

Water Quality Assessment and Treatment of Zawgyi River Water by Phytoremediation

Khin San Win¹, Htun Htun Naing²

Abstract

Today, the population is increasing day by day. So the social activities and industrialization impact the water quality. Zawgyi river flows from the Shan Mountain range to the middle Myanmar. Hence, it was being contaminating. So, in this research Zawgyi river water sample was selected for Water Quality Assessment and Treatment of Zawgyi River Water by Phytoremediation. This research work involved the comparison of water quality of three different sites and two periods (July 2016 and November 2016) of Zawgyi river from Singaing Township, Mandalay Region. Aquatic plant such as *Neptunia acinaciformis* Miq. (Water mimosa) was chosen for the study of water treatment. Before and after treatment of water samples were analyzed to know physical and chemical characteristics. The characteristic properties of water samples were studied by various analytical methods using pH meter and spectrophotometer. The physical and chemical parameters determined in this research are color, total dissolved solid, pH, total hardness, calcium, magnesium, chloride, sulphate, DO and BOD values. Bacteriological examination such as Coliform and *E. coli* were done. Lead contents in water before and after treatment were determined by Atomic Absorption Spectrophotometric method.

Keywords: Water quality, Treatment, Physical and Chemical parameters, Phytoremediation

Introduction

Zawgyi River is a river in the region of Mandalay, Myanmar with an average elevation of 69 meters above sea level. It is 280 km long. It flows through the foothills of the Shan Mountain range in Shan State. It is a tributary of the Myitnge River (Doktawaddy) entering it about 18 miles north of Kyaukse at Kyun Oo. Rice, gram, wheat, corn, banana and other crops are produced from the villages along the river, irrigated by water from the river.

If any toxic substances or any substances, which are caused contamination of water, are present in drinking water, the consumers will be encountered great danger to health. There are so many complicated great danger to health and health problems in connection with unwholesome water (K.LDuggn, 1971). Dirty water is the world's biggest pollution problem and therefore, chemical investigations and water treatment should be done on drinking water to determine its portability. Many countries can no longer manage pollution by dilution, leading to higher levels of aquatic pollution. The real and potential loss of development opportunity because of diversion of funds for remediation of water pollution has been noted.

Phytoremediation is the use of plants and trees to clean up contaminated water. This technology is currently in its infancy, and more research needs to be done before it is widely accepted as a remediation technique. The majority of research is concentrated on quantifying the mechanisms by which the plants convert pollutants, and determining which contaminants are amenable to phytoremediation(Nordell, Eskel, 1971).

The purpose of water analysis monitoring is to determine the physical, chemical and biological properties of natural water. The sample is collected from Zawgyi river in Singaing Township, Mandalay Region, which contains industrial wastewater, agricultural waste, bacteria, other microorganisms, chemical, sewage and visible suspended matter.

¹ Associate Professor, Department of Chemistry, Yadanabon University

² Lecturer, Department of Chemistry, University of Mandalay

In this research, physical parameters such as colour, total dissolved solid of water before and after treatment were analyzed. Total hardness, alkalinity, metallic constituents and inorganic nonmetallic constituents were investigated as chemical quality. Plants were used for treatment. The aim of this research is to analyse the quality of water from Zawgyi river in Singaing Township, Mandalay Region, Myanmar and to treat Zawgyi river water by phytoremediation.

