit of drinking water quality (WHO, 2011)
**United States Environmental Protection Agency for domestic water (USEPA, 2005)
Day I to Day VII = Water samples after using fertilizers

Relative Abundance of Elements in Corn Cob Powder and Activated Corn Cob Charcoal

Table 4 shows the relative abundance of elements in corn cob powder and activated corn cob charcoal. From the EDXRF report, it was found that corn cob powder contains chlorine in highest content of 4.325 % and vanadium the lowest, 0.004 %. Moreover, activated corn cob powder contained 0.563 % silicon followed by potassium 0.491 % and phosphorus 0.478 %. Other elements are present in small amount. It can be seen that these adsorbents are composed of significant amount of some elements.

Table 4 Elemental Compositions of Corn Cob Powder and Activated Corn Cob Charcoal

No	Element	Relative abundance (%)	
		Corn cob powder	Activated corn cob charcoal
1	Chlorine (Cl)	4.325	-
2	Calcium (Ca)	3.197	-
3	Silicon (Si)	1.059	0.563
4	Potassium (K)	0.970	0.491
5	Phosphorus (P)	0.229	0.478
6	Aluminium (Al)	0.052	-
7	Sulphur (S)	0.050	0.115
8	Iron (Fe)	0.035	0.009
9	Manganese (Mn)	0.009	0.003
10	Titanium (Ti)	0.009	-
11	Zinc (Zn)	0.005	0.003
12	Barium (Ba)	0.004	-
13	Vanadium (V)	0.004	-
14	Copper (Cu)	-	0.002
15	Chromium (Cr)	-	0.001

Surface Morphology of Corn Cob Powder and Activated Corn Cob Charcoal

Figure 2 shows the SEM image of corn cob powder. Porous nature of corn cob powder was observed. It has different sizes of pores. SEM image of activated corn cob charcoal is shown in Figure 3. From the SEM images, it can be clearly seen that the corn cob charcoal particles were cluster form and have different size of holes. More pores are clearly seen in activated corn cob charcoal.

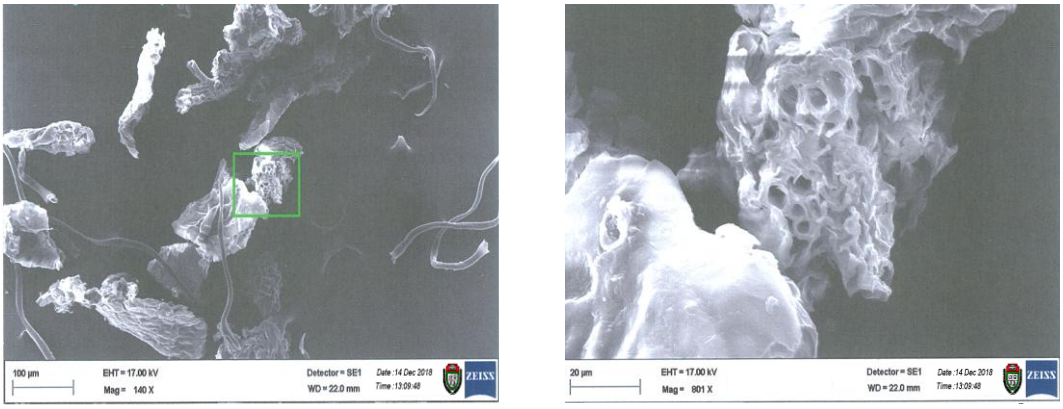
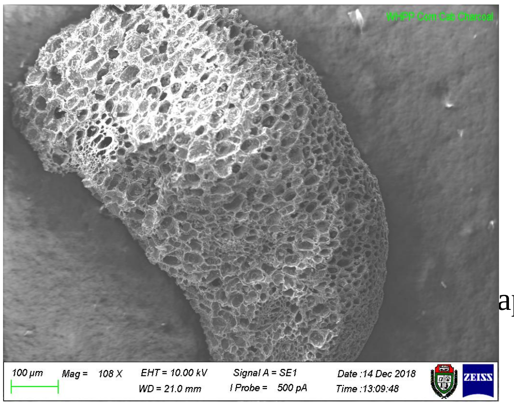


