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THE EFFECT OF GIVING CABBAGE LITTER ON POPULATION GROWTH OF THE AFRICAN NIGHT CRAWDER EARTHWORM (*Eudrilus eugeniae*)

Puput Melati, Karnan*, and I Wayan Merta
Biology Education Study Program, Faculty of Teacher Training and Education, University of Mataram, Mataram, Indonesia
*Email: karnan.ikan@unram.ac.id

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Abstract: Cabbage (*Brassica oleracea*) is one of the vegetable wastes that is often produced by the Amahami market, Bima City. With its easy-to-wilt nature and high water content, cabbage causes it to rot quickly, which will impact environmental problems. Processing market waste certainly requires sustainable management. One model of waste management is to use it as feed. This research aims to determine the effect of giving cabbage waste on the increase in the population of earthworms (*Eudrilus eugeniae*). The research was carried out in Bima City, Ule Village, Asakota District, Tolotongga Environment. The type of this research is experimental. The research design was a Completely Randomized Design (CRD) with four treatments and ten replications. The parameter observed was the increase in the number of earthworms, analyzed using One Way Anova and followed by Duncan's Multiple Range Test (DMRT). The results of the research showed that giving cabbage waste (*Brassica oleracea*) as feed had a significant effect (0.009<0.05) on increasing the population of earthworms (*Eudrilus eugeniae*). The treatment with the highest results was P1 (50 grams of cabbage), with an average number of worms of 367.30.

Keywords: *Earthworm (Eudrilus eugeniae), Cabbage, Earthworm Medium*

INTRODUCTION

One of the problems that is still the biggest challenge and has not been able to be resolved to date is problems related to waste. The Bima City Environmental Service (DLH) stated that several areas that contribute the most waste in Bima City, including the market, can produce 2 tons of waste daily [1]. The type of waste produced by markets, in general, is organic waste in the form of vegetables and fruit. Cabbage (Brassica oleracea) is one of the vegetable wastes that is often produced by the Amahami market in Bima City. With its easy-to-wilt nature and high water content, cabbage causes it to rot quickly, which will impact environmental problems. Cabbage has the potential to be used as feed because it contains complete nutrients for the growth of earthworms. The nutritional composition of cabbage per 100 g of fresh ingredients consists of calories 25 cal; protein 1.7 g; fat 0.2 g; carbohydrates 5.3 g; calcium 64 mg; phosphorus 26 mg; Fe 0.7 mg; Na 8 mg; niacin 0.3 mg; fiber 0.9 g; ash 0.7 g; vitamin A 75 Sl; vitamin Bl 0.1 mg; Vitamin C 62 mg and water 9l-93% [2].

Apart from food factors, the population density of earthworms is very dependent on the environmental conditions where the earthworms are. Various abiotic factors such as pH, temperature, humidity, and other chemical and physical factors have a significant influence on the life of worms [3]. The normal temperature for the growth of earthworms is around 15-25^{o}C. Meanwhile, the optimum temperature for earthworms to reproduce is around 21-29^{o}C. Media humidity good for worm breeding is around 30-50% [4]. The ideal pH for maintaining earthworms is around 6.5-7.2 [5].

Worms are starting to be widely cultivated in Indonesia. Some people who already know the benefits of cultivation will be very enthusiastic about continuing to develop their business, but some people who need help understanding the potential of this business will think that worms are just disgusting and ridiculous animals. The protein content of worms is around 76%. When compared to the protein in meat and fish, worm protein is higher [6]. The worm's body also contains various enzymes, which are very useful for human health [7]. The nutritional content in the bodies of earthworms will provide significant benefits for multiple sectors such as agriculture, animal husbandry, health, and beauty.

Generally, control of cabbage waste will not be completely resolved, but to minimize the accumulation of cabbage waste, one alternative is to use it as feed for cultivating earthworms. This study aims to analyze the effect of giving cabbage vegetable waste on the increase in the population of the earthworm *E. eugeniae*.

