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The Productivity of *Lumbricus rubellus* Earthworms in Cow Manure Media with the Addition of Cricket Manure

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ABSTRACT

Earthworms are one of the animals used as indicators to assess soil quality and fertility. In earthworm cultivation, several factors affect the life of earthworms, including temperature, pH, moisture, nutrient content, and media texture. This study aims to evaluate the productivity of earthworms (*Lumbricus rubellus*) in a mixed medium of cow manure and cricket manure. The method used in this study is a Completely Randomized Design (CRD) with 6 treatments and 3 replications, along with a Tukey post-hoc test. The results showed that the addition of cricket manure to cow manure as a cultivation medium could increase earthworm productivity. The use of 90% cow manure with the addition of 10% cricket manure resulted in an average weight increase of 17 g, an average of 94 cocoons, and an average media reduction of 260.50 g. The addition of more than 10% cricket manure to cow manure could reduce earthworm productivity.

Keywords: cricket manure, cattle manure, *Lumbricus rubellus*, productivity

ABSTRAK

Cacing tanah merupakan salah satu hewan yang digunakan sebagai indikator untuk menilai kualitas dan kesuburan tanah. Dalam budidaya cacing tanah, terdapat beberapa faktor yang mempengaruhi kehidupan cacing, antara lain suhu, pH, kelembapan, kandungan nutrisi, dan tekstur media. Penelitian ini bertujuan untuk mengkaji produktivitas cacing tanah (*Lumbricus rubellus*) pada media campuran kotoran sapi dan kotoran jangkrik. Metode yang digunakan dalam penelitian ini adalah Rancangan Acak Lengkap (RAL) dengan 6 perlakuan dan 3 ulangan, serta uji lanjut Tukey. Hasil penelitian menunjukkan bahwa penambahan kotoran jangkrik pada kotoran sapi sebagai media budidaya dapat meningkatkan produktivitas cacing tanah. Penggunaan kotoran sapi sebesar 90% dengan penambahan 10% kotoran jangkrik menghasilkan peningkatan berat rataan sebesar 17 g, jumlah kokon rataan 94 butir, dan penyusutan media rataan sebesar 260.50 g. Penambahan kotoran jangkrik lebih dari 10% pada kotoran sapi dapat menurunkan produktivitas cacing tanah.

Kata kunci: kotoran jangkrik, kotoran sapi, *Lumbricus rubellus,* produktivitas.

INTRODUCTION

Earthworms are one of the soil fauna used as indicators of and quality and soil fertility (Purwaningrum, 2012). They belong to the group of lower animals, are invertebrates, and are classified as segmented annelids (Brata 2006). There are approximately 1,800 species of earthworms, but only a small number of these species have been commercialized (Kartini, 2018). Brata (2006) and Endrawati *et al.* (2020) further noted that four species of earthworms have been cultivated and developed for commercial purposes, namely *Pheretima sp.*, *Eisenia fetida* (Tiger), ANC (African Night Crawler), and *Lumbricus rubellus*.

Lumbricus rubellus has notable advantages and potential, such as its ability to accelerate organic waste decomposition, high productivity levels, rapid weight gain, cocoon production, and ease of maintenance (Febrita *et al*. 2015). Additionally, this species is well-suited for feeding and adapts well to the Indonesian climate (Endrawati *et al*. 2020).

The cultivation of earthworms has become increasingly popular among the public due to its relatively simple maintenance. However, some farmers have expressed concerns regarding the composition of the media. Argantara (2006) stated that improper media composition can slow down the growth of earthworms. Sihombing (2000) added that earthworms thrive in animal manure, and livestock manure is particularly well-suited for earthworm cultivation, as their natural habitat often includes animal waste. According to Brata (2009), manure from animals like cows, buffaloes, horses, sheep, goats, and chickens serves as an excellent substrate for earthworm cultivation. In addition to animal manure, earthworm farming also encourages the use of easily accessible materials in the environment, such as organic waste and leaf litter (Pradnya *et al.* 2023). Abiotic factors such as temperature, humidity, and soil pH also influence the life of earthworms (Rahayu *et al.* 2021).