Figure 2 Scanning electron micrographic image of corn cob powder



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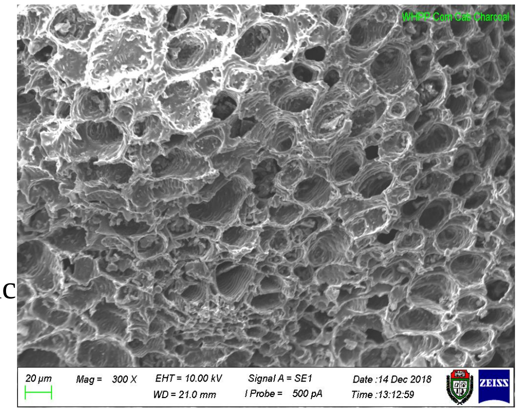

Comparison of Some Physicochemical Parameters of Water Samples after Treatment by Using Corn Cob Powder and Corn Cob Activated Charcoal

Table 8 and Figure 4 show total dissolved solids (TDS) in water samples before and after treatment by using corn cob powder and corn cob activated charcoal. Before treatment TDS values obtained on Day 1 to Day VI were higher than the permissible limit of WHO and EPA standards. After treatment with corn cob powder and corn cob activated charcoal TDS values were found to decrease and lower than the permissible limit. On Day VII, the reduction percents of TDS were 90.5 % and 93.4 %, respectively, from its original TDS value by corn cob powder and corn cob activated charcoal. It was noted that the higher amount of decrease was observed in water sample treated with corn cob activated charcoal.

Table 8 Total Dissolved Solid in Water Samples before and after Treatment by Using Corn Cob Powder and Corn Cob Activated Charcoal

Day of collection	TDS(mg/L) before treatment	TDS(mg/L) after treatment	
		Corn cob powder	Corn cob activated charcoal
Day I	720	85.6	56.2
Day II	706	60.5	50.3
Day III	680	60.5	50.0
Day IV	630	55.6	46.5
Day V	510	68.5	55.2
Day VI	500	76.5	45.1
Day VII	460	68.7	47.4

Day I to Day VII = Water samples after using fertilizers

Table 9 and Figure 5 show the total alkalinity of water samples and Table 10 and Figure 6 show hardness of water before and after treatment by using corn cob powder and corn cob activated charcoal. After treatment total alkalinity values and also the hardness were below the permissible limit. The reduction percents from its original total alkalinity value were found to be 85.0% and 90.5% for corn cob powder and activated charcoal respectively. Reduction percents of hardness from its original value were 76.1 % by corn cob powder and 79.2 % by activated charcoal. Since the many pores were present in activated charcoal the decreases by charcoal powder was more than corn cob powder.

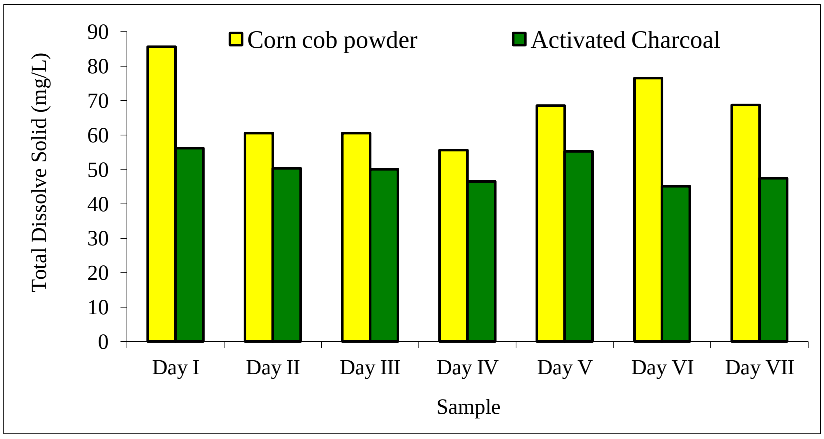

Figure 4 Total Dissolved Solids in water samples after treatment using corn cob powder and corn cob activated charcoal

Table 9 Alkalinity in Water Samples before and after Treatment by Using Corn Cob Powder and Corn Cob Activated Charcoal

Day of collection	Alkalinity(mg/L) before treatment	Alkalinity (mg/L) after treatment	
		Corn cob powder	Corn cob activated charcoal
Day I	400	140	100
Day II	300	140	110
Day III	400	80	60
Day IV	380	60	40
Day V	180	80	60
Day VI	200	60	40
Day VII	260	60	38

