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ASSESSMENT OF SOME SELECTED METALS FROM TEXTILE EFFLUENTS IN AMHARA REGION USING AAS AND ICPOES

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ABSTRACT

Heavy metals are some of the common pollutants that are found in industrial wastewaters a variety sources one of them textile industries. In Ethiopia, there are more than fourteen major textile and garment factories. The study of industrial wastewater, it is important to select the appropriate wastewater treatment program. Samples of textile effluents from textile industries found in Amhara Regional State Bahir Dar, Kombolcha, and Debre Brihan textile industries were collected. Heavy metal concentrations effluents were determined using FAAS and ICP-OES. The determined heavy metal concentration of Pd 0.85 to 0.61, As 1.3 to 0.4, Cr 0.08 to 0.03, Zn 2.6 to 0.32 and Mn 0.37 to 0.25 mg/L by FAAS. The determined heavy metals in all textile industries didn't have significant effluence to environment, but there is a significant difference between FAAS and ICP-OES. The concentration of all the studied heavy metals except Mn were comparable with the WHO and EEPA guideline. This study suggests quick intervention and closes monitoring to arrest and solve the growing environmental pollution.

Contribution/Originality: The paper's primary contribution is finding that influence of environmental pollution assessment with standards of EEPA and WHO and determined heavy metals Pb, As, Cr, Zn and Mn from textile industries waste water effluents in Ahmara region, Ethiopia and comparison of FAAS and ICP-OS methods.

1. INTRODUCTION

Heavy metals are some of the common pollutants that are found in industrial wastewaters. These species can have series impact if released into the environment as a result of bioaccumulation, and they may be extremely toxic in trace quantities also causes serious environmental and health problems like carcinogenic [1, 2]. Toxic heavy metals like zinc, copper, nickel, mercury, cadmium, lead and chromium variety sources of metal plating facilities, mining operations, tanneries, textile, batteries, paper industries and pesticides industries effluents [3]. Untreated sludge coming from textile effluent treatment plant may accumulate unsafe levels of physical and heavy metals that are very active to circulate on environment [4].

The textile industry is the largest manufacturing industry in Ethiopia. There are more than fourteen major state-owned and private textile and garment factories. But, most of them lack effluent treatment plants. Instead, they directly discharge untreated toxic effluent into the nearby canals, rivers, lakes, and streams [5]. The pollutants also have an impact on the fertility of soil; reduce the agricultural yield, the crops and vegetables grown on a soil affected by pollutant, an indirect impact on human being through food web. Heavy metals cannot be biodegradable, but hold bioaccumulative and may direct threat to higher organisms, including humans. The scientist pointed out that heavy metals are inconvertible to soil contamination [6]. The study of industrial wastewater, it is important to select the appropriate wastewater treatment program that it is important to minimize the water pollution load [7]. Therefore, the main objective of the study is to assess some selected heavy metals from textile effluents in Amhara region using AAS and ICPOES.

2. MATERIAL AND METHODS

A. Sample site, Sampling and sample collection: Samples of textile *effluents from textile industries found in Amhara* Regional State Bahir Dar, Kombolcha, and Debre Brihan textile industries were collected. The sampling sites were selected based on access, safety, potential sources of pollutions, and wastewater effluents. Corresponding to each site, samples were collected from the out let of textile industries. For each, 1.5 L of wastewater was collected with a polystyrene plastic bag. Samples were collected from January, 2019 from different sampling sites. Samples were taken from each sampling site and labeled the sample to indicate date of sampling and the sampling site.

B. Sample Digestion: By examining different literatures, the optimized procedure was selected depending upon the clearness of the digested which was obtained with less digestion time, less reagent volume and simplicity of the digestion procedure. A chemicals distilled water, Hydrochloric acid (37% Aldrich, A.C.S. Reagent, Germany), Nitric acid (69-72%, BDH laboratory supplies poole) were used for digestion. the samples were determined by atomic absorption spectroscopy (buck scientific model-210VGP) and ICP-OS (PerkinElmer optima 8000).

