Use of vermiculture technology for waste management and environmental remediation in Argentina

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Abstract: Throughout the world, there have been increasing interests in the recycling of wastes for sustainable development. This especially applies for organic materials of municipal and agro-industrial origin. Recycling initiatives in Argentina are still incipient. In the last years, the use of earthworms for stabilising organic wastes has been evaluated. In this paper, the authors compile the research results of vermicomposting of organic residues from different raw materials and its use as a biofertiliser, to provide a general outlook of the development of vermiculture technology in Argentina within the last decade. Research results of bioaccumulation of some trace elements by worms in artificially contaminated systems are also provided.

Keywords: earthworms; organic waste; biodegradation; bioaccumulation.

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1 Introduction

Large volumes of organic wastes are produced all over the world, creating a serious disposal problem and a major source of environmental pollution. Argentina is the second largest country of Latin America and the Caribbean. According to the 2001 census, the Metropolitan Area of Buenos Aires (AMBA) is made up of a population of approximately 12 million people. This makes the AMBA the third largest urban agglomeration in Latin America, following Mexico City and Sao Paulo. The amounts of organic materials from Municipal Solid Wastes (MSW), sewage sludge and wastes of agro-industrial origins have increased exponentially in the last years. As in many other countries, waste disposal from households and industries is becoming an increasing concern.

About 1,800,000 metric tons of sewage sludge is annually produced in the City of Buenos Aires (Torri and Lavado, 2008). Sludge products are aerobically stabilised and presently discarded in land farming and, to a minor extent, as a soil amendment on lawns or land filling. However, the unavailability and rising cost of land, together with public concern over odour and possible groundwater contamination, makes finding new sites difficult, expensive and impractical. On the other hand, the creation of the CEAMSE (State Company for Ecological Coordination in the Metropolitan Area) in 1978 put MSW management on a metropolitan scale with the implementation of controlled waste disposal methodology where lands have been recovered for recreational purposes. At present, the waste management system is undergoing a transition towards a system of urban solid waste recovery and recycling. In this sense, the city of Buenos Aires has made significant progress regarding its legal framework. Law 1854/05, also known as the Zero Garbage Law, sets down a schedule to reduce urban solid waste end disposal, and stipulates a total ban on burying recyclable material by the year 2020. New laws and regulations have also been promulgated over the last few years, compelling the industries to reduce and treat contaminated wastes.

The recent intensification of agricultural production, agro industries or industries generates increasing quantities of solid waste, which may constitute a problem of potential contamination for the population if its management is not correctly planned (Navarro and Font, 1993). Another important source of biodegradable wastes is animal breeding. New livestock production systems based on intensification in large farms produce huge amounts of manure, which has to be managed under appropriate disposal practices to avoid negative impacts on the environment (Burton and Turner, 2003).

The use of municipal wastes, sewage sludge, compost and farmyard manures as fertilisers on agricultural soils has been encouraged in many parts of the world as a sustainable alternative to stockpiling and incineration (Lima et al., 2009). Land application of organic wastes is generally considered the best option of management because it offers the possibility of recycling plant nutrients, provides organic material to the soil and improves the soil's aggregate stability, porosity and water infiltration rate (Weber et al., 2007). However, recycling initiatives in Argentina are still incipient. Direct land application of untreated waste might result in nitrogen immobilisation, phytotoxicity due to release of ammonia, low molecular weight organic acids or salts (Cooperband, 2000; Torri and Lavado, 2009). Consequently, organic materials should be treated appropriately before being land applied. The conventional and most traditional method of composting consists of an accelerated bio-oxidation of the organic matter as it passes through a thermophilic stage (45–65°C) where microorganisms liberate heat, carbon dioxide and water (Domínguez et al., 1997). However, in recent years, researchers have become progressively interested in using another biological process for stabilising organic wastes, which does not include a thermophilic stage, but involves the use of earthworms. Certain species of earthworms can rapidly fragment organic material residuals into much finer particles by passing them through a grinding gizzard, an organ that all Anellida possess (Ndegwa and Thompson, 2001). The earthworm species most commonly utilised for the breakdown of organic wastes are *Eisenia fetida* (Savigny) and its related species *Eisenia andrei* (Bouché). Worldwide, considerable work has been carried out on vermicomposting of various organic materials such as animal dung, agricultural waste and food wastes (Singh and Sharma, 2002). Similarly, industrial and distillery wastes have been vermicomposted and turned into nutrient-rich manure (Suthar, 2007). In Argentina, Campitelli and Ceppi (2008b) studied the chemical and physicochemical properties of humic acids from different vermicomposting plants that used different raw materials, like mixtures of sorghum and tomato, urban waste, chicken manure, soybean and bagasse. They concluded that carbon content of humic substances was similar in all the organic amendments studied, whereas carbon content of humic acids apparently increased with vermicomposting time. These results suggest that long stabilisation processes led to the mineralisation of easily degradable fractions and the appearance of larger concentration of more recalcitrant molecules like humic acids. Although this technique has been tried and tested in many countries with positive results, vermicomposting is still a relatively new technology in Argentina, and has not yet been fully explored. Nonetheless, numerous organic wastes have been studied as possible substrates, and the vermicompost obtained was tested for plant growth.