Currently, cow dung has not been fully utilized as a living medium for earthworm cultivation. According to Gultom (2022), the organic matter content in cow dung can serve as a living medium and food source for earthworms. Dewi *et al*. (2017) reported that cow dung contains 8.3% protein, which can be beneficial for earthworms but is still insufficient. According to Nur *et al*. (2016), earthworms require 9-15% protein. To meet this requirement, additional media can be added. Cricket dung contains 10-12% protein, 19-24% crude fiber, 2.00-4.05% crude fat, and 28-33% ash (Hardman 2019). As cricket manure has not been utilized properly, with its high nutritional content, cricket dung can be used as an addition to cow dung for earthworm cultivation media to support their production. Therefore, research on the productivity performance of earthworms (*Lumbricus rubellus*) in cow manure media combined with cricket manure is necessary.

MATERIAL AND METHODS

Material

The tools used in this study include writing instruments, a digital scale with a precision of 0.01 g, maintenance boxes measuring 38 cm x 30 cm x 12 cm, gloves, a mini shovel, a sprayer, a digital thermo-hygrometer, a soil meter, tarpaulin bags, and covered barrels. The materials used include 900 g of *Lumbricus rubellus* earthworms, with 50 g of earthworms allocated for each experimental unit, cow dung, fermented cricket dung, EM4 of agricultural, and water.

Methods

Media Preparation: The living media used in this study consist of two types: fresh cow dung and fermented cricket dung, with 18 plastic maintenance boxes serving as containers. Before using fresh cow dung as an earthworm habitat, it must be air-dried to remove ammonia content (Maulida 2015). Similarly, cricket dung must be fermented before being used as a habitat for earthworms to reduce its high ammonia content. The materials used for fermenting cricket dung include 20 kg of cricket dung, 1 liter of EM4 of agriculture, 1 liter of molasses, 1 kg of fine bran, and 50 liters of water, all mixed in a 100-liter barrel. During the fermentation process, stirring is done on the 10th days. The characteristics of well-fermented cricket dung include a dark greenish color, a temperature of 25-27 ºC, a fine texture, and no odor.
The treatments used in this study, with 3 replications:
P0: 100% cow dung (control);
P1: 95% cow dung + 5% cricket dung;
P2: 90% cow dung + 10% cricket dung;
P3: 85% cow dung + 15% cricket dung;
P4: 80% cow dung + 20% cricket dung;
P5): 75% cow dung + 25% cricket dung.

Dispersal. Earthworms (*L. rubellus*) were introduced into the maintenance boxes at a rate of 50 g per box, with the worms being 2.5-3 months old. Earthworms begin to mature after 2-3 months of age characterized by the presence of a bracelet (clitelum) on the front of the body (Pangestika *et al.* 2016). After dispersal into the media, the earthworms were observed to ensure the suitability of the media. If the media is suitable, the worms will burrow into it, indicating that the conditions are appropriate for their growth and development.

Water Spraying: Watering was performed daily before measuring the environmental and media temperatures. Water was applied using a sprayer, sprayed onto the surface of the media, and administered once a day at a volume of 100 mL.

Measurement: The weight and number of cocoons were measured manually once a week. Earthworms were manually separated from the media using the hand-sorting method, while samples for temperature, humidity, and pH measurements were collected from five locations in each experimental unit, covering the four corners and the center of the media. These measurements were taken every three days, beginning from the day the worms were introduced into the media. The vermicompost was measured by weighing the media on the 30th day.

Data Collection: Data on weight gain, earthworm population, and cocoon count are collected every 7 days over a 28-day period in each container, with the worms being separated from the media using the hand-sorting method. The weight loss of the media is recorded on the 28^{th} day. Temperature, humidity, and pH measurements are taken from five points in each container, including the four corners and the center. Media temperature and humidity are monitored daily, while pH is measured every 3 days, starting from the initial placement of the earthworms into the media.