Day I to Day VII = Water samples after using fertilizerS

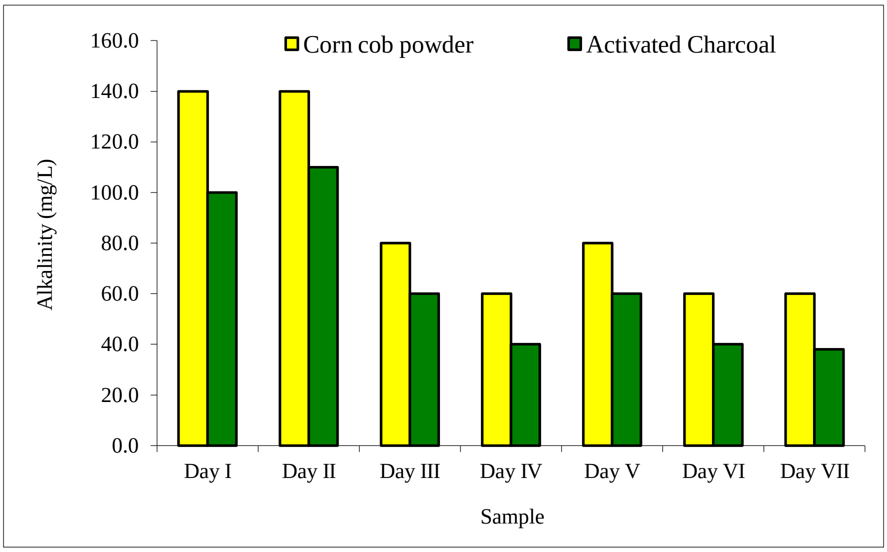

Figure 5 Alkalinity of water samples after treatment using powder and activated charcoal of corn cob

Table 10 Hardness of Water Samples before and after Treatment by Using Corn Cob Powder and Corn Cob Activated Charcoal

Day of collection	Hardness (mg/L) before treatment	Hardness (mg/L) after treatment	
		Corn cob powder	Corn cob activated charcoal
Day I	380	200	180
Day II	260	180	163
Day III	220	190	175
Day IV	100	90	83
Day V	120	80	63
Day VI	140	87	67
Day VII	160	91	79

Day I to Day VII = Water samples after using fertilizers

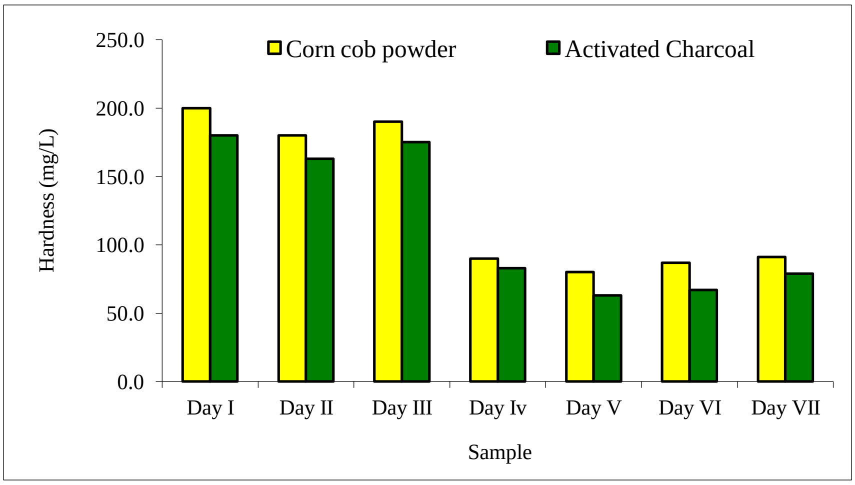

Figure 6 Hardness of water samples after treatment using powder and activated charcoal of corn cob

Table 11 and Figure 7 show nitrate nitrogen of water samples, Table 12 and Figure 8 show the ammonia nitrogen and Table 13 and Figure 9 show phosphate content in the water samples from agricultural site before and after treatment with corn cob powder and corn cob activated charcoal powder. By comparison of the results of these parameters of water samples before treatment and after treatment with corn cob powder and its charcoal, it can be clearly seen that all of the measured parameters after treatment are reduced. However, activated corn cob charcoal powder can reduce the pollutants of water more than corn cob powder due to its higher adsorptive property.

