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Production of *Eudrilus eugenia* and Compost From Breeding Manure (Cattle, Cavies, Rabbits, And Poultry) In South Of Côte D'ivoire

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Abstract

To support agriculture, developing countries must integrate available natural resources and promote management of livestock waste. feeding animal like poultry is also a challenge for African breeders. Earthworms can be introduced as input into monogastric animals feed. How to produce earthworms, with what, in quantity to use them in animal feed. Thus earthworm Eudrilus eugeniae was cultivated in 4 simples treatments and 6 treatments with mixed manure. These treatments are combination or not of cattle, cavies, rabbit and poultry manure. Ten treatments were carried out from four simple treatments and six mixed treatments with four types of livestock manure. Mixed treatments consist of a mixture of two manures of equal volume. Each treatment underwent 3 repetitions. The experiment lasted 12 weeks. The numerical productivity of E. eugeniae and the biomass of E. eugenia were determined by treatments. The results showed those based on poultry or guinea-pig manure and the control range between 5 and 6.5 and are therefore more acidic. The average density and the earthworm biomass of the MC + MR treatment respectively 2889 ± 333 ind./ m^2 and 397.22 ± 234.44 g / m^2 are different from other treatments. The mixture of cattle and rabbit manure constitutes a preferred medium for the Eudrilus eugeniae production for use as input in animal feed. This significant biomass of earthworms can be used in fish farming or in feeding monogastric animals.

Keywords: Eudrilus eugeniae, earthworm, compost, manure

1. Introduction

Intensive and industrial breeding programs of conventional animal species are implemented in order to produce meat at low cost to meet the needs of population [15]. However, breeders or agro pastoralists benefiting from these projects have been confronted with various problems, the most important of which are inputs unavailability of manufacture of livestock feed and the installation local structures of flour production for fish whose increases the cost of feed due to the selling price [8]. They were thus forced into a massive import of animal meal from Western countries. In order to sustainable agriculture and protect environment , it is important to integrate conservation of natural resources and promote management of manure [18][22]. Ignored in various breeding programs, livestock waste and food refusals are either abandoned, used to fill ravines, or stored in raw landfills, thus polluting the environment [25]. Therefore, the potential of worms of land to decompose organic waste have to be exploited [19]. Vermicomposting combines production of earthworms and humus.

Ground earthworms can be used as an input into composition of fish and poultry feed and humus as natural fertilizer [20]. *Eudrilus eugeniae* [3] is a species of earthworm that belongs to the family of Eudrilidae [2]. It is often used in the vermicomposting process in tropical and subtropical countries. *Eudrilus eugeniae* is interesting to recover organic waste in these areas [6]. It is characterized by an elongated cylindrical body made up of successive rings [19]. Using earthworm meal as a substitute for fish or meat meal can improve the nutritional value of livestock feed. *Eudrilus eugeniae can* play a relatively important role in poultry farming [17]. it can be produced and processed to be incorporated into poultry feed (Bakare, 2013) [4]. How can we produce a large quantity of earthworm biomass that can be used as a livestock input in developing countries? The aim of this study is to produce the earthworm *Eudrilus eugenia* from breeding manure. Concretely, this involves determining the environmental conditions for better production of earthworm, numerical productivity and biomass produced by simple or combined manure.

2. Material and Methods

2.1 Material

The studies were carried out at experimental farm of University Nangui Abrogoua in Abidjan, located 5°23'19" north latitude 4°0'54" west longitude on the Gulf of Guinea in june 2020 to december 2020. The experiments, lasted 26 weeks and were carried out with the manure worm *Eudrilus eugeniae*. Four types of livestock manure were used: cavies (Guinea pig) manure (MG), poultry manure (MP), cattle manure (MC) and rabbit manure (MR). The cavies manure (MG), was consistued of droppings and food refusals composed of *Pennisetum sp*. or *Panicum sp*., *Manihot esculenta* (cassava) leaf, potato stems and leaves and leftover bread. It comes from the experimental cavy breeding of University Nangui Abrogoua. Poultry manure (PM) consisted of manure, wood shavings used for bedding. This manure was taken from the "FAMA" farm located in Abatta village, in Bingerville sub-prefecture, east of Abidjan. The cattle manure (MB) was taken from a cattle park located within Nangui Abrogoua University. This manure is mainly composed of cow dung and park powder. The herd of cattle is led on a natural pasture. The last one, rabbit manure (MR), was made up of rabbit droppings and food rejects made up of granulated foods. It was taken from a rabbit farm of University Nangui Abrogoua. Livestock manure was used for vermicomposting. The choice of this waste is justified by its availability and the large quantity of its discharge on farms and livestock structures.

