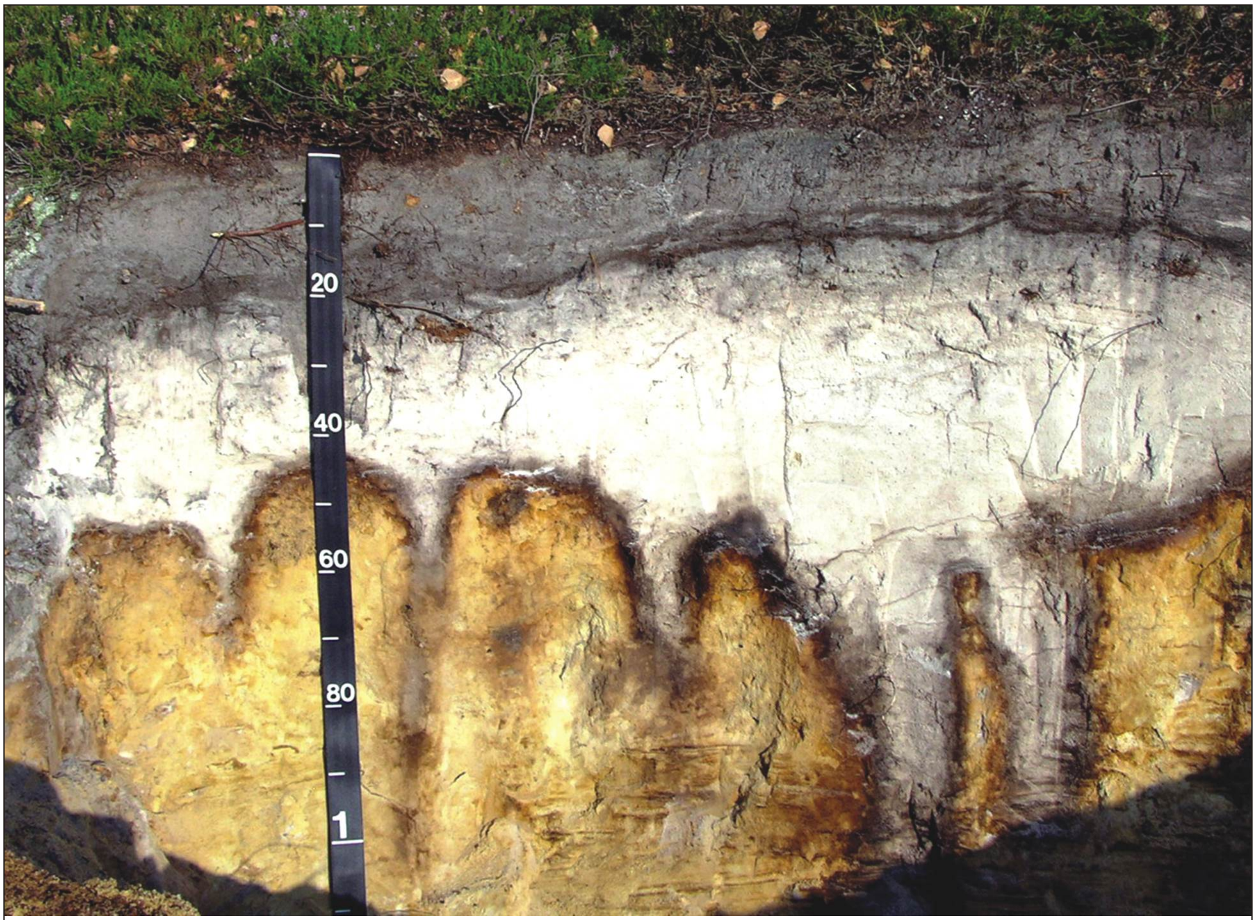

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Comparison of Specific Nutrients of Tunisian Textile Sludge and Produced Composts

[1]Mohamed Anis El Hammadi, [2]Melika Trabelsi and [1, 2]Belgacem Hanchi
[1]Faculté des Sciences, Campus Universitaire, Tunis, 1060, Tunisie
[2]Centre International des Technologies de l'Environnement de Tunis (CITET),
Boulevard de l'Environnement, 1080 Tunis, Tunisie

Abstract: The composting of textile sludge is an alternative to the traditional disposal of residues and also involves a commitment to reducing the production of waste products. A comparative study was made for major nutrient elements or macronutrients (include carbon, nitrogen, phosphorous, potassium, calcium) and the micronutrient elements mostly used (sodium, magnesium) present in the textile sludge taken from the a textile-wastewater treatment plant in the north of Tunisia. The two produced composts were made from the above sludge, mixed in two proportion (1:1 and 1:3 sludge and green plant waste (v/v)). The two produced composts showed higher C, N, Ca, Mg, K, P and lower Na contents than the above sludge. Sludge composting reduce the Na content of the sludge, provide a stabilized organic matter and improve the physicochemical properties of the textile sludge. However, other studies are necessary for a complete evaluation of the two produced composts before land application.