C. Method Validation: Precision: of an analytical procedure is usually stated as standard deviation of measurements [8] by triplicate readings for each sample. *Limit of Detection*: is the amount of analyte that gives a signal equal to the blank [9]. The limit of detection of each metal was expressed by multiplying the standard deviation of the reagent blank by three divided by the slope of the calibration line [10]. *Recovery:* Known amount of each metal were spiked to the flask containing each sample. The spiked samples were digested the same as the developed digestion method for wastewater and analyzed. *The instrument was calibrated* using six series of working standards solutions of metal were prepared by diluting the standard solution.

D. Statistical Analysis: the significance of difference within the sample site metal analysis and between AAS and ICP-OS spectroscopy were studied using ANOVA.

3. RESULTS AND DISCUSSION

a) Optimization: The result of optimization sample digestion in the hot plate in the 3:1 reagent volume ratio, $105^{0}c$ temperature, 2:30 hr digestion time and remaining reagent volume 12 mL were selected. During this procedure the sample clear, colorless and no residue was obtained as shows in Table 1.

Table-1. Optimization for the digestion of heavy metals.

Reagent	Vol. (ml)	Temp. (°c)	Time (hr)	Color of solution
HNO_3:HCl	5:2	150	3:00	Not clear
HNO_3:HCl	6:1	120	2:45	Light yellow
HNO_3:HCl	9:2	100	2:10	Not clear
HNO_3:HCl	3:1	105	2:30	Clear and color less

b) Method Validation: The results of method validation precision, limit of detection, recovery and calibration of instruments are acceptable. A results precision of can be expressed by standard deviation, it was reliable and below P = 0.05, percentage of recovery becomes on the rage (80-120%) [10] and correlation coefficient also above

0.99. The results of analysis of heavy metals are greater than limit of detections. Therefore, the obtained results of heavy metals in textile industries waste water by this method are accepted and reasonable.

c) Determination of heavy metals Concentrations in the samples: The concentration of Pb, As, Cr, Zn and Mn metals in the textile industries waste water samples were determined by AAS and ICP-OS spectroscopy Table 2 and Figure 1.

Table-2. Concentrations of heavy metals of mean ± SD in samples (mg/L) by spectroscopy.

Elements	FAAS			ICP-OES		
	Debre Brihan	Kombolcha	Bahirdar	Debre Brihan	Kombolcha	Bahirdar
Pd	0.85±0.4	0.67±0.3	0.61±0.2	0.12±0.005	0.1±0.004	0.1±0.059
As	0.66±0.2	1.3±0.1	0.4±0.1	0.056±0.004	0.04±0.03	0.1±±0.002
Cr	0.06±0.1	0.08±0.3	0.03±0.1	0.02±0.004	0.05±0.02	0.04±0.001
Zn	0.32±1.2	0.58 ±0.2	2.6±1.3	0.18±0.004	0.3±0.015	0.311±0.02
Mn	0.33±0.8	0.37±1.2	0.25±1.3	0.078±0.002	0.2±0.001	0.016±0.00

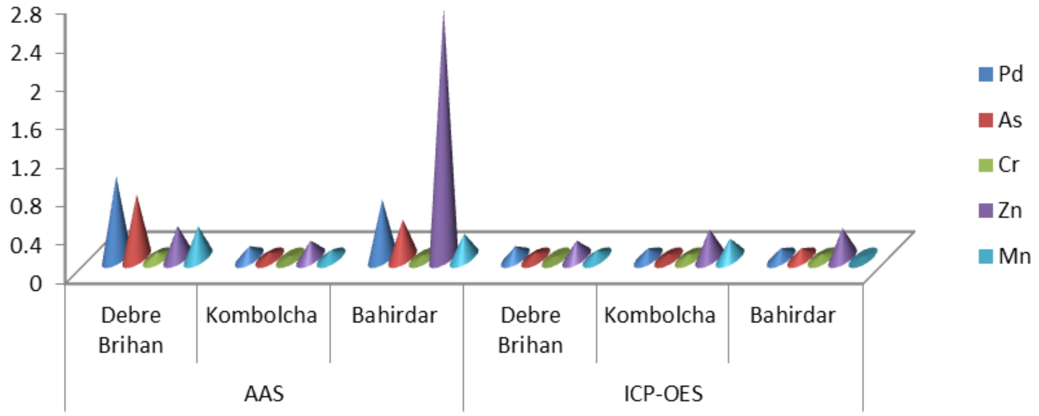

Figure-1. Heavy metal distribution in textile industries sample site.

