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Microbial and Mineral Content of Sewage Sludge from Riyadh and Yanbu, Saudi Arabia

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ABSTRACT

Sewage sludge samples from Riyadh and the industrial city of Yanbu were analyzed for microbial and heavy metals content. Twenty one species belonging to 13 genera were isolated from the tested samples. Metal concentration of Al, Cd, Co, Cu, Mn, Ni, Pb and Zn in samples from the industrial City of Yanbu were higher than that of Riyadh samples. The study suggests that the use of sewage sludge without treatment as a soil additive may cause rise to environmental pollution.

Key words: Microbial content, Minerals, Pollution, , Sewage, Saudi Arabia.

INTRODUCTION

There are many kinds of sewage wastes applied to land, including both raw waste water, and liquid or solid products that have passed through various kinds of microbial and chemical treatment. When liquid and solid phases are eventually separated the heavy metals are present in far higher concentration in the solid than in the liquid phase (Leeper, 1978), The problem of sewage disposal is considered to be one of the most important problems that faces those who in charge of the environment nowadays.

The sludge contain various heavy metals which have potential ecological, biological and health impacts. The heavy metal content of sludges from various countries has been reported (Berrow and Webber, 1972; Linnaman et al., 1973; Page, 1974; Williams et al., 1979; Fergusson, 1990; Hashem, 1995). Sewage provides a normal and good habitat for many microorganisms (Nelson, 1978; Dean and Lund, 1981; Volk and Wheeler, 1988). The present work was carried

out to determine both microbial and heavy metal content of sewage sludge obtained from Riyadh and Yanbu, Saudi Arabia.

MATERIALS AND METHODS

Raw sewage sludge samples were collected in sterile polyethylene bags from three applied sludge sites from Riyadh and the industrial Yanbu city. A total weight of 1000 g from the sites were mixed and used for microbial isolation and metal analysis.

The soil dilution plate method was used for microbial isolation (Hashem, 1995). Czapek's agar and nutrient agar media were used for fungal and bacterial isolation, respectively. The dishes were incubated at 37 °C for 3 days for bacterial isolation and 7 days for fungal isolation. Fungal and bacterial genera and species were identified according to Booth, 1971; Ellis, 1971; Bauchnan and Gibbons, 1974; Raper and Fennell, 1985; Zycha and Siepmann, 1971, Ramirez, 1982.

For metal analysis, oven dried sewage sludge was ground for 90 min. in a mechanical agate mortar. The samples were then treated as follow: one gram of air dried sludge was placed in a 100 ml beaker with 15 ml concentrated nitric acid covered with a watch-glass and heated at 95 °C for 30 min. After digestion, a sample solution was made up to 50 ml with deionized water and analyzed for Al, Cd, Co, Cu, Mn, Ni, Pb and Zn using an Atomic Absorption Spectrophotometer (Hashem, 1990).

RESULTS AND DISCUSSION

Sixteen fungal species and five genera of bacteria were isolated (Table 1). Fungal species in the present study were isolated earlier from Saudi Arabian soils (Ali, 1977; Hashem, 1993), while *A. alternata, A. flavus, A. niger, Fusarium oxysporum, Mucor* sp., *P. chrysogenum, P. citrinum, Trichoderma* sp. and *Ulocladium* sp.were isolated from sewage sludge from Saudi Arabia (Hashem, 1995). Bacterial genera in the present study were isolated from soil and sewage sludge from Saudi Arabia and from different places of the world (Berry and Marx, 1976; Abdel-Monem and Aly, 1990; Hashem, 1995).

Table 1. Genera and species of isolated microorganisms

Genera and Species	Riyadh	Industrial Yanbu city
Alternaria alternata (Fr.) Keissler	+	+
Alternaria chlamydospora Moushacca	+	-
Aspergillus candidus Link ex Fries	+	-
Aspergillus clavatus Desm.s	-	+
Aspergillus flavus Link	+	-
Aspergillus nidulans Thom & Raper	-	+
Aspergillus niger Van Teighem	+	-
Curvularia lunata (Wakker) Boedign	-	+
Fusarium moniliforme Scheldon	+	+
Fusarium oxysporum Schlecht.	+	+
Fusarium solani (Mart.) Sacc.	+	-
Mucor racemosus Fres.	+	+
Penicillium chrysogenum Thom	+	-
Penicillium citrinum Thom	-	+
Trichoderma viride Pers. ex Fr.	+	+
Ulocladium chlamydosporum Mouchacca	+	+
Bacillus sp.	+	+
Clostridium sp.	+	+
Escherichia coli	+	+
Pseudomonas sp.	+	+
Staphylococcus sp.	+	+

Decomposition of sludge by microorganisms resulted in released carbon dioxide, methane, ethane, and other volatile gases

which even at low concentrations are toxic to plants and other microorganisms (Alexander, 1977). Concern with environmental pollution has led to many inquiries on the microbial utilization of sewage sludge.

