ANALYSIS OF TEXTILE SLUDGE TO DEVELOP A SLOW RELEASING ORGANIC FERTILIZER

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ABSTRACT

Textile sludge is an inevitable solid waste resulted from various stages of textile processing and treatments that are dumped into landfilling sites and awaits a suitable disposal method. As the textile sludge is a rich source of macro and micronutrients, textile sludge of one of the leading textile company was analyzed to assess its possibility to develop into a slow releasing organic fertilizer. The amount of primary nutrients namely nitrogen, phosphorus and potassium (N, P, K) were determined using standard Kjeldahl method, phosphovanadomolybdate method and atomic absorption spectroscopy respectively. The results revealed that textile sludge inherently present nitrogen, phosphorus and potassium in the percentage of 1.758%, 0.26%, and 0.338%. Additionally micronutrients and heavy metals were analyzed using atomic absorption spectroscopy. The textile sludge contained micro nutrients such as Fe (82.23 ppm), Mg (37.558 ppm) and Ca (928.579 ppm) and heavy metals Cd (0.025 ppm), Cr (3.693 ppm), Pb (1.033 ppm), Ni (2.994 ppm), Cu (14.983 ppm) and Zn (7.248 ppm). Finally attempts were made to remove heavy metals using acid extraction procedure.

Keywords: Textile sludge, Fertilizer, Slow releasing organic fertilizer

1. INTRODUCTION

Textiles being the basic needs of human being undoubtly, textile industries have great economic significance. Textile industry involves processing of raw materials and fabric into finished cloth involving various stages of processing and operations consuming large quantities of water and various types of chemicals and dyes [1, 2]. Textile industries have been placed in the category of most polluting industries in the world. Usually textile effluents contain dissolved organic and inorganic substances, colloidal or suspended forms and it is typically colored due to the presence of residual dye stuffs [3, 4]. Also it is often contaminated with non-biodegradable organics [5] termed refractory materials. Typical example for such materials is detergents [6]. As a consequence; textile waste effluents cause serious environmental issues. Textile wastewater came from dyeing and finishing [7] processes causes the major pollution. Input of a wide range of chemicals and dyestuffs [8], which are generally organic compounds [9] of complex structure are required for those processes [10]. As all of them are not contained in the final product, they become waste and caused disposal problems.
Since it generates huge quantities of unused materials including dyes in the form of waste water during various stages of textile processing, the improper waste management and the direct discharge of this waste water into environment affects its ecological status by causing various undesirable adverse effects [4]. This can lead to contaminate surface and ground water, affect public health and atmosphere due to odor problems.

It is usually expected that the textile effluents contain highly toxic dyes, salts, acids, alkalis and bleaching agents [5, 11, 12]. Heavy metals like cadmium, copper, zinc, chromium and iron have also been found in the dye effluents [5, 12, 13, 14].
Land application of textile sludge can be a good solution, whereas it is cost-effective disposal method for treatment plants and also can provide a favorable fertilizer for agricultural lands. A study of analysis of plant nutrients and organic matter in textile sludge in Gazipur, Bangladesh has been reported its potential application as a fertilizer. It provides an economical alternative for the final disposal of the textile sludge, but heavy metals in textile sludge is always an issue restricting its general use. Therefore, removal of heavy metals prior to land application is likely to be a possible and practical means for reducing metal content in textile sludge. In our work plant nutrients present in textile sludge was analyzed and potential use of this textile sludge as a fertilizer is being investigated.

2. METHODOLOGY

Textile sludge samples were subjected to basic oven dry procedure to obtain dried sludge which is free from water. Wet textile sludge was oven dried at 120 $^{\circ}$C till constant weight obtained. Then dried sludge was ground well with a motar and pestle to get finely ground powder and kept for analysis.

2.1 Determination of nitrogen:

Three samples of textile sludge of weight 1.0097 g, 1.0037 g and 1.0024 g were weighted and transferred into a dry Kjeldahl flask and Kjeldahl tablet was added. Then 12.50 ml of concentrated sulphuric acid was added and flask was placed on the heating device inclining the neck at an angle of about 60^o. Heating was continued for 30 minutes until the solution has become colorless or clear.

In the Distillation step, Boric acid solution (25.0 ml) was added to a conical flask and added two drops of the Methyl Red indicator. Few boiling chips and 50.0 ml of distilled water were added to the digested mixture in the Kjeldahl flask. To the Kjeldahl flask, 50.0 ml of 12 M NaOH(aq) was added and heated the mixture until it boiled. Titration was carried out with the resulted solution using 0.25M HCl(aq) solution and blank determination was performed.