1. Total body weight (Darmawan *et al.* 2023)
   The weight of the earthworms is measured by weighing the worms on day 0, 7, 14, 21, and 28.

   WG = TWn – W0

   where: WG = Weight gain rate; TWn = Total weight on day n; W0 = Initial weight of the previous measurement.
2. Cocoon count (Darmawan *et al.* 2023)
   The count of earthworm cocoons is determined by counting the number of cocoons on day 0, 7, 14, 21, and 28.

   CC = CCn – CN0

   where: CCR = Cocoon count rate; NCn = Count of cocoons on day n; N0 = Initial cocoon count from the previous measurement.
3. Population count (Darmawan *et al.* 2024)
   The population of earthworms is determined by counting the number of individuals on day 0, 7, 14, 21, and 28.

   PC = CPn – C0

   where: PC = Population count rate; CPn = Count of individuals on day n; C0 = Initial count of population from the previous measurement
4. Media loss (Darmawan *et al.* 2024)
   Media loss of earthworms is calculated by weighing the media on day 0 and day 28.

   ML = Mf - Mi

   where: ML = Media loss; Mf = Final media weight; Mi = Initial media weight.

Analisis Data

This study utilized the Completely Randomized Design (CRD) method and incorporated four treatments: P0: 100% cow dung (control without substitution); P1: 95% cow dung + 5% cricket dung; P2: 90% cow dung + 10% cricket dung; P3: 85% cow dung + 15% cricket dung; P4: 80% cow dung + 20% cricket dung; P5): 75% cow dung + 25% cricket dung. Each treatment was repeated three times, leading to a total of 18 experimental units. The data gathered will be analyzed using analysis of variance (ANOVA) with a 95% confidence level, followed by Tukey's test (Steel and Torrie 1997). The mathematical model used in the analysis is as follows:

$$Yij = \mu + P(i) + \mathcal{E}(ij)$$

Where:
Yij : the observation,
µ : the overall mean,
P(i) : the effect of treatment at the *i*-th level on the variable, and
Ɛ(ij) : the experimental error of the *i*-th treatment on the *j*-th replication.

RESULTS AND DISCUSION

Conditions of the Media for Earthworms (*Lumbricus rubellus*)

The condition of the media is a crucial factor in earthworm cultivation. Data on the media conditions for earthworm maintenance are presented in Table 1. The research results indicate a significant difference in media temperature ($P<0.05$), with variations ranging from 26.00°C to 26.60 °C. The control treatment (P0) exhibited the lowest temperature at 26 °C, while the highest temperature was observed in treatment P5 at 26.60 °C. This temperature variation is attributed to the higher levels of cricket dung, which contains a relatively high protein content. Increased protein levels in the media result in higher maintenance temperatures. Even so, all the treatments have temperature that still in optimal condition for earthworm cultivation which (15-31 °C) (Kartini 2018). The productivity of earthworms is significantly influenced by the media used, which serves as both habitat and food source. For optimal earthworm maintenance, several media aspects must be met, including pH, relative humidity, and temperature.

The findings show that not only the temperature, but the humidity, and pH of the media remain within optimal ranges for earthworm maintenance. Zulkarnain *et al.* (2019) stated the good condition for earthworms havethe ideal humidity within the range 40–50%, and pH between 6,8–7.2. Therefore, the conditions of temperature, pH, and humidity during the study support the growth and productivity of earthworms. This is consistent with Heraini *et al.* (2019), who state that high environmental temperatures are detrimental to livestock, affecting feed consumption and behavior.