RESEARCH METHODS

The research was conducted from April 19-July 1, 2023. It was carried out in the Tolotongga area, Ule Village, Asakota District, Bima City. The materials prepared were 2,000 *E. eugeniae* earthworms, cow dung, banana stems, lime, EM4, water, and cabbage waste. The tools used were 40 plastic trays measuring 36.5x27x11.5 cm, sacks, cameras, stationery, a hand sprayer, cake scales, a soil tester, a machete, a plastic bucket, bamboo, a tarp, and a net.

The research design used was a Completely Randomized Design (CRD) with four treatments and

ten replications. The population used is homogeneous. Homogeneous, in this case, includes the uniformity of the media used as a mixture of cow feces and banana stems. The initial number of worms introduced, changing the media, watering, feeding time, and checking the condition of the media must be the same. The concentration of cabbage feed used consisted of P0 (0g cabbage feed), P1 (50g cabbage feed), P2 (100g cabbage feed) and P3 (150g cabbage feed). The total number of worms in the study was 2,000, which were purchased from earthworm cultivators. Each plot was filled with 50 adult *E. eugeniae* earthworms. Plot placement was randomized by drawing lots, and a sticky note was attached to each field as a marker according to the level of treatment.

The parameter observed was an increase in the number of earthworms. The data obtained was analyzed statistically using one-way ANOVA. If the differences are significant, proceed with Duncan's Multiple Range test (DMRT) to determine the differences between the four treatments. Several stages must be prepared for research into earthworm cultivation, including:

The first stage is making the cage. The cage is made using only simple materials that are easy to obtain, such as a tarp used as a roof, then the bamboo is used as a media storage place, and the nets are used as cage walls. Place the cage next to the house because it is quite cool. Apart from being shaded by a tarp, the roof has trees at the top of the house, providing shade. A relatively hot rearing location will cause earthworm activity to only occur in the media and rarely rise to the surface. Meanwhile, the feed is on the surface. The effect is that the growth and development of worms slow down [4].

In the second stage of media creation, the media used in this research were cow dung and banana stems. The nutritional content of cow dung consists of 93.15% dry matter, 12.66% crude protein, 2.28% crude fat, 34.95% crude fiber, and 27.43% nitrogen-free extract [8]. Banana stems, or what are known as gedebog bananas, are one of the organic ingredients that contain quite high levels of fiber. This material can be obtained from anywhere, such as private plantations. The average nutritional composition of banana stems includes dry matter (DW) 87.7%, ash 25.12%, crude fat (LK) 14.23%, crude fiber (SK) 29.40%, crude protein (PK) 3%, including amino acids, amine nitrate, glycosides, contains N, glycolipids, vitamin B, nucleic acids, non-nitrogen extract (BENT) 28.15%, carbohydrates, sugar and starch [9].

The steps for making it: First, wet cow feces are dried by drying them in the sun or placing them in the open for four days. Then, continue by chopping one banana stalk until it is small. Second, mix dry cow feces and chopped banana stems until evenly mixed, then mix 1 liter of EM4 into 50 ml of water and pour into the media. Stir again until evenly mixed. Third, close the media and leave it for one week. Fourth, the fermented media is put into a media box with a media height of 5 cm.

The third stage is making feed. Additional feed in the form of cabbage vegetable waste is obtained from the Amahami Market, which is thrown away by traders because it is damaged or rotten. Collection is carried out every time the feed supply runs out. Cabbage vegetables, before being given, are cut first to a size of 2-3 cm. Put the chopped cabbage into a sack and let it sit for a few days until the feed turns to mush. The aim is to facilitate digestion in the worm's stomach because worms can only eat by sucking.

The fourth stage is parent selection. The worm seeds used in this research were sexually mature, visible by the presence of the clitellium. Worms begin to mature after 2-3 months of age. Nurseries were obtained from earthworm cultivators with a total number of 2,000 individuals.

The fifth stage is spreading seeds. Each media will be filled with 50 earthworms each. The process of spreading seeds is carried out little by little on the surface of the media, with the aim that the worms can acclimatize first. Suppose the worms enter directly into the media. In that case, this indicates that the media is suitable, whereas if it is not, the worms will wander around and try to leave the media. To find out whether the worms can adapt or not, observations are made for approximately 30-60 minutes to determine the suitability of the media.