2.2 Determination of phosphorus:

A solution of $[(NH_4)_6Mo_7O_{24}.4H_2O]$ and Solution of $[NH_4VO_3]$ mixed well and diluted up to 1000.0 ml to obtain vanadate- molybdate reagent.

Calibration curve was obtained using standard phosphate solution of potassium dihydrogen phosphate (KH_2PO_4). For the three clear solutions of sludge (2 ml) vanadate-molybdate reagent (10 ml) was added and finally diluted to 50.0 ml and mixed thoroughly.

The colorimetric determination of phosphate is carried out using uv-visible spectrophotometer by measuring absorbance vs concentration at wavelength of 420 nm. The absorbances of the phosphovanadomolybdate complex of standard solutions were measured and plotted standard curve of the absorbance vs concentration of the three phosphate samples.

2.3 Determination of potassium:

Potassium standards were prepared from potassium chloride (1.9070 g). Three sludge samples (5.0020 g, 5.0023 g, 5.0019 g) were placed in three crucibles and kept in muffle furnace at 450˚C for about three hours until samples ashed. After samples cooled to room temperature conc. HCl (30 ml) and conc.HNO_3 (10 ml) (3:1 ratio volume /volume) was added and kept in a steam bath for about 30 minutes and filtered to 100.0 ml once the samples were cooled. Total potassium content of these three samples was determined using AAS.

2.4 Determination of concentrations of other metals:

Total concentration of different metals (Cu, Cd, Ni, Pb, Fe, K, Cr, Mg, Ca) presented in textile sludge (5 g) was determined using AAS. Graphite Furnace was used to determine total As content in textile sludge sample.

Acid extraction procedure was employed to study efficiency of heavy metal removal.Three textile sludge samples of weight 4.001 g, 4.000 g, and 4.000 g were treated with 20% HNO_3 (20 ml) and allowed to shake for 30 minutes on the shaker. Each sample was filtered and diluted with distilled water and heavy metals extracted into acid phase were determined using AAS. The same procedure was carried out with 20% H_2SO_4 (20 ml) as given above for another three textile sludge samples of weight 4.002 g, 4.000 g and 4.001 g. The above acid extraction procedure was slightly modified by treating textile sludge samples (4.000 g, 4.000 g. 4.001 g) with 50% HNO_3 and allowing to shake samples on the shaker for three hours and AASmeasurements were obtained for heavy metals namely Cr, Cu, Ni, Cd and Pb.

Leachability of heavy metals under acidic conditions was performed using a portion of concentrated nitric acid (64 µl) was diluted in 100.0 ml to prepare pH 2 solution and portion of this solution (20 ml) was added to textile sludge samples of weight 4.000 g, 4.000 g, 4.000 g and kept for nearly three days with frequent shaking. Three samples were filtered and filtrates were analyzed using AAS to determine concentration of leached heavy metals.

3. RESULTS AND DISCUSSION

Percentages of primary nutrients (N, P, K) of textile sludge were compared with common organic manures and chemical fertilizers. The data were presented in Table 3.1.

It was clear from the data that the amount of N present in textile sludge was always higher than all organic manures. Even though P percentage was usually low, however the amount was comparable with the amount in compost. The amount of K is lower than any of the organic fertilizers. Nevertheless the amount was better compared to zero K found in chemical fertilizers.

Table 3.1: Comparison of N, P, K of textile sludge with some commonly used chemical fertilizers and organic manures [11]

Name of organic manure/ chemical fertilizer	Nitrogen (N) %	Phosphorus (P) %	Potassium(K) %
Textile sludge	1.758	0.26	0.338
Cow dung	0.5-1.5	0.4-0.8	0.5-1.9
Poultry manures	1.6	1.5	0.85
Farmyard manure	0.5-1.5	0.4-0.8	0.5-1.9
Compost(general)	0.4-0.8	0.3-0.6	0.7-1.0
Urea	46	-	-
Ammonium sulphate	21	-	-
Diammonium	18-21	20	-

Results obtained from analysis for other metal ions present in the textile sludge were summarized in Table 3.2. Where as comparison of these metal ions with WHO standards were depicted in Figure 3.1.