Weight Gain of Earthworms (*Lumbricus rubellus*)

The weight gain of earthworms showed significant differences ($P<0.05$), with treatment P2 exhibiting the highest weight gain and treatment P5 showing the lowest. The higher weight gain observed in treatment P2 is attributed to the acceptable level of cricket dung addition for *Lumbricus rubellus.* It is suspected that the medium in treatment P2 contains good and sufficient nutrients for the needs of the earthworms. According to Hardman (2019), cricket dung contains approximately 10-14% protein in its dry state, while earthworms require 9-15% protein (Nur *et al*. 2016). Additionally, the medium in treatment P2 was characterized by a loose and fine texture, facilitating nutrient

Table 1. Average pH, relative humidity (RH), and temperature of the media for the maintenance of *Lumbricus rubellus* earthworms

Treatment	pH±SD	Relative humidity±SD (%)	Temperature±SD (ºC)
P0	6.62±0.06	69.43±0.87	26.00±0.20c
P1	6.55±0.05	69.50±0.56	26.20±0.10bc
P2	6.58±0.08	69.07±0.31	26.30±0.10abc
P3	6.55±0.09	69.17±0.06	26.33±0.06ab
P4	6.60±0.00	69.10±0.10	26.43±0.06ab
P5	6.60±0.05	68.50±0.62	26.60±010a
Optimal	6.0-7.2*	60-80%*	15-31**

Different letters in the same column show different real results (P<0.05); * = Zulkarnain *et al.* (2019);** = Kartini (2018)

absorption and good aeration for the earthworms. Pangkulun (2010) explains that the looseness of the medium is crucial for weight gain rate and preventing the accumulation of acidic gases.

Treatment P5, which used a mixture of 75% cow dung and 25% cricket dung, had the lowest average weight gain. This was due to the dry medium (low moisture and high temperature), as indicated by the research results, which led to a low water retention capacity. This issue is attributed to the high ash content in cricket dung. Edwards and Lofly (1977) note that earthworm media with high sand content is unfavorable for earthworms because the coarse particles cannot retain the moisture needed by the worms. Excessive mucus production in earthworms can lead to reduced weight gain. Earthworms living in low-humidity media tend to produce more mucus to maintain their survival (Pangkulun, 2010).

Cocoon Production of Earthworms (*Lumbricus rubellus*)

Analysis revealed that the treatment significantly affected the number of cocoons produced. The increase in cocoon production was influenced by the availability of organic material and the texture of the maintenance medium. The results indicate that the highest average cocoon production was in treatment P2, with 94 cocoons. Cocoon production is influenced by factors such as the age of the earthworms, population size, nutrient composition of the medium, and the medium's texture. According to Nurdiansyah *et al*. (2018), earthworms require adequate nutritional content and organic material in the medium to meet their needs and produce cocoons. Gaddie and Douglas (1975) state that the protein content in the medium affects ovum growth, sperm production, and overall reproductive performance. Earthworms are capable of producing cocoons at 2.5-3 months of age, with a typical production of 2-4 cocoons.

The lowest average number of cocoons was observed in treatment P5, with 27 cocoons. This lower average is attributed to the sandy texture of the medium. Sandy media negatively impacts the earthworms' ability to absorb nutrients. This finding is consistent with Pangestika *et al*. (2016), who note that nutrient absorption in the medium is a critical factor in earthworm growth and cocoon production. Aside, the temperature, humidity, and pH of the media also affect the productivity of the earthworm. In treatment P5 is known to have an average temperature around 26.60 ± 0.10 which is still included in the normal range of 15-31 °C, however, treatment P5 has higher acidity (6.60 ± 0.05) compared to the optimal condition for earthworm cultivation which ranging around 6,8-7,2 (Zulkarnain *et al*. (2019).

Earthworm survival and population growth were impacted by acidity in the soil (Klok *et al,* 2007). Sihombing (2000) states that an earthworm's clitellum may rupture due to an overly acidic medium. Besides the inappropriate pH, treatment P5 also has a humidity level of 68.50 ± 0.62%, this humidity is higher than the normal range of 40-50%. As stated from Ivask *et al.* (2006), the quantity of earthworm communities is more influenced by soil moisture than soil type. Humidity higher than 60% might cause the nutrients washed away (Wibowo *et al.* 2016).

