ANALYSIS OF WATER QUALITY AND ABSORPTION RATE WITH PURIFICATION STRATEGIES FOR WASTEWATER FROM RAJSHAHI'S SILK PRODUCTION SECTOR

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Abstract

Attire is a fundamental necessity for humans, second only to food, and Bangladesh is celebrated for its manufacturing of high-quality garments. Rajshahi is the sixth-largest city in Bangladesh, popularly known as the Silk City for its sericulture. The firms involved in this process consume a significant amount of water. As per some research, approximately 376 liters of water are needed to produce one silk shirt. The drainage system receives a fraction of this enormous volume of water. This wastewater may contain various kinds of heavy metals, and it can be dangerous to the extent if those are released into the environment. Contaminants produced and used in the silk reeling process were the main causes of the water pollution effects. This study is about determining the physicochemical water quality parameters of wastewater from the silk production industry and the presence of heavy metals in the drainage water of Rajshahi City. Also, finding out the changes in physicochemical parameters after adding natural absorbent material and comparing with standard values of WHO. Powdered eggshells, primarily composed of calcium carbonate ($CaCO_3$), were used as a natural bio-absorbent due to their alkaline and adsorption properties. The novelty of this study lies in the evaluation of eggshell powder as a low-cost natural absorbent for treating silk industry wastewater in Rajshahi City. The study systematically compares physicochemical parameters before and after treatment at different contact times and evaluates the results against WHO standards, providing practical insights for sustainable wastewater management in small-scale silk industries

***Keywords**: Silk; Wastewater; Pollution; Absorption; Heavy Metal.*

1. INTRODUCTION

Silk is a natural fiber produced by silkworms through a series of biological and industrial processes. This procedure involves mainly boiling the worms, getting raw threads from the worms, and then making the thread useable by riling and degumming. Sericulture, the practice and science of cultivating silkworms for silk production, is an agribased industry that involves both farming and industrial processes. Farming includes cultivating silkworm food plants, rearing silkworms to produce cocoons, and producing eggs. A huge amount of water is needed at every step of these procedures. Also, after the work is done, the discharged water carries numerous chemicals and pollution. Often, these polluted waters are exposed to the environment without any purification or alteration by the factories. Thus, it impacts harmfully on the environment or can cause health issues. Being known as the Silk City of Bangladesh, Rajshahi City often faces this problem. This study measures the number of pollutants that can be found in the daily produced silk water and how much that effect can be minimized after using an absorbent agent like eggshells. Silk production is a delicate and intricate process. It all begins with silkworms, which are the caterpillars of flightless silk moths. The cocoons, which contain silk threads, are boiled to loosen the fibers. Once softened, the silk threads are carefully unraveled and reeled into yarn, known as "raw silk". Afterward, this yarn undergoes various treatments to prepare it for weaving into luxurious silk fabric. The byproduct of silk wastewater called sericin can produce bioactive peptides that are used in medical, food, or cosmetic industries. However, the discharge and seepage of polluted wastewater, even after treatment, into open environments, lead to agricultural land infertility and drinking water scarcity due to contamination of natural water sources, such as arsenic contamination in Bangladesh. Also, studies have shown that the harmful dyes used in silk fabrics can lead to cancer due to the presence of genotoxic properties. This dyeing process led to water acidification or water ecotoxicity. To resolve this issue, various biocompatible materials, including silk, have been investigated for water treatment applications. Silk has been extensively utilized in textiles and biomedical fields due to its remarkable biocompatibility, mechanical strength, and non-toxic properties. While silk materials exhibit excellent biocompatibility, enhanced strength, and biodegradability, making them suitable for environmental applications, they also face certain challenges in processing and functionalization compared to commercial polymeric materials, which should be carefully considered for water treatment applications. The wastewater has a higher Chemical Oxygen Demand (COD) level which can be reduced by applying a reverse osmosis process. Additionally, the review examines the applicability of silk fibers for oil-water separation, detailing the separation mechanism. The study‟s results highlight the presence of hazardous materials in wastewater discharged by the industry. The wastewater primarily contains dye residues, sericin protein, and high dissolved ionic content, while heavy metals such as chromium, arsenic, lead, cadmium, and mercury were tested and found absent. To protect the environment, it is essential to treat and purify the water before releasing it, which can be achieved by setting up a proper treatment plant. Furthermore, this study focuses on the toxic materials present in silk wastewater and how they are reduced after using absorbent agents.

