(RESEARCH ARTICLE)

Heavy metals assay of herbal pharmaceutical effluent

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Abstract

Environmental pollution particularly from heavy metals in effluent is the gravest problem in developing countries like Pakistan. Effluents of Herbal Pharmaceutical are waste water generated during Herbal Medicines manufacturing process. When these effluents deprived of appropriate treatment are released directly into the environment, results in potential adverse effects on human health and the environment. This research work examined the heavy metals parameters of effluents discharged by Herbal pharmaceutical industry in Karachi, Pakistan. In all, 08 parameters were studied. These include Cr, Mn, Fe, Co, Ni, Cu, Ag and Pb. The study revealed that ranges of Ag and Fe were exceeding the allowable limit of WHO (World Health Organization) and NEQS (National Environmental Quality Standards). This calls for an immediate use of latest treatment plants to decrease the harmfulness that results from waste water.

Keywords: Herbal medicines; Wastewater; Heavy metals pollution; Toxicity

1. Introduction

Herbal drugs is growing rapidly and their use as organic medicine all over the world specially in developing countries because of its effectiveness, safety, traditional acceptability, reasonable cost and low side effects related to allopathic medicines [1, 2, 3, 4]. World Health Organization (WHO) is reported that herbal medicines are profitable worldwide and they represent a market worth of approximately US$ 43 billion per year. Nearly 80% population of the world use herbal drugs mainly in the developing countries.

Because of difference in the kinds of medicines generated, raw materials used and founded upon market demands Herbal pharmaceutical industries produce a huge volume of extremely biodegradable effluent. It is reported by WHO [5] that a significant proportion of people use medicinal plant remedies and the figure is on the increase as population increase particularly in younger generation in both developed and developing countries [6,7,8]. It is reviewed that there are 10 renowned regulatory industries producing herbal pharmaceutical goods merely that are circulated in all the sectors of the country.

Various kinds of pollutants are present in the effluent produced during the manufacturing process of herbal medicines [9, 10, 11]. This effluent is a complex constituent of heavy metal ions, alkaloids, toxic solutes and plant extracts that participate to environmental pollution [12, 13, 14]. The nature of pollutant in effluent is in soluble and insoluble [15]. The waste water release into drainages and then move into water bodies making widespread pollution and frightening to the aquatic life and health of nearby human population [16]. The present study is undertaking with the objective to examine the presence of heavy metals: Cr, Mn, Fe, Co, Ni, Cu, Ag and Pb in herbal pharmaceutical industry effluent and their possible impacts if any.

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2. Material and methods

2.1. Sampling

This research work was carried out in Karachi. Pakistan. The selected Herbal Pharmaceutical industry discharges its effluent without treatment because there is no operational wastewater treatment capability within its vicinity. Effluents are released at every phase of production including run off water into exposed drainage. Total 08 representative samples are collected in three different sampling points. The parameters determined were: Cr, Mn, Fe, Co, Ni, Cu, Ag and Pb.

2.2. Analytical Procedures

The chemicals were of analytical grade and according to the specification of manufacturer's, all the instruments were calibrated and tested. The collection of samples, handling and analysis were conducted according to the standards [17]. Duplicate analyses of the samples were run. Appearance, odor and color of the herbal industry wastewater were measured in the field itself. Cr, Mn, Fe, Co, Ni, Cu, Ag and Pb were measured by using Atomic Absorption Spectrophotometry (AAS). Data obtained from the analyses were run using SPSS-20.

