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Waste-waste treatment technology and environmental management using sawdust bio-mixture

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Abstract

The industrial wastewater (WW) of potato-chips factory is characterized by its high biological oxygen demand (BOD) and chemical oxygen demand (COD), in addition to a medium content of oil & grease (O&G), total dissolved slats (TDS) and total suspended solids (TSS). A new technique for wastewater treatment has been applied using bio-mixture of selected strains of *Aspergillus terreus* or *Rhizopus sexualis* in addition to the natural flora of sawdust (SD-BIOMIX) in the form of mobile micro-carrier in activated sludge system. Different kinds of composted sawdust were used as a microbial carrier, support and source of nutrients and enzymes to enhance the wastewater treatment process; in order to improve the quality of treated wastewater and resulting sludge. The parameters of treated wastewater in terms of BOD, COD, O&G, TDS and TSS were greatly improved by 85.0, 79.0, 82.7, 74.6 and 87.7% respectively, in relation to the retention time and kind of tested materials. The 14 days microbial–treated (composted) sawdust by *A. terreus*, or *R. sexualis* as (SD-BIOMIX) exhibited the highest enzymes contents and was the most efficient materials for the wastewater treatment process in comparison with commercial biomixture products e.g. C157 and EM solution. Furthermore, the retention time of the treatment process could be reduced to 4 hr only. Finally, the resulting sludge(s) of (SD-BIOMIX) was easy to separate (in 5-10 min.) from wastewater. The sludge, according the chemical analysis, can be safely used in agriculture as an organic fertilizer and soil conditioner. In addition, different kinds of resulting sludge have been tested as biosorbents and exhibited high ability to remove chromium (89.1 - 99.3%), nickel (84.3 - 98.0%) and zinc (85.6 - 97.7%) from the heavy industrial wastewater. Data indicated the possibility of magnifying the introduced (SD-BIOMIX) as a new technique for the treatment of wastewater and as new trend for wastes management and pollution prevention and could be applied in Kingdom of Saudi Arabia as one of advanced biotechnology to solve many of environmental problems in KSA.

Keywords: *A. terreus*, environmental management, *R. sexualis* , sawdust, waste-waste treatment

Introduction

Environmental management, wastes recycling, treatment and disposal, pollution control and prevention and wastewater reuse became the most important issues and in the top of the global agenda [1, 2, 3]. Waste water usually can be processed for disposal or recycling by one or more steps. The first step, usually, the preliminary and primary treatment, which is physico-chemical treatment. Because of the objection properties of the effluent, the secondary treatment, which is biological treatment, is employed. The operation involves the biological degradation of organics; both dissolved or suspended materials by microorganisms under controlled conditions [4]. Biological treatment can be accomplished in a number of ways, but the basic characteristic of the system is the use of mixed microbial culture; bacteria, fungi and / or algae, for the conversion of pollutants. In most cases, organic materials are converted to oxidized products, mostly carbon dioxide and new microbial cells (the sludge). The organic materials serve as an energy and carbon sources for cell growth [5, 6, 7].

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Biological treatment is divided into two configurations in common use: film flow (fixed – film flow system) and suspended or fluidized culture. Suspended-culture processes in use include activated sludge, aerated lagoons, oxidation ponds and anaerobic treatment process [5, 8, 9, 10].

Trickling filter is the most common used example of film – flow – type process. Wastewater is sprayed over a bed of support media (gravel, rock or plastic balls) covered with a biological film [4,5]. Other configurations of film – flow reactors are the rotating biological contactor (RBC). This system utilizes lightweight materials such as Styrofoam to support microbial film and the system operates by moving the microbial film though the wastewater. Industries that have found the trickling filter and rotating biological contactor (RBC) processes especially suitable are the food products industries [11, 12].

Recently, Industrial wastewater of potato – chips factory has been successfully treated by new method [13], which could be classified as one of suspended culture processes. Starch – wastewater was treated by modified technique of suspended growth systems [14, 15]. Generally potato – chips wastewater is usually characterized by high content of organic materials which are the direct reason for the high biological and chemical oxygen demands (BOD & COD) of the factory wastewater [13].