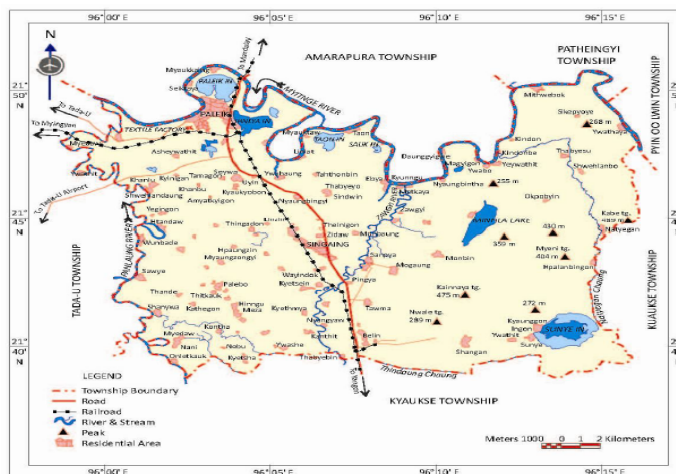


Figure (1). Location Map of Sampling in Zawgyi River

Water Treatment

Water treatment is any process that makes water more acceptable for a specific end-use. The end use may be drinking, industrial water supply, irrigation, river flow maintenance, water recreation or many other uses including being safely returned to the environment. Water treatment removes contaminants or reduces their concentration so that the water becomes fit for its desired end-use. Types of water treatment are sedimentation, filtration, ion exchange, absorption and disinfection (Chlorination / Ozonation) (Nordell, 1971).

Phytoremediation

Phytoremediation is a cost-effective plant based approach of remediation that takes advantage of the ability of plants to concentrate elements and compounds from the environment and to metabolize various molecules in their tissues. Toxic heavy metals and organic pollutants are the major targets for phytoremediation.

Botanical Description of *Neptunia acinaciformis* Miq.

- Botanical Name : *Neptunia acinaciformis* Miq.
Family Name : Mimosaceae
English Name : Water Mimosa
Myanmar Name : Yay Hti Ga Yon
Part Used : The whole plant



Figure (2). The Plant of *Neptunia acinaciformis* Miq.

Materials and Methods

Sample Collection

Water samples were collected from Zawgyi river near KyunOo village (site 1), Zawgyi village (site 2), and Sanpya village (site 3) on July 2016 and November 2016. Water samples were collected 15 feet apart from river bank and 2 feet depth.

Sampling Sites	Sample Locations		Sampling Date
	Latitude (N)	Longitude (E)	
1	21° 43' 21"	96° 07' 38"	22.7.2016
2	21° 46' 15"	96° 08' 56"	
3	21° 45' 01"	96° 08' 29"	
1	21° 43' 21"	96° 07' 32"	26.11.2016
2	21° 42' 10"	96° 08' 54"	
3	21° 40' 08"	96° 09' 21"	



Figure (3). Zawgyi Rive
Site 1



Figure (4). Zawgyi River
Site 2



Figure (5). Zawgyi River
Site 3

Analysis of Physical and Chemical Properties of River Water Collected from Site 1, Site 2 and Site 3

Evaporation method, Titrimetric method, Argentometric method, Gravimetric method and Atomic Absorption Spectrophotometric method were used for estimation of total dissolved solid, total hardness, calcium, magnesium, chloride, sulphate and lead content of water sample.

Treatment of Zawgyi River Water by Using *Neptunia acinaciformis* Miq. (Water Mimosa)

Zawgyi river water sample (Site 1) collected on November, 2016 was selected for treatment due to the most polluted one. 7 plants (100 g) of *Neptunia acinaciformis* Miq. (Water Mimosa) were planted in plastic tank containing 20 liters of collected water (Site 1).



Figure (6). The Plants of *Neptunia acinaciformis*
Miq. (Water Mimosa)

After three weeks for site 1, all of *Neptunia acinaciformis* Miq. (Water Mimosa) were taken out from the tank and the physical and chemical properties of phytoremediated water were determined. The results were shown in Table (6).

The phytoremediated water (site 1) from the tank was collected after three weeks. Removal of lead ion from water was carried out by Atomic Absorption Spectrophotometric method. The results were tabulated in Table (8).

Treatment of Lead II Nitrate Solution by using *Neptunia acinaciformis* Miq. (Water Mimosa)

The plants of *Neptunia acinaciformis* Miq. (Water Mimosa) were collected from Tawma Village, Kyaukse Township on October 2016.

10 plants (100 g) of *Neptunia acinaciformis* Miq. (Water Mimosa) were planted in plastic tank containing 20 liters of 0.1 mg/L lead II nitrate solution.

The phytoremediated lead II nitrate solution was collected after 1 week, 2 weeks and 3 weeks. Removal of lead ion from solution was carried out by Atomic Absorption Spectrophotometric method. The results are presented in Table (9).

Results and Discussion

Physical and Chemical Properties of Zawgyi River Water Samples on July 2016

Water quality of different sites of Zawgyi river were determined and the results are shown in Table (1).

