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Monitoring Sludge Production from Elmogran Water Supply as Organic Fertilizer Free from Pollutant Elements

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ABSTRACT

Over a period of five months (February 2007-June 2007) experiment was carried out to study the chemical characteristics of sludge resulting from Elmogran Water Supply as Organic Fertilizer Free from Pollutant Elements. A number of samples were collected. Analyses were done using Atomic Absorption and the total contents of metals were compared with Florida Soil Cleanup Target Levels (SCTLs). For example results showed that Cu 0.3172 mg kg-1 bellow the pollutant level 110 mg kg-1, Mn 0.1929 mg kg-1 bellow the pollutant level 1.6mg kg-1, Fe 0.1704 mg kg-1 bellow the pollutant level 23000 mg kg-1 . There-fore sludge consider free from pollutant elements and hence can be used as organic fertilizer

INTRODUCTION:

Most water treatment facilities produce large quantities of sludge resulting from drinking water treatment processes such as flocculation and filtration (Timothy et al, 2001). Disposal of the sludge is becoming expensive and difficult because of limited available land for disposal as well as high land tipping fee, beneficial use options have been proposed for the materials. For application where the sludge is placed in direct contact with the environment, concern has been raised by regulators in regard to chemical characteristics of the sludge and the potential risk to human environment. The development of existing resource and the addition of new sources free from pollutant elements are becoming more interesting; on the other side application of sludge produced from water to soil/sand is the most appropriate solution for some of the pollution problems of chemical fertilizers. The sludge produced directly from Elmogran station is related to, and depends on the raw water quality and particularly to the suspended solids concentration in the Nile River, produced either through pre-treatment or by clarification where the annual amount exceeded 50.000 ton; this causes problem, if it is not recycled. Studies on the use of drinking water treatment sludge as plant nutrients, supply are few. Therefore, the objective of this study was to determine and monitoring chemical characteristics of drinking water sludge. The increased importance of drinking water sludge necessitates that its management strategies should focus on maximizing the benefits of its recycling. This sludge can be used safely and beneficially for agricultural purposes (Zbytiniewski and Buszeshi, 2005).

Materials and Methods:

Over a period of five months (February 2007-June 2007), sampling trips were made to water treatment facility in the state. Drinking water sludge samples were collected from drying beds from six replicates. A number of analyses were performed to characterize the material and total content analyses for metals were conducted for chemical characterization. Total content of metals were compared with the Florida Soil Cleanup Target Levels (SCTLs).

Analysis was done using Atomic Absorption. Inorganic ions were compared to the Florida Groundwater Guidance Concentration (FGGC) to assess the potential risks. Sludge production process involves main process to produce sludge from water treatment namely, pretreatment (screening and pumping), Coagulation, Sedimentation, Filtration and Disinfection. These were illustrated in the following stages:

1- Screening and pumping: Concider a raw water, the treatment included grit removal, debris removal, suspended trees and fishers.

2- Coagulation: the sludge produced by this step depends on the pretreatment water quality and the required coagulation dosage to achieve coagulation.

The common coagulant chemical was Aluminum sulphate (Al2 (So4)3) with rapid and/or slow mixed to achieve equilibrium with the (-ve) charge. The proposed coagulant polyaluminum chloride (Pacl) at estimate dosage concentration 3-20mg/l. The sludge composition will be mainly clay, associated with the pretreatment raw water turbidity, with a small portion associated with the coagulant dosed. The volume of sludge produced depends on the underflow concentration of the Flat Bottom Clarifier (FBC) with the sludge volume to be disposed dependent on the sludge handling process downstream.

3- Sedimentation: this process done by gravity force in a cycle basin which it takes 2-6hr to sediment and this time joined the rate flow and volume of water. In this stage the percentage of removal turbidity was 90%.

4- Filtration: the common filters used were rapid sand filter, active carbon and chloride (Cl2), suspended absorbed in this stage and chloride dosage 1-2ppm.

Disinfection: the common agents were Ozone (O3), Florid (F2), Iodine (I) and Chloride (Cl2). Their effectiveness to kill viruses half hour and removed bacteria from water.

Results and discussion:

1- Metals:

Table 1: Total Na concentration mg kg^{-1}

	Samples					
Month	R1	R2	R3	R4	R5	R6
February	0.6	0.1	0.8	1.2	5	0.8
March	7.7	2.8	0.72	0.24	0.2	0.12
April	0.09	0.24	1	1.4	0.09	0.72
May	0.1	1.4	1.9	3.7	1.4	1.4
June	0.9	0.9	0.52	0.38	0.49	0.06
Minimum	0.1	0.1	0.52	0.24	0.09	0.06
Maximum	7.7	2.8	1.9	3.7	5	1.4
Average	2.45571	1.878	0.988	1.2	1.4256	0.62
SD±	3.27275	1.09074	0.53807	1.38877	2.05777	0.551

R1: sample before pumping R2: sample before sedimentation/clarification R3: from clarification/pre sedimentation R4: sample before the addition of chlorine. R5: sample after the addition of chlorine. R6: Final sedimentation (Detection was based on 2 gm dry sample weight).As shown in Table (1) Na was detected in all samples where monthly averages were 2.45, 1.878, 0.988, 1.2, 1.425 and 0.62 mg kg^{-1} for R1, R2, R3, R4, R5 and R6 respectively, These concentrations concerning normal level for pollution. The highest value recorded from R1 was (7.7±3.277) compared with R6 (0.62±3.277).