Table 11 Nitrate Nitrogen of Water Samples before and after Treatment by Using Corn Cob Powder and Corn Cob Activated Charcoal

Day of collection	NO_3-N(mg/L) before treatment	NO_3-N(mg/L) after treatment	
		Corn cob powder	Corn cob activated charcoal
Day I	23.2	5.9	ND
Day II	24.0	0.8	ND
Day III	2.6	1.0	0.4
Day IV	8.2	2.0	ND
Day V	21.6	7.0	0.6
Day VI	9.5	5.2	0.8
Day VII	7.5	3.6	ND

Day I to Day VII = Water samples after using fertilizers

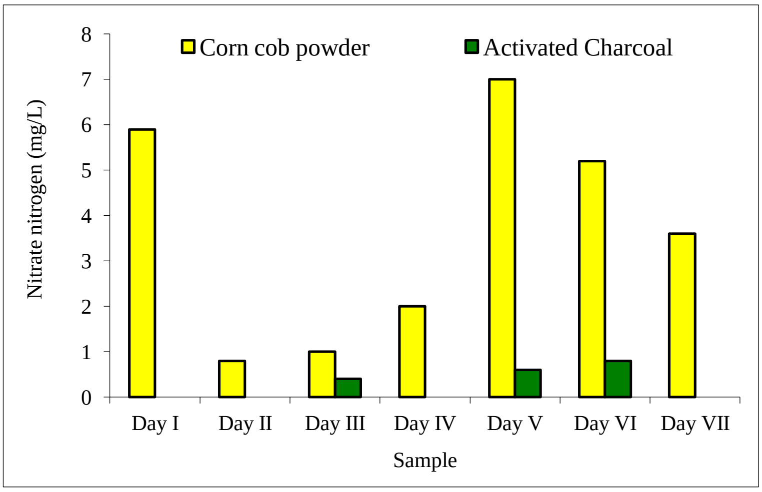

Figure 7 Nitrate nitrogen of water samples after treatment using corn cob powder and corn cob activated charcoal

Table 12 Ammonia Nitrogen of Water Samples before and after Treatment by using Corn Cob Powder and Corn Cob Activated Charcoal

Day of collection	NH_3-N(mg/L) before treatment	NH_3-N(mg/L) after treatment	
		Corn cob powder	Corn cob activated charcoal
Day I	0.35	0.13	0.12
Day II	0.29	0.11	0.09
Day III	0.29	0.14	0.12
Day IV	0.26	0.15	0.13
Day V	0.24	0.17	0.11
Day VI	0.22	0.19	0.12
Day VII	0.22	0.17	0.13

Day I to Day VII = Water samples after using fertilizers

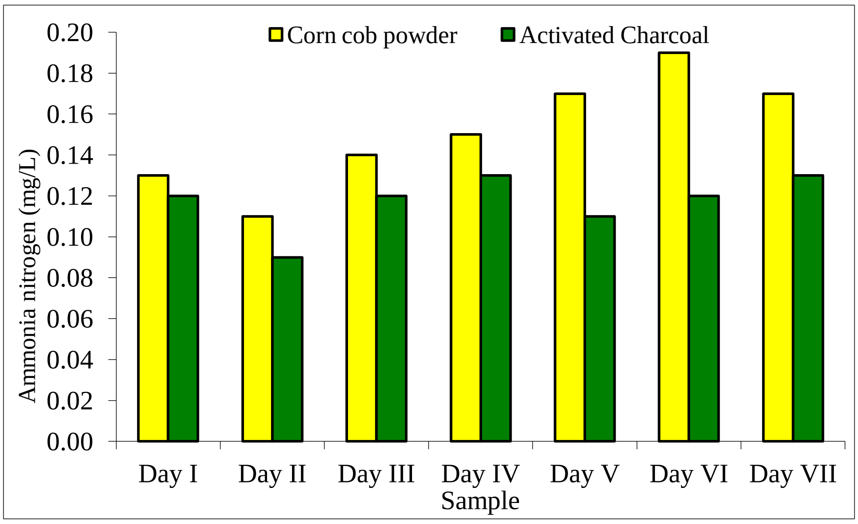

Figure 8 Ammonia Nitrogen of water samples after treatment using powder and activated charcoal of corn cob

Table 13 Phosphate of Water Samples before and after Treatment by Using Corn Cob Powder and Corn Cob Activated Charcoal

Day of collection	PO_4^{3-} (mg/L) before treatment	PO_4^{3-} (mg/L) after treatment	
		Corn cob powder	Corn cob activated charcoal
Day I	0.33	0.10	0.06
Day II	0.26	0.07	0.04
Day III	0.24	0.08	0.02
Day IV	0.21	0.08	0.01
Day V	0.18	0.05	0.02
Day VI	0.10	0.03	ND
Day VII	0.10	0.02	ND

