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Performance Pheretima sp. and The Quality of Vermicompost on Media Using Clam and Snail Shell Flour

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ABSTRACT

The abundance of green mussel shells, clam shells, and snail shells that have not been maximally utilized has caused environmental disturbances. These shells can be used as a substitute for worm food because of their good nutritional content. This research aimed to analyze the productivity of *Pheretima* sp. with the combination of shell powder (green mussel, clam, and snail) and cow dung to their living media (feed) and the quality of vermicompost. The data were analyzed using SAS Studio application with completely randomized design (CRD), 10 treatment levels, with 3 replications each. The observed variables included earthworm productivity, vermicompost quality, and vermicompost performance. The results of the study show a significant ($P<0.05$) on the use of green mussel shell 10% in all earthworm productivity variables, and show a significant ($P<0.05$) on the use of green mussel shell 30% in vermicompost quality and vermicompost performance. The combination of 10% green mussel shell powder in cow dung media can increase the productivity of *Pheretima* sp. The best vermicompost testing result on water spinach plants was found in the treatment with the addition of 30% green mussel shell powder in cow dung media.

Keywords: ***Cow dung, Pheretima, shells, vermicompost***

ABSTRAK

Melimpahnya limbah cangkang kerang hijau, cangkang kerang, dan cangkang bekicot yang belum dimanfaatkan secara maksimal telah menimbulkan gangguan lingkungan. Cangkang ini dapat dijadikan pengganti makanan cacing karena kandungan nutrisinya yang baik. Penelitian ini bertujuan menganalisis produktivitas *Pheretima* sp. dengan media berupa kombinasi tepung cangkang (kerang hijau, kerang, dan bekicot) dengan kotoran sapi terhadap media hidup (pakan) dan kualitas vermikompos. Data dianalisis menggunakan aplikasi SAS Studio dengan rancangan acak lengkap (RAL), 10 taraf perlakuan, masing-masing 3 ulangan. Variabel yang diamati meliputi produktivitas cacing tanah, kualitas dan performa vermikompos. Hasil penelitian menunjukkan terdapat pengaruh signifikan ($P<0.05$) pada penggunaan cangkang kerang hijau 10% pada seluruh variabel produktivitas cacing tanah, dan menunjukkan adanya pengaruh nyata ($P<0.05$) pada penggunaan cangkang kerang hijau 30% pada kualitas dan performa vermikompos. Kombinasi tepung cangkang kerang hijau 10% pada media kotoran sapi dapat meningkatkan produktivitas *Pheretima* sp. Kombinasi tepung cangkang kerang hijau 30% pada media kotoran sapi dapat meningkatkan kualitas dan performa vermikompos pada tanaman kangkung.

Kata kunci: Cangkang, feses sapi, *Pheretima*, vermikompos

INTRODUCTION

Earthworms are one of the lower animals that have benefits for humans. The species that have been extensively investigated in Indonesia are primarily from the Megascolicidae family in the *Pheretima* and *Perionyx*, and the Lumbricidae family in the *Lumbricus* and *Eisinia*. Species *Pheretima* sp. was chosen because it has a wide tolerance of feeding conditions (living medium), can live and reproduce well in organic and inorganic land conditions (Jayanthi *et al.* 2014). The abilities possessed by *Pheretima* sp. is that it can decompose organic material and increase soil fertility. *Pheretima* sp. is also a type of earthworm that exhibits good adaptation to cultivation media (Darmawan *et al.* 2023). The presence of earthworms can increase the nitrogen content in the soil (Edwards and Lofty 1972).

Shell production increases from year to year. Based on BPS data (2016), there were 115.60 tons of clam shell waste in Indonesia in 2015. In 2018 shellfish production of green shells reached 309,886 tons/year. The high level of shell waste production results in a buildup that has the potential to become an environmental pollutant if not managed properly. Efforts have been made to utilize shells by making crafts from shells, but these efforts have not succeeded in reducing the pile of shell waste properly. An example is the accumulation of shell waste from fishing in coastal areas which has been happening for a long time (Kusumaningrum *et al.* 2021). The shellfish caught by fishermen are only used for meat while the shells are discarded and become waste. One effort to handle organic waste is by using an appropriate organic waste processing method, namely vermicomposting, which is a process of decomposing organic material that involves earthworms (Liberty *et al.* 2022). Vermicomposting will produce vermicompost which is the result of the digestive process of worm bodies and can be used as organic fertilizer.

