الأكاديمية العربية للعلوم والتكنولوجيا والنقل البحري

Arab Academy for Science, Technology & Maritime Transport

Title:

Composting the organic wastes into an organic fertilizers using the earthworm *Eisenia fetida* (red wiggler)

الأكاديمية العربية للعلوم والتكنولوجيا والنقل البحري

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<u>Short Title or Acronym:</u>

Vermicomposting of agricultural wastes.

Keywords:

vermicompsting- earth worms – agricultural wastes.

Total cost

500,000 pound and period of 12 Months for the CRP,

Research Theme:

Agriculture

Proposal English Summary:

Recycling the organic waste is considered as a great problem allover the world and especially in the Arab countries which have an increase rate of population and development. Most of these organic wastes are dumped in landfills and a very few are buried in specially designed underground places. The decomposing of such organic wastes leads to the production of greenhouse gases as CO2 and methane. Also, it causes many problems to the underground water.

The current project aims to the building a sustainable composting unit for the disposal of the organic wastes using the earthworm which will feed on them. After digesting the worms for these organic wastes, it produced a cast called vermicompost which is very rich in organic nutrients as well as growth hormones which will be very useful for plant growth.

Moreover, the production rate of these worms is very high and also its protein content reach 70%. So, the dried worm meal can be used as a supplementary feed for fish and poultry. This in turn will decrease the fish and poultry production coast and hence decrease the overall prices of such important human food.

So the current project is trying to solve the problem of organic wastes in cities and also converting them to a valuable and important product. Moreover, such techniques will decrease the overall emission of greenhouse gases.

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Proposal Arabic Summary:

الملخص العربى:

تعتبر المخلفات العضويه سواء من المخلفات الزراعية او مخلفات المدن من اكبر المشكلات التى تواجه العالم باسرة والدول العربية بخاصة والتى تتزايد فيها معدلات النمو السكانى بصورة مرتفعه مما ينتج عنها من العديد من المخلفات العضويه. وهذة المخلفات العضويه يتم تجمعيها وإلقاءها فى مناطق مفتوحه حتى يتم تحللها او دفنها فى مدافن خاصه تتطلب بناءها أمكانتيات كبيرة، تحلل هذة المخلفات ينتج عنه غازات الإحتباس الحرارى مثل غاز ثانى اكسيد الكربون وايضا غاز الميثان. كما ان تحللها فى المدافن الأرضيه يسبب مشاكل عديدة للمياة الجوفية. كل هذا دعا الى البحث والتفكير عن طريقه مثالية للتخلص من هذة النفايات بل وتحويلها الى مكاسب بيئيه،

تعتمد فكرة المشروع الحالى على تقديم هذة النفايات العضويه كطعام لنوع من الديدان الأرضية والتى تعتبر شرهه للغذاء على هذة النفيات تسمى ديدان الريد وجلير.

بعد هضم هذة الديدان للنفايات العضويه تقوم بإخراجها فى صورة مخلفات صغيرة تحتوى على محتوى من العناصر الغذائيه والإنزيمات وايضا منشطات النمو كل هذة العناصر. تعتبرللنباتات سماد عضوى غنى المحتوى بالعناصر الغذائيه اللازمه وايضا من العناصر التى تساعد النباتات على مقاومه الحشرات والآفات.

ايضا تمتاز هذة الديدان الأرضية بسرعه نموها وتكاثرها وبتجفيف هذة الديدان وجد ان محتواها الحيوى من البروتين يصل إلى 70%. وعليه فإننا يمكن تحويل هذة الديدان بعد تجفيفها الى مكملات لعلائق الدواجن والأسماك. هذا الإتجاة يساعد على تخفسض اسعار العلائق وبالتالى يمكن ان يساهم فى تخفيض اسعار الدواجن والأسماك مما يعود بالنفع على المستهلك.

وعلى ما تقدم يتضح لنا ان المشروع الحالى يقدم حل بيئى لمشكله المخلفات العضويه بل وتحويلها الى قيمه مضافه مما يعود بالنفع المباشر على المواطن وايضا يقلل من انبعاثات غازات الإحتباس الحرارى.

