ENVIRONMENTAL IMPACT FROM WASTEWATER EFFLUENT OF THE SILK COTTAGE INDUSTRY: A CASE STUDY OF PAK THOHG CHAI, NAKHON RATCHASIMA, THAILAND

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ABSTRACT

The study was conducted at Pak Thong Chai district in Nakhon Ratchasima Province, where high quality Thai silk is produced. Extensive chemical substances, dyes and water are used during bleaching and dyeing process. Effluents were released directly onto the ground or into canal that affect the local environment and national resources in these areas. The aims of study were to determine the wastewater characteristics; pH, Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD) and Total Dissolved Solids (TDS) from bleaching and dyeing process and to investigate the contamination of lead (Pb) and Cadmium (Cd) in water ,sediments and soil nearby silk cottage industry. According to the Thai industrial effluent standard, all samples of wastewater had high pH value but not exceed the standard (5.5-9). The determination of the BOD, COD and TDS were 338 - 2,483, 480 - 1,325 and 437.64 - 628.73 mg/L, respectively that higher than the level allowed by the national standard. The contamination of Pb and Cd in water resources were 5.722 – 15.024 and 0.285 - 0.834 ppb, respectively, whereas Pb and Cd in sediments were 158.47 – 262.26 and 2.46 – 4.13 ppb, respectively. The contamination of Pb and Cd in soil nearby silk production areas were 19.36 - 33.03 and 0.02 - 0.34 ppm, respectively. The sample site that polluted by effluent had Pb and Cd concentration higher than another area. It was found from the field observation that all sample sites were untreated effluent and overflowed to the land, even though some have small onsite treatment. Therefore, implementation of the appropriate wastewater system should be promoted to silk cottage industry.

Keywords: silk cottage industry, wastewater, BOD, COD, Pb, Cd

1. Introduction

As a consequence of the 1997 Asian financial crisis and the rural economic development policy of the previous Thai government, silk production in the informal economy has expanded from micro production to small and medium size enterprises. This is because SMEs in the formal sector mostly subcontracted their orders to new entrepreneurs in peri-urban areas. To achieve a large scale production, other process tasks, such as reeling, spinning and weaving have been distributed to home workers in villages or nearby areas. Therefore, silk production has become another important source of income for agricultural areas. However, the growth of these silk businesses had an unexpected effect on the local environment and natural resources in rural and peri-urban areas. Environmental problems of the silk cottage industry are mainly caused by discharges of wastewater. Wastewater from silk dyeing contained high chemicals, turbidity, strong color, and hydrocarbon substances which were difficultly degraded in the environment [1]. It has been found that one household, in a famous silk craft village in northeastern Thailand, had the silk dyeing undertaken 11 times per month, consuming water for dyeing 1,572 liters per month or 143 liters per time. Moreover, most silk producers were found discharging their wastewater directly to the environment with no treatment [2]. Due to lack of appropriate waste management, effluent is typically not treated to public health standards. Additionally, excess effluent has often overflowed onto common land or into reservoirs. This contamination has led not only to environmental deterioration but also to conflicts between villagers in relation to health and local resources utilisation, particularly in Pak Thong Chai, Nakhon Ratchasima province. [3] The aims

of this study were to determine the wastewater characteristics; pH, Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD) and Total Dissolved Solids (TDS) from bleaching and dyeing process and to investigate the contamination of lead (Pb) and Cadmium (Cd) in water ,sediments and soil nearby silk cottage industry.

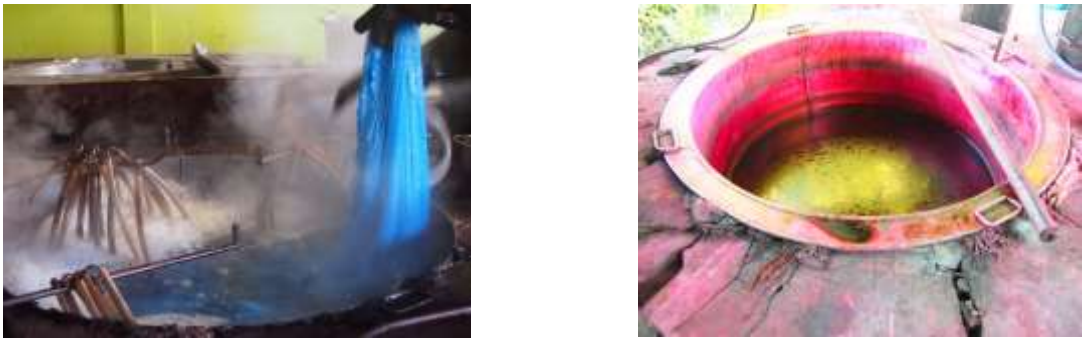
2. Materials and methods

2.1. Study Site

The study was conducted at Pak Thong Chai District in Nakhon Ratchasima, Thailand. Pak Thong Chai District became one of Thailand's most famous silk-weaving centres when Jim Thompson started buying silk here. The silk cottage industry in the Pak Thong Chai municipal area was established in the late 1960's, silk weaving work was subcontracted to villagers outside the municipality and had become a regular source of supplementary income.

2.2. Sampling and analysis

Wastewater samples were taken after reactive dyes are being used to colourise silk from different sites; the Macchada Thai silk factory (Fig. 1A) and Ban Don Khwang (Fig. 1B) , located in Pak Tong Chai District.



