African Journal of Tropical Hydrobiology and Fisheries 14: 66- 70 (2016)

Domesticating Ugandan Local Earthworms: Survival of African nightcrawler *Eudrillus eugeniae* and Common Earthworm *Lumbricus terrestris* under Different Feeding Rates in Culture Systems

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Abstract

There is increasing price of fish meal which is the sole protein source in fish feeds and an alternative and cheaper protein source is found to substitute or complement the expensive fishmeal to reduce the feeding cost. Five treatments, each with two replications were designed for each species (*Eudrillus eugeniae* and *Lumbricus terrestris*) at different feeding rates as follows: A, 1%; B, 3%; C, 5%; D, 10%; E, 15%. Feeding rates waere as follows; A, 15± 0.7; B, 32±2.1; C, 47±4.2; D, 50±1.4 and E, 58±0.7. For *L. terrestris*, survival was as follows; A, 65±2.1; B, 67±1.4; C, 78±4.9; D, 82±3.5; E, 90±2.8 and *E. eugeniae* There was significant effect ($P<0.05$) of feeding rate on the survival of both species and the Fisher's LSD multiple comparison test also showed significant different ($P<0.05$) in the survival among the two species. *L. terrestris* showed to be a good candidate for vermimeal while *E. eugeniae* showed to be suitable for vermicompost production.

Keywords: Vermiculture, Vermimeal, Vermicompost, Uganda's earthworms, *L. terrestris*, *E. eugeniae*

Introduction

Earthworms are segmented invertebrates that inhabit soil and organic wastes. Worldwide there is an estimated 1800 species of earthworms (Edwards and Lofty, 1977) belonging to the phylum Annelida. Generally, earthworms are hermaphrodites and usually reproduce by mating. During mating each partner fertilizes the other and after they retract their bodies through the clitellum and produce cocoons. The produced cacoons can take one to eight months to become mature and thereafter parents can contine to reproduce at regular intervals through out their entire lives (Edwards and Arancon, 2004).

Earthworms have a great use in managing solid biodegradable wastes, improve fertility of soils, and enrich the protein content of animal feeds and pharmaceutical industry. Earthworms are able to process sewage sludge and solids from wastewater, brewery wastes, processed potato wastes, waste from paper industries, wastes from supermarkets and restaurants, brewery wastes, animal wastes from poultry, pigs, cattle, sheep, goat, horses, and rabbits; as well as horticulture residues from dead plants, yard wastes and wastes from mush room industry (Edwards, 1988).

In the United States of America (USA), earthworms are produced commercially for animal feed and for fish bait of which this production started in 1950 (Guerrero, 2009). When used as animal feeds, the worms have been found as an excellent source of animal feed protein, essential amino acids, fats, vitamins, and minerals for livestock and fish. Chemical analysis of the body tissues of earthworms showed to have a composition of: protein 60-70%, fat 7-10%, carbohydrate 8-20%, and minerals 2-3% (Edwards and Arancon, 2004).

Although fish is stated as the cheapest and best source of protein, the status of most global capture fisheries indicate that are declining, mainly due to overexploitation and environmental degradation, an outcome of increasing demand as a result of increased population (Spinelli, 1998; FAO, 2012).

Aquaculture is widely considered important for the future of fish supply to fill the gap of the increasing demand. However, it is seriously constrained by fish feeds (Yaqub, 1997). There is high competition for the same foodstuffs between man and his animals. This has increased the price of fish meal which is the sole protein source in fish feeds. It is therefore very crucial that an alternative is found (Jauncey and Ross, 1982) to reduce feeding cost and make aquaculture a viable and attractive venture.

Earthworm meal has been found to be a good source of protein (Guerrero, 1981; Tacon *et al*., 1982). From experiments, fish that fed on diets contained 30%, 70% and 100% of fish meal protein, replaced by earthworm meal had similar or higher growth rate, protein efficiency, and energy retention than those fed the fish meal based control diet (Tuan and Focken, 2009) and the growth performance and feed conversion ratio of catfish (*Heterobranchus isopterus*) fry over 30 days was better on earthworm meal than on fish meal (Yaqub, 1997). Earthworms are used as additive to produce pellet feeds in the USA, Canada and Japan, which account for 50% of the pellet feed market (Xu and Dai, 1998).

Proximate analysis of an African nightcrawler vermimeal in dry and pulverized form revealed the following composition: 68% crude protein, 9.57% fat, 11.05% nitrogen-free extract, and 9.07% ash (Guerrero, 2009). Evaluation of earthworm (*Hyperiodrilus euryaulos*) meal as protein source in diets for *Heterobranchus longifilis* fingerlings under laboratory condition (Sogbesan and Madu, 2008) revealed that 25% replacement of fish meal by earthworm meal supported higher net gain in weight and specific growth rate than fish fed 0 (control), 50, 75 or 100% earthworm meal. Earthworms of the species *Dendrodrilus subrubicundu,* collected from the trickling filter beds of a domestic sewage works and freeze dried, could replace 10, 50 and 100% protein meal in the diets of rainbow trout (Stafford and Tacon, 1984).