On the other hand, thousands tons of organic and agriculture solid waste mainly plant waste materials (PWM) e.g. rice strew, bagasse and sawdust are accumulated in the environment [1, 16]. Most of these materials (P.W.M) are burnt in the field causing air – pollution and health problems. In this work one of the solid wastes, sawdust is used as microbial supporting matrix and biomixture in new system of biological treatment (as bioconductor- suspended culture) to treat wastewater from potato – chips producing factory. The main target of the present work is a trial to apply new technique to improve both the wastewater and sludge quality, as well as the reuse of the resulting sludge in agriculture as fertilizer, soil condition and water holder; and in heavy industry as a metal biosorbent.

Materials & Methods

Collection and preparation of samples

For the main part of the work, wastewater of potato-chips factory at 6th of October, Egypt, has been collected, at the end-pipe, in sterile clean glass bottles, then stored at 4˚C. Ten liters of galvanizing wastewater has been collected in clean bottles from metal finishing factory in 10th of Ramadan industrial city

Fungi used

Aspergillus terreus Thom (IMI 281190) and/or *Rhizopus sexualis* smith-Callan (IMI 103481) were used as test organisms for the treatment processes of wastewater and rice-sawdust

Media used

Czapeck`s Dox broth and agar (3.5% Oxoid) was selected as the most appropriate culture medium to grow up, maintain the fungal growth and produce the fungal biomass and spores.

Collection and preparation of Sawdust

Sawdust (4 kgs) has been collected from wood-workshop around Cairo and then divided into four parts each 1 kg. First part has been kept as it is, to be used in the waste water treatment. Second part has been mixed with 300 ml of potato-chips wastewater in glass-jar. Third and fourth parts were treated as second one, but, the third one was inoculated by 10 agar discs (each 1 cm) of 7 days old culture of *A. terreus*, while the fourth one was inoculated by 10 agar discs (each 1 cm) of 7 days old culture of *R. sexualis* in glass- jar, separately. The glass-jars were incubated at 25 °C for 14 days.

The microbial / fungal growth on/in the sawdust has been microscopically investigated. Amounts of fresh municipal sludge from Zinin sewage station has been collected, the major part of the sludge was dried in the air for 8 days to constant weight. One gm of non-composted or composted sawdust or sludge were suspended in 10 ml of distilled water, filtrated, and 0.1 ml of the filtrate was examined for its enzymatic content [16, 17].

Preparation of fungal biomass and enzymes

Two sets of four 250 ml conical flasks each containing 150 ml. Czapeck's Dox liquid medium were autoclaved then inoculated with two agar discs of 7 days old culture of *A. terreus* or *R..sexualis*. The flasks were incubated at 25°C for 14 days on a rotary shaker at 100 r.p.m. The mycelium was harvested by filtration and 0.1ml / flask of the filtrate was examined for its enzymatic content [16, 17]. The fungal biomass was then, dried in air and kept at 4 °C.

Potato-chips wastewater treatment

The primary (physico-chemical) treatment of the potato-chips wastewater was run according to Kerri *et. al.* (1995) by using 1% of alum and left to settle-down for 15 min. then two liters of the wastewater has been transferred to clean glass-jar. The second (biological) treatment; one liter of the primary treated wastewater was run according to the introduced new technique (SD-BIOMIX). Ten gm of biomass of *A. terreus* or *R. sexualis*, or municipal sludge or non-composted or kinds of composted sawdust (by natural flora of it, natural flora plus *A. terreus* or natural flora plus *R. sexualis*) or 10 ml of C157 (bio-product of American water tech. Co.) or 10 ml of EM (bio-product of Japanes water Tech. Co.) was mixed, separately, with one liter of primary treated wastewater, in 2 liters steering glass-jar under aerobic conditions for 4 or 8 h. at 25 °C. The wastewater was left to settle down for ½ h, the precipitated sludge amount was measured, every 5 min., and calculated (v/v) in percentage. The wastewater was separated from the sludge then, its parameters before and after the treatment, were determined [18]. The amount of settling sludge was divided into two parts: The first part was analyzed for its parameters [18]. The Standards of The Egyptian Ministry of Agriculture for the possible use as soil fertilizer and conditioner in agricultural were recognized. The second part of the sludge, was examined for its use as biosorbent to remove heavy metals from galvanizing wastewater [13].

Galvanizing wastewater treatment

One gm of the test materials, dry sawdust or different kinds of the resulting sludge, was added to 100 ml of galvanizing wastewater of one of metal finishing factory in 10^{th} of Ramadan industrial city. The test material was considered as biosorbent and has been used to remove various heavy metals from the wastewater. The experimental work has been run and the metal removal (sorption) percentage was calculated as described in [13, 19].