As technical material, a decameter was used to size the experimental perimeter and the pits; a shovel, a pickaxe, a hoe, a machete for making a pit, a wheelbarrow for collecting waste, a 10 liters plastic watering can for watering substrates; a sheet of aluminium sheet and small jars for collecting, sorting, and counting earthworms during the tests; a probe thermometer to read temperatures; two barrels of 15 liters each to carry out vermiculture.

2.2. Methods

2.2.1.Vermicomposting

The experimental device consists of 33 pits numbered from 1 to 33. Vermicomposting was carried out in these pits of length 1 meter, width 1 meter and a depth of 0.20 meters. These pits were dug outdoors.Ten (10) treatments were carried out using four simple treatments and six mixed treatments with four types of livestock waste. Mixed treatments consist of a mixture of two manures of equal volume. In addition to these treatments, there is a control treatment consisting of soil taken during the design of the pits. The treatments are distributed as follows:

- control treatment: T (100% soil);

- simple treatments: 100% MG; 100% MP; 100% MR; 100% MC;
- mixed treatments: (50 % MG + 50 % MR); (50 % MG + 50 % MP); (50 % MG + 50 % MC); (50 % MR + 50 % MP); (50 % MR + 50 % MC); (50 % MC + 50 % MP).

Each treatment undergoes 3 repeats. In order to maintain location randomness of each treatment, a random drawing of numbers was carried out. After the collection of manure, a volume of 0.2 m^3 was introduced into each pit according to different treatments. This volume is equivalent to 2 full wheelbarrows. For mixed treatments, a homogenization operation (homogeneous mixing) was carried out. Each full pit received a thin layer of soil to cover it. They were watered twice a week with 15 dm^3 per watering. The pits are turned over once a week. The temperature is measured twice a week to follow the development of substrate. The precomposting phase lasted 9 weeks.

The earthworms were removed by digging in garbage. They were raised in barrels containing soil and litter from the place of digging. The whole was put under shade. The worms were regularly fed with litter and watered until the soil was saturated for a period of 2 months.

2.2.2. Conduct of the test

Mature earthworms were removed from barrels to be placed in the pits after 9 weeks of pre-composting. Each pits received 25 mature earthworms introduced at 5 different points at the rate of 5 worms per seeding point. To reduce drying out, the pits were covered with coconut branches and banana leaves. The trial lasted 17 weeks.

2.2.3. Estimation of parameters

At the end of the vermicomposting, weekly average temperature (Th) was evaluated according to the following formula: Th = (Tm1 + Ts1 + Tm2 + Ts2) / 4 with:

- Tm1 = Morning temperature at the beginning of the week;
- Te1 = Evening temperature at the beginning of the week;
- Tm2 = Morning temperature at the end of the week;
- Te2 = Evening temperature at the end of the week.

The average density (Dm) of earthworms of each sample by pit was evaluated by this formula:
Dm = (D1 + D2 + D3 + D4 + D5) /5.S
with D1 to D5 = effective earthworms of 5 samples.
The average biomass (Bm) of earthworms taken from the pit is obtained according to the following formula: Bm = (B1 + B2 + B3 + B4 + B5) / 5.S with B1 to B5 = biomass of earthworms from 5 samples, S = surface of the sample.
The average density and the average biomass of samples per pit as well as the final pH and the final height of each pit were recorded.

2.2.4. Data analysis

On basis of the 3 repetitions of the treatments, average density, biomass, pH and average height of the treatments were calculated. The results obtained were statistically compared by the analysis of variance (ANOVA) and by the Turkey test, at 5 % significatively. This test compares all of the means in order to detect any significant differences between them.

3. Results and discussion

3.1 Results

3.1.1 Temperatures during pre-composting

The temperatures recorded during pre-composting are recorded in the figure 1. They are generally low for all treatments except MG + MR treatment. They are between 20.96 ° C and 38.15 °C. Slight increases were recorded in the first 3 weeks. The greatest increase was recorded two weeks after and stabilized around the 8th and 9th week due to the decomposition of the material by aerobic and anaerobic microbes.. However, the Turkey test shows that there is no significant difference ($p \geq 0.05$) between the temperatures obtained each week for the different treatments. Note that when sowing earthworms, the substrate temperatures varied between 24.76 ° C and 27.63 ° C.

3.1.2.Final pH and final height of the different treatments

The average pH and final values of each treatment were recorded in Table I presents. The pH of MP + MR, MG and MR treatments are statistically different (Turkey test, $p < 0.05$) from MG, MC, MP + MC, MG + MC, MG + MR treatments and control treatment T. All treatments containing rabbit manure in their composition have a pH close to 7 (neutral pH) with the exception of the MC +MR treatment. The pH of substrates based on poultry manure or cavies and the control range 5 to 6.5 They are acidic.