The quality of vermicompost as fertilizer really depends on the organic material contained, including N, P, and K. The N, P, and K content in vermicompost is influenced by the living media or feed used (Chaniago and Inriyani 2019). Livestock dung, including that of cows, buffaloes, horses, and goats, is a suitable living medium for worm culture (Brata 2009). Sihombing (2000) stated that cow dung is ideal as a medium for growing earthworms because of its high crude protein content. Green mussel shells contain 8.53% crude protein, 1.10% crude fat, and 0.76% crude fiber (Darmawan *et al.* 2023), as well as the macrominerals calcium around 0.24%, sodium 0.16%, and magnesium 0.02% (Saritha *et al.* 2015). Clam clam shells contain 11.20% protein, 2.44% fat, and 2.20% water (Agustini *et al.* 2011), as well as macrominerals such as 0.23% calcium, 0.54% sodium, and 0.42% magnesium. % (Abida *et al*. 2023). Snail shells contain many compounds, including protein, fat, water, chitin, and minerals such as potassium, magnesium, iron, zinc, and manganese (Rakhmawati 2007), as well as macrominerals such as calcium (around 1.44%), sodium (0.02%), and magnesium (approximately 0.12%) (Nkansah *et al.* 2021). Therefore, shell waste can potentially be used as a rearing medium and food for worms, while reducing the potential for environmental pollution due to shell accumulation. This research aims to analyze the productivity of *Pheretima* sp. earthworms with a combination of shell meal in their living medium (feed) and the quality of the vermicompost produced.

MATERIAL AND METHODS

Material

The tools used are a box-shaped plastic container measuring 38 cm x 30 cm x 12 cm, digital thermohygrometer, soil tester, poly bag measuring 30 cm x 30 cm, digital scales with an accuracy of 0.01 g.

The materials used include *Pheretima* sp worms. 2-3 months old, cow dung, shell waste (green mussels, scallops and snails) from seafood traders around Dramaga, water spinach seeds, NPK 16-16-16 fertilizer, and water.

Methods

Preparation of *Pheretima* sp. earthworm rearing media. The cow dung used is aerated and dried in the sun for 5-7 days. Green mussel shells, scallop shells, and snail shells that have been washed clean, dried in the sun, then floured with a 60 mesh size. The test container is a plastic box that has been perforated and cleaned as many as 36 units. All plastic boxes were filled with a combination of media, namely cow dung and green mussel shell flour, cow dung and clam shells, as well as 2 kg of cow dung and snail shells according to the treatment.

Distribution of *Pheretima* sp. worms and maintenance of earthworms. Earthworms (*Pheretima* sp.) were spread in a test container containing a combination of 50 g of media. The adult worms used aged 2–3 months which had been weighed using digital scales with an average individual weight ranging from 0.8–1 g. The condition of the earthworms after they were stocked is observed for ensuring the suitability of the worms for the media.

Cultivating earthworms uses a combination of media, namely cow dung and green mussel shell flour, cow dung and clam shells, as well as cow dung and snail shells. Media humidity was maintained throughout the study (42 days) by spraying water as needed. The vermicompost harvesting process was carried out at the end of the research period (42 days).

Analysis of earthworm (*Pheretima* sp.) productivity. The average weight gain was measured by weighing the worms that had been separated from each medium with a digital scale. The average population increase was calculated by hand-sorting the worms from the media and counting them, then taking the difference between each population. The average production of unhatched cocoons was measured by hand-sorting the cocoons from the media and then counting them. Worm samples were taken, and temperature, humidity, and pH was measured from five points in each experimental container, at 4 corners and 1 center of the container. Vermicompost measurements were calculated by weighing the media weight on the day 42^{nd}. These are the formula used to measure earthworm's productivity according to Darmawan *et al.* (2023):

WGR = TWn – W0

where: WGR = Weight gain rate; TWn = Total weight on day n; W0 = Initial weight of the previous measurement

PC = CPn – C0

where: PC = Population count rate; CPn = Count of individuals on day n; C0 = Initial count of population from the previous measurement

CC = CCn – CN0

where: CCR = Cocoon count rate; NCn = Count of cocoons on day n; N0 = Initial cocoon count from the previous measurement