Results

The enzymatic contents of the tested materials after 14 days of incubation or composting using various liquid or solid waste media are shown in (Table 1). Both the municipal sludge and non-composted sawdust have low concentration of cellulase(s) with little bit of α-amylase(s), in case of non-composted sawdust, also both α- amylase(s) and protease(s) were of low concentration in the culture filtrate of *A. terreus* and *R. sexualis* (Table-1). The enzymatic productivity of the two fungi grown in sawdust appeared to be higher than it in Czapeck's medium (Table 1). Results indicated that sawdust gave high yield of enzymes. The 14 days composted sawdust, as biomixture of sawdust and fungal growth (Table 1) served as an enzymatic store, particularly for cellulase(s) and α-amylase(s), microbial carrier and biosorbants (Tables 3-5). The potato chips wastewater exhibited high BOD, COD, O&G, TDS and TSS, even after the primary treatment and sedimentations as shown in Table 2.

Table 1. Data of enzymatic assays in 0.1 gm or 0.1 ml of the tested materials after 14 days of incubation at 25˚C.

Test Material	Mean diameter of clearing zone (mm)			
	α-Amylase	Protease	Lipase	Cellulase
Municipal sludge	0	0	0	11.5
Non-composted sawdust	0.5	0	0	0.5
Culture filtered of *A. Terreus*	10.5	10.5	1.5	1
Culture filtered of *R.. Sexualis*	11.5	10.5	0	0.5
14- days composted sawdust by natural microflora and Potato-wastewater	10.5	10.5	2.5	27
14-days composted sawdust by natural microflora and Potato-wastewater plus *A. terreus*	32	13	10.5	45
14-days composted sawdust by natural microflora and Potato-wastewater plus *R. sexualis*	27.5	11.5	5	35.5

Table 2. The wastewater parameters (mg/L) of potato-chips factory before and after the physcio-chemical treatment by1.0 % mixture of Alum as coagulant and left to settle-down for 15 min.

Parameter (mg/L)	Allowable limits acc. Law 4/94*	Raw influent (before treatment)	After physico-chem. treatment
PH	6 - 10	5.1	7.2
Biological Oxygen Demand (BOD)	400	3600	1800
Chemical Oxygen Demand (CDD)	700	5700	2100
Total Suspended Solids (TSS)	500	5225	2200
Total Dissolved Solids (TDS)	2000	1100	1850
Oil & Grease (O&G)	100	160	110

* Egyptian Environmental Law No. 4 for year 1994.

Biological treatment of the primary treated wastewater by microorganisms or microbial containing materials (bio-mixture) was the favorable solution. All the tested – materials, except the non-composted sawdust (Tables 1-4) exhibited range of success in the bio-treatment process of wastewater, particularly, the fungal and microbial composted sawdust (bio-mixture) after retention time of 4 or 8 h. (Tables 3& 4). The use of non-composted sawdust had drastic effects on the wastewater quality (Tables-3&4) and lead to the increase of BOD and COD. The parameters of the wastewater treated by bio-mixtures were improved by 66.7 – 85%, 65.7 – 79.0% and 61.8 – 82.7% for BOD, COD, O&G respectively. The use of municipal sludge or pure fungal growth (pellets) or commercial bio-products (C157 and EM) was less efficiency in the process of wastewater treatment (Tables 3&4).

The remarkable results were obtained for the TDS ratio which could be reduced during the biological treatment processes by pure fungalpellets or fungal –sawdust compost (bio–mixture) by 67.5 – 74.6% (Table – 4), particularly after 8 h of incubation (retention time).

These results indicated the ability of fungal growth or bio–mixture to remove or uptake the salts from wastewater.

Furthermore, the settling – time for separation of sludge from wastewater was reduced to 10 min, in case of the use of bio–mixture of composted sawdust (Table – 5), where, in case of municipal sludge, for example, the separation (settling) time was 20 min. However, the microscopic investigation of sawdust, before and after the inoculation by tested fungi and during the composting processes for 14 days, was indicated that, the sawdust has rough surface which is suitable for microbial spores / cells attack and growth on it. Further, the sawdust could be a good supporting matrix for the microbial – film or / and growth.