2. METHODOLOGY:

After completing the procedure of silk manufacturing, the wastewater is collected from different procedures. At first, the water used for coloring was taken into the lab to conduct some lab tests to know the amount of turbidity and pH present in the sample of water. Here, all tests before adding absorbent agents are done by machine tests and by using a small number of samples to find the actual number of contaminants. All methods are explained in detail.

Turbidity: 5 ml sample of water was taken into a beaker. Turbidimeter TN 100 was submerged in the sample. After a few times, the reading was shown. Fig. 1 illustrates the process of the turbidity test, showing the turbidity meter and the solutions in the flasks.

Figure 1. Turbidity Test

pH: At first, 5 ml samples were taken and the temperature of the sample was recorded. Then pH calibration meter HI98107 was submerged into the sample and the reading was taken.

Figure 2. pH Test

Conductivity: To assess how many dissolved ions were present in the water samples, a conductivity meter with a probe was used. The probe was carefully inserted directly into the samples, ensuring precise extraction and reliable results. This device sends a small electrical current through the solution and measures how easily it flows. The easier the current moves, the higher the conductivity indicating more dissolved salts or other ions.

Figure 3. Conductivity Test

Heavy Metal: Heavy metals like Chromium, Arsenic, Lead, Cadmium's presence were tested but not found.

Figure 4. Heavy Metal Test

After that a 5-gm sample of eggshells were mixed in three beakers of water sample and the first beaker were stirred for 30 minutes, the 2nd beaker was stirred for 60 and the 3rd one was stirred for 90 minutes. Then the eggshells were removed from the sample through filter paper and all parameters were measured again for three beakers and compared.

Figure 5. Eggshells were converted to powder, and 5gm powder was measured to add with sample.

Figure 6. Samples were taken into 3 different beakers, and eggshells were added

Figure 7. The samples were mixed by machine at 80 rpm speed

3. RESULTS AND DISCUSSION:

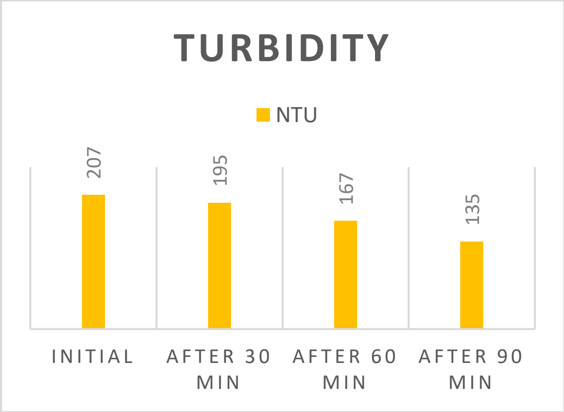
Table 1: Results of physiochemical water quality parameters for colored wastewater before and after adding absorbent agent:

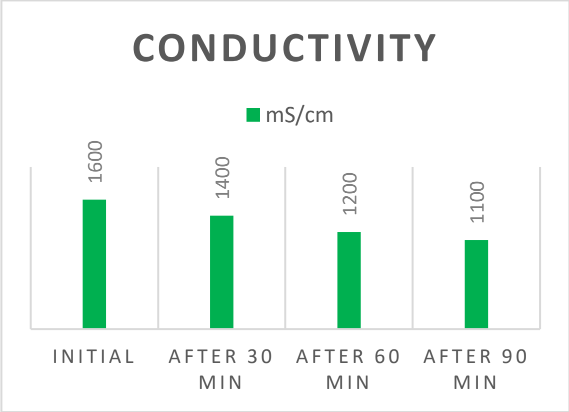
Parameters	Before using Absorbent	After using Absorbent		
		1st Beaker (30 Minutes)	2nd Beaker (60 Minutes)	3rd Beaker (90 Minutes)
pH	8.0	8.1	8.3	8.4
Turbidity (NTU)	207	195	167	135
Conductivity (mS/cm)	1600	1400	1200	1100