Sixth stage of maintenance. The media container uses plastic trays measuring 36.5x27x11.5 cm, totaling 40 pieces. Worm feeding is done once every three days, according to the specified concentration. Maintenance, in this case, includes changing media, watering, stirring, measuring temperature, pH, and humidity. Measure temperature, pH, and humidity using a soil tester. Stirring aims to ensure that the media is always loose so that air circulation within it is maintained. Watering is carried out when the media appears dry, and the watering and stirring processes are carried out simultaneously.

Seventh stage of harvest. The research was carried out for two months. The reason is that the worms mature after 2-3 months old. Once the worms are mature, it will be easier to count the number of earthworms during the harvest process at the end of the research. The harvesting process can be done by separating the worms from the media with the help of lighting tools such as lamps. Earthworms are very sensitive to light. In this research, the harvesting process was carried out in the morning to make it easier to count the number of worms.

RESULTS AND DISCUSSION

Data collection on the increase in the number of earthworms was carried out after being treated for 60 days. Calculation of the number of worms was done manually. Feed was given once every three days, 19 times the feed given during the study.

The final average number of earthworm populations in each treatment was found to be, in treatment P0 (without cabbage feed), the average number produced was 262.00 heads. P1 (proportion of 50 grams of cabbage waste) produces 367.30 heads. P2 (proportion of 100 grams of cabbage waste) produces 140.80 heads. P3 (proportion of 150 grams of cabbage waste) amounted to 240.10 heads. The average results of the increase in the number of earthworms after treatment can be seen in Figure 1.

Based on the analysis of variance, it shows that feeding cabbage with various proportions of cabbage waste has a significant effect (0.009<0.05) on the increase in the population of *E. eugeniae* earthworms. Given this real influence, the DMRT test was continued. Further analysis of the Duncan Multiple Range Test (DMRT) showed that the lowest average increase in earthworm populations was obtained in treatment P2 (the proportion of cabbage waste was 100 grams). Meanwhile, the highest average increase was obtained in treatment P1 (50 grams of cabbage waste). In line with the results of previous research, it was stated that the highest final population of earthworms was found in the treatment of 50 grams of cabbage feed with an average of 192.50 ± 9.57% [10]. To find out if worms eat their food, you can see the degradation process carried out by worms in cabbage vegetables, which produce vermicompost and cocoons. Feeding fermented cabbage is degraded more quickly by earthworms [11].

Cabbage feeding has a significant influence on the number of earthworms. This is because cabbage contains quite high nutrition and a complete composition. Apart from that, the water content in cabbage vegetables is very high. The nutritional content of cabbage crops per 100 grams consists of calories (25.0 cal), protein (1.7 gr), fat (0.2 gr), carbohydrates (5.3 gr), calcium (64.0 mg), phosphorus (26.0 mg), iron (0.7 mg), sodium (8.0 mg), niacin (0.3 mg), fiber (0.9 gr), ash (0.7 gr), vitamin A (75.0 SI), vitamin B1 (0.1 mg), vitamin C (62.0 mg), water (93.6 gr) [2]. Feed is an important factor in the growth of worms to help their development process. The type of feed used has a big influence on earthworms. If the feed is rich in organic matter, the development of earthworms will increase. Feed that contains more carbohydrates and fiber will stimulate egg laying in worms that are in production or adults [12]. Food or nutritional sources that contain lots of protein will get a quick response from earthworms, and food that has lots of protein sources will influence earthworm cocoon production [13].

High water content in feed will be preferred because it rots easily and decomposes, making it easier for worms to digest. Palangkun stated that the water content that is good for use as worm feed is 80%. High water content in feed will increase worm body weight by 15% [14]. Earthworm activity will be disrupted if there is a lack of water in their body, especially when they gain weight. Lack of water will cause the worms' appetite to decrease, while excess water will increase their appetite. If the nutritional content and nutritional value of the feed are sufficient, the growth of earthworms will be much better. Providing cabbage with a fine texture, like porridge, can make it easier for earthworms to eat the food. The fibrous texture can cause earthworms to have difficulty digesting it because the earthworm *E. eugneae* does not have teeth to chew the food given. Feed that has been fermented for 1-2 days can increase nutritional value and facilitate digestion in the worms' stomachs [15]. Earthworm growth will be high if earthworms like and eat their food [16].