Introduction/Background:

Management of municipal solid waste (MSW) is a major challenge faced by municipal authorities across the world. Effective waste management is among big challenges in most Arab countries, including Egypt, due to high population growth rate and rapid urbanisation. Current global MSW generation levels are approximately 1.3 billion ton per year and are expected to increase to approximately 2.2 billion ton by 2025 (Danso *et al* 2006). These numbers represent an expected significant increase in per capita waste generation rates, from 1.2 to 1.42 kilograms (kg) per person per day. Egyptian Environmental Affairs Agency (EEAA) estimated the generation of Egyptian MSW with 0.3 to 0.8 kg/day/capita, with an annual growth of 3.4%. In addition, there is 6.2 million ton/year industrial waste including 0.2 million ton of hazardous waste and 23 million ton/year of agricultural waste (EEAA, 2011).

Municipal solid waste can be organic and inorganic and is generally categorized as organic, paper or cardboards, plastics, glass, metals, textiles, *etc*. A large proportion of municipal waste in developing countries is organic material. In low-income countries, 65–75% of waste is organic, compared with an average of 28% in high-income countries (Hoornweg and Bhada-Tata 2012). Organic waste can be recycled for use in agriculture, and recycling can thereby become a win-win strategy for both the sanitation and agriculture sectors. Organic waste can be recycled for use in agriculture, and recycling can thereby become a win-win strategy for both the sanitation and agriculture sectors.

Composting is the process of decomposing or breaking down of organic waste materials by microorganisms such as bacteria, protozoans, fungi and invertebrates into a valuable resource called compost. Microbial degradation reduces the mass and volume of organic materials, thereby generating heat and creating an environment necessary for the deactivation of pathogens. The process allows for the recovery of nutrients and organic matter for use in agriculture. Urban and peri-urban agriculture represent a good opportunity for nutrient recycling, provided that technological and socio-economic strategies for optimum recovery are taken into account (Cofie et al. 2014).

The majority of municipal solid waste is placed in landfills. In Egypt, the major types the landfills are called open dumps which potentially lead to adverse environmental impacts and threaten human health. Within the landfill a complex sequence of chemical, physical, and biological processes occur that lead to waste degradation. These processes are naturally occurring but can be enhanced by controlling landfill internal conditions. The degradation processes lead to the emission of biogas and to the leaching of material from the landfill. Gas and leachate must be effectively managed to protect the environment. Because of their biodegradability, land filled biogenous wastes cause in huge emissions contributing to greenhouse effect (methane) and pollution of groundwater, respectively.

The methodology used for organic waste recycling in the present proposal is called as "Vermicomposting". Vermicomposting is a method of making compost, with the use of earthworms, which generally live in soil, eat biomass and excrete it in digested form. This compost is generally called vermicompost or Wormicompost.

The potential benefits of organic waste recycling are particularly reduced environmental impact of disposal sites, extended capacity of existing landfills, replenished soil humus layer and minimized waste quantity (Zurbruegg and Drescher 2002; Cofie *et al*. 2006; Banegas *et al*. 2007; Gu *et al*. 2011). Other benefits of organic waste recycling are:

- It reduces overall waste volume, transport costs and landfill lifetime
- It enhances waste collection, recycling and incineration operations by removing moist organic matter from the waste stream
- It promotes environmentally sound practices, such as the reduction of methane generation at landfills.
- It is flexible for implementation at different levels, from household efforts to large-scale centralized facilities, *i.e.*, can also be started with very little capital and has limited operating costs.
- It enhancement of water holding capacity, porosity, aggregate stability, microbial life in soil,
- It closes the nutrient and the organics cycle, which helps to save the soil functions by adding stable humus compounds as well as nutrients to agricultural land.
- It from economical point of view, organic waste recycling will add decrease of cost of waste transportation and land filling also, it will greatly reduce the usage of the inorganic fertilizers in agriculture and so enhance the organic food production.
- More over, the composting earthworms will be used as a supplementary food in fish aquaculture and poultry sector. So it will reduce the cost of the fish and poultry feed, which will consequently reduce the price of fish and poultry production.
- Earthworms can also maintenance of environmental quality and monitor of the environment for soil fertility, organic and heavy metal non-biodegradable toxic material pollution.

Questions and Objectives:

The objective of the current project is to develop an environmentally sound vermicomposter unit which decrease the environmental impact of the agricultural wastes from the landscape areas in the AAST main compass in Abu Qir which is estimated to be in average about 1 ton/month. Also, the kitchen scarps produced from the student hotels in the main compass is also a great source of organic wastes. On the other hand, the produced organic fertilizers will be used in the landscape areas both in the main compass in Abu Qir and in the other sites as Elalmen campuss, so encoring the concept of organic agriculture and reduce the costs of inorganic fertilization of the landscape areas.