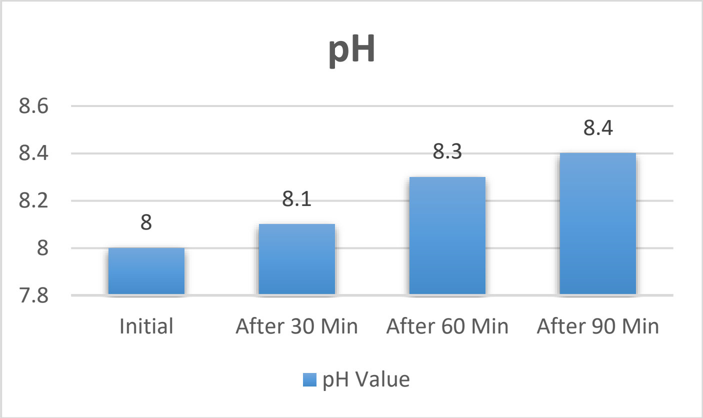
Table 2: Comparison to WHO standards (General Drinking Water Guidelines):

Parameter	Value				WHO Standard (Guideline Value)	Exceeds Standard?
	Before using Absorbent	After using Absorbent				
		1st Beaker	2nd Beaker	3rd Beaker		
pH	8.1	8.2	8.3	8.4	6.5-8.5	No
Turbidity (NTU)	207	195	167	135	5	Yes
Conductivity (mS/cm)	1600	1400	1200	1100	No guidelines, but high is a concern	N/A

Here, the measured pH, Turbidity, Conductivity is compared to the WHO Standard Value. We have confirmed the absence of all five tested heavy metals—mercury, lead, chromium, cadmium, and arsenic—in the water sample. Before adding eggshells, the pH value was alkaline but inside the acceptable range. The value of Turbidity is extremely high, and conductivity also indicates a high range of dissolved ions. After adding the eggshells into the sample, after stirring for 30 minutes, the first beaker shows some improved result. But the pH remains alkaline and closer to acceptable range. Turbidity and Conductivity values are improved but not that much. From the 2nd and 3rd beaker it is shown that the values are improving.







4. CONCLUSION

The analysis of wastewater samples indicates significant contamination. Additionally, pH levels ranging from 8.1 to 8.4, with the colored sample being highly alkaline poses further risks to aquatic life. Due to use of eggshells which contains Calcium Carbonate, which is an alkaline material, the pH of the sample keeps increasing. Some pH reductant material can be used for reducing this value to neutral. These findings underscore the urgent need for effective wastewater treatment to mitigate environmental and health risks before discharge or reuse. Using organic substances, all the water samples were supposed to be purified and made reusable. But in this study, it is shown that using eggshells as absorbent hasn't created many differences in the result. If the eggshells were kept stirring for more time, there would be more visible changes. Also, other ways need to be found and applied to get better results. Although turbidity and conductivity values decreased with increased contact time, turbidity remained significantly higher than WHO drinking water standards, indicating that eggshell adsorption alone is insufficient for complete purification. Those might prevent toxic and hazardous elements from mixing with the earth and will prevent both the environment and water from being contaminated. Although turbidity and conductivity values decreased with increased contact time, turbidity remained significantly higher than WHO drinking water standards, indicating that eggshell adsorption alone is insufficient for complete purification The wastewater primarily contains dye residues, sericin protein, and high dissolved ionic content, while heavy metals such as chromium, arsenic, lead, cadmium, and mercury were tested and found absent. Since the factory does not discharge any heavy metals and the water in Rajshahi is also free from such contaminants, no specific treatment for heavy metals is required.

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