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* Egyptian Environmental Law No. 4 for year 1994.

Table-3: The wastewater parameters (mg/L) of potato-chips factor after the biological treatment using the commercial bio-solution (0.1%) or test materials (1.0%) as mobile biomixture (SD-Biomix) for 4 hr. under aerobic conditions at 25˚ C.

Parameter	Commercial Biosolution		Test Material						
			1	2	3	4	5	6	7
	C 157	EM	Municipal Sludge	Non.com. sawdust	Culture filtered A. terreus	Culture filtered R. sexualis	SD-Biomix	SD-Biomix plus A. terreus	SD-Biomix plus R. sexualis
pH	8.1	7.6	8.1	7.5	5.2	5.7	6.5	6.2	6.8
BOD	900	980	1100	1950	800	720	600	550	520
COD	1450	1120	1320	2600	1000	1050	925	720	700
TSS	790	780	1005	2310	510	620	560	350	460
TDS	1750	1100	1750	1800	995	1000	1000	960	1100
O&G	50	45	70	85	65	75	55	26	30

Table-4: The wastewater parameters (mg/L) of potato-chips factor after the biological treatment using the commercial biosolution (0.1%) or test materials (1.0%) as mobile biomixture (SD-Biomix) for 8 hr. under aerobic conditions at 25˚ C.

Parameter	Commercial Biosolution		Test Materials						
			1	2	3	4	5	6	7
	C 157	EM	Municipal Sludge	Non. com. sawdust	Culture filtered A. terreus	Culture filtered R. sexualis	SD-Biomix	SD-Biomix plus A. terreus	SD-Biomix plus R. sexualis
pH	8.1	7.6	8.5	8.5	6	5.7	6.8	6.5	7.1
BOD	874	920	900	1870	390	420	650	300	270
COD	975	987	720	2550	710	700	635	510	440
TSS	710	723	750	2190	510	490	490	270	310
TDS	1430	1000	895	960	600	650	560	470	510
O&G	34	30	54	62	42	50	40	19	22

Table 5. The percentage of settling sludge after 5,10, 15 and 20 min. of 4 hr – wastewater treatment process by using various test materials.

Test – material	Percentage of settling sludge after			
	5 min.	**10 min.**	**15 min.**	**20 min.**
Municipal Sludge	1.50	5.00	6.50	8
Non-composted sawdust	6.50	8	10	10
Culture filtered of A. Terreus	7.50	8	9.00	9.50
Culture filtered of R.. Sexualis	7.60	7.50	11.50	15.70
14- days age SD-Biomix	10.90	14.60	17.30	21.50
14- days age SD-Biomix plus A. Terreus	12.50	17.40	21.30	29.00
14- days age SD-Biomix plus R. Sexualis	11.70	14.70	18.90	27.60
C 157	4.50	6.00	7.50	8.50
EM	7.50	9.50	11	12

Table 6. Comparative chemical composition and physical characters of the resulting sludge from wastewater treatment process for 4 or 8 hr. by using different test materials.

Test Materials	pH		Water holding Capacity %		Organic Matter %		Organic Carbon %		Total mg/kg nitrogen		Total mg/kg Phosphorus	
	4hr	**8hr**	**4hr**	**8hr**	**4hr**	**8hr**	**4hr**	**8hr**	**4hr**	**8hr**	**4hr**	**8hr**
Municipal Sludge	7.5	8.1	135	110	25	27	30	27	1.7	1.9	0.2	0.19
Non-composted sawdust	7	7.7	107	120	79	69	58	66	0.3	0.5	0.1	0.3
SD-Biomix	7.5	8.1	135	147	52	48	21	20	1.5	1.6	0.42	0.51
SD-Biomix plus *A. Terreus*	7.1	7.1	145	160	51	50	30	23	2	2.4	0.71	0.73
SD-Biomix plus *R. Sexualis*	6.5	7.3	192	175	41	42	25	26	1.9	2.1	0.65	0.7

Table 7. The biosorptive efficiency (%) of heavy metals (Chromium, Nickel and Zinc) by using the 4 or 8 hr. resulting sludge (biomass) of wastewater treatment process by different test materials according to Tables (3&4).