Table 1 Heavy metals concentration in Effluent

S.NO	Metals	Concentration (ppm)				NEQS/ WHO
		Effluent-A	Effluent-B	Effluent-C	Composite Effluent-D	
1	Co	0.01	0.015	0.019	0.015	
2	Cr	0.01	0.013	0.018	0.014	1.0 ppm
3	Ni	0.01	0.012	0.016	0.013	1.0 ppm
4	Pb	0.01	0.011	0.014	0.012	0.5 ppm
5	Ag	3.85	3.89	3.99	3.91	1.0 ppm
6	Fe	3.4	3.46	3.47	3.44	2.0 ppm
7	Cu	0.02	0.024	0.026	0.023	1.0 ppm
8	Mn	0.11	0.116	0..118	0.115	1.5 ppm
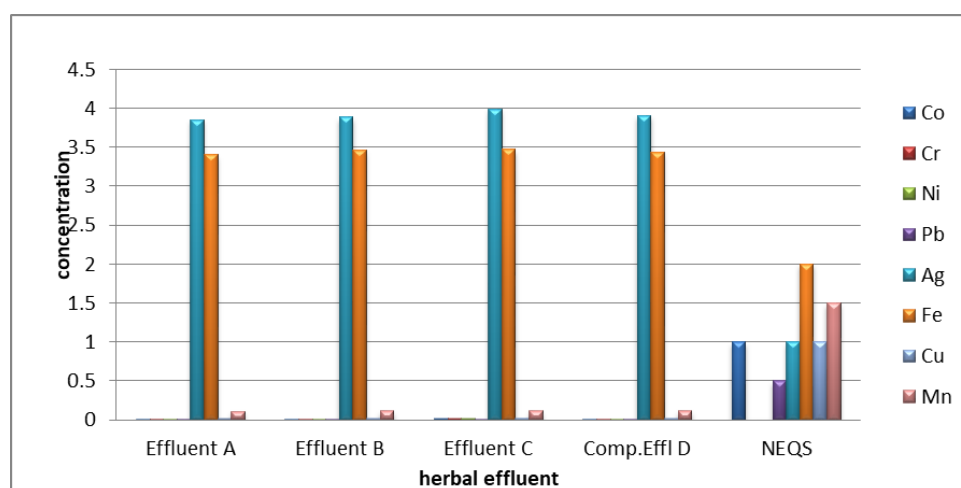
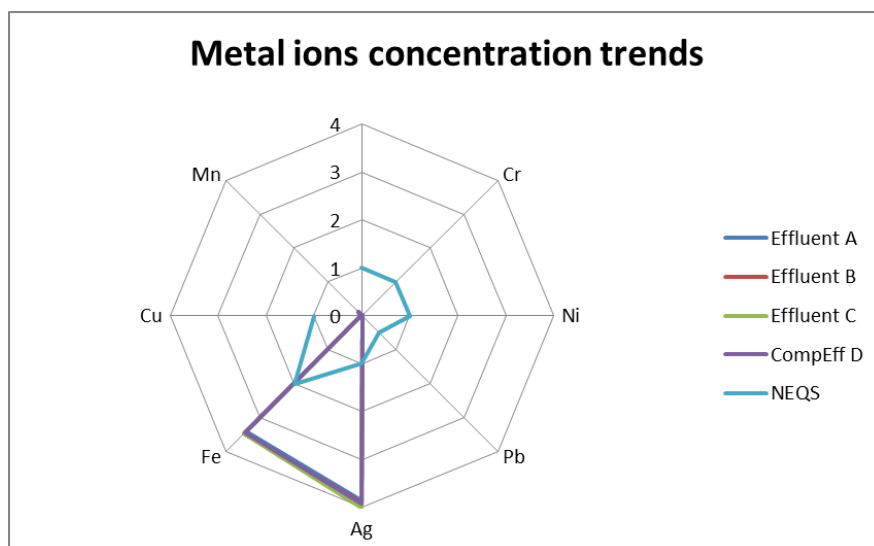**Figure 1** Heavy metal ions concentration

Figure 2 Heavy Metal ions concentration trends

Table 2 Descriptive statistics of heavy metal ions

Metals	N	Minimum	Maximum	Mean		Std. Deviation
	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic
Co	4	0.010	0.019	0.01475	0.001843	0.003686
Cr	4	0.010	0.018	0.01375	0.001652	0.003304
Ni	4	0.010	0.016	0.01275	0.001250	0.002500
Pb	4	0.010	0.014	0.01175	0.000854	0.001708
Ag	4	3.850	3.990	3.91000	0.029439	0.058878
Fe	4	3.400	3.470	3.44250	0.015478	0.030957
Cu	4	0.020	0.026	0.02325	0.001250	0.002500
Mn	4	0.110	0.118	0.11475	0.001702	0.003403
Valid N(list wise)	4					

Table 3 Correlation analysis

	Co	Cr	Ni	Pb	Ag	Fe	Cu	Mn
Co	1							
Cr	0.979*	1						
Ni	0.968*	0.999**	1					
Pb	0.940	0.989*	0.995**	1				
Ag	0.952*	0.994**	0.996**	0.994**	1			
Fe	0.942	0.855	0.829	0.772	0.805	1		
Cu	0.986*	0.938	0.920	0.878	0.906	0.980*	1	
Mn	0.977*	0.912	0.891	0.846	0.865	0.989*	0.989*	1