The average final height of the treatments is also saved in Table I. The Turkey test shows that there is a significant difference ($p < 0.05$) between final height of control treatment T and the other treatments.

3.1.3.Digital productivity of earthworms in each treatment

The average densities of earthworms produced by the different treatments are recorded in Table II. Earthworms are present in all treatments except in the control. However, there is a statistically significant difference (Turkey test, $p < 0.05$) between different treatments. In fact, the average density of earthworms in MC + MR treatment (2889 ± 333 ind./ m2) is different from other treatments. Also, the treatments MR; MC; MP + MR, MC + MP, MG + MP, MG + MB are statistically (Turkey test, $p < 0.05$) different from MC + MR treatments. The density of earthworms production is higher in MC +MR treatment than others treatments. In addition, the average densities of earthworms produced by MR, MC, MP + MR, MC + MP, MG + MP and MG + MC treatments are statically identical to each other, as well as between MG, MP and MG + MR. The average density of earthworm produced in these treatments is the same. Furthermore, the average densities of earthworms produced by MR, MC, MP + MR, MC + MP, MG + MP and MG + MC treatments are statistically identical, as well as between MG, MP and MG + MR treatments ($p \geq 0.05$). The potential for production of earthworm *Eudrilus eugeniae* by these different treatments is equal.

3.1.4.Average biomass of earthworms in each treatment

The average biomass weight of earthworms produced by different treatments is recorded in Table I. The statistical analysis show (Turkey test, $p < 0.05$) a significant difference ($p < 0.05$) between the earthworm biomass of MC + MR treatment (397.22 ± 234.44 g / m2) and other treatments. The earthworm biomass of MB, MR, MG + MC, MC + MP and MP + MR treatments are statistically identical ($p \geq 0.05$), but are significantly different ($p < 0.05$) from those treatments MG , MP, MG + MP and MG + MR.

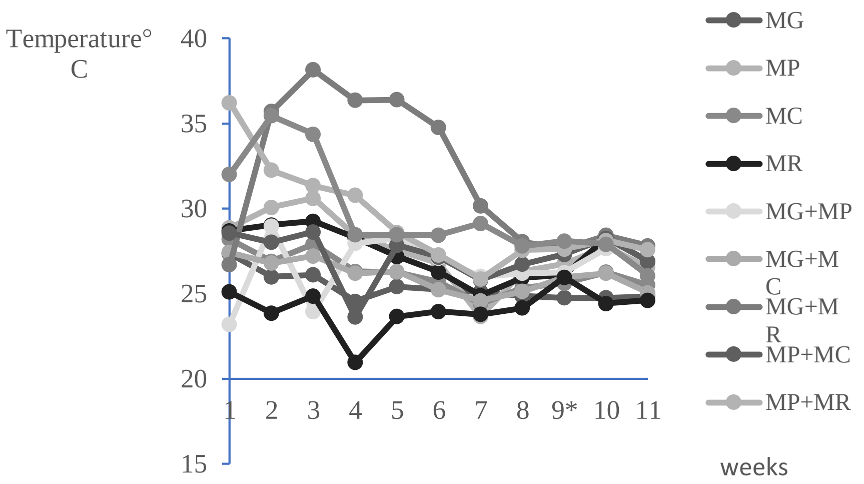

Figure 1:
Average weekly temperature (Th) recorded during precomposting in each treatment
* Sowing earthworm

Table I: average final pH, average final height, average density, and average biomass of the treatment earthworm

	Treatments										
	MG	MP	MC	MR	MG +MP	MG + MB	MG + MR	MC +MP	MC + MR	MP + MR	T
Final pH average of treatment	5.65 c ± 0.23	5.87 c ± 0.12	6.46 b ± 0.14	7.13 a ± 0.13	6.27 b ± 0.19	6.72 b ± 0.13	6.63 b ± 0.42	6.87 b ± 0.09	7.04 a ± 0.06	7.14 a ± 0.11	4.52 d ± 0.10
Final height of treatment average (cm)	10.16 b ± 0.62	10.83 ± 0.62	10 b ± 0.5	9.83 b ± 0.23	10.5 b ± 0.5	9.66 b ± 0.28	10.5 b ± 0,5	10.33 b ± 0.57	10 b ± 0.5	9.66b ± 0.76	18 a ± 0.5
Earthworm density average (ind./ m2)	778 c ± 278	556 c ± 111	1333 c ± 111	1444 c ± 167	611 c ± 111	1667 b ± 389	667 c ± 111	1778 b ± 222	2889 a ± 333	2889 a ± 222	0
Earthworm biomass average (g / m2)	94.44 c ± 22.77	33.33 c ±4.44	136.66 b ± 25.55	164 b ±23.88	94.44 c ± 15	149.44 b ±17.32	50.55 c ± 9.44	191.11 b ± 234.44	397.72 a ± 234.44	163.33 b ± 14.44	0