ML = Mf – Mi

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

Vermicompost Quality and Performance Analysis. The vermicompost that produced on the 42nd day was weighed, followed by the weighing of 300 g of vermicompost from each treatment, totaling 10 samples for analysis at the IPB University Soil Science Laboratory. The composition of the vermicompost analyzed consisted of C organic, nitrogen, phosphorus and potassium. Observing the quality of vermicompost is comparing the macro nutrients in the research with organic fertilizer standards based on SNI 7763:2018. Planting tests were carried out on water spinach with a mixture of soil and vermicompost, specifically 25% soil and 75% vermicompost (Mance *et al.* 2016). Vermicompost's performance can be seen from the results of measurements on plants, such as measuring the number of leaves, which calculated from all plant leaves that are fully open and still green, measuring plant height by measured from the surface of the planting medium or the base of the plant to the highest growing point (Kresna *et al.* 2016).

Research Design

The experimental design used in the earthworm cultivation research and vermicompost planting test research was a completely randomized design (CRD) with 10 treatments with 3 replications each as follows: PKL0: 100% cow dung (control); PKH1: 90% cow dung + 10% green mussel shells; PKH2: 80% cow dung + 20% green mussel shells; PKH3: 70% cow dung + 30% green mussel shells; PKS1: 90% cow dung + 10% clam shells; PKS2: 80% cow dung + 20% clam shells; PKS3: 70% cow dung + 30% clam shells; PBK1: 90% cow dung + 10% snail shells; PBK2: 80% cow dung + 20% snail shells; PBK3: 70% cow dung + 30% snail shells.

Data Analysis

The data obtained was analyzed using analysis of variance (ANOVA) with the SAS Studio application. Results that showed significant differences ($P<0.05$) were followed by the Tukey test at the 5% level. The following mathematical model was used:

$$Y_{ij} = \mu + A(i) + E(ij)$$

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

RESULTS AND DISCUSSION

Research Environment Temperature and Humidity

The average data for air temperature and humidity in the research environment are around 24.46-27.76 °C and 78.19%-96.31% (Table 2). The temperature required for the growth of earthworms according to Palungkun (2010) is around 15-25 °C. Meanwhile, humidity is suitable for cultivating earthworms according to Zulkarnain *et al.* (2019), namely between 60%-80%, thus the temperature and humidity during the research supported the growth of earthworms.

Conditions of *Pheretima* sp. Earthworm Maintenance Media

Earthworm productivity is significantly influenced and dependent on the cultivation medium, which functions as both a living medium and a food supply. The pH, temperature, and humidity of the maintenance media are vital variables for supporting earthworm growth and reproduction. (Manurung 2014).

There were no significant differences between treatments in Table 3. The temperature of the maintenance media ranged from 24.86-25.60 °C and humidity ranged from 71.81%-72.21%. The temperature and humidity of the rearing media are still within the range suitable for rearing

Table 1. Content of cow dung, green mussel shell flour, clam shell flour, snail shell flour

Living Media Materials	Contains (%)				
	Ash	CP	CF	EE	NFE
Cow Dung*	5.40	8.36	31.40	2.85	18.83
Green Mussel Shell Flour**	77.29	8.53	0.76	1.10	9.82
Clam Shell Flour***	97.15	2.36	0.05	0.32	0.04
Snail Shell Flour***	89.12	5.24	0.08	2.24	2.06

Note: *: source Guntoro et al. (2015); ** source Darmawan (2023); ***this research; CP= crude protein; CF= crude fiber; EE= ether extract; NFE= nitrogen-free extract.

Table 2. Average temperature and humidity research environment

Time	Temperature (°C)	Humidity (%)
Morning	24.46±1.08	96.31±4.26
Afternoon	27.76±1.52	78.19±9.98
Evening	26.86±1.74	83.45±9.94
Average	26.36±1.70	85.98±9.32

Table 3. Average pH, temperature and humidity values for the living media of Pheretima sp. worms for 6 weeks

Treatments	Parameters		
	pH	Temperature (°C)	Humidity (%)
PKL0	6.63±0.07a	25.33±0.32	72.07±0.32
PKH1	6.55±0.05ab	25.38±0.43	72.12±0.34
PKH2	6.46±0.05b	25.29±0.46	72.17±0.25
PKH3	6.46±0.05b	25.60±0.29	72.19±0.04
PKS1	6.66±0.12a	25.09±0.30	71.81±0.19
PKS2	6.68±0.03a	25.20±0.29	71.90±0.23
PKS3	6.62±0.07a	24.86±0.42	71.93±0.00
PBK1	6.67±0.03a	25.38±0.24	72.05±0.11
PBK2	6.66±0.03a	25.15±0.17	71.98±0.18
PBK3	6.67±0.05a	25.04±0.34	71.98±0.11