On the other hand, earthworms are relatively efficient accumulators of certain essential and non-essential trace elements from soil and sediments, either through direct dermal contact with chemicals in the soil solution or soil atmosphere and by ingestion of bulk soil or specific soil fractions (Lanno et al., 2004). Van Hook (1974) claimed that earthworms could serve as useful biological indicators of contamination because of the fairly consistent relationships between the concentrations of certain contaminants between earthworms and soils. Earthworms may also be used to reclaim contaminated soils. Vermiremediation is especially relevant in acidic soils, because of the near-neutral to alkaline pH of vermicompost and the suppression of labile aluminium (Mitchell and Alter, 1993). There are no records of soil surface polluted areas in Argentina. Nevertheless, some bioassays were performed to determine the uptake and bioaccumulation of trace elements by some worms.

In this paper, the authors compile the research results of vermicomposting, of organic residues and of bioaccumulation of some trace elements by worms in artificially contaminated systems, to provide a general outlook of the development of vermiculture technology in Argentina within the last decade.

2 Vermiculture technology for waste management

2.1 Type of waste

2.1.1 Municipal Solid Waste (MSW)

The organic composition of MSW ranges between 40% and 60%, although this composition may change according to the region considered. In general, rural households generate more organic waste than urban households. The end product quality of traditional composts and vermicomposts using MSW produced in the NW Patagonia region was compared by Tognetti et al. (2005). The earthworm used was *Eisenia fetida*. Two kinds of vermicompost were prepared: inoculated with earthworms after having undergone a two-month maturity phase and a backyard vermicompost produced during four months without a previous thermophilic phase. Tognetti et al. (2005) reported that Electrical Conductivity (EC) of municipal compost and municipal vermicompost was within the range considered acceptable for plant growth, being significantly lower for vermicompost compared with traditional compost and backyard vermicompost. The three composts had alkaline pH values, probably due to the high wood ash content of the MSW. Total N and P were significantly higher in municipal vermicompost than in municipal compost, whereas organic matter content did not significantly differ between the three amendments. When compost and vermicomposts were applied to degraded soil and sown with ryegrass, significantly higher ryegrass aerial biomass was produced with vermicompost, which increased ryegrass yield by 15–17% compared with the traditional compost and backyard vermicompost. These results may have been due to enhanced soil microbial activity, population size and substrate degradation capacity, indicating the importance of the processing technology employed (Gaur and Singh, 1995).

2.1.2 Sewage sludge

In Buenos Aires City, sludge products are aerobically stabilised in two treatment plants (North and South-western purifying plants) and are presently discarded in land farming, and to a minor extent as a soil amendment on lawns or land filling. Composting in a large scale is not yet performed mainly due to a lack of economic investment. The management of sewage sludge through the action of earthworms has been suggested for depuration plants (Masciandaro et al., 1997) as an option for resource recovery. The contents of Cd, Cu and Pb in sewage sludge do not exceed ceiling concentrations for land application recommended by Argentine regulation (S.A.D.S., 2001, Res.97/01) and the US EPA (US EPA, 1993; Torri and Lavado, 2008). This option is actually being studied by the author.