Key words: Composting, textile sludge, nutrients, heavy metals, *E. coli*

INTRODUCTION

Actually, a great problem in Tunisia is the final destination of some types of residues. Sedimentation both before and after wastewater biotreatment produces sewage sludge. Additionally, the upgrading and expansion of wastewater treatment plants have greatly increased the volume of sludge generated along with developing industry, agriculture and in improving human life. Textile sludge is an inevitable by-product of textile wastewater treatment processes (Yongjie and Yangsheng, 2005). Recently, large volumes of this waste is generated by the textile industry and released into the environment. Therefore, there is a growing need to find alternative solutions for textile sludge management. Textile sludge has a variable composition (Balan and Monteiro, 2001) and contains heavy metals and inorganic salts. Additionally, dyes, heavy metals and pathogenic microorganisms may be present and composting is often required for utilization and transformation of these wastes into a soil amendment. (Balasubramanian *et al*., 2006). Composting is defined as the aerobic biological decomposition and stabilization of organic substrates, under conditions that allow development of thermophilic temperatures as a result of biologically produced heat, to obtain a final product that is stable, free of pathogens and plant seeds and can be beneficially applied to land (Bertran *et al*., 2004). Kaushik and Garg (2003) evaluated the composting of textile sludge and concluded that the waste could be converted into a fertiliser product for agricultural use. Other advantages of composting include killing pathogens and improving handling characteristics of sludge by reducing volume and weight. Composting can decrease or eliminate the toxicity of textile sludge (Araujo and Monteiro, 2007). The quality of compost is related to its agronomic and commercial value as an organic solid conditioner and

Corresponding Author: Mohamed Anis El Hammadi, Faculté des Sciences, Campus Universitaire, Tunis, 1060, Tunisie Tel: 216 94 86 51 15, 216 77 30 43 46

the application of composts to agricultural soils has many advantages, which include providing a whole array of nutrients to the soil (Tejada *et al*., 2001). The aim of the physico-chemical analyses in the present study is to conduct an analytical survey of nutrient elements and to compare their contents in selected textile sewage sludge and the produced compost.

MATERIALS AND METHODS

Site and Climatic Conditions

The field study was conducted from May 2006 to January 2007 in Tunis International Center for Environmental Technologies. The climatic characteristics of the study area are as following: annual precipitation did not vary obviously year by year within the study time, the average mean air temperature was 30°C, the lowest air temperature was 0°C in January and the highest air temperature was 45°C in August.

Composting Design and Sampling

The physico-chemical sewage sludge came from a textile-wastewater treatment plant in Ras Jebel (in the north of Tunisia). A mixture of sludge and greenwaste was composted on a composting platform in periodically turned outdoor piles. Prior studies suggested that the most appropriate piles proportion was 1:1 v/v (pile 1) and 1:3 v/v (pile 2) sludge/greenwaste ratios for the best integration of materials. Piles were sampled for analysis after the beginning of the composting process and monitored over 90 days. The compost piles were built following the same protocol and comprised a layer of green waste followed by a layer of sludge and according to the design of the experiment. The well progress of composting and microbial activities was followed by measuring with a portable thermometer the pile temperature and external temperature during the composting process. The mixture was turned over periodically to ensure aerobic conditions. Numerous samples from various points of the compost heaps were collected. The two selected times of sampling were T = 0 (initial mixture) and after 90 days. The samples were kept deep frozen until analysis.

Compost Parameters

Nitrogen was determined by the Kjeldahl method (NF ISO 11261), the organic matter by Gravimetry (Rodier 8th edition). Total organic carbon is measured according to Colorimetry method (ISO 14235). The C/N ratio was calculated from contents of Total Organic Carbon (TOC) and total nitrogen (Kjeldahl) in air-dried samples. The pH was determined with a glass electrode. Na_2O, K_2O, CaO, MgO, P_2O_5 were analyzed by emission spectrometry-ICP (NF EN ISO 11885). The elements Cd, Cu and Cr were analyzed by emission spectrometry-ICP (NF EN ISO 11885).