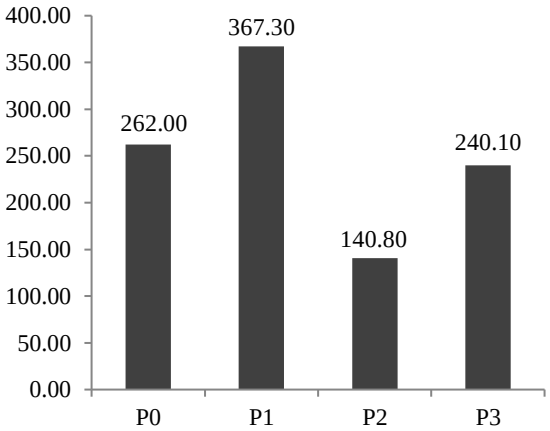

Figure 1. Average number of earthworms in each treatment

The mating of a pair of earthworms, each will produce a cocoon which contains a zygote resulting from fertilization between the egg and sperm. The cocoon will hatch around 14-21 days after it is separated from the earthworm's body. The cocoons are oval-shaped, yellowish-green in color, and will turn red when they hatch [7]. In Duncan's test results, the average number of earthworms in each treatment was different. In treatments P0 (0 262.00 individuals) and P1 (367.30 individuals), there was an increase in the number of earthworms, then in treatments P2 (140.80 individuals) and P3 (240.10 individuals), the number of earthworms decreased. A decrease in the number of earthworms can be caused by food not being eaten optimally, deaths that cannot be detected, and other factors can be caused by the release of earthworms from the media. Food materials that are too dense in the media can reduce aeration, which will cause the death of earthworms [17]. The exit of the worms from the media occurs on days one and two during the adaptation process to their new environment, which is different from the previous environment [15]. Several factors above will influence the reduction in the number of earthworm populations and the small number of cocoons produced.

The population density of earthworms is very dependent on the environmental conditions where the

earthworms are. Various abiotic factors such as pH, temperature, humidity, as well as other chemical and physical factors have a significant influence on the life of worms [3]. Humidity is the water content contained in the media. Table 1 shows the average results of measurements of temperature, pH, and media humidity during the research.

Table 1. Average parameters of humidity, pH, and media temperature

Treatment	Parameter		
	Temperature (°C)	pH	Humidity (%)
P0	24.9	6.5	33
P1	25	6.8	33
P2	25	6.2	29
P3	25	6.5	30

Table 1 shows the average media humidity measurement results ranging from 30-33%, temperature 24.9-25oC, and pH 6.2-6.8.

Media conditions during the research were good for the survival of earthworms. Media humidity good for earthworm breeding is around 30-50%, and the normal temperature for growth is around 15-25°C [4]. For good growth, earthworms require a slightly acidic or neutral pH of around 6-7.2 [7]. Earthworms develop well at neutral pH, so increasing soil pH increases the earthworm population [18].

Generally, market waste control will not be completely resolved, However, to minimize the accumulation of cabbage, one alternative is to use it as feed for cultivating *E. eugeniae* earthworms. The process of managing organic waste using worms provides double benefits. Firstly, the organic waste eaten by the worms will help them reproduce in large numbers so they can be marketed. Secondly, the vermicompost can be used as an organic fertilizer. Vermicompost contains growth regulators macro elements, namely N, P, K, Ca, Mg, and C, and microelements, namely Mn, Zn, Fe, and Cu [11]. These elements are really needed by plants to fertilize and loosen the soil, stimulate the growth of roots, stems, leaves, and flowers, speed up harvests, and increase productivity [19]. The third benefit is that the problem of organic waste accumulation in cabbage vegetables can be minimized. Worm cultivation is an initial effort to carry out other businesses (20).

CONCLUSION

There is an effect of giving cabbage vegetable waste on the increase in the population of the earthworm *E. eugeniae*. The research data obtained can be used as a source of information, especially for worm breeders regarding the effect of cabbage vegetable feed on the population of *E. eugeniae* earthworms. Readers can provide additional references regarding the business prospects for cultivating earthworms using only organic waste that is easily available. It can also provide a solution for handling market waste that is good and environmentally friendly through cultivating *E. eugeniae* worms.

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