2.1.3 Manure

The feeding of livestock in confinement is progressively increasing in Argentina. This activity generates large volumes of organic waste that may create a serious disposal problem and a major source of environmental pollution. Composting of animal manures has been traditionally carried out by the farmers after manure collection for better handling, transport and management. However, the cost of composting can be considerably higher than its direct utilisation. Recycling of manure as vermicomposting is a promising strategy of agronomical, economical and ecological importance. The characteristics of vermicomposting derived from manures of different origin have been investigated in the last years. Ullé et al. (2003) studied in San Pedro, Buenos Aires province, the characteristics of cow manure, bed-of-chicken, pig manure and horse manure as raw organic wastes, composted and vermicomposted by *Eisenia foetida* after a thermophilic phase (US EPA 40 CFR Part 503). Giulietti et al. (2008) also studied vermicompost originated from cow, horse, goat and hen feces in San Luis province whereas Campitelli et al. (2008) evaluated the quality of vermicomposted rabbit manure in Cordoba province. Caprines for milk and meat production are a key source of income for rural families in Santiago del Estero province, with 15% of the national production. González et al. (2008) compared traditionally composted and vermicomposted goat, horse and cow manures. Physicochemical properties for fresh manures, traditionally composted and vermicomposted manures are summarised in Table 1.

The pH value is one of the most frequent parameters used to characterise composted and vermicomposted materials. Several legislations suggest pH values ranging from 6.0 to 8.5 for this kind of organic amendments to ensure compatibility with most plants (Hogg et al., 2002). The pH of the vermicomposted products was, in general, lower compared with fresh manures, presumably due to the production of carbon dioxide, initial volatilisation of ammonia and the production of organic acids by microbial activity during vermicomposting (Elvira et al., 1998). The pH of all vermicomposts ranged from neutral to alkaline. Possible contributions to the near-neutral pH of vermicompost may be the secretion of ammonium and the activity of calciferous glands in earthworms. These glands contain carbonic anhydrase, which catalyse the fixation of dioxide and calcium carbonate, thereby preventing the fall in pH (Kale et al., 1982; Lee, 1985).

Table 1 Nutrient contents and some properties of raw, composted and vermicomposted manure

Manure		*pH*	*EC*	*OM* (%)	*Nt* (%)	*K* (%)	*C : N ratio*	*P* (mg kg^{-1})	*References*
Poultry	Raw	9.11	5.58	59.8	2.4	2.30			1,2
	Composted	8	3.7	44.2	1.74	3.24			1,2
	Vermicomposted	7.7	1.2	31.5	1.19	0.43	15 : 1		1,2
		8.2		15.82	0.84			400	3
Cow	Raw		9.28	26.2	1.17	0.45			1,2
	Composted	6	1.5	22.5	1.08	1.30			1,2
		7.2	7.3	14			11		6
	Vermicomposted	6.7	0.7	20.4	0.93	0.40	10 : 1		1,2
		6.6		13.18	0.7			139.9	3
		6.7		29.71	1.25	0.11%		32	5
		6.8	14.6	15			13		6
Horse	Raw		4.87	53.6	1.53	1.81			1,2
	Composted	8.5	1.7	23.0	1.21	3.06			1,2
		7.0	11.8			11.5			6
	Vermicomposted	8	0.8	31.0	0.85	0.52	14 : 1		1,2
		6.7		23.44	1.23			208.9	3
		7.0	13.3				11		6
Hog	Raw		5.69	47.3	2.25	1.17			1,2
	Composted	7	2.5	28.3	1.45	1.22			1,2
	Vermicomposted	7.3	1.6	29.9	1.05	0.23	11 : 1		1,2
Goat	Raw	7.0		53.0	1.22	0.52			6
	Composted	7.6	11.7	11.7			13		6
	Vermicomposted			10.88		0.09		35.99	3
		7.6	15.0	15.0			11		6
Rabbit	Raw	9.23	1.78	62	2.06				4
	Composted	9.15	2.43	40.3	1.49				4
	Vermicomposted	8.51	2.65	37.9	1.42				4

EC: Electrical Conductivity; OM: Organic Matter; Nt: total nitrogen; K: potassium; C : N: carbon : nitrogen; P: phosphorus.

1: Ulle et al. (2004); 2: Ulle et al. (2005); 3: Giulietti et al. (2008); 4: Campitelli and Ceppi (2008); 5: Castillo et al. (2005); 6: González et al. (2008).

EC is another parameter to be considered. Salts in fresh manure tend to be high (Table 1). The EC in the final product greatly depends on the raw material used for vermicomposting, in agreement with Atiyeh et al. (2000). Lasaridi et al. (2006) suggested that the maximum EC value should be 4 dS/m, which is considered tolerable by plants of medium sensitivity for salinity. Among the vermicomposts produced, all of them except those derived from rabbit manure had lower EC values than traditional composts.