RESULTS AND DISCUSSION

The pH values tended to diminish to a neutral pH in the two mixtures (Table 1). The initial pH value was lower for sludge than produced composts. After pile 1 formation (Fig. 1), a rapid increase in temperature was recorded from 25 to 67°C during the first 6 days and then fluctuated until day 36 (thermophilic phase) at which point the temperature stabilized gets lower values. These distinct phases were also observed during the process after pile 2 formation, but a rapid increase in temperature was recorded and temperature reached the same as that of the ambient temperature after 32 days of composting. Sludge and produced composts showed variability in total carbon (C), nitrogen (N) and Organic Matter (OM) contents and the two matured composts recorded higher C, OM and N values than the textile sludge. OM rose throughout the composting process indicating the humification of the OM (Paredesa *et al*., 2005). In addition, the total C content in the sludge was 18.6 g kg^{-1} DW,

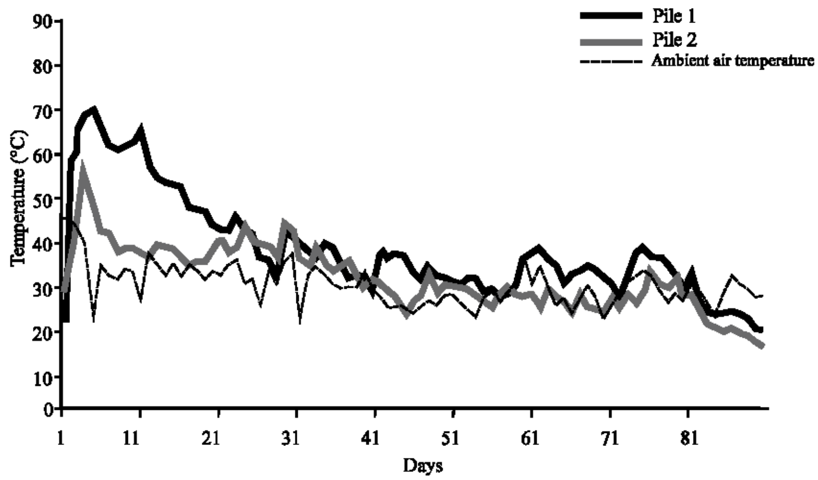

Fig. 1: Changes in ambient air temperatures and pile temperatures during composting

Table 1: Typical characteristics of the sludge and the produced composts

Properties	Sludge	C1	C2
PH	7.05	7.85	7.50
DM [b]	30.9	80.00	70.7
OM [a]	114	344.00	364
TKN [a]	2.89	14.2	18.3
TOC [a]	18.6	179	166
C/N	6.43	12.6	14.69
Escherichia coli [c]	1.1×10^7	7.5×10^3	9.3×10^2

[a]Results expressed in g kg^{-1} dry basis. [b]Results expressed in %. [c]Colony Forming units g^{-1} fresh material. OM: organic matter, TKN: total Kjeldahl nitrogen, TOC: total organic carbon

Table 2: Specific nutrient contents of the sludge and the produced composts (Results expressed in g kg^{-1} dry basis)

Properties	Sludge	C1	C2
Mg	0.82	6.46	5.91
Ca	5.46	76.90	86.70
K	0.32	13.11	9.80
P	0.12	6.33	5.01
Na	6.32	3.58	2.06

Table 3 : Amount of heavy metals in the produced composts (Results expressed in dry basis)

Metal	C1	C2	Limit values (NFU 44095)
Cd [a]	<0.6	<0.6	3
Cu [a]	24.7	21.3	300
Cr [a]	35.6	32	120

[a]Results expressed in mg kg^{-1} of dry matter

increased considerably in the produced composts C1 and C2 to 179 and 166 g kg^{-1} DW, respectively. During composting, new water soluble carbon compounds of microbial origin may be formed, since composting is a synthesis process (Charest *et al*., 2003). The comparative concentrations of specific nutrients in the sludge and the two produced composts are of interest (Table 2). The two Composts showed potentially toxic heavy metal contents lower than the limits established by the French norm (NF U 44-095) (Table 3) and contain generally high amounts of nutrients than the originated sludge and their composition is variable according to their respective sludge ratio. Thus, they have a generally slightly alkaline pH value (pH 7.5 to 7.6). The nutrient contents in the two produced composts with various percentage of sludge indicate that the fertiliser value of the mixtures was generally increasing with increasing percentages of sludge. In addition, the alkaline components of composts correlates with their Ca and Mg contents. The concentration of Ca and Mg in the sludge are, respectively 5.46 and 0.82 g kg^{-1} DW. In the mature composts C1 and C2, there are higher amounts of Ca (76.9 and 86.7 g kg^{-1} DW, respectively) and Mg (6.46 and 5.91g kg^{-1}DW). The textile sludge is carried out using physico-chemical system and had a high calcium and magnesium contents, which came mainly from coagulating chemicals (magnesium salts and lime) (Balasubramanian *et al*., 2006). It can be assumed that a substantial part of the Ca and Mg is generated during the composting process, by precipitation of $CaCO_3$ and $MgCO_3$, respectively. Generally, where sludges are applied to land, the amount of phosphorus applied is more than sufficient to supply the needs of the crop and high P levels could significantly increase the risk of surface water contamination. However, In this study, the P concentration is very low in the textile sludge (0.12 g kg^{-1} DW) and increased in the two final composts. The results show that P is a limitant factor for the above sludge to be used in land application (Walter *et al*., 2006). In addition, the sludge used in this study came from a physico-chemical wastewater plant and the use of chemical flocculants during treatment processes can decrease P mineralization from sludges and composts (Warman and Termeer, 2005). The originated sludge contains relatively small amount of K because most of the K present in the influent readily passes through the wastewater treatment facility and is discharged with the effluent. Generally, When sewage sludge is applied to agricultural land, the sludge usually does not provide enough K to meet the requirements for forage and corn growth even though the availability of K in septic waste and sewage sludge is rated very high (Warman and Termeer, 2005). In this experiment, the compost treatment provided a relatively high amounts of K. The two produced composts C1 and C2 had lower levels of Na than the native sludge (3.58 and 2.06 g kg^{-1} DW, respectively) compared with the produced composts. Comparing these results with study previously carried out by Eghball *et al*. (1997) from composting windrows not protected from rainfall, it was observed that the Na content appear to be in lower concentration. In fact, the large salt concentration (especially Na) might limit the use of compost (Contreras-Ramos *et al*., 2003). In the present study, the Na contents of these composts are considered to be very satisfactory for their further agricultural use.