The great production rate of the earthworm will lead us to the production of dried worm meals. The dried worm meals will contribute for the research in both the fish production units as well as the research in the filed of human malnutrition.

Project Description:

Vermicompost is worm castings or digested excretions, and is largely used by gardeners and landscapers as a soil amendment. These castings originate from organic materials, which the worms feed on. The materials consumed by worms undergo physical breakdown in the gizzard resulting in particles <2 μ, giving thereby an enhanced surface area for microbial processing. This finally ground material is exposed to various enzymes such as protease, lipase, amylase, cellulase and chitinase secreted into lumen by the gut wall and associated microbes. These enzymes breakdown complex biomolecules into simple compounds. Only 5- 10% of the ingested material is absorbed into the tissues of worms for their growth and rest is excreted as cast. Mucus secretions of gut wall add to the structural stability of vermicompost.

Vermicompost contains many plant available nutrients, vitamins, enzymes, antibiotics and growth hormones. The castings improve soil structure by enhancing soil porosity, aeration, and moisture holding capacity resulting in enhanced plant growth.

Vermicompost horbours certain microbial populations that help in N fixation and P solubilization. Its application enhances nodulation in legumes and symbiotic mycorrhizal associations with the roots.

In the current project the produced vermicompost will be analyzed for its chemical and physical and biological proprieties.

Earthworms

The used earthworm in the present project is the *Eisenia fetida* (red wiggler) which is an epigeic species (that form no permanent burrows and live on the surface). The worms feed on any biodegradable matter producing vermicomposting. One earthworm reaching reproductive age of about six weeks lays one egg capsule (containing 7 embryos) every 7-10 days. Three to seven worms emerge out of each capsule. Thus, the multiplication of worms under optimum growth conditions is very fast. The worms live for about 2 years. Fully grown worms could be separated and dried in an oven to make 'worm meal' which is a rich source of protein (70%) for use in animal feed.

The overall objectives of the current project can be summarized in the following points:

1- Studying the environmental conditions (Temperature, humidity, % of organic matter, *etc.*) which enhance the vermicompost production.

2- Studying the chemical and the nutrient composition of the produced vermicompost.

3- Studying the variables affecting the production of the earthworms.

4- Testing the protein content of the new produced worms using different organic wastes.

Research Team Information Table:

Name of Res. Team Member in English	Name of Res. Team Member in Arabic	University / Institute In English	Position / Title	% of time spent on project	No. of months	Incentive per month (LE)	Number of other projects and their IDs	Total % of time spent on other projects	Contact No
Dr. Essam Abdel-Mawla	د عصـام عبـد المولى	AASTMT(PI)	Dean of Aquaculture Research Center	25	12	2500	-	-	01066623970
Dr. Yaser Sangak	د. ياسر سنجق	AASTMT	College of Fisheries technology	25	12	2500	-	-	
Mr. Mohamed Yousry	ا. محمد يسرى	AASTMT	Aquaculture Research Center	25	12	1000	-	-	
Mr. Mahmoud El sayed	ا. محمـــــــود السيد	AASTMT	Aquaculture Research Center	25	12	1000	-	-	
Mis. Nadia Hassan	م. ناديه حسن	AASTMT	Aquaculture Research Center	25	12	1000	-	-	

Anticipated Results and Evaluation Criteria:

The units of the composting agriculture waste will be made in triple units. The nutrient content of the produced vermicompost will be analyzed for each unit. The number of the newly produced worms will be counted in each unit .

The protein content of the earthworms will be analyzed according to the stander method.

Expected Project Outcomes and Impact to AASTMT:

The main outcome from the current project is a prototype for a small-scale composting unit which is capable of producing vermicompost as well as a newly hatched earthworm. For AASTMT, prevention of dumping the agriculture and organic waste into the landfills will reduce the emission of methane and CO2 into the environment. Using vermicompst as an organic fertilizer for the AASTMT landscape will reduce the inorganic fertilizers and will encourage the production of organic agriculture. All the previous achievements is in agreement the 17th (SPG) goals of the sustainable development of the united nations.

From the Socio-economic point of view the vermicompst unit will be an economic model for the small-scale projects. Its main feeding materials is the kitchen scraps and the organic wastes and the output is a healthy organic fertilizer as well as the dried worm meal which will be used in fish and poultry culture.

Resources:

The following The available resources in Aquaculture Research Center in the main campuss in Abu Qir are:

1- Green houses for planting experiments and evaluating the vermicompost as an organic fertilizer.