Population of Earthworms (*Lumbricus rubellus*)

Analysis results indicate a significant effect (P<0.05) on the average earthworm population with varying levels of cricket dung addition. The study found that the highest population was in treatment P1, with 23 earthworms, while the lowest average was observed in treatments P4 and P5, each with 4 earthworms. The increase in population is related to the number of cocoons and the hatching success of these cocoons. Both the number of cocoons and their hatching success are influenced by the texture of the earthworm's living medium.

Treatment P1 had the highest average population. Cocoons in treatment P1 hatched in greater numbers compared to other treatments. Although treatment P2 had a high number of cocoons, it did not show a corresponding increase in population. Cocoons typically require 7-21 days to hatch, as stated by Mashur *et al*. (2000). The population increase in treatment P1 is attributed to the medium's texture, which is suitable for earthworms being neither compact nor coarse. Putra *et al*. (2018) indicate that the looseness of the medium is crucial for earthworm movement and facilitates oxygen entry into the living medium.

Treatment P5 had the lowest average population due to the high proportion of cricket dung, which made the medium dry and sandy because of the high ash content in the cricket dung. This dry and sandy medium hindered nutrient absorption by the earthworms. This finding aligns with Darmawan *et al.* (2023), who state that media with high ash content tends to be more sandy, less fine, and dries out quickly, leading to reduced earthworm populations.

Table 2: Average body weight gain, number of cocoons, population count, and media reduction during the study.

Treatment	Variable±SD			
	WG (g)	CC (grain)	PC (tail)	ML (g)
P0	14.48±0.68a	41±6.64ab	21±4.59a	139.17±15.78bc
P1	16.45±1.68a	68±5.79ab	23±3.79a	252.33±68.70ab
P2	17.00±4.64a	94±5.51a	19±3.46a	260.50±49.62a
P3	13.57±0.93a	57±39.70ab	6±3.50b	133.33±12.29c
P4	13.44±1.77a	65±24.52ab	4±2.13b	141.50±49.00bc
P5	1.44±1.13b	27±26.58b	4±1.51b	71.50±16.04c

WG = Total body weight rate; CC = Cocoon count rate; PC = Population count rate; ML = Media loss. Different letters on the same line show different real results (P<0.05).

Media Loss of Earthworms (*Lumbricus rubellus*)

The shrinkage of the cultivation medium with varying levels of cricket dung addition had a significant effect (P<0.05). According to the study, as shown in Figure 4, the highest average medium shrinkage was observed in treatment P2, at 260.33 *g*. This is attributed to the organic content in treatment P2, which meets the nutritional needs of *Lumbricus rubellus*. Medium shrinkage is directly proportional to both earthworm weight and population; greater medium shrinkage generally corresponds to heavier earthworm weight. This finding is consistent with Rahayu (2022), who indicates that increased medium shrinkage is associated with higher consumption of the medium by earthworms. Additionally, the substantial medium shrinkage in treatment P2 is due to its larger earthworm population compared to treatments P3, P4, and P5, with population size being directly proportional to medium shrinkage.

Treatment P5, with a composition of 75% cow dung and 25% cricket dung, exhibited the lowest medium shrinkage, at 71.50 *g*. This is related to the earthworm performance, specifically weight gain. In treatment P5, earthworm weight did not increase significantly due to reduced feed consumption in the medium. This condition is due to the medium's slightly sandy texture, which, according to Rahayu (2022), is less favorable for earthworms. Sandy media are less preferred by earthworms because their coarse texture can cause discomfort and restrict movement, leading to reduced feed consumption.

CONCLUSION

The use of cow manure supplemented with cricket manure as a living medium affects positively the productivity of earthworms (*Lumbricus rubellus*). Pecifically, the application of 90% cow dung with an additional 10% cricket dung resulted in an increase in earthworm weight by 17 grams, an average cocoon count of 94, and a medium shrinkage of 260.50 grams.

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