*. Significant at the 0.05 level; **Significant at the 0.01 level

3. Results and discussion

3.1. Herbal effluent characteristics

Table 2 showed the descriptive statistic of heavy metals values. The data was compared with the permissible limit of NEQS and WHO and showed in Table 1 and Figure 1. In the current research study period, the Co ranges was 0.010 ppm to 0.019 ppm and mean value was 0.014 ppm with standard deviation 0.003; Cr ranges was 0.010 ppm to 0.018 ppm and mean value was 0.013 ppm with standard deviation 0.003; Ni ranges was 0.010 ppm to 0.016 ppm and mean value was 0.012 ppm with standard deviation 0.002 ; Pb ranges was 0.010 ppm to 0.014 ppm and mean value was 0.011 ppm with standard deviation 0.001; Ag ranges was 3.8 ppm to 3.9 ppm and mean value was 3.91 ppm with standard deviation 0.058; Fe ranges was 3.40 ppm to 3.47 ppm and mean value was 3.44ppm with standard deviation 0.03; Cu ranges was 0.02 ppm to 0.026 ppm and mean value was 0.02 ppm with standard deviation 0.002 and Mn ranges was 0.110 to 0.118 and mean value was 0.114ppm with standard deviation 0.003. A thorough study of tables and graphs reveals that the heavy metals Fe and Ag values were significant and exceeding the permissible limit Figure 2 in the samples of herbal industry. This exceed values of heavy metals parameters cause several harmful effect [18]. An alteration in the comparative composition and profusion of the organisms in the water body brings about a corresponding alteration in the heavy metal aspect. Heavy metal parameters considers as ecological variables because high ecological status resemble completely to the values for the heavy metal quality elements must remain within the ranges generally related with uninterrupted conditions[19].

3.2. Correlation Analysis

In correlation, four parts of information are significant; the sign of the correlation coefficient, the arithmetic value of the correlation coefficient, the effect size of the correlation and the statistical importance of the correlation. The Pearson correlation of eight parameters of heavy metals is shown in Table 3.

All heavy metals showed very strong positive correlation among themselves. Cr-Ni (r = 0.999) , Cr- Pb (r = 0.989) , Cr- Ag (r = 0.994) , Cr- Fe (r = 0.855) , Cr-Cu (r = 0.938) and Cr-Mn (r = 0.912); Fe-Cu (r =0.980) , Fe-Mn (r = 0.989); Co-Cr (r = 0.979), Co-Ni (r = 0.968), Co-Ni (r = 0.968), Co-Pb (r = 0.940), C0-Ag (r = 0.952), Co-Fe (r = 0.942), C0-Cu (r = 0.986) and Co-Mn (r = 0.977); Ni-Pb (r = 0.995) , Ni-Ag (r =0.996) , Ni-Fe (r = 0.829) , Ni- Cu (r = 0.938) and Ni-Mn (r = 0.891); Cu- Mn(r = 0.989); Ag- Fe (r = 0.805), Ag- Cu (r = 0.906) and Ag-Mn (r =0.865) ; Pb- Ag (r = 0.994) , Pb-Fe (r = 0.772), Pb-Cu (r = 0.878) and Pb-Mn (r = 0.846). High correlation of heavy metals parameters indicates same source

4. Conclusion

The present investigation on heavy metals of Herbal pharmaceutical industry effluent shows high concentration of Ag and Fe as compared to permissible limit of NEQS and WHO. The upshot of untreated wastewater from herbal pharmaceutical industry has accrued over years causing into pollution of water bodies around the effluent's drainage and in the sub-soil.

Correlation analysis indicates moderate to strong correlation among heavy metals. The strong positive correlation is a sign of same source. The exposed parameters are governed by the similar anthropogenic source

The current research work reveals that the constituents of herbal pharmaceutical wastewater are heavy metals that are released into the environment. They are hazardous in nature and can deteriorate the environment. Following measures should be taken to overcome this issue:

- The raw materials of different sorts that are used in herbal pharmaceutical industry should either modify or substitute with other non-hazardous materials.
- The source of hazardous materials and manufacturing design should be amended by engaging different sorts of scientific techniques.
- Zero liquid waste discharged concepts should be adopted.
- Rules, regulation and norms of Herbal pharmaceutical industries should be strict.

Compliance with ethical standards

Disclosure of conflict of interest

Authors declare no conflict of interest.

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