Total N content was lower in all vermicomposts analysed than the corresponding composts or fresh manure. Although microorganisms are largely responsible of organic matter decomposition, and ammonia volatilisation, earthworms may directly affect the rates of decomposition by digesting organic matter and feeding microorganisms, or indirectly involving stimulation or depression of microbial populations (Lavelle and Spain, 2001). Total N content in vermicompost ranged between 7 and 23 g kg^{-1}, in good agreement with data reported by Elvira et al. (1998).

The C/N ratios for vermicomposts of different origin were relatively high. The actual ratio obtained depended on the composition of the original material. A C/N ratio of 10–12 is considered an indicator of stability (Jimenez and Garcia, 1992). Lee (1985) indicated that earthworms ingest and re-ingest available organic matter. However, earthworms do not ingest all the plant litter, dung or other organic material that they move.

These results indicate that vermicomposts from different raw material and time of process may differ in its quality, as reported by Goyal et al. (2005) and Zmora-Nahum et al. (2007). Few attempts have been made to find and define properties, which can be useful to assess end-quality for composts of varying sources and from various facilities. Campitelli and Ceppi (2008a) have proposed a statistical methodology for the classification of organic amendment from different sources. The multivariate technique was carried out using Principal Component Analysis (PCA) and typical classification techniques (LDA) by determining parameters related to physical, chemical and biological characteristics of composts, including: pH, Total Nitrogen (TN), Total Organic Carbon (TOC), Water-Soluble Carbon (WSC), Germination Index (GI), TOC/TN and WSC/TN. Through the use of statistical techniques, organic amendments were classified in the categories A, B_1, B_2, B_3 and C, according to stability, maturity and quality characteristics.

2.1.4 Industry wastes

Industries produce huge quantities of liquid and solid wastes, resulting in sludge generation. Economical and ecologically acceptable disposal of industrial sludge is becoming a great challenge to industries, due to the high cost of sludge stabilisation reactors, dehydration systems and transportation to disposal sites. Food processing has emerged as one among the most important industrial activities in recent years. Industrial wastes that are rich in organic matter and free from toxic elements or substances may be suitable substrates for vermicomposting (Yadav and Garg, 2009). Transformation of industrial sludge into vermicompost is of double interest: on the one hand, the waste is converted into a valuable product, and, on the other, it controls a pollutant that is a consequence of increasing industrialisation. Several research has been conducted on the potential use of *Eisenia fetida* earthworm in nutrient recovery from industrial sludges, including organic residues from fruits and vegetables (Sánchez de Pinto et al., 2006), carnic and tobacco wastes (Altamirano and Zankar, 2008), fish offal (Laos et al., 2002); lemon pulp waste (Navarro et al., 2009); rice hulls (Leconte et al., 2009) and puffed rice scrap (Schuldt et al., 2005). Laos et al. (2000) reported that during the composting period, values of total nitrogen, total organic carbon, total organic carbon: total nitrogen ratio, and pH did not show a clear trend, whereas in most cases EC, ammonium as nitrogen (NH_4^+–N) and volatile fatty acids decreased significantly.

The results obtained in all cases confirm that vermicomposting may transform solid residue into a commercially valuable organic amendment under controlled conditions.

2.2 Use of vermicompost as a biofertiliser

There is scientific evidence that vermicompost can significantly influence the growth and productivity of plants (Edwards, 1998). Various greenhouse and field studies have examined the effects of a variety of vermicomposts on a wide range of crops including perennial grasses, like *Digitaria eriantha* (Giulietti et al., 2008); vegetables, like tomato seedlings, Cv. *platense* (Valenzuela and Gallardo, 1997) and *Lycopersicon esculentum* Mill. (Premuzic et al., 1998); lettuce, *Lactuca sativa* L. (Chiesa et al., 2006; Coria-Cayupán et al., 2009), cv Marianella (Ullé et al., 2005) and cabbage, *Brassica oleracea* (Cracogna et al., 2008); ornamental and flowering plants, like basil seedlings, *Ocimum basilicum* L. var. Catamarca (Cabanillas et al., 2006), *Impatiens walleriana* (Asciutto et al., 2006); field crops, like garlic, *Allium sativum* L. (Argüello et al., 2006).

