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Annals of Biological Research, 2012, 3 (5):2500-2506
(http://scholarsresearchlibrary.com/archive.html)

Annals of Biological Research
Scholars Research Library
ISSN 0976-1233
CODEN (USA): ABRNBW

A review on earthworm *Esienia fetida* and its applications

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ABSTRACT

Esenia fetida belongs to the family of lumbericidea and genus esenia. By red, purple or brown color, this worm is a kind of surface-born and essentially is waste-born and fertilizer- maker and lives in a wide range of climate type and it is active in all seasons. This article introduces eisenia fetida genus and its different applications in different areas. One of its most important applications is on feeding farmed fish, such as salmon, sturgeonet and the feeding of crustoceans like shrimp .It is has Ssuitable compounds and fatty acids and essential amino acids and high amount of omega-3.These characteristics distinguishe it from plant resources. The biological fertilizer that is made by earthworm is so useful in agriculture and residual waste and used as a fertilizer that has an important role in environmental protection. Finally we can say that this organism plays a crucial role in human life.

Keywords: nutrition of aquaculture, biological fertilizer, earthworm *eisenia fetida*.

INTRODUCTION

According to growing trend of using chemical fertilizers in agriculture and its associated environmental impacts specially in developing countries, application of management strategies are necessary to reduce its effects. Non-fundamental and long-term consumption of fertilizers not only lead to degradation of soil quality,but also can reduce product quality, that disrupt the natural balance of the ecosystems and increases the environmental pollution . In the past half century, using chemical fertilizers significantly has incre ased yield of the agriculture products. The environmental stability results from the use of fertilizers, on one hand and lack of reaction in most of these products to the higher use of fertilizer due to the uncontrolled use of it and on the other hand, will face problems food production in the coming decades [1]. One of one way to improve plants growth is using organic fertilizers which is kind of biological fertilizer that is made of earthworm *"eisenia fetida*". Earthworms have been brought by early European immigrants to North America in the 17th and 18th centuries. If there were earthworms in North America before, it was probably during the last Ice-Age, that was about 10.000 to 50.000 years ago. Most species are native to New Zealand but about two dozen have been brought randomly from Europe to New Zealand .A number of studieses have been performed on development of biological technology of the earthworm and multi-purpose use of it has become well common in the world. Its expansion and development is growing every day. Now a days this technology, especially in developed countries is quite common, and has many advocates. This is due to the progress of science and agriculture industry in these countries and the necessity of using biological fertilizers. This technology was transferred to the Asian countries at recent decades and gradually fertilizers and biological fertilizers with natural origin were replaced with chemical fertilizers that directly or indirectly can lead to some problems and complications.

Initially Waste production project by using earthworms was introduced in United States and Japan that followed by European countries like Britain, France, Germany, Switzerland and Hungary, and now is running in many Asian countries like India, Malaysia, Philippines, and Armenia [2,3].

1- Earthworm *eisenia fetida* characteristics

This worm belongs to the family of *lumbericid*ae and genus *eisenia*, which isknown by other names such as the tiger worm, garlic worm (abdominal bad odor fluid when alarmed release the smell of the garlic), flatworm, cadillac worms and worm for fishing bait. The color of these worms is red, purple or brown and yellowish in abdomen part . The number of its segment is about 80-110 and it's between 23-130 mm length. During puberty, the genital belt reaches to 7-9 pieces in between parts 24, 25 or 26 or 32. Adult worms weight is approximately 1.5g and about 50 to 55 days after coming out of the cocoon they are able to reproduce. Adult worms can create a cocoon every three days on average that after 23 days one- third of newborns come out of the cocoon. Although all infants do not survive. Earthworm *esienia fetida* worm is a kind of surface-born and essentially is waste-born and fertilizer- maker and its habitants are mass manure, horticultural land that contains large amounts of organic material, forest and areas containing much wooden and leaves waste and it can act as a suitable degrading in soil, and it can live in a wide range of climate type and is active in all seasons. The food consumption and reproduction rate in these worms is high and have life, nutrition and reproduction ability in environments are rich in organic matter so that these worms are able to use the daily equivalent of half its weight of organic waste [1].