2- Environmentally controlled laboratory for rearing the earthworms,

3- A small vermicompsting pens.

The technical persons worked in Aquaculture Research Center are well trained in the vermicompost production facility.

References

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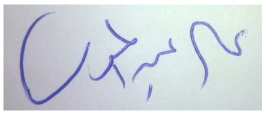
Declaration of original submission and Other Grant(s):

I declare that their proposal did not and will not be submitted in whole or part for funding; twice within the same cycle, or to other funding programs within AASTMT, or other funding agencies. This is to avoid any possible co-funding.

Acknowledgment Form: _

By signing below, I acknowledge that I have read, understand and accept to comply with all the terms of the foregoing application, mentioned in AASTMT general conditions and guidelines for submitting a research proposal,



Date & Signature: _ 14-3-2021__

Table of Eligible Cost

<table>
<tr><th>Eligible costs</th><th colspan="2">Break downs</th><th>AASTMT support (L.E.)/month</th></tr>
<tr><td rowspan="6">▪ Staff Cost</td><td colspan="2">PI Dr. Essam Abdel Mawla</td><td>2500 *12</td></tr>
<tr><td colspan="2">Dr. Yaser Sangak</td><td>2500 *12</td></tr>
<tr><td colspan="2">Mr. Mohamed Yousry</td><td>1000 * 12</td></tr>
<tr><td colspan="2">Mr. Mahmoud El sayed</td><td>1000 * 12</td></tr>
<tr><td colspan="2">Miss. Nadia Hasan</td><td>1000 * 12</td></tr>
<tr><td colspan="2">Total</td><td>96,000</td></tr>
<tr><td rowspan="3">(B) Equipment</td><td colspan="2">Equipment</td><td>300,000</td></tr>
<tr><td colspan="2">Spare parts</td><td>4000</td></tr>
<tr><td colspan="2">Total Equipment</td><td>400,000</td></tr>
<tr><td rowspan="3">(C) Expendable Supplies & Materials</td><td colspan="2">Stationary</td><td></td></tr>
<tr><td colspan="2">Miscellaneous Laboratory, Field supplies, Materials</td><td></td></tr>
<tr><td colspan="2">Total expendable Supplies & Materials</td><td>10,000</td></tr>
<tr><td rowspan="3">(D) Travel</td><td colspan="2">Internal Transportation</td><td></td></tr>
<tr><td colspan="2">Accommodation</td><td></td></tr>
<tr><td colspan="2">Total travel</td><td></td></tr>
<tr><td rowspan="8">(E) Other Direct Costs</td><td rowspan="3">Services</td><td>Manufacture of specimens & prototypes</td><td>40,000</td></tr>
<tr><td>Acquiring access to specialized reference sources databases or computer software</td><td></td></tr>
<tr><td>Computer services</td><td>5,000</td></tr>
<tr><td colspan="2">Report preparation</td><td>10,000</td></tr>
<tr><td colspan="2">Publications & patent Costs</td><td>30,000</td></tr>
<tr><td colspan="2">Workshops organization or Training</td><td>5,000</td></tr>
<tr><td colspan="2">Others (explain)</td><td></td></tr>
<tr><td colspan="2">Total other direct costs</td><td></td></tr>
<tr><td>(G) Total Costs</td><td colspan="2"></td><td>500,000</td></tr>
</table>

DETAILED PLAN ON PROJECT'S ACTIVITIES (*GANTT CHART*):

Activity Name	M1	M2	M3	M4	M5	M6	M7	M8	M9	M10	M1 1	M12
Main 1: Main Task 1 Building the vermicompost pen	:::::	:::::										
Sub 1.1: Sub Task 1.1 Collecting and fermenting the organic waste		:::::										
Sub 1.2: Sub Task 1.1 Acclimation of the starting earthworms (weight and count)		:::::										
Main 2: Main Task 2 Feeding and rearing the worms			:::::	:::::	:::::							
Sub 2.1: Sub Task 2.1 Collecting and drying the vermicompost						:::::						
Main 3: Main Task 3 Analyzing the nutrient and chemical content of the vermicompost							:::::					
Sub 3.1: Sub Task 3.1 Evaluating the vermicompst as a plant fertilizers (evaluating a plant production cycle)								:::::	:::::	:::::		
Main 4: Main Task 4 Estimating the production rate of the worms/year (weight and count of the final worm content in the unit											:::::	
Sub 4.1: Sub Task 4. Reporting, publication and finalization												:::::