The use of vermicompost as biofertilisers produced an increase in yields in horticultural crops both in fresh and in dry matter (Spiaggi et al., 2001; Coria-Cayupán et al., 2009). The growth response of lettuce cv Marianella was evaluated in plots where four vermicomposted manures (poultry litter, cattle, horse bed and swine) were applied at similar rates (Ullé et al., 2005). All treatments rendered plants with higher average plant weight compared with unamended control, though average weight was significantly higher in the poultry litter vermicompost amended soil than in the rest of the treatments. Similarly, lettuce crop yield significantly increased and an enrichment in its pigment contents was observed when vermicomposts produced through the processing of cattle manures, agro-industrial organic wastes were applied (Coria-Cayupán et al., 2009). However, antioxidant value and phenolic levels were reduced in some cases. Some other authors concluded that vermicompost contain humified organic matter characterised by high molecular weight and an enzymatically active humic fraction, which has been found to possess phytohormonal properties that stimulate plant germination and growth (Garcia et al., 1992; Dell'Amico et al., 1994). The use of vermicompost as amendments to reduce soilborne pathogen diseases is gaining the interest of plant pathologists, manufacturing and processing industries, regulators, consumers and growers (Lazarovits et al., 2001). The results obtained by Rivera et al. (2004) confirm that vermicomposts can be included in the development of effective alternatives to control tomato damping-off. In addition, it may be a tool to promote seedlings growth.

On the other hand, this organic material has large particulate surface areas that provide many micro-sites for microbial activity and for the strong retention of nutrients (Shi-wei and Fu-Zhen, 1991). Vermicompost contains nutrients in plant available form such as nitrates, phosphates and exchangeable calcium and soluble potassium (Edwards, 1998). The availability of P in vermicompost is often significantly greater than in bulk soil. This can be attributed to the quantities of phosphorus ingested by earthworms in the organic matter they consume, which pass through the intestine and is afterwards excreted. Some authors believe that the greater release of P from casts is due to enhanced microbial activity (Lee, 1985; Scheu, 1987), while others suggest it is due to increased phosphatase activity (Lavelle and Martin, 1992).

The use of vermicompost as a peat substitute in greenhouses has also been proposed. Valenzuela and Gallardo (1997) evaluated the growth of tomato seedlings (cv *Platense*) in mixtures of different proportions of soil and vermicompost. They reported that total nitrogen, extractable phosphorus, available potassium and soluble salts increased as the proportion of vermicompost increased in the mixture. These authors concluded that EC values of 2.07 dS/m, corresponding to a 2 : 3 mixture of vermicompost and soil, negatively affected tomatoes (cv *Platense*) seedlings growth. On the contrary, Premuzic et al. (1998) reported that tomatoes *L. esculentum* Mill. grown in a glasshouse on vermicompost or on a 1 : 1 mixture of vermicompost and soil had significantly higher weight, number of fruits, and contained significantly more Ca, C vitamin and less Fe than fruits grown on a hydroponic inorganic media. However, P and K content in *L. esculentum* Mill. did not significantly differ from vermicompost or hydroponic inorganic substrates. Arguello et al. (2006) reported that the use of a 1 : 1 mixture of vermicompost and soil as a substrate caused early bulbing and lengthened bulb filling period in 'Rosado Paraguayo' garlic bulbs. The treatment with vermicompost also increased scorodose accumulation, resulting in greater yield and bulb quality.

2.3 Use of vermicompost in urban agriculture

Vermiculture was introduced in the Empalme Graneros neighbourhood of Rosario City, Santa Fe province, in 2001. The project was based on international experience of urban agriculture to lessen to some degree the food problems that large sectors of this community were facing. One of its objectives was to introduce large-scale vermiculture as an appropriate technology for processing organic waste and producing biofertiliser in productive urban agriculture systems. Trials with fluid and standard vermicompost were performed with tomato (L. *esculentum var. platense*), aromatic and medicinal plants. An increase in the number and weight of fruit was observed with the use of fluid and standard vermicompost. Thus, vermiculture resulted in an appropriate biotechnology for transforming waste into an input at a small to medium scale. Moreover, its low cost and simple handling made it available to small producers and urban inhabitants with few financial resources (Spiaggi, 2005). Actually, this community transforms about 6 t of organic waste per year in 2.6 t of vermicompost.