2- Vermicomost and its applications

2-1 Nutrition of aquaculture by earthworm *eisenia fetida*

The compounds of each material, especially protein are important factors in selecting this worm as aquaculture and livestock and poultry's feed . In aquaculture like other animals in the breeding, feeding and nutrition are key success element in fish farming(aquacultures farming) producing. useing alive animal(creature)as other animals feed foods is considerable in terms of maintain the value of other valuable applications. Among a variety of live feed, using some worms and worm *shakeela* is increasing.

These organisms such as low tar and polychaetes worms beetle vermiform larvae and other insects given appropriate nutritional value and their nutritional value can meet aquatic s needs such as good amount of protein , fat and all kinds of fatty acids and amino acids, have been considered. The advantage of using this species in addition to appropriate nutritional value is, its possible animals breeding in every environments. This provides them breeding in any environment. The aim is introducing some live feed in the aquacultural world with emphasis on their nutritional value [4].

Generally, the types of farmed fish, especially fish that need 35.5% protein and 5.20% fat in their diets. These numbers change by aquatic growing with diet species and environmental and breeding conditions. So that in salmon farming ,for changing from active diet to productive diet, 45.52 proteins and 9.15% fat is needed . These figures in breeding common carp reach to 36.45% protein and 8.18% fat and in shrimps is 35.45% protein and 5.10 % fat in their diet . The essential fatty acids and amino acids are also needed . In the case of linoleic fatty acid (n-3 3:81) and the amino acid arginine in trout breeding , 8.0-6.1 percent fat and 8.3 - 5.3 percent protein , in common carp 70-71 and 0.4-2.4 percent ,and types of shrimps 05.0-52/0 and 5.8-2.80 percent, respectively is needed [5,6].

Using variety of live feed to complement with the variety of foods formulated granules, aquatic food needs to be easily covered.

2-2- Nutrition of aquaculture with earthworm *eisenia fetida*

Using this organism in live or dried is important in the aquaculture diet. Suitable compounds of fatty acids and essential amino acids and high amount of omega 3 in this organism distinguished it from plant resources [7,8].

In one study , African catfish fingerling clariasgriepinus fed by
earthworm eisenia fetida.. Results of this study show that fry feeding with earthworm *eisenia fetide* causes faster growth and higher percentage of resistance against stress and survival in comparison with control fish which did not feed with earthworm *eisenia fetida* [9]. fresh water fishes that were fed with eisenia fetida during guttatus, mystus ,grew up better than control group fishes during Increasing growth at farming fish rainbow trout, Siberian sturgeon *acipenser baeri*, snake fish *angullia japonica seriala quinquer diater anguilla angullia* in Japan and Thailand were fed with different types of earthworm *eisenia fetida* were also observed [10,11,12,13].

2-3- Feeding aquaculture species crustaceans by earthworm *eisenia fetida*

Earth worm *eisenia fetida* is used to feed shrimp post larvae in order to increase their growth and accelerate the Shrimps'spawning . As other examples feeding western white feet shrimp post larvae *penaeus vannanei* and freshwater large shrimp of *macrobra chium rosenbergi* with types of less rare worms including earthworm *eisenia fetide* can be pointed out. In these cases, post larvae feeding with worms and shrimp growth rate was significant [4,10,14].

feeding cray fish *marrom* with earthworms *eisinia faetida* with the scientific name of *cheraxtenuimanus* in Australia obtained significant results . This study carried out [5] and showed that this organism is able to provide almost complete nutritional needs and protein in marrem and on the other hand, worm fat meet all needs of fat in crab and this removal tuna fish oil used in the diets of lobster. Removing the tuna fish oil, significantly reduce the Feed preparing cost and crab breeding costs as well. The size of this organism is also very important, practically. This makes direct use of feeding aquaculture worms that have a big mouth such as "sturgeons". As the worm is able to move in the water so long, it can be used as live feed in aquatic feeding which move toward food to eat , by delay. But in white worms because of their small size, they face with difficulties. producting earthworm is simple and not much equipments are required , that it makes low cost production of earthworms possible . But production of other live vermiform foods such as white worm, larvae of blood worms and Tubifex costs more and requires more equipment. It is determined by comparing protein percent of some mentioned foods that after Tubifex, the earthworm has the highest protein and ash and fat percent [6].