Research into vermicomposting, vermiculture and commercial projects have been developed in many countries, including; USA, Cuba, Mexico, Bahamas, China, Japan, Philippines, India and other parts of Southeast Asia, including; Australia, New Zealand, America Samoa and Hawaii and many countries in South America (Edwards and Arancon, 2004) but few studies have been conducted on vermiculture or vermicomposting technology in Uganda and Africa in general. Therefore, the current study aimed at domesticating and evaluation of survival rates for mass production of local earthworms using locally available farm and domestic wastes. It was hypothesized that the survival rate of the most common species of earthworms in Uganda (*E. eugeniae* and *L. terrestris*) does not directly correspond to feeding rates and the survival rate does not differ between the two species.

Materials and Methods

A study on the survival of *E. euginiae* and *L. terrestris* at different feeding rates was conducted for 45 days. Earthworm samples of *E. eugineae* were collected from

Lwamunda Forest Reserve, in Muduuma Sub County, Mpigi district. This species is collected during a wet season from potato farmers who used to dig and make heaps for their crop and in the process get earthworms from the ground for experimentation.

L. terrestris was collected from Kakunyu agriculture farm wetland in Wakiso sub County, Wakiso distict, were dredging of fish ponds was going on and samples were collected from the sides of the pond and water channels. A total of five treatments with 10 replicates were installed. Treatments were arranged according to the feeding rate of the worms which weighed between 6-13g and the treatments included; A, 1%; B: 3%; C, 5%; D, 10%, and E, 15% of the body weight of the earthworms and the worms were feed twice a week. A total of twenty culture units (replicates) were set in gunny bags of 50 cm high and 50 cm diameter. The gunny bags were used as culture boxes and were filled with bedding material which composed of 5 kg of loam soil dry leaves and dry grass.

The gunny bags were perforated on the sides and at the base to allow free movement of fresh air and water. The culture units were watered and worms were stocked five days after the setting of the experiment. Earthworms were fed on decomposed fruit wastes mainly; banana peelings, mangoes, pawpaw and water melon pieces collected from Nakasero market in Kampala city, Uganda. Experimental conditions mainly temperature and pH were closely monitored and the temperature ranged between 20-24˚C while pH ranged between 6.9 to 7.1.

Statistical analysis was conducted using One-way ANOVA of SAS software version 9.1.3 with significant level at *P=0.0001*. Fisher's LSD was used to test for differences between means of treatments of the two species at *P=0.05*.

Results

Survival rate (%) of both earthworm species generally increased with increase in the feeding rate. The trend of performance of *E. euginiae* at different feeding rates was as follows; A, 15± 0.7; B, 32±2.1; C, 47±4.2; D, 50±1.4 and E, 58±0.7 and while for *L. terrestris*, survival was as follows; A, 65±2.1; B, 67±1.4; C, 78±4.9; D, 82±3.5; E, 90±2.8.

The effect of feeding rates on the survival of the earthworms showed a significant effect (*P<0.0001*) of feeding rate on the survival of both species and means of treatments of the two species also showed significant different (*P<0.05*) in the survival among the two species. The trend of survival increased with food availability in both species. In addition, higher survival rate was recorded in *L. terrestris* compared to *E. eugeniae* (Figure 1).

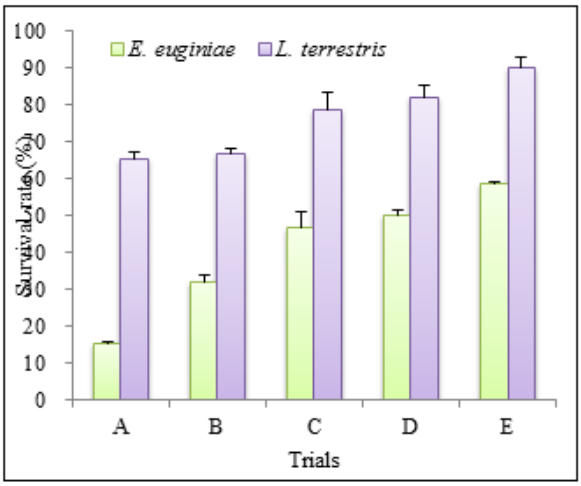

Figure 1: Performance of *E. eugeniae* and *L. terrestris* at different feeding rates. Trials, A: 1%, B: 3%; C. 5%; D. 10 and E. 15% of the body weight of the earthworms.

Discussion

Among the two species *L. terrestris* had higher survival rate than *E. eugeniae* and the difference was mainly due to reduction of food in treatments of *E. eugeniae* and when food reduced from the culture units, this species escaped. With the growing interest in earthworm farming for the numerous roles in different domains, identification of different species of earthworms to perform different roles is important for vermiculture and

vermicomposting industry development

Survival of the two species (*E. eugeniae* and *L. terrestris*) increased simultaneously with increase in feeding rate; however, there was a statistical difference ($P<0.001$) between the survival rate of these species. *E. eugeniae* showed lower survival rate than *L. terrestris* (Figure 1), which could have been related to the higher number of escapes recorded from *E. eugeniae* culture units, which was probably due to shortage of food. During the monitoring process of the bedding substrates, most food materials in trials A(1%) and B(3%) were already eaten after the three day feeding interval and fewer worms could be found in culture units compared to trials B (5%); C (10%) and E (15%) in both species.