Table 3.2: Total metal content of textile sludge

Metal	Concentration (ppm)
Fe	82.23
Mg	37.558
Ca	928.579
Cd	0.025
Cr	3.693
Pb	1.033
Cu	14.983
Ni	2.994
Zn	7.248

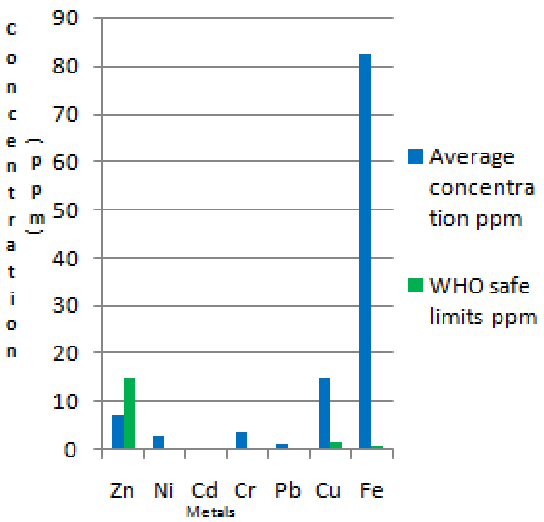

Figure 3.1: Graph of average concentrations of metals and WHO safe limits

According to Figure 3.1 concentration of Zn ions were within the safe limit while that of the concentrations of Cd, Cr, Pb, Cu are higher than the safe limit in soil recommended by WHO. However the amount of Cd and Pb in sludge is not significant as Cr, Cu and Ni. Among the metals shown in the Figure 3.1, Fe is the most abundant metal presented in the sludge. Since Fe, Zn and Cu are considered as micro nutrients, plants will benefit from sludge. High abundance of iron, magnesium and zinc in textile sludge indicate its potential in supplying rich source of nutrients for application as a fertilizer.

An attempt was made to remove heavy metals present in textile sludge as it can cause adverse effects on the environment. Experimental data obtained from the removal of heavy metals from sludge is shown in Figure 3.2.

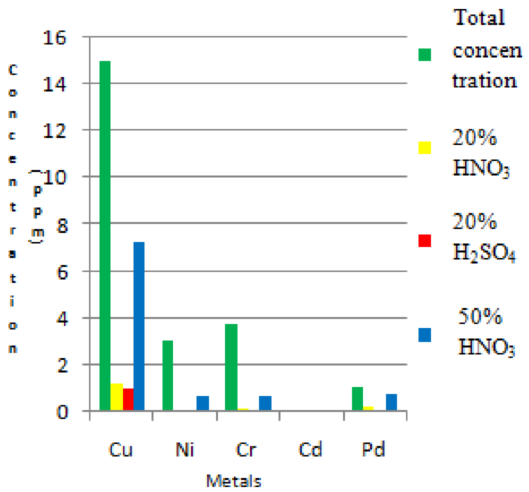

Figure 3.2: The graph of effectiveness of acid extraction

It is evident that tendency in removing heavy metals increase with increasing acid concentration. It is a wellknown fact that, if acid is added to sludge, the heavy metals present in the sludge can be exchanged and then exist in solution. The percentage of extraction was increased as the acid concentration, temperature and the contact time increased.

And this was further explained by carrying out leachability effect at pH 2. These data (Table 3.3) clearly showed that even at pH 2, there was no leaching of metal ions except Cu and Fe in very insignificant amount. It is very important to state that there were no leaching of metal ions at soil pH, where it is safe to apply as a fertilizer.

Table 3.3: Leachability of heavy metals under pH 2

Metal	Leached metal Concentration (ppm)			
	Sludge sample 1	Sludge sample 2	Sludge sample 3	Average concentration
Cu	0.204	0.484	0.185	0.291
Cr	0.000	0.000	0.000	0.000
Cd	0.000	0.000	0.000	0.000
Pb	0.000	0.000	0.000	0.000
Ni	0.000	0.010	0.000	0.003
Fe	0.104	0.395	0.068	0.189

4. CONCLUSION

The results revealed that analysis of textile sludge in terms of primary plant nurients namely nitrogen, phosphorous and potassium was highly successful. More importantly, experimentally found average nitrogen content in textile sludge (1.758%) was significant compared to nitrogen content present in commonly used manure. Secondly, average phosphorus (0.26%) and potassium (0.34%) content were approximately similar to amount of phosphorus (0.3%-0.6%) and potassium (0.5%) concentrations found in common manure. In addition the results revealed that the presence of range of micronutrients specifically Ca, Mg, Fe, Cu and Ni which are essential requirement for plant growth.

Eventhough the amount of some heavy metals associated with sludge were slightly higher than the WHO permissible limit, it can be inferred that heavy metals were not leachable under normanl environmental conditions since heavy metals were immobile even under at acidic pH 2. Therefore the present research study demonstrates the potential of wasteful textile sludge to use as a fertilizer.

5. REFERENCES

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