Table (1). Comparison of Physicochemical Properties of Water Samples from Zawgyi River on July 2016

No.	Test	Site 1	Site 2	Site 3	WHO Standard	
					Highest desirable level	Maximum permissible level
1.	Colour (Platinum, Cobalt Scale)	> 50	> 50	> 50	5	50
2.	Total Dissolved Solid (mg/L)	175.9	176	161	500	1500
3.	pH	7.5	7.1	7.1	7.0 to 8.5	6.5 to 9.2
4.	Total Hardness (mg/L)	200	188	180	100	500
5.	Calcium (mg/L)	48	48	48	75	200
6.	Magnesium (mg/L)	20	15	15	30	150
7.	Total Alkalinity (mg/L)	220	220	180	200	500
8.	Sulphate (mg/L)	< 200	< 200	< 200	200	400
9.	Chloride (mg/L)	10	12	10	200	600
10.	Total Iron(mg/L)	> 0.2	> 0.2	> 0.2	0.1	1.0

The water quality of different sites of Zawgyi river were compared. The physical properties such as the amount of total dissolved solid, the chemical properties such as pH, the amount of total hardness, calcium, magnesium, total alkalinity and total iron were found to be within WHO standards and fit for portable water. The colour of water sample was found to be higher than WHO standard so unfit for portable purpose. The sulphate and chloride value of the water sample were lower than WHO standard.

Bacteriological Examination of Water Samples on July, 2016

Bacteriological Activities of water samples collected from site-1, site-2 and site-3 were examined. The results are shown in Table (2).

Table (2). The Results of Bacteriological Examination of Water Samples on July, 2016

No.	Test	Result of Site 1	Result of Site 2	Result of Site 3
1.	Probable Coliform Count	5/5	5/5	2/5
2.	<i>Escherichia coli</i> Count	Isolated	Isolated	Isolated

E. coli were isolated from all water samples. From the point of view of bacteria, the water samples were found to be unsatisfactory.

Lead Content of Zawgyi River Water Samples on July, 2016 by AAS

AAS analysis was performed in Department of Medical Research (Upper Myanmar), Pyin Oo Lwin.

Table (3). Comparison of Lead Content of Zawgyi River Water Samples on July, 2016

No.	Test	Site 1	Site 2	Site 3
1.	Lead (mg/L)	0.0830	0.0166	0.0664

Lead content of site 1 water sample was found to be the greatest among these water samples.

Physical and Chemical Properties of Zawgyi River Water Samples on November, 2016

Water quality of different period of Zawgyi river were determined. The results are shown in Table (4).

The physical properties such as total dissolved solid was found to be within WHO standards. The colour of the water sample are the same. The amount of total dissolved solid of the water sample on November, 2016 was found to be higher than that of the water sample on July, 2016.

pH of the water sample were found to be slightly alkaline. The amount of total hardness, calcium, magnesium, total alkalinity and chloride of the water sample on November 2016 were greater than that of the water samples on July, 2016. Due to the increase in these parameters, the water sample on November, 2016 was found to be more polluted than that of the water sample on July, 2016.

Table (4). Comparison of Physicochemical Properties of Water Samples from Zawgyi River on November 2016

No.	Test	Site 1	Site 2	Site 3	WHO Standard	
					Highest desirable level	Maximum permissible level
1.	Colour (Platinum, Cobalt Scale)	> 50	> 50	> 50	5	50
2.	Total Dissolved Solid (mg/L)	440	350	302	500	1500
3.	pH	7.4	7.4	7.1	7.0 to 8.5	6.5 to 9.2
4.	Total Hardness (mg/L)	280	268	240	100	500
5.	Calcium (mg/L)	64	72	51	75	200
6.	Magnesium (mg/L)	29	21	27	30	150
7.	Total Alkalinity (mg/L)	280	196	188	200	500
8.	Sulphate (mg/L)	< 200	< 200	< 200	200	400
9.	Chloride (mg/L)	15	12	12	200	600
10.	Total Iron(mg/L)	> 0.2	> 0.2	> 0.2	0.1	1.0

Bacteriological Examination of Water Samples on November, 2016

Bacteriological Activities of water samples collected from site 1, site 2 and site 3 were examined. The results are shown in Table (5).

