PRODUCTION OF EARTHWORM MEAL FOR AQUACULTURE

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ABSTRACT
Three soil sample media (loamy, sandy and clayey) were used to culture earthworm, (*Eudrilus eugeniae* (Kinberg) in earthenware pots for ten weeks, under laboratory conditions. The aims of the research are to culture earthworms as replacement for fish meal, and to determine the best suitable soil medium for culturing and breeding of earthworms. Two sets of treatments were set up with the three soil samples; the experimental containing organic matter (cow dung) and the controls lacking organic matter. Watering was done every three days to keep the culture moistened, but not saturated. Results of the study showed that loamy soil had the highest number of earthworms harvested, followed by sandy and then clayey soil. Increase in number of harvested earthworms between the experimental and control groups differ significantly ($P<0.05$), with the experimental group having higher number of harvested earthworms. Loamy soil was the most favourable medium that enhanced the growth and survival of earthworms, when cultured under laboratory conditions, for fish meal replacement in aquaculture.

INTRODUCTION
The challenges facing the aquaculture industry today are numerous, among which are the increasing demand, high cost and scarcity of fish meal. This has led to the aquaculture nutritionist searching for alternative sources of protein other than fish meal in fish feed. Between 40 and 70% of the cost of operations in aquaculture come from feed alone (Ogbe *et al.*, 2004).Thus, reducing feed cost becomes essential in aquaculture nutrition for economic sustainability. Earthworm *Eudrilus eugeniae* (Kinberg) is one of the readily available substitutes that needs to be investigated as a potential source of cheap protein. According to Tacon et al., (1983), earthworm contains 56% crude protein.
The objectives of the present research were to explore the prospect of culturing earthworms under laboratory conditions as replacement for fish meal in fish diet, and to determine which of the three soil samples was most suitable for the production of the earthworms.

MATERIALS AND METHODS
Loamy and clayey soil samples were collected from the Botanical Garden of the Department of Biological Sciences, Ahmadu Bello University Zaria, while the sandy soil was obtained from the University dam (Kubanni Lake) in the main campus, Ahmadu Bello University Zaria, Nigeria. The university dam lies on longitude 07°39'E and latitude 11°08'N, at an altitude of 642.52m above sea level. The soil samples collected were thoroughly sieved to remove any debris using 2mm mesh size sieve (Madge, and Sharma, 1969).

The earthworms were collected from the muddy and mashy areas along the University dam, by digging, and hand sorting using hand trowel (Ashby,1976). Cultivation of the earthworm was done using three types of soil sample media namely loamy, sandy and clayey soils. Twenty four (24) earthenware pots were used for the culture. Two experiments were set up consisting of control group A and experimental group B. Twelve pots were used in each group (i.e. the control and the experimental groups). Four pots were used for each soil medium in each group. The pots were filled with 9500g of each soil sample and to an average depth of 25cm. Ten earthworms of equal sizes were introduced on top of the soils in each pot, and allowed to burrow down. Exactly 750cm^3 of water was sprinkled on each pot content every three days, so as to keep the culture moistened, but not saturated.
The experimental group B were treated with organic matter in form of cow dung. While the control group A were not so treated. Cow dung measuring 300g were spread on top of the culture media every week and cover with one centimeter of the soil sample. Thus, only the experimental groups contain organic matter. The culture lasted for a period of ten weeks, and the harvested earthworms were counted, weighed, measured to determine their individual lengths, bottled and preserved with 5% formalin (Madge, and Sharma, 1969). The fresh body weights of the earthworms were measured in grams using an electric top loading balance (Metler balance). The initial stocking weight of adult earthworms in each experimental and control group, as well as the body weight of individually selected earthworms during harvesting were recorded for each soil sample (Edward and Lofty 1976).
The lengths of the earthworms were measured and expressed in centimeters using a measuring board. The contracted lengths of the earthworms were obtained when static, while the extended lengths were

recorded when in motion (Lucker and Lucker 1971). Mean counts of harvested earthworms amongst the three soil samples were analysed by ANOVA.

RESULTS

The percentage increases in the number of earthworms in each of the three soil culture media are presented on Table 1. It indicates that the loamy soil sample has the highest percentage increase in number of earthworms harvested in both the control and experimental groups with 50.75% and 60.04% increase respectively. This was followed by sandy soil with 27.61% and 30.06% increase for the control and experimental group respectively. The least increase in the number of earthworms was recorded in clayey soil with 21.64% and 9.90% for control and experimental group respectively. It also showed that the percentage increase in number of earthworm was more in the experimental group treated with cowdung than the control group.

Table1: Earthworms harvested in the three soils sample culture media

Soil sample	Control group				Experimental group			
	Initial no. of earthworms	Final no. of earthworms	Increase in no. of earthworms	% increase in no. of earthworms	Initial no. of earthworms	Final no. of Earthworms	Increase in no. of earthworms	% increase in number of Earthworms
Loamy soil	40	108	68	50.75%	40	1398	1358*	60.04%
Sandy soil	40	77	37	27.61%	40	720	680*	30.06%
Clayey soil	40	69	29	21.64%	40	264	224*	9.90%
Total	120	254	134	100%	120	2382	2262*	100%

* - Significant increase in harvested earthworm populations between control and experimental ($P<0.05$)

Figure 1 shows the lengths of the earthworms harvested from each of the three soil samples, revealing that the lengths of the harvested earthworms varied with the soil samples with earthworms harvested from the clayey soil having the greatest length. This was followed by loamy soil, while the least length was recorded in the sandy soil. It was also observed that the earthworms in the experimental soil samples treated with cowdung increase more in length, than those in the control soil samples without cowdung. The mean weights of the earthworms harvested from the soil media were presented in Figure 3. It shows that earthworms from the clayey soil have the largest weight, followed by those from loamy soil, while the least weight was recorded in the sand soil medium. It also indicated that the earthworms in experimental soil samples with cow dung recorded more weight than those in the control soil samples without cow dung.