Test Materials	**Metal Sorption (%)**					
	4 hr. – Sludge (biomass)			**8 hr. – Sludge (biomass)**		
	Cr	**Ni**	**Zn**	**Cr**	**Ni**	**Zn**
Municipal Sludge	65.3	50.8	53	75	62	55.3
Non-composted sawdust	41.2	37	42.2	52.4	50.1	62.2
Culture biomass of *A. terreus*	84	89.1	91	82.5	84.2	82.9
Culture biomass of *R.sexualis*	97	96	96.1	89.2	91	90.7
SD-Biomix	89.1	84.3	85	91.4	90	87.2
SD-Biomix plus *A. terreus*	97.5	96.1	94.7	90	88.7	85.6
SD-Biomix plus *R. sexualis*	99.3	98	97.7	91.2	91	89.1
Activated Carbon	80	79	81.5	80	79	81.5

The different kinds of resulting sludge of wastewater treatment processes which is composed plant materials and microbial biomass (bio-mixture) are rich with organic contents (Table – 6) and microbial biomass which could be considered as humus. For that reason, the sludge can be used in many industrial and agricultural applications.

First, is in agriculture, the resulting sludge or bio–mixture of the bio-treatment process of potato – chips wastewater (Tables 3 &4) exhibited reasonable characters of water holding capacity, organic and minerals contents (Table 6). These characters are supporting the possible use of these kinds of sludge in agriculture or soil reclamation. Second is, in metal – industry, the resulting sludge or biomass, with the exception of municipal sludge and non- composted sawdust, exhibited high ability to remove or sorb heavy metals from industrial wastewater (Table 7).

The bio–mixtures could be used successfully as biosorbents to remove chromium, nickel and zinc from galvanizing wastewater by 95.0 – 99.3 %, 94.7 – 98.0 % and 90.6 – 97.7% respectively, while activated carbon sorption efficiency ranged between 79.0- 81.5%.

Discussion

Wastewater and solid wastes may the most pollution threatens to the global environment [20 .[Sawdust is one of solid wastes of many activities with no real or limited use [1, 6]. The new technique of wastewater treatment is depending on the use of the sawdust with microbial growth or bio-film on / in it as a mobile system which could be considered as fixed – film flow and suspended or fluidized culture [4, 5, 9, 10, 21], and may be called "SD-BIOMIX". The biomixture (SD-BIOMIX), has the benefit of the suspended culture processes e.g. activated sludge system and the advantages of the film – flow reactors e.g. trickling filter and rotating biological contactor (RBC) as detailed descriped in [6, 11].

The results indicated that, the sawdust saturated with Potato-chips wastewater is a very good medium for the microbial growth and activities, where microorganisms particularly fungi can produce good amounts of biomass (Azab, 2000a&b) and enzymes (Table 1). Sawdust in this phenomenon is similar to other plant and solid waste materials e.g. bagasse, potato – peels, rice-husks and other wastes and it may be better than other for its slow biodegradation [1, 9, 13, 16, 17, 21, 22]. Furthermore, sawdust has rough surface and slow decomposing characters as a result for its high lignin contents [21, 23]. These results supported the use of sawdust as good matrix or support for the microbial growth in addition to its long-life and lightweight.

Potato – chips wastewater is characterized by its high contents of suspended and dissolved organic contents [13], as a result of industrial process and this is the direct reasons of high BOD, COD, TSS and oils [14]. The potato – chips wastewater after the primary treatment was still not applicable with the Egyptian law 4 for 1994 (Table-2), and there is an urgent need for biological treatment. Municipal sludge, is a traditional inoculate usually used in the anaerobic or / and aerobic biological treatment [10, 11, 14]. The use of municipal sludge has many health problems and drastic effects on the soil and environment as a source for hazard pollutants [8, 24]. In the introduced new technique (SD-BIOMIX), clean and safe substance (sawdust) and microorganisms have been used. Fungus, Aspergillus terreus or Rhizopus sexualis exhibited high growth on and in the small pieces of sawdust and produce good amount of enzymes (Table – 1) which may help, accelerate and activate the bio-treatment and reduces the retention time of the wastewater .