(A) (B)

Figure 1: Wastewater samples from the Macchada Thai silk factory (Fig. 1A) and Ban Don Khwang (Fig. 1B)

The pH value, Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD) and Total Dissolved Solids (TDS) from bleaching and dyeing process were analyzed. pH was measured by multi probe meter (Consort C532T). BOD, COD and TDS were determined according to standard methods for the examination of water and wastewater [4] BOD was analyzed by BOD 5 day test method. COD was analyzed by closed refluxed method. TDS was analyzed by drying at 103 - 105 ^{o}C

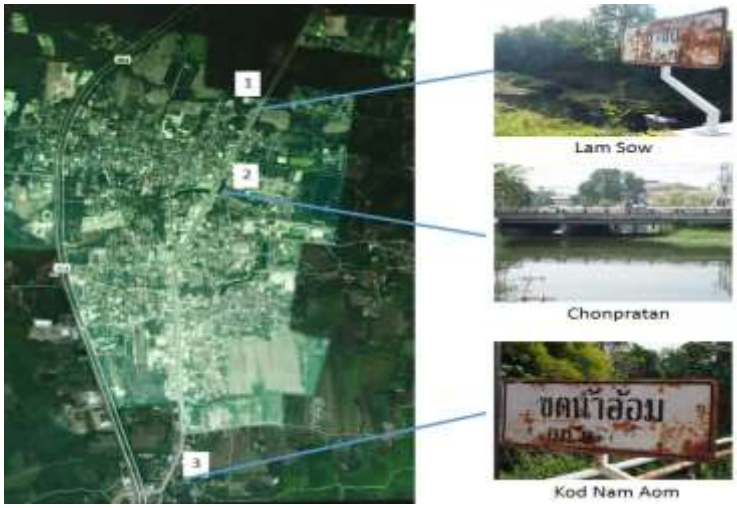


Figure 2: Water and Sediment sampling sites

Water and Sediment samples were taken from sampling sites; Lam Sow, Chonpratan and Kod Nam Aom as Shown in Fig.2.

Soils samples were taken from Ban Don Khwang sampling sites; dyeing area (Fig. 3A) and agricultural areas around dyeing area (Fig. 3B), located in Pak Tong Chai District.

(A)

(B)

Figure 3: Soils sampling sites; dyeing area (Fig. 3A) and agricultural areas around dying area (Fig. 3B)

The water samples from different sampling location were collected in plastic bottles. The samples were delivered to the laboratory and kept at 4 ^{o}C during experiment study. Pb and Cd in water, sediments and soil were analyzed by Method 3020a: Acid digestion of aqueous samples and extracts for total metals for analysis by GFAAS Spectroscopy.

3. Results

3.1. Wastewater characteristics from bleaching and dyeing process

According to the Thai industrial effluent standard, all samples of wastewater had high pH value but not exceed the standard. The determination of the BOD, COD and TDS were 338 - 2,483, 480 - 1,325 and 437.64 - 628.73 mg/L, respectively that higher than the level allowed by the national standard as shown in Table 1.

Table 1: Wastewater characteristics from bleaching and dyeing process

Parameters	Macchada Thai silk factory	Ban Don Khwang	Industrial Effluent Standards [5]
pH	7.39 – 7.86	7.54 - 7.93	5.5 - 9
BOD_5 (mg/L)	338 - 1,869	571 - 2,483	not more than 20 mg/L depending on receiving water or type of industry under consideration of PCC but not exceed 60 mg/L
COD (mg/L)	480 - 875	690 - 1,325	not more than 120 mg/L depending on receiving water of type of industry under consideration of PCC but not exceed 400 mg/L
TDS (mg/L)	437.64 - 529.83	463.18 - 628.73	not more than 3,000 mg/L depending on receiving water or type of industry under consideration of PCC but not exceed 5,000 mg/L

Remarks: 1) PCC Pollution Control Committee

3.2. Water resources characteristics

All samples of wastewater had the pH value not exceed the standard, whereas BOD_5 of all samples were higher than National Standards as shown in Table 2.

Table 2: Water resources characteristics

Parameters	Lam Sow	Chonpratan	Kod Nam Aom	National Standards [6]
pH	6.8	7.2	6.8	5.0 - 9.0
BOD_5 (mg/L)	29.15	11.75	6.05	not more than 2.0 mg/L
COD (mg/L)	56.0	28.0	12.0	-
TDS (mg/L)	385	242	224	-

3.3. Contamination of Pb and Cd in water, sediments and soil

According to Notification of the Ministry of Natural Resources and Environment issued under the Enhancement and Conservation of the National Environmental Quality; concentration of Cd and Pb in water must be not more than 0.005 and 0.05 mg/L, respectively. All samples of water had concentration of Cd and Pb not exceed the standard. The soil samples that polluted by effluent from dyeing process had Pb and Cd concentration higher than another area as shown in Table 3.

Table 3: Contamination of Pb and Cd in water, sediment and soil

Samples site	**Pb (mg/L)**	**Cd (mg/L)**
Water		
Lam Sow	0.015	0.0008
Chonpratan	0.010	0.0008
Kod Nam Aom	0.006	0.0002
Sediments		
Lam Sow	0.189	0.002
Chonpratan	0.158	0.004
Kod Nam Aom	0.262	0.004
Soil		
Dying area	32.99	0.34
Agricultural area around dying area	12.26 - 19.92	0.02 - 0.23

4. Conclusions

The monitoring of environmental quality such as water characteristics and soil contamination were important factors that should be discussed with stakeholder in order that they should be aware of the health and environmental impact. Furthermore, the appropriate wastewater management is necessary for silk cottage industry to protect environmental impact from wastewater effluent such as water pollution, accumulation heavy metal in sediments and soils especially agricultural areas around the dyeing area that can led to health problems.

ACKNOWLEDGEMENTS

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