Use of this organism due to its different sizes in different periods of its life, does not limit to certain age and with regard to the objectives and for facilitating aquaculture workshop, mature worms, young worms, larvae and even cocoon can be used as feed . But, in case of white worm because of its small size, just during the larval period and for feeding newborn aquaculture can be used and with the growth of aquatic, this organism searches for larger food that is suitable for its mouth size, so the use of white worm is not logical and practical [8].

By using dry earthworm *eisenia fetida*, preparation of a meal is easier and more economical than preparation of white worm meal by other worms. The preparation of white worm meal due to high cost of worm production and also its small size is not economical [4].

Table 1. The worms and worm *shakeela* are used as live food is presented Adopted from [3]

Species	Body composition based on dry weight				Reference
	Protein	Fat	Ash	NFE	
Earthworms	65	11	6	19	[3]
Eisenia Foetida	59	9	17	15	[4]
Dendrobaena veneta	45	11	29	3	[3]
Tubifex tubifex	65	14	15	-	[4]
En chytraeus albidus	46	14	7	-	[6]
Chironomid mirei	51	12	13	18	[3]
Bomby mori	72	19	3	5	[3]
Tenebrio molitor	58	29	4	2	[3]
NFE: Nitrogen Free Extract					

Table 2. The amount of amino acids and essential fatty acids in body composition earthworm *eisenia fetida* and aquatic nutritional needs to them Adopted from [3]

Composition type	Name	Rate in Earthworm (100g)	Necessary amount in aquatic diet in terms of diet protein and fat percent		Types of farming shrimp
			Rainbow trout	Common carp	
Essential amino acids	Histidine	2302	1.7 -1.6	2.1 -2.0	2.32 -1.5
	Methionine	302	9.1 -2.2	3.1 -3.0	2.4 -1.8
	Phenylalanine	306	3.5 – 3.2	6.5 –6.4	4.3 – 4.1
	Lysine	508	5.4-5.3	5.3 – 5.4	7.5 -6.2
	Linolenic acid	601	1.2 -1.0	1.1 -9	0.8
	Linolenic acid	9	1.6 -0.8	1.1 -1.0	0.5

3-Preparation of vermicompost using earthworm *eisenia fetida*

With increasing world population and the use of animal and crop products, tremendous amount of biological residue is produced throughout the world that has created a large excretory problem and become a major source of pollution. This waste will require the extensive land for disposal process and the smell of ammoniak in water vapor, which can lead to contamination of groundwater and would threaten human health [15].

this garbage can be rarely mixed with the soil and causes severe damage to soil fertility [16,17].

And can lead to conflicts because of the mobility and toxicity to plants are nitrogen [15].

Some methods of disposal of these wastes is that theycould be buried under the ground(in the soil) and protect environment**.**

Manure-making, generally defined as the transfering a biological aerobic biological of a bio-waste into a resistant organic product that can be added to soil without harming plant growth [18] .

It is known as the most suitable method for recycling and biological waste management [15,16,19,20].

During manure-making, biological wastes are recycled to fixed products that can be added as an organic odorless and dry material to the soil . Resulte will have better in comparison with the raw materials for organic and biological soil fertility. The most traditional contractual method is accelerated bio-oxidation of a biological material during its transition from thermotropism steps (45°C-60°C) whereby microorganisms are released heat, carbon dioxide and water [17].

The ability of some earthworm *eisenia ftida* to analyze a wide range of biological organic waste such as sewage sludge, animal manure, residual bodies and industrial waste is Considerable [21,22,23,24].

Earthworm *eisenia fetida* during the feeding process crush the residual layer and increase bacterial activity and decomposition rates. In this way, with carbon dioxide and to unstable of waste, leading to decompose or manure-making . The final product commonly called vermicompost.

In this process, vermicompost is a kind of compost that is produced by the help of a species of earthworm *eisenia fetida* that converting the result of partial digestion of organic remains, while passing through the digestive tract of these animals occur.