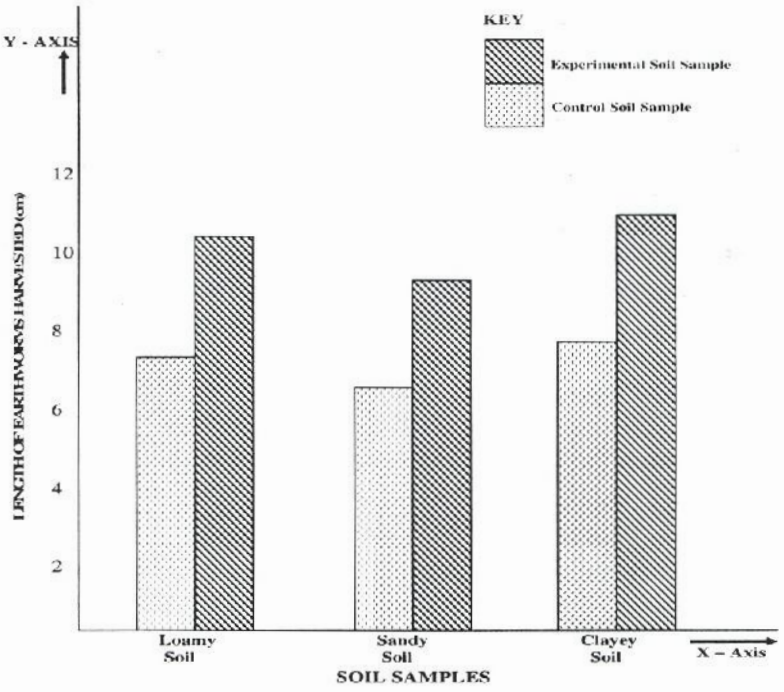

Figure 1: length of earthworms harvested in the three soil sample

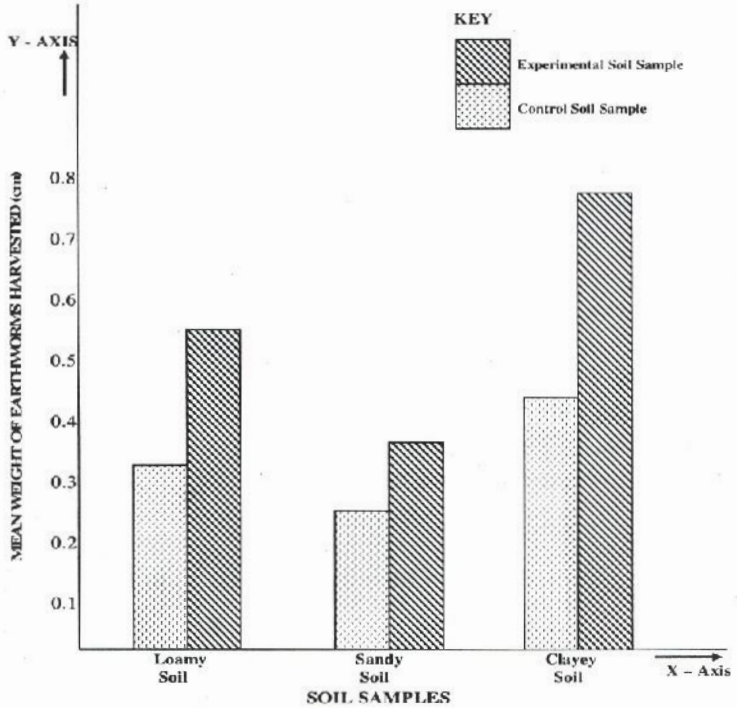

Figure 2: Mean Weight of earthworms harvested in the three soil sample

DISCUSSION

The highest populations of earthworms were obtained in the loamy soil medium, followed by the sandy and lastly the clayey soil. This corroborates the work of Guild (1948), who reported that light and medium loamy soils had higher total population of earthworms than heavier clayey and more open gravelly sand. This can be attributed to the soil structure which influenced the ability of the earthworm to penetrate into soil. Thus, too compact soils like clay hinder earthworm penetration, while too loose soils such as sand make the burrows unable to retain their shape, and the earthworm may suffocate due to inadequate aeration (Madge and Sharma, 1969; Boston, 1986; Joschko *et al.*, 1989). Therefore, earthworms prefer and would multiply faster in loamy soil than either sandy or clayey soil.

The organic matter content of the experimental soil samples were increased over those of the control soil samples, by the addition of cow dung. This provided a better nutrition to the annelids which translated to greater weights. More so, the loamy soil sample had the highest population of earthworm, than the clayey and sandy soils, and this could be attributed to the fact that loamy soil

contain more organic matter than the clayey and sandy soils. These results were in agreement with the findings of Edward and Lofty (1976) who reported that soils that were poor in organic matter did not usually support large number of earthworms. Duweini and Ghabbour (1965) also observed that, increase in the organic content of the soil were in association with increase in number of earthworms. Thus, it can be concluded that loamy soil has the most favourable environmental conditions, and therefore supported the highest population of earthworms, than the sandy and clayey soils. Earthworms could therefore be cultivated using simple technique of nutrient enhanced loamy soil in earthen pots for feeding fish in ponds. Localised moisturisation as done in this study could sustain the production of earthworms in the dry season when natural fish food are scarce. Thus constant supply of the earthworms could be maintained throughout the year, even during the cold and dry season, when they may not be easily procured from the field.

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