Table 2: Total Cu concentration mg kg^{-1}

Residential SCTL=110 mg kg^{-1},Industrial=76,000mg kg^{1}						
	Samples					
Month	R1	R2	R3	R4	R5	R6
February	0	0.079	0.078	0.095	0.087	0.8
March	0.049	0.051	0.067	0.021	0.025	0.08
April	0.063	0.031	0.042	0.02	0.075	0.081
May	0.09	0.07	0.088	0.066	0.077	0.55
June	0.025	0.034	0.09	0.065	0.08	0.075
Minimum	0.025	0.031	0.042	0.02	0.025	0.06
Maximum	0.094	0.079	0.09	0.095	0.087	0.55
Average	0.0642	0.0642	0.073	0.0534	0.01752	0.3172
SD±	0.02882	0.0213	0.0196	0.03236	0.0249	0.33838

R1: sample before pumping **R2**: sample before sedimentation/clarification **R3**: fro clarification/pre sedimentation **R4:** sample before the addition of chlorine. **R5**: sample after the addition of chlorine**.** **R6**: Final sedimentation (Detection was based on 2 gm dry sample weight).As shown in Table (2) Cu was detected in all samples where monthly averages were 0.0642, 0.064, 0.073, 0.053, 0.017 and 0.3172 mg kg^{-1} for R1, R2, R3, R4, R5 and R6 respectively. The highest value recorded from R6 was (0.3172±0.33) and the minimum was R5 (0.017±0.33).The average of copper content in all samples was below the residential and industrial SCTLs (110 mg kg^{-1} and 76,000 mg kg^{-1}).

Table 3: Total Mn concentration mg kg^{-1}

Residential SCTL=1,600 $mgkg^{-1}$,Industrial=22,000$mgkg^{-1}$						
			Samples			
Month	R1	R2	R3	R4	R5	R6
February	0.098	0.112	0.098	0.09	0.098	0.08
March	0.024	0.038	0.148	0.154	0.052	0.63
April	0.008	0.084	0.163	0.111	0.134	0.062
May	0.08	0.09	0.1	0.07	0.115	0.05
June	0.02	0.11	0.09	0.085	0.13	0.14
Minimum	0.008	0.3	0.09	0.07	0.05	0.05
Maximum	0.09	0.112	0.16	0.15	0.13	0.62
Average	0.04686	0.046	0.1198	0.09	0.02464	0.1924
SD±	0.0402	0.02989	0.03323	0.03257	0.03324	0.24706

R1: sample before pumping **R2**: sample before sedimentation/clarification **R3**: fro clarification/pre sedimentation **R4:** sample before the addition of chlorine. **R5**: sample after the addition of chlorine**.** **R6**: Final sedimentation Detection was based on 2 gm dry sample weight). As shown in Table (3) Mn was detected in all samples where monthly averages were 0.046, 0.046, 0.119, 0.09, 0.024 and 0.1924 mg kg^{-1} for R1, R2, R3, R4, R5 and R6 respectively. The minimum value was (0.04±0.04) and the highest was (0.1924±0.04).The average of Manganese content in all samples was below the residential and industrial SCTLs (1,600 mg kg^{-1} and 22,000 mg kg^{-1}).

Table 4: Total Fe concentration mg kg^{-1}

	Residential SCTL=23,000mg kg^{-1}, Industrial= 480,000mg kg^{-1}					
	Samples					
Month	R1	R2	R3	R4	R5	R6
February	0.096	0.11	0.089	0.085	0.14	0.09
March	0.084	0.129	0.179	0.361	0.232	0.211
April	0.208	0.221	0.331	0.34	0.345	0.152
May	0.1	0.14	0.09	0.08	0.07	0.099
June	0.099	0.095	0.086	0.13	0.25	0.3
Minimum	0.084	0.095	0.08	0.08	0.07	0.09
Maximum	0.208	0.221	0.5	0.36	0.345	0.211
Average	0.12557	0.1174	0.155	0.085	0.08192	0.1704
SD±	0.05105	0.04899	0.10594	0.13968	0.1058	0.0871

R1: sample before pumping **R2**: sample before sedimentation/clarification **R3**: fro clarification/pre sedimentation **R4:** sample before the addition of chlorine. **R5**: sample after the addition of chlorine**. R6**: Final sedimentation (Detection was based on 2 gm dry sample weight

As shown in Table (4) Fe was detected in all samples where monthly averages were 0.12557, 0.117, 0.155, 0.085, 0.085 and 0.1704 mg kg^{-1} for R1, R2, R3, R4, R5 and R6 respectively, A minimum of 0.085 mg kg-1 and maximum of 0.155 mg kg^{-1}.The average of ferrous content in all samples below the residential and industrial SCTLs (23,000 mg kg^{-1} and 480,000 mg kg^{-1}). None of the 7 samples contained iron constitutes a risk for use of Drinking Water Sludge (DWS) as organic fertilizer.