The average levels of heavy metals assessed for effluent samples are presented in Figure 1 whereas Table 2 presents the corresponding levels determined for wastewater samples. The heavy metal concentrations in the samples collected from Bahir Dar, Kombolcha and Debre Birhan textile industries and analyzed by AAS and ICP-OES. In the present study, a total of six heavy metals (Pb, As, Cr, Zn, and Mn) were assessed in the samples. It have been reported that the major problem associated with textile processing effluents is presence of heavy metal ions, which arise from material used in the dyeing process or in a considerably high amount, from metal containing dye [11]. All selected heavy metals were analyzed and detected in effluent of the Bahir Dar, Kombolcha and Debre Birhan textile industries.

Pb: The maximum concentration of Pb recorded in the present study (0.85 mg/L//AAS in Debre Birhan textile industry). on the other hand the determined concentration are comparable (0.67 mg/L//AAS and 0.12 mg/L//ICP-OES) Bahir Dar and Kombolcha textile industries. Beshir [12] stated that the lead concentration was 1.522-1.538 mg/L by FAAS in Kombolcha textile effluent [12] it is comparable with the present study.

As: Present study result determined that the highest concentration of As was 1.3 mg/L//AAS in Kombolcha and 0.056 mg/L//ICP-OES in Debre Birhan in textile industries.

Cr: The maximum concentration of Cr recorded in the present study (0.08 mg/L//AAS and 0.05mg/L//ICP-OES in Kombolcha textile industry). on the other hand the determined concentration of Cr(0.093 mg/L//AAS) in Hawassa Textile Factory, Ethiopia also Nigeria (0.255 mg/L, India (2.38 mg/L), Pakistan (2.0 mg/L to 4.0 mg/L) was found in a Textile Industry Effluent [13]. The concentrations of Cr determined in present study are much below the provisional discharge limit values (1 mg/L) of EEPA [14] but the comparable precisely 0.05 mg/L limit of World Health Organization [15].

Mn: Present study result determined that the average concentration of Mn was 0.33 mg/L//AAS in Kombolcha and 0.016 mg/L//ICP-OES in Bahir Dar. Solomon, et al. [13] in Hawassa Textile Factory, Ethiopia determined that 0.42 mg/L and 0.19 mg/L) in textile industries. Mn concentrations of 0.11 mg/L of India, (0.3 to 1.65 mg/L) of Nigeria were reported [13]. The highest concentration of Mn recorded at Kombolcha of the present study is higher than the standard (0.2 mg/L) set by WHO [14].

Zn: The concentration of Zn (2.6 mg/L//AAS) at Bahir Dar is extremely highest than other sites and methods. Solomon, et al. [13] in Hawassa Textile Factory, Ethiopia determined that 0.372 and 0.103 mg/L) [13]. These are above the EEPA [14]. The industrial effluent samples was above the permissible limit of 5 and 15 mg/L and WHO reported that the range of values for zinc concentration in all the sampling points was between 2.6 mg/L to 0.18 mg/L, lower than the maximum permissible value [14].

(d) Comparison between AAS and ICP-OES: The results obtained heavy metals expressed the concentrations of all studied elements from ICP-OES and AAS determinations were compared. Both methods described in the determination of metals were successfully validated and are applicable to the analysis of wastewater samples. The ICP is suitable for all concentrations from ultra trace levels to major components; detection limits are generally low for most elements ICP-OES when performing quantitative analysis. The concentrations of all studied elements from ICP-OES and AAS determinations were compared using one way ANOVA (P = 0.05), significant differences between the methods having been found. Considering the time consumption when analyzing five elements in three samples,

4. CONCLUSION

Heavy metals such as Pb, As, Cr Zn and Mn have been determined by FAAS and ICP-OES. The concentration of lead was higher than other in Debre Birhan textile industry. The level of chromium was lowest heavy metal. The results of analysis obtained by two methods (ICP-OES and FAAS) proved that in this case, were significantly different methods. The effluent demands frequent control and proper treatment before being discharged to the environment and treated effluent have exceeded the recommended values of EEPA and WHO.

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