Numbers with same letters on same line are statistically identical (Turkey test, $p \geq 0.05$)

3.2. Discussion

The analysis of the average temperatures during our experiments, before seeding earthworms showed that temperatures are between 20,96 ° C and 38,15° C in all the treatments except the treatment MG + MR where temperature is higher than 36 ° C. These results can be justified either by composition of our substrates in fermentable materials or biodegradable compounds or by presence of a very small proportion of microorganisms likely to activate fermentation . In addition, the depth of pits limits height and volume of heaped substrates. However, slight increase in temperature with MG + MR can be explained by combination of manure, which would contain higher rate of sugar, source of fermentation. In fact, nature of food waste can constitute a supportive environment for microorganisms (thermophiles) multiplication activating biodegradation. It is important for ensuring optimal growth and activity of microbes [23]. In vermicomposting, activity of earthworm, its metabolism, growth, respiration, and reproduction are strongly influenced by temperature [27].

Regarding height of treatments at the end of the experiment, a significant difference is observed between control and other treatments. This difference is explained by nature of component of each treatment compared to the control. The presence of earthworms observed in the various treatments of manure except the control, This is agreement with [24] results which attests that *Eudrilus eugeniae* is growing in many kind of manure of animal. However, analysis of productivity and earthworm biomass results show significant differences between MC + MR treatment and all other treatments. It appears that MC + MR treatment produces an important quantity (digital productivity and biomass) of earthworm. This quantity is twice produced by MG + MC, MC + MP, MP + MR, and MC + MR treatments, three times produced by MG, MP, MG + MP and MG + MR. These results are consistent with those of [26] who obtained more *Eisenia foetida in* in rabbit, cattle manure. They obtained identical productivity from *E. eugeniae* for all their treatments. This low productivity of *Eudrilus eugeniae* with other treatment could be explained by the chemical composition of MC + MR treatment, by the physical characteristics of rabbits and cattle manure, and from the microflora present in these different manures according to [10]. For [9] the characteristics of manure vary with animal species and nature of the food. Rabbit and cattle manure, which has a very loose texture and retains less water, seems to be very easy to ingest by earthworms. To this may be added the very high rate of nitrogen in rabbit and cattle manure [1]. According to [11], *Eudrilus eugeniae* grows well and produces more cocoons when fed on a substrate rich in nitrogen. Similarly, [5] shows that *E. eugeniae* grows quickly when it is in cocoa powder containing 3.6 % of nitrogen than in the oat flake which contains only 1.92 %. Rabbit, cattle, and poultry manure contains 13.1 %, 8.4 % and 3.6 % respectively [1].

From the analysis of these results, it therefore appears that mixed or simple treatments having at least 50 % of MR or MC are statically identical to each other but statically different from treatments not containing them. Treatments without MC and MR are acidic. They have a pH below 6.75. The low productivity of these treatments (MG + MP, MP, MG, MR) can be explained by their high composition of aldehydes, the oxidation of which acidifies the substrate[13].

The results obtained (low biomass and low numerical productivity) with treatments containing 50 % of guinea pig manure or 100 % poultry manure can be explained by the fact that cavy has a manure composed of fibrous droppings and food residues (*Panicum* spp, cassava stems) with a high level of lignin and cellulose [7]. These chemical elements by their presence slow down the activity of microorganisms and therefore subsequently that of earthworms.

As for poultry manure, the presence within of wood chips makes its ingestion and digestion difficult because of the presence of lignin, of cellulose [16]. The presence of these compounds, combined with nitrogen deficiency slow the action of earthworms [14]. Also, we can add the phenomenon of immigration or emigration of worms. Indeed, these earthworms move by digging galleries in the ground, in search of better quality food or by fleeing from conditions unfavorable to their survival [21]. The living environment of *Eudrilus eugeniae* is not limited to the surface layer of the soil. He is able to live in the deep layers and to dig subhorizontal galleries there in search of better lives [12].

4. Conclusion

In this study on earthworm production, the mixture of cattle and rabbit manure resulted in more biomass and density of *Eudrilus eugeniae* earthworms. This mixture of manure is therefore a preferred environment for the growth of *Eudrilus eugeniae*. This significant biomass of earthworms can be used in monogastric feeding. Compost can also be used in agriculture. In addition, vermicomposting can be a solution for recycling waste from human activities with a view to cleaning up the environment, the by-products of which can be recovered.

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