4- Effect of vermicompost fertilizers on plant growth

Manure vermicompost is a very powerful and useful fertilizer for crops, arable land , green space , fruits and vegetables. Today Vermicompost production can be done widely by rearing and multiplication of these organisms in the context of waste, especially animal waste and after complete processing, worms with cocoons isolated from the substrate. This manure has a very soft texture ,it is light, clean and dark colored . In terms of quality it has an organic material that is adjusted in PH . Rich in humic substances and nutrients absorbed by plant. They contain vitamins and require plant growth hormones and different enzymes. Vermicompost improves soil structure and increase the capacity of water and soil porosity and has important role in plant growth and breathing [25].

They have a wide range of surface that have resulted in high levels of nutrient uptake [22,26].

Vermicompost has positive and profitable effects on plant growth. Whether using as a mixture in the soil or part of the garden environment, vermicompost improved germination and growth rates of plants.

Vermicompost has positive effect on seed germination, flowering, blooming plants, fruits and vegetables such as long pepper and tomato and on a wide range of flowers such as petunia, marigold, marjoram, chrysanthemum, henna flowers, sunflower, and poinsettia [17].

Anyway, manure-making and vermicompost are two quite different processes and they are separate from each other , especially given the highest temperature needed for each process and microbial and bacterial populations that had prevailed during the process. Waste material that is used in this process is also different . For example (heat-born bacteria in manure-making and merophic bacteria and fungi in vermicompost) [17,22].

Studies show that the number of initial worms used in the vermicompost were 5000 that after 90 this number increased to about 13 000 . In this study, the electrical conductivity in the resulting vermicompost and raw materials has been 907.33Ms/cm and 1813.33 ms/cm, respectively. This decrease reflects lower salinity in the vermicompost. Some salt has been deleted by earthworms in the compost process [27].

special advantage of *eisenia* is accumulation of heavy metals in biological vermicompost production that it rarely occurs in the compost mixture [27,28].

But iron-manganese concentrations in vermicompost production in this study are 287.66 and 1794.16 mm/L which is more than their concentrations in the raw material which is 2193.22 and 892.5 mg/L, respectively.

Table 3. The mean values of chemical compound and importantparameters in vermicompost raw material Adopted from [27]

Material type / Paramaters		Raw material	Vermicompost
Organic material	(%)	87.8	61.92
Ash	(%)	12.2	38.076
PH	)Ms/cm(	7.92	81.4
EC	(%)	1813.3	907.3
TC	(%)	43.9	30.95
OC	(%)	30.43	22.32
P	(%)	0.33	0.49
K	(%)	0.98	0.47
N	(%)	1.49	2.4
Na	(mg/kg)	0.21	0.93
Fe	(mg/kg)	2193.33	2876.66
Mn	(mg/kg)	892.5	1794.16
Cr	(mg/kg)	30.82	25
Cd	(mg/kg)	2.5	0
Pb	(mg/kg)	36.66	24.16
Ni	(mg/kg)	0	0
C/N	-	29.5	14.47
Humidity	(%)	36.33	68.66

Table 4. Microbial and parasitic quality of vermicompost produced by the worm *esenia fetida* Adopted from [27]

Parameter / Number	Coliform/100cc (mpn/100cc)	Coliform/100cc (mpn/100cc)	The parasites
1	7	0	Some died Nematode Larvae
2	11	0	Dead protozoa Soil nematode
3	13	0	Low protozoa
Mean	10	0	

5- Vermicompost free from coliforms

Microbial and parasitic quality of vermicompost produced by the worm *esenia fetida and the* microbial and parasitic quality of raw waste and vermicompost mixture is described in table 4 and 5.

.The result represents a reduction in the number of coliforms in raw waste materials of vermicompost that changed from 1103 to 10 of fecal coliforms, from 94 t0 zero, respectively. In case of parasites as you see in the tables, many of the parasites compared with raw materials, decreased in a considerable extent in the vermicompost that is because of efficiencyof useing in compost manure product [27,22].