E. eugeniae was also found to be more mobile than *L. terrestris* which could have increased the chances of being attached by predators in and outside the culture units. Basing on the endogeic nature of *E. eugeniae* and aneic behavior of *L. terrestris* (Munnoli, 2007), mobility in these species was probably due to the differences in feeding behavior as *E. euginiae* was found to escape with a decrease food availability and thus higher survival rate was recorded in *L. terrestris* than its counterpart. The Ugandan *L. terrestris* also survived at 20-24˚C which is higher than the 10˚C reported by Edwards and Lofty, (1977) while *E. euginiae* survived within the temperature range recorded by (Viljoen and Reinecke, 1992)). Given the wide temperature adaptation range, culturing these species for vermimeal and vermicompost was found to be possible and escapes of worms was also found to be controllable by use of well-designed windrows or culture boxes.

Conclusion

The two species showed to be sensitive to food availability and showed the same trend of increasing survival with feeding rate. However, *L. terrestris* had higher survival than *E. eugeniae* which could have resulted from higher incidences of escapes in *E. eugeniae* culture units caused by higher food consumption than in *L. terrestris* culture unites. From this study, *L. terrestris* showed to be a good candidate for vermimeal and bait production as it is less mobile and easier to feed while the fast feeding *E. eugeniae* showed to be suitable for vermicompost production, and the wide temperature adaptation range of these Uganda's earthworm species gives an opportunity for large scale vermiculture and vermi-fertilizer industry in to complement or substitute expensive fishmeal and bolster organic farming in the country.

Acknowledgement

This is to appreciate staff of Centre for Biodiversity and Aquaculture Research (CeBAR) for their efforts in collecting earthworm samples and participation in the culture experimentation trials.

References

Edwards, C.A. (1988). Breakdown of animal, vegetable and industrial organic wastes by earthworms, Earthworms in waste and environmental management. SPB, Academic Publishing, the Hague, pp. 22-31.

Edwards, C.A. and Arancon, N.Q. (2004). Vermicompost suppress plant pests and disease attacks, REDNOVA NEWS.

Edwards, C.A. and Lofty, J.R. (1977). Biology of Earthworms. Chapman and Hall London.

FAO. (2012). The State of World Fisheries and Aquaculture, FAO, Rome.

Guerrero, R.D. I. (1981). Culture and use of Peronya excavatus as a protein resource in the Phillippines, Dorwin Centenary Sympossium on Earthworm Ecology. Institute of Terrestrial Ecology, UK, pp. 250.

Guerrero, R.D.I. (2009). Vermicompost and Vermiculture Production. MARID Agribusiness Technical manual 22 pp.

Jauncey, K. and Ross, B. (1982). A guide to Tilapia feeds and feeding. In: U.o.S. Institute of Aquaculture (Editor). University of Stirling Press, Scotland, pp. 111.

Munnoli, P.M. (2007). Management of industrial organic solid wastes through vermiculture biotechnology with special reference to Micro-organisms., Goa University, India, 1-334 pp.

Sogbesan, O.A. and Madu, C.T. (2008). Evaluation of Earthworm (*Hyperiodrilus euryaulos*, Clausen, 1914; Oligocheata: Eudrilidae) Meal as protein feedstuff in diets for Heterobranchus longifilis Valenciennes, 1840 (Teleostei, Clariidae) fingerling under laboratory condition. *Journal of Environmental Sciences* **2**: 23-31.

Spinelli, J. (1998). Unconventional feed ingredients for fish feed, FAO/UNDP training course in fish feed technology. FAO, Washington Seattle, Washington, USA, pp. 187-214.

Stafford, E.A. and Tacon, A.G.J. (1984). Nutritive value of the earthworm, Dendrodrilus subrubicundus, grown on domestic sewage, in trout diets. *Agricultural Wastes* **9**: 249-266.

Tacon, A.G.J., Haaster, J.V., Feathstone, P.B., Ker, K. and Jackson, A.J. (1982). Studies on the utilisation of full fat soybean and solvent extracted soybean meal in a complete rainbow trout, pp. 32.

Tuan, N.N. and Focken, U. (2009). Earthworm Powder as Potential Protein Source in Diets for Common Carp (*Cyprinus carpio L.*), Biophysical and Socio-economic Frame Conditions for the Sustainable Management of Natural Resources. Tropentag, Hamburg.

Viljoen, S.A. and Reinecke, A.J. (1992). The temperature requirements of epigeic worm Eudrilus eugeniae (Oligochaeta) Laboratory study. *Soil Biology and Biochemistry 24*: 1345-1350.

Xu, K. and Dai, X. (1998). Culture and utilization of earthworms, pp. 14.

Yaqub, H.B. (1997). Earthworm and maggot meals as a potential fish meal replacement Marine Fisheries Division, Tema.