Soils may receive non treated sludge. In such grossly contaminated localities, plants are drastically affected, and commercial agriculture may be impossible. Manipulating the treated sludge to favor microbial growth promotes the degradation and hence alleviates the actual or potential pollution.

The acid extracted metal composition of sewage sludge samples from Riyadh and the industrial Yanbu city, varied highly in their mineral composition (Table 2). The concentration of Al, Cd, Co, Cu, Mn, Ni, Pb and Zn in the present study were higher than those reported in earlier findings in some Saudi Arabian soils (Hashem, 1990, 1993).

Table 2. Average acid extracted metal concentration (μg/g) of Al, Cd, Cu, Mn, Ni, Pb and Zn in samples from Riyadh and the industrial Yanbu city (n=5 ± standard deviation)

Metal	Riyadh	Industrial Yanbu city
l	101 ±3.11	303 ± 5.31
Cd	12 ± 0.36	18 ± 0.95
Co	25 ± 0.89	61 ± 1.09
Cu	53 ± 1.93	489 ± 5.92
Mn	36 ± 0.98	125 ± 1.68
Ni	31 ± 1.08	111 ± 2.37
Pb	25 ± 1.03	116 ± 2.16
Zn	58 ± 5.61	379 ± 6.89

In England, Jenkins and Cooper (1964) reported that acid digested sewage sludge contained Al, Cd, Co, Cu, Mn, Ni and Zn higher than in the present study. Low values determined in Riyadh

region, may be due to a lesser contamination of metals as compared to the industrial Yanbu city which has a greater number of refining and petrochemical plants, as well as a broad range of other manufacturing and support operations. Sewage sludge generally contains relatively large amounts of heavy metals and several pathogenic microorganisms which undoubtedly will affect the soil and plant growth and become a major public health and ecological problem (Hashems, 1998)

In Saudi Arabia, the use of untreated sewage sludge as a source of macronutrients in some farms has become common practice. Attention is drawn to the possible danger from heavy metals in applied sewage sludge. The high concentrations of heavy metals in sewage sludge for land application could result in long term phytotoxic effects and food chain contamination (Webber, 1972).

Microbial transformation and assimilation of heavy metals are well known (Gadd and Griffiths, 1978). Microbial growth on high metal concentrations results in soil contamination with heavy metals with the use of sludge as fertilizer over a number of years. This could result in the increase of the heavy metal concentration in soil. Therefore, sludge should be assessed for its metal content before being used as soil fertilizer. In the present study, heavy metal content of the sludge tested was below the standard but it may be hazardous on long term application as a soil additive.

CONCLUSION

Sewage sludge generally contains relatively large amounts of heavy metals and several pathogenic microorganisms which will affect the soil properties and plant growth and become a major public health and ecological problem.

REFERENCES

Abdel-Monem, M. and A. Aly. 1990. Existence of soil microflora producing amylases and proteases in eastern region of Saudi Arabia. Arab Gulf Sci. Res., 8:121-135.

Alexander, M. 1977. Introduction to soil microbiology. John Wiley and Sons, New York.

Ali, M. L. 1977. On the fungal flora of Saudi Arabia. I. Wadi Hanifa. Bull. Faculty of Science, Riyadh University. 8:7-20.

Bauchnan, R. and N. Gibbons. 1974. Bergey's Manual of Determination Bacteriology, 8th ed. William and Wilkins Co., Baltimore.

Berrow, M. and Webber. 1972. Trace elements in sewage sludge. J. Food and Agriculture. 23:93-100.

Berry, C. and D. Marx. 1976. Sewage sludge and *Pisolithous tinctorius,* their effect on growth of Pine seedlings. Forest Science. 22:351-358.

Booth, C. 1971. The genus fusarium. Common wealth Mycological Institution, Kew.

Dean, R. and E. Lund. 1981. Water Reuse. Academic Press. New York.

Ellis, M. 1971. Dematiaceous Hypomycetes. Commonwealth Mycological Institute. Kew.