Table 5- Microbial and parasitic quality of raw waste and vermicompost mixture. adopted from [27]

Parameter / Number	Coliform/100cc (mpn/100cc)	Fecal Coliform/100cc (mpn/100cc)	The parasites
1	.1600>	140	Paramsy (protozoa), High paramsy, Soil nematode larvae (Rhabditoid) fasciola hepatica egg
2	1600	140	Soil nematode, beef Ascaris egg high protozoa
3	110	23	high protozoa, Paramsy (protozoa), Nymph

With regard to the experiences and results of experiments**,** during the composting process carry out earthworm *eisenia fetida***,** due to continuous aeration resulted in the produced channels in production of compost, temperature increased that resulted in reduction of microbial contamination in the vermicompost. This is also confirmed by the experts in this area [29].

Similar results were obtained in parasitology testing . So the parasites such as beef *ascaris* eggs, eggs of *fasciola* hepatica, larvae paramsy, soil nematode and many protozoa were lost during vermicompost process and there was found only some of the soil nematode larvae (Rabed tiofaed) and other soil protozoa in the final product which is abundant in agricultural soils.
In addition to aeration, *eisenia fetida* by continuous movement in the surface layer and lower compost mass scattered microscopic organisms within the compost mass and consequently resulted to rapid decomposition of organic waste [27,28] .

Adjusting temperature to 20-30°C and humidity range of 60-70%, as mentioned in the literature , created suitable condition for activity of earthworms, particularly *eisenia fetida* that is the main effect of experiments had been performed [27]. Earthworms in the compost mass that are prepared under specific conditions can affect the plant

wastes and reduce and somewhat eliminate some of the heavy metals found in municipal waste (Biological accumulation) among which cadmium, chromium and lead is named. Some metals such as iron, manganese, can not be store as a biological accumulation in the earthworm's body type *eisenia fetida*. it is possible that these materials would be combined with worm fecal are excreted [27,28].

6- Earthworm by-products

In addition to direct use in agricultural and soil and plants fertilizing ,it can also have by-products. However, technology and science development , in many parts of the world, countries such as Canada, technology and are still using it. Protein extracted from the biomass of earthworms is common nowadays. This protein which extracted from worms in many industries such as food and cosmetics and sanitary and in industry are used in various forms.

In addition to topics that mentioned above, earthworms have medicinal uses. The research proved that they have an important effect on bone diseases, bladder, and impotence and hemorrhoids.
It is interesting to know that in early human societies, the ash of earthworms was used as a tooth paste for cleaning teeth . Today, in some parts of the world, the earth worms are used in the treatment of rheumatic and in some areas it is used in preparation skin ointments. Finally it is proven in the medical studies that pregnancy diagnostic through urine test and tumor detection is possible through using a mixture of earthworms.

On the other hand, in some countries like New Zealand some people can prepare delicious food of earthworms. In Japan a mince pie is made by earthworms.

Another valuable product is compound called tea compost that has solution structure, and it can be easily extracted from the solid vermicompost. This combination can be used to increase plant resistance against diseases and also provide nutrients needed for plant growth and it is used directly on plant organs. This combination is usually obtained from a mixture of appropriate amounts of vermicompost and water that is fermented in the temperature of 15-20 °C and in aerobic conditions. The process according to the quality of solid manure (vermicompost) will continue till three weeks. After treatment, obtained extracts are used as tea compost. Making this product, should be done carefully. Otherwise not only the process will not be effective but also may cause considerable damage to the product.

Earthworms meal

This product can also be obtained in the production of vermicompost. In this way that the appropriate volume of earthworms can be placed in a suitable temperature in the oven and after drying use as powder . At this time, significant percentage is lost through the worm body and can be considered as an appropriate protein source in feed for poultry.

CONCLUSION

With regard to the review of studies and research can be concluded that earthworm *eisenia fetide* plays an important role in environment and by the help of this organism, many hazards that endanger human life are avoided.

Specific and exceptionally behavioral of this organism was not hiden from the experts sharp eyes. This valuable soil-born organism called Soil architects. It gives more uniform composition of the soil by creating tunnels and enhances soil structure and will raise soil air and it will increase the drainage and also can be said that earthworms in soil waste recycling and transform it into a biological fertilizer and it can help to build sustainable agriculture and it can be stated that elimination of chemical fertilizers helped in agriculture and to produce healthy crops and put in human hands. Also the uses of this organism in feeding aquaculture and poultry can produce useful proteins with lower cost. It is hoped that the value of this organism to the human life could be demonstrated to make a better use of it.

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