Note: Different superscripts on the same column shows significant (P < 0.05); PKL0 = 100% cow dung (control); PKH1 = 90% cow dung + 10% green mussel shells; PKH2 = 80% cow dung + 20% green mussel shells; PKH3 = 70% cow dung + 30% green mussel shells; PKS1 = 90% cow dung + 10% clam shells; PKS2 = 80% cow dung + 20% clam shells; PKS3 = 70% cow dung + 30% clam shells; PBK1 = 90% cow dung + 10% snail shells; PBK2 = 80% cow dung + 20% snail shells; PBK3 = 70% cow dung + 30% snail shells.

earthworms, namely temperature 21-29°C and humidity 50%-80% (Sihombing 2000).

The data in Table 3 shows the pH range of the maintenance media was 6.46-6.68. There was a significant difference (P<0.05) in pH between treatments after Tukey's test. The 10% green mussel treatment had a media pH of 6.55 and which was significantly different from the 30% green mussel treatment with the lowest media pH of 6.46. The real difference that occurs in the pH of the rearing media is still at the optimum pH of the earthworm rearing media, namely in the range of 5-7.2 according to Brata (2009) as the optimum pH of the rearing media.

Productivity of *Pheretima* sp. Earthworms

Earthworm productivity can be measured using numerous metrics, including increased body weight, increased population size, increased individual weight, increased individual length, cocoon creation, and loss of rearing media. Data in Table 4 shows that there was a significant difference in weight gain (P<0.05). The Tukey test showed that the 10% green mussel treatment resulted in the highest average increase in earthworm weight (6.94 ± 2.27 g), while the 30% green mussel treatment resulted in the lowest earthworm weight (-6.43 ± 0.61 g). The texture of the living media which has coarse and large grains because it contains 30% green mussel shell flour can cause a decrease in worm weight. Darmawan *et al*. (2023) stated that the food absorption capacity of worms will decrease if the rearing medium is dry. Those with coarse grains are generally not liked by earthworms because they are unable to store enough water for the earthworms' needs (Edwards and Lofty 1977).

Based on Table 4, there is a significant difference (P<0.05) in the average population increase of *Pheretima* sp. Earthworm population. The highest average population increase was 36.11 ± 27.90 worms in the 10% green mussel treatment, and the lowest average occurred in 30% green

Table 4. Average productivity of *Pheretima sp.* Worms

Treatments	Parameters			
	WG (gram)	PC (tail)	CC (grain)	ML (%)
PKL0	5.05±0.62a	30.19±49.60ab	44.37±17.64ab	16.39±0.01ab
PKH1	6.42±1.88a	36.11±27.90a	59.06±6.74a	18.67±0.01a
PKH2	-0.90±2.80b	0.33±1.48c	32.61±6.65bc	11.42±0.03de
PKH3	-6.43±0.61c	-3.17±0.67c	3.28±0.19d	8.60±0.01ef
PKS1	2.58±0.91ab	5.39±15.41c	43.72±6.96ab	17.03±0.01abc
PKS2	3.00±1.35ab	9.61±4.54c	22.33±7.54c	12.95±0.01cde
PKS3	3.41±0.96ab	2.28±2.50c	16.00±2.09cd	12.12±0.01de
PBK1	2.82±1.63ab	14.50±1.04abc	22.78±7.30c	13.63±0.01bcd
PBK2	5.43±0.70a	13.67±11.53bc	23.33±3.40c	11.93±0.02de
PBK3	4.17±1.58ab	7.83±1.04c	20.89±7.03c	6.85±0.02f

Note: WG = Total body weight rate; PC = Population count rate; CC = Cocoon count rate; ML = Media loss. Different superscripts on the same column shows significant (P < 0,05); PKL0 = 100% cow dung (control); PKH1 = 90% cow dung + 10% green mussel shells; PKH2 = 80% cow dung + 20% green mussel shells; PKH3 = 70% cow dung + 30% green mussel shells; PKS1 = 90% cow dung + 10% clam shells; PKS2 = 80% cow dung + 20% clam shells; PKS3 = 70% cow dung + 30% clam shells