Table (5). The Results of Bacteriological Examination of Water Samples on November, 2016

No.	Test	Result of Site 1	Result of Site 2	Result of Site 3
1.	Probable Coliform Count	4/5	5/5	5/5
2.	<i>Escherichia coli</i> Count	Isolated	Isolated	Isolated

E. coli were isolated from all water samples. From the point of view of bacteria, the water samples were found to be unsatisfactory.

Physical and Chemical Properties of Zawgyi River Water Samples on November, 2016 Treated with *Neptunia acinaciformis* Miq (Water Mimosa)

The water sample was collected from site-1 on November 2016. The water was treated with *Neptunia acinaciformis* Miq. (Water Mimosa). The physical and chemical properties of water sample were determined and the results are shown in Table (6) and (7). Lead content of water before and after treatment were determined by AAS method. The results are tabulated in Table (8).

Table (6). Comparison of Physicochemical Properties of Water Samples on November, 2016 Before and After Treatment

No.	Test	Site 1		WHO Standard	
		Before treatment	After treatment	Highest desirable level	Maximum permissible level
1.	Colour (Platinum, Cobalt Scale)	> 50	> 50	5	50
2.	Total Dissolved Solid (mg/L)	440	376	500	1500
3.	pH	7.4	7.5	7.0 to 8.5	6.5 to 9.2
4.	Total Hardness (mg/L)	280	240	100	500
5.	Calcium (mg/L)	64	51	75	200
6.	Magnesium (mg/L)	29	26	30	150
7.	Total Alkalinity (mg/L)	280	240	200	500
8.	Sulphate (mg/L)	< 200	< 200	200	400
9.	Chloride (mg/L)	15	70	200	600
10.	Total Iron(mg/L)	> 0.2	> 0.2	0.1	1.0

After treatment of site-1 water sample with *Neptunia acinaciformis* Miq. (Water Mimosa), they tend to reduce the amount of total dissolved solid, total hardness, calcium, magnesium and total alkalinity. However, the amount of chloride was found to be greater than that of water sample before treatment.

Table (7). Comparison of Chemical Properties of Water Samples on November, 2016 Before and After Treatment for Site 1

No.	Test	Site 1		
		Before treatment	After treatment	WHO standard
1.	DO (mg/L)	4.88	4.62	≥ 5
2.	BOD (mg/L)	3.98	3.80	2

After treatment with Water Mimosa, they tend to reduce the amount of DO and BOD values. The amount of DO value is lower than WHO standard. So it was unfit for aquatic environment and water quality.

Table (8). Comparison of Lead Content of Water Samples on November 2016 Before and After Treatment for Site 1

Amount of lead = 0.410 mg/L (Before Treatment)

No.	Treatment time	Amount of lead (ppm)	Amount of lead removal (ppm)	% removal of lead
1.	1 week	0.397	0.013	3.17
2.	2 weeks	0.393	0.017	4.15
3.	3 weeks	0.389	0.021	5.12

Lead content of Zawgyi river site-1 after treatment of one week, two weeks and three weeks was found to be decreased. Percent removal of lead content is the highest in treatment by plants after three weeks.

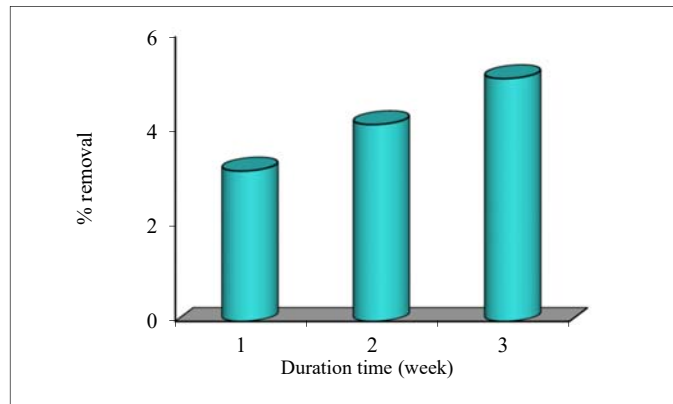


Figure (6). Percent Removal of Lead Content of Zawgyi River Site 1 by *Neptunia acinaciformis* Miq. (Water Mimosa)