Further, the microbial or/ and composted sawdust (bio-mixture) could be considered as a new safe and effective microbial inoculum's in comparison with the municipal sludge for the biological (secondary) treatment of potato – chips wastewater. Various kinds of the tested bio–mixture showed higher efficiency in the wastewater treatment processes, (Tables 3&4) and improved the water quality, particularly BOD, COD and O&G even after 4 h. incubation time. Furthermore, The SD-Biomixture is safer, more efficient and much cheaper than commercial bio-treatment solution (C157 or EM). Of the tested materials, the use of non-composted sawdust slightly increased the BOD and COD of the wastewater; this may be referred to its content of organic material. These results may reveal- to many factors- the better use of composted sawdust (bio–mixture) than the municipal sludge in the wastewater treatment. First one, is the free of the bio – mixture from the various municipal sludge pathogens and contaminants, free of microorganisms of other environment, its safe to handle, transfer and the sludge could be reused. Second, the great surface-area of sawdust plus Potato-wastewater provides natural nutrients and attached or supported matrix for the microbial growth. Third, the bio – mixture is working as a good supplier for microbial spores, biomass and continues enzymatic injection [21, 25, 26, 27] during the wastewater treatment processes. Application of membrane bioreactors as a source for enzyme in wastewater treatment processes was tried [28]. Generally, all membrane–systems are expensive and complicated.

Fungal pellets of *Aspergillus niger* in treatment process of starch – wastewater, 90% starch decomposition process was achieved after 16 days was successfully applied [15]. In this system (SD-BIOMIX), about 85 % of the organic matters in the wastewater (in term of BOD) were decomposed after 4-8 h. The fast decomposition of the organic matter may be due to the high enzymatic contents of the bio–mixture and active microorganisms (Tables – 1-4). Further, the lightweight of small to very small pieces of sawdust covered with microbial – film have large surface area and high mobility in the treatment system of the potato chips waste water. Finally, the sawdust may be_considered as 1) good support matrix, 2) source of nutrients, 3) attached surface slow biodegradable material and all these work together with the microbial – film as a micro – bioreactor in the wastewater treatment process.

On the other hand, lime or / and activated carbon, usually added in the final stages of wastewater treatment processes to enhance the microbial growth or to reduce the volume of the resulting sludge [11, 29]. Activated carbon, in particular, is expensive, very slow biodegradable substance in comparison to sawdust. The results in this work (Table-5) enhanced and supported the theory of the use of sawdust in wastewater treatment process as cheap, slow biodegradable and more efficient material than the activated carbon. Furthermore as mentioned before, it's good surface for microbial growth, easy to separate from wastewater and reduces the sludge volume. Although, the total dissolved salts (TDS) was, fortunately, reduced by 67.5 – 74.6%, thus indicated the desalination ability of tested fungi or bio – mixture. The desalination phenomenon was recorded in some selected strains of fungi [30].

Furthermore, the results indicated the possible use of the resulting sludge (bio – mixture) after the wastewater treatment processes as a soil fertilizer and conditioner (Table-6), in addition to its use as a metal – biosorbent in the process of wastewater treatment of galvanizing and metal industries (Table-7). The resulting sludge of Potato-wastewater (the solid waste after the treatment process) is a bio – mixture of microbial biomass and composted plant/wood materials. It is well known that such sludge can be of use as soil fertilizers (Table–6), soil conditioner and water – holder according to the recommendations of the Egyptian Ministry of Agriculture for sandy soil [31, 32, 33]. Further, the resulting sludge of the new system (SD-BIOMIX) may play a very important role in soil mineralization for its high content of and 4) carrier for microbial growth and spores; 5) spongy and organic matter (Table-6); and its free of toxic pollutants and pathogenic organisms [8, 24, 34]. On the other hand, both fungal biomass of species of Aspergillus or Rhizopus [9, 16, 35, 36], and plant waste materials as composted or non – composted [1, 13, 21, 35], had shown high metal retention or biosorption of various metal ions from water and wastewater. The biosorbtion mechanisms have been already explained [16, 35, 37, 38]. Furthermore, the resulting sludge of (SD-BIOMIX) system can be used to remove heavy metals (Table-7) and according to previous studies, it can uptake / sorb other toxic pollutants e.g. cyanide [39], organic halide [40], dyes [16], from industrial wastewater.

In conclusion, The application of the mobile biomixture (SD-BIOMIX) in many of industrial wastewater treatment processes may be considered as a new efficient and non–expensive biotechnological solution for many of environmental problems of solid and/ or liquid industrial wastes. Further the work is establish and confirmed the waste-waste treatment technology and a step in sustainable development programs.

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