3 Use of vermiculture technology in environmental remediation

Most contaminants that are discharged to aquatic environments have the tendency to bind to sediment particles (Alcock et al., 2002; Zheng et al., 2008). Nriagu and Simmons (1984) reported that about 60% of the metal present in aqueous systems is bound to sediments. Sediment-bound contaminants may pose a particular risk to the whole aquatic system, for they may be released by desorption, increasing their concentrations in the aqueous phase, or may be ingested by benthic organisms and released into the gastrointestinal tract of the animal (Chapman et al., 2002). The impact of these pollutants range from simple nuisance substances to severe ecological impacts, involving fish, birds, mammals and human health. Thus, in situ remediation processes have to be conducted to reduce contaminants to an acceptable level.

The Matanza-Riachuelo River is located in the province of Buenos Aires, and is the most contaminated river basin in Argentina and in Latin America (Olson et al., 1998). This river has been used as a sewage destination since the colonial years, and throughout the centuries pollution levels have steadily increased along with industrialisation. The basin, with an area of 2,200 km^2, is also home to Argentina's largest population of poor communities. Overall, the industrial facilities located along the watershed can be characterised by use of old-fashioned technology and low levels of pollution control. Usually, existing treatment facilities do not work well, and environmental compliance is extremely low. Nonetheless, the government of Argentina, through the Secretary of Environment and Sustainable Infrastructure (SAyDS), has made the Matanza-Riachuelo problem the top-priority in its environmental agenda.

The complex mixture resulting from industrial effluents, municipal wastewaters, and landfill leachates dumped into the Riachuelo River are mainly accumulated into the river sediments. An experimental model based on the use of artificial particles as analogues of natural sediments has been proposed to investigate the bioavailability and bioaccumulation of several organic chemicals bound to sediments (Verrengia Guerrero et al., 2001; Verrengia Guerrero et al., 2003). *Lumbriculus variegates* is a freshwater oligochaete that feeds on sediments. This species has been recommended and widely adopted as standard organism for bioaccumulation studies and toxicity tests (Phipps et al., 1993; US EPA, 1994; ASTM, 1995). Moreover, numerous researchers investigated the bioavailability and bioaccumulation of trace elements by *L. variegates* using these artificial particles. Miño et al (2006) studied the uptake and bioaccumulation of lead (Pb); Piol et al. (2006) used these artificial particles with and without humic acid to investigate the bioavailability and bioaccumulation of cadmium (Cd) whereas Puelles et al. (2008) exposed worms to a mixture of Cd and Pb in the presence of artificial particles with sizes in the range of 40–60 μm, to ensure worms' ingestion.

The main pathways for chemical absorption are dermal uptake for soluble elements, and gut and digestion for the insoluble ones (Weltje, 1998). Becquer et al. (2005) concluded that the ingestion of metals bound to soil components followed by their cellular assimilation are likely to be the most important pathway for metals to enter the body tissue of invertebrates, whereas dermal uptake of dissolved ions is less important, except perhaps for Cd. Both studied elements accumulation were abnormally high in water (Puelles et al., 2008). These results were explained because, in the absence of particulate matter, *L. variegates* was unable to burrow and was probably more stressed and mobile than they would be in a natural situation, leading to a higher accumulation than expected, as it was previously observed by Miño et al. (2006). In this way, *Lumbriculus variegates* species can accumulate Cd and Pb, when these elements are in aqueous phase, or when Cd and Pb are bound to minerals or organic compounds by ingestion, as simulated with the artificial particles. The results obtained by Miño et al. (2006), Piol et al. (2006) and Puelles et al. (2008) suggest that L. *variegates* may be potentially used as a bioindicator organism to reduce inorganic pollution in aquatic sediments.

4 Conclusion

The experiments reported in Argentina have substantiated the feasibility of utilisation of different kinds of waste (MSW, manure and industry wastes) for vermicomposting. In this way, solid residues that cause economic and environmental problems may be transformed into a commercially valuable organic amendment under controlled conditions. Amending soils with vermicompost increased the growth and yield of some horticultural crops, ornamental and flowering plants. Nonetheless, the availability of trace elements in vermicompost has to be carefully studied. Vermiremediation studies are incipient in Argentina. Nevertheless, research on *L. variegates suggest that this species* may be potentially used to reduce inorganic pollution in marine sediments.

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