Lead Content of 0.1 mg/L Lead II Nitrate Solution After Treatment with *Neptunia acinaciformis* Miq. (Water Mimosa) by AAS

Table (9). Comparison of Lead Content of Lead II Nitrate Solution Before and After Treatment with *Neptunia acinaciformis* Miq. (Water Mimosa)

Amount of lead = 0.1 mg/L (Before Treatment)

No.	Treatment time	Amount of lead (ppm)	Amount of lead removal (ppm)	% removal of lead
1.	1 week	0.068	0.032	32
2.	2 weeks	0.052	0.048	48
3.	3 weeks	0.029	0.071	71

Lead content of 0.1 mg/L lead II nitrate solution after treatment of one week, two weeks and three weeks was found to be decreased. Percent removal of lead content is the highest in treatment by plants after three weeks.

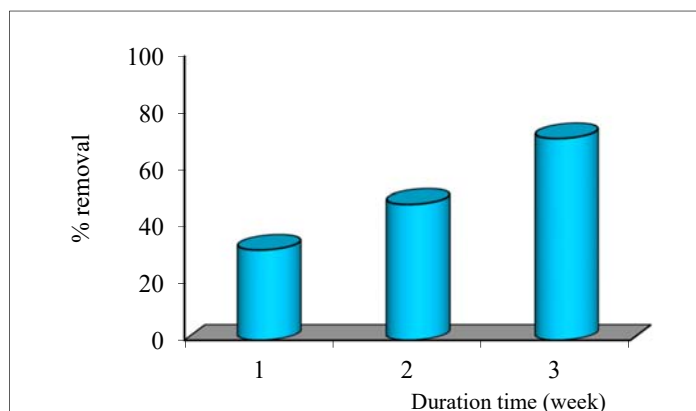


Figure (7). Percent Removal of Lead Content of Lead II Nitrate Solution by *Neptunia acinaciformis* Miq. (Water Mimosa)

The water quality of different sites of Zawgyi river were compared. The physical properties such as the total dissolved solid, the chemical properties such as pH, the amount of total hardness, total alkalinity were found to be within WHO standard. The amount of total hardness and total alkalinity were found to be decreased from site-1 to site-3. The calcium sulphate, chloride and total iron content of the water sample were nearly the same in three sites. pH values of the water samples were found to be slightly alkaline. *E. coli* were isolated from all water samples. From the point of view of bacteria, the water samples were found to be unsatisfactory.

Water quality of different periods of Zawgyi river were compared. The water samples were collected from site-1 to site-3 on July 2016 and November 2016. pH of the water samples were found to be slightly alkaline. The amount of total dissolved solid, total hardness and total alkalinity of the water samples on November, 2016 were greater than that of water samples on July, 2016. *E. coli* were isolated from all water samples. From the point of view of bacteria, the water samples were found to be unsatisfactory. Due to the increase in total dissolved solid, total hardness, total alkalinity and chloride of the water samples on November, 2016 were found to be more polluted than that of the water samples on July, 2016.

Zawgyi river water samples (site-1) collected on November, 2016 were selected for treatment due to more polluted than site-2 and site-3. Zawgyi river water samples on November, 2016 was treated naturally by phytoremediation. *Neptunia acinaciformis* Miq. (Water Mimosa) plants were used for phytoremediation.

After treatment of site-1 water sample with *Neptunia acinaciformis* Miq. (Water Mimosa), they tend to reduce total dissolved solid, total hardness, total alkalinity, calcium, DO and BOD value. However, the amount of chloride were found to be greater than that of water samples before treatment.

Lead contents of water samples site-1 before and after treatment were determined by Atomic Absorption Spectrophotometric method. Lead contents of phytoremediated water collected after 1 week, 2 weeks and 3 weeks were less than that of untreated water samples. Percent removal of lead content is the highest in treatment by plants after 3 weeks. Therefore phytoremediation should be carried out with *Neptunia acinaciformis* Miq. (Water Mimosa) to improve water quality.

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