CONCLUSIONS

It can be concluded that both chemical and microbiological parameters provide valuable information on the nutrient contents of sludge and produced composts. Present experiment showed that co-composting textile sewage sludge with greenwaste could provide a potential means for improving the low sludge nutrient contents. We found considerable difference in the fertilizer value of the waste material and the two produced composts. In view of their beneficial effects, this kind of compost could be successfully used to restore degraded areas and for soil remediation; and potential use for the textile sludge composting technology should be further explored, but these results must be investigated to evaluate the impact of the produced composts in a natural ecosystem, so that these resources can be effectively utilized for crop production without adverse effects on the environment.

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REFERENCES

Araujo, A.S.F., R.T.R.Monteiro and E.M.S Carvalho, 2007. Effect of composted textile sludge on growth, nodulation and nitrogen fixation of soybean and cowpea. Bioresour. Technol., 98: 1028-1032.

Balan, D.S.L. and R.T.R. Monteiro, 2001. Decolorization of textile indigo dye by lignolytic fungi. J. Biotechnol., 89: 141-145.

Balasubramanian, J., P.C. Sabumon, U. John and R. Lazar Ilangovan, 2006. Reuse of textile effluent treatment plant sludge in building materials. Waste Manag, 26: 22-28.

Bertran, E., X. Sort, M. Soliva and I. Trillas, 2004. Composting winery waste: Sludges and grape stalks. Bioresour. Technol., 95: 203-208.

Charest, M.H., H. Antoun and C.J. Beauchamp, 2003. Dynamics of watersoluble carbon substances and microbial populations during the composting of de-inking paper sludge. Bioresour. Technol., 91: 53-67.

Contreras-Ramos, S.M., D. Alvarez-Bernal, N.Trujillo-Tapia and L. Dendooven, 2003. Composting of tannery effluent with cow manure and wheat straw. Bioresour. Technol., 94: 223-228.

Eghball, B., J.F. Power, J.E. Gilley and J.W. Doran, 1997. Nutrient, carbon and mass loss of beef cattle feedlot manure during composting. J. Environ. Qual., 26: 189-193.

Kaushik, P. and V.K. Garg, 2003. Vermicomposting of mixed solid textile mill sludge and cow dung with the epigeic earthworm *Eisenia foetida*. Bioresour. Technol., 90: 311-316.

Paredesa, C., J. Cegarrab, M.P. Bernalb and A. Roigb, 2005. Influence of olive mill wastewater in composting and impact of the compost on a Swiss chard crop and soil properties. Environ. Int., 31: 305-312.

Tejada, M., M.M. Dobao, C. Benitez and J.L. Gonzalez, 2001. Study of composting of cotton residues. Bioresour. Technol., 79: 199-202.

Walter, I., F. Martý´nez and V. Cala, 2006. Heavy metal speciation and phytotoxic effects of three representative sewage sludges for agricultural uses. Environ. Pollut., 139: 507-514.

Warman, P.R. and W.C. Termeer, 2005. Evaluation of sewage sludge, septic waste and sludge compost applications to corn and forage: Yields and N, P and K content of crops and soils. Bioresour. Technol., 96: 955-961.

Yongjie, W. and L. Yangsheng, 2005. Effects of sewage sludge compost application on crops and cropland in a 3-year field study. Chemosphere, 59: 1257-1265.