Day I to Day VII = Water samples after using fertilizer

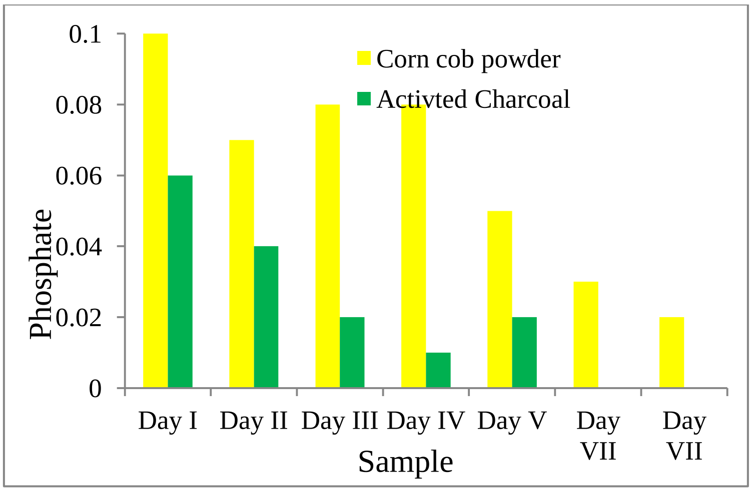

Figure 9 Phosphate in water samples after treatment using powder and activated charcoal of corn cob

Metal Composition of Water Samples after Treatment by Using Corn Cob Activated Charcoal

The metal composition of water sample was determined after treatment by using activated charcoals. The results are shown in Table 14. By observation of the results, it was found that the effective adsorbent activated corn cob charcoal reduced the trace metal contents which were non-detectable in all tested water sample.

Table 14 Elemental Compositions of Water Samples by Atomic Absorption Spectroscopy before and after Treatment using Corn Cob Activated Charcoal

Element	Elemental content (mg/L)	
	Before treatment	After treatment
Fe	0.002	ND
Cu	0.095	ND
Pb	0.003	ND
Cd	0.001	ND
K	0.003	ND

Comparison of Some Physicochemical Parameters of Water Sample after Three Column Filtration by Using Corn Cob Activated Charcoal

Water sample collected on the Day I after using fertilizer was treated continuously with three columns filtration using the more effective adsorbent, activated corn cob charcoal. Thereafter, some physicochemical properties of this sample after treatment of three times filtrations are expressed in Table 15. According to the results, it was seen that the more frequent the contact between water and adsorbent, the greater the pollution of water can be reduced.

Table 15 Comparison of Some Physicochemical Parameters in Water Sample in 2018 after Three Column Filtration by Using Corn Cob Activated Charcoal

Parameter	Unit	Before filtration	1^{st} time filtration	2^{nd} time filtration	3^{rd} time filtration
TDS	mg/L	720	56.2	42	25
Alkalinity	mg/L	400	100	71	40
Hardness	mg/L	380	300	211	166
NH_3-N	mg/L	0.35	0.12	0.10	0.01
NO_3-N	mg/L	23.2	0.01	ND	ND
PO_4^{3-}	mg/L	0.33	0.10	0.06	0.01

Conclusion

In this research, sampling site (common drainage) was chosen to study the environmental contamination by water from agricultural sites in Patheingyi Township, Mandalay Region. In September 2018, from the experimental data, it was observed that first day sample after using fertilizers was more polluted than other days. Moreover, the pollution level was gradually decreased from day II to day VII. It was found that, ammonia nitrogen, phosphate, alkalinity and hardness of all water samples were over the limit of EPA standard. The dissolved oxygen level and Biochemical Oxygen Demand in all water samples were lower than EPA standard, but the Chemical oxygen demand values were over the limit of EPA standard. Thus, the water samples collected in September 2018 were chosen to treat the pollution levels due to agricultural sites. The polluted water samples in September 2018 were treated by filtration using the prepared adsorbents (corn cob powder, activated corn cob charcoal,) to reduce the extent of contamination of water from agricultural sites. All adsorbents reduced the parameters after treatment. In comparing the removal activities, activated charcoal sample can reduce the pollutants more than powder sample. The pollution level caused due to agricultural sites can be reduced by using activated charcoal obtained from food wastes such as corn cob. Corn cob charcoal was more effective adsorbent with more frequent time of filtration.

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