Fergusson, J. 1990. The heavy elements: chemistry, environmental impact and health effects. Pergamon Press, New York.

Gadd, G. and A. Griffiths. 1978. Microorganisms and heavy metals toxicity. Microbial Ecology. 4:303-317.

Hashem, A. R. 1990. Analysis of water and soils from Ashafa, toroba, wahat and wehait. J. King Saud University Science. 2:87-94.

Hashem, A. R. 1993. Soil analysis and mycoflora of the industrial Yanbu city, Saudi Arabia. Arab Gulf Sci. Resh. 11:91-103.

Hashem, A.R. 1995. Microbial and heavy metals analyses of sewage sludge from Saudi Arabia. J. King Saud University Science. 7:207-213.

Hashem, A. R. 1998. Metal pollution of sewage sludge from industrial city Yanbu, Saudi Arabia. J. King Saud Univ. 10, 1:1-6.

Jerkins, S. H. and J. S. Cooper. 1964. The solubility of heavy metal hydroxidase in water, sewage sludge. II. The solubility of heavy metals present in digested sewage sludge. Int. J. Aime. Wat. Poll. 8:695-703.

Leeper, G. W. 1978. Managing the heavy metals on the land. Marcel Dekker, Inc., New York.

Linnaman, L., D. Williams, J. Corey, A. Page, and T. Ganje. 1973. Trace elements in sewage sludge. Arch. Enviro. Health. 27:45-47.

Nelson, L. 1978. Industrial water pollution, Addisin-Wesley Publishing Company, London.

Page, A. D. 1974. Fate and effect of trace elements in sewage when applied to agricultural lands. National Environmental Research Center, USEDA Report 67012, 74-85.

Ramirez, C. 1982. Manual and atlas of *Penicillia.* Elsevier Biomedical Press. Amsterdam.

Raper, K. and D. Fennell. 1985. The genus *Aspergillus.* Williams and Wilkins, Baltimore.

Webber, J. 1972. Effect of toxic metals in sewage on Crops. Water Pollution Control. 71:404-413.

Williams, D., J. Viamis, A. Pukite, and J. Corey. 1979. Trace elements accumulation, movement and distribution in the soil

profile from a massive applications of sewage sludge. Soil Sci. 129:119-132.

Volk, W. and M. Wheeler. 1988. Basic microbiology. Harper Row, Publishing, New York.

Zycha, H. and R. Siepmann. 1971. Mucoralas. Verlag Von J. Cramer, Germany.

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المحتوى الميكروبي و المعدني لمخلفات الصرف الصحي لمدينتي الرياض و ينبع، المملكة العربية السعودية

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ملخص

تعد مخلفات الصرف الصحي في الوقت الحالي من أهم المشاكل البيئية التي تواجه القائمين في مجال الحفاظ على البيئة نتيجة للاستنزاف الجائر و زيادة الطلب على الماء و التطور السريع للصناعات المختلفة، التي يقابلها عدم قدرة الطرق التقليدية على التخلص من تلك المخلفات. كشفت العديد من الأبحاث العلمية احتواء مخلفات الصرف الصحي على العديد من العناصر المعدنية السامة بالإضافة إلى كونها البيئات الملائمة لنمو و حدوث التفاعلات الكيموحيوية للكائنات الحية الدقيقة، تم في هذه الدراسة التحليل الميكروبي و المعدني لمخلفات الصرف الصحي لمدينتي الرياض و ينبع الصناعيتين. لوحظ زيادة المحتوى المعدني لعنصر الألومنيوم و الكادميوم و الكوبالت و النحاس و المنجنيز و النيكل و الرصاص و الخارصين لمدينة ينبع الصناعية عن ذلك في مدينة الرياض الصناعية، كما سجل في العينات التي حللت إحدى وعشرون نوعا و ثلاثة عشر جنسا من الفطريات و البكتريا. و قد أوصت هذه الدراسة على إن احتواء مخلفات الصرف الصحي على التراكيز العالية لتلك العناصر المعدنية السامة بالإضافة إلى الكائنات الحية الدقيقة المسببة للأمراض يؤدي إلى زيادة مشكلات التلوث البيئي إذا استخدمت كسماد او في الري دون معالجتها، كما إن استمرار إضافتها إلى التربة يعمل على زيادة تركيزها مما ينتج عنه العديد من المشاكل و الإضرار الصحية و الاقتصادية على الإنسان.

كلمات مفتاحية: المحتوى الميكروبي، المعادن، التلوث، الصرف الصحي، السعودية