Table 5: Total Zn concentration mg kg^{-1}

	Residential SCTL=23,000mg kg^{-1}, Industrial=560,000mg kg^{-1}					
	Samples					
Month	R1	R2	R3	R4	R5	R6
February	0.093	0.09	0.086	0.097	0.087	0.09
March	0.071	0.026	0.088	0.094	0.012	0.084
April	0.026	0.034	0.066	0.087	0.091	0.09
May	0.06	0.04	0.03	0.02	0.01	0.08
June	0.09	0.06	0.05	0.04	0.045	0.035
Minimum	0.02	0.026	0.03	0.02	0.01	0.035
Maximum	0.09	0.09	0.08	0.09	0.09	0.09
Average	0.06429	0.068	0.064	0.097	0.032	0.0758
SD±	0.02714	0.02565	0.02458	0.03523	0.0391	0.0232

R1: sample before pumping **R2**: sample before sedimentation/clarification **R3**: fro clarification/pre sedimentation **R4:** sample before the addition of chlorine. **R5**: sample after the addition of chlorine**.** **R6**: Final sedimentation (Detection was based on 2 gm dry sample weigh) . As shown in Table (5) Zn was detected in all samples where monthly averages were 0.064, 0.068, 0.064, 0.097, 0.032 and 0.075 mg kg^{-1} for R1, R2, R3, R4, R5 and R6 respectively. A minimum of (0.032±0.0391) mg kg^{-1} and maximum of (0.075±0.0232) mg kg^{-1} .The average of ferrous content in all samples was below the residential and industrial SCTLs (23,000 mg kg^{-1} and 560,000 mg kg^{-1}).

1- Inorganic Irons:

Table 6: Total Cl concentration meq/L

	Samples					
Month	R1	R2	R3	R4	R5	R6
February	16.7	15.03	14.04	15.3	18.4	16.6
March	10.02	8.35	8.35	10.02	10.02	8.9
April	8.35	6.68	6.68	6.68	8.35	6.68
May	5.01	6.68	6.68	8.35	8.35	10.02
June	6.09	6.9	10.5	6.8	8.8	7.5
Minimum	5.01	6.68	6.68	6.68	8.3	6.68
Maximum	16.7	15.03	14.04	15.3	18.4	16.6
Average	9.69714	9.234	9.25	15.3	3.0464	9.94
SD±	4.60617	3.59125	3.10348	3.55144	4.31196	3.93779

R1: sample before pumping **R2**: sample before sedimentation/clarification **R3**: fro clarification/pre sedimentation **R4:** sample before the addition of chlorine. **R5**: sample after the addition of chlorine**.** **R6**: Final sedimentation (Detection was based on 2 gm dry sample weight). As shown in Table (6) CL was detected in all samples where monthly averages were 9.697, 9.234, 9.25, 15.3, 3.04 and 9.94 mg kg-1 for R1, R2, R3, R4, R5 and R6 respectively, A minimum of (3.0464±4.311) mg kg^{-1} and maximum of (15.3±3.55) mg kg^{-1}.

Table 7: Total EC concentration dS/m

	Samples					
Month	R1	R2	R3	R4	R5	R6
February	0.85	0.7	0.809	0.79	0.69	0.8
March	0.81	0.788	0.8	0.772	0.809	0.8
April	0.832	0.82	0.82	0.82	0.84	0.799
May	1.294	1.278	1.318	1.303	1.304	1.361
June	0.6	6.6	6.2	6.5	6.5	7.15
Minimum	0.6	0.7	0.8	1.303	1.304	0.799
Maximum	1.264	6.6	6.2	6.5	6.5	7.15
Average	0.89286	0.8772	1.9894	0.79	1.78856	2.182
SD±	0.2539	2.56055	2.36408	2.50467	2.5105	2.78781

R1: sample before pumping **R2**: sample before sedimentation/clarification **R3**: fro clarification/pre sedimentation **R4:** sample before the addition of chlorine. **R5**: sample after the addition of chlorine**. R6**: Final sedimentation (Detection was based on 2 gm dry sample weight).As shown in Table (7) EC was detected in all samples where monthly averages were 0.8928, 0.877, 1.98, 0.79, 1.788 and 2.182 mg kg^{-1} for R1, R2, R3, R4, R5 and R6 respectively, A minimum of (0.79±2.50) mg kg^{-1} and maximum of (2.182±2.78) mg kg^{-1}.

Conclusions:

1- For the total analysis of all samples especially R6 (DWS), most metals concentrations were below the appropriate soil cleanup target level. However, samples during all months of monitoring were above the industrial limit of soil.

2- Clearly DWS are safe for environmental use. All samples were free from toxicity level to plants.

Inorganic ions such as chlorine, the concentrations were below the limit of Florida Groundwater Guidance Concentration (FGGC).

Recommendation:

This study recommends using of DWS in crop production through a wide application in different soils.

Reference:

Timothy, G; Yong.C.J and Thabet, T., (2001). Characterization of drinking water sludge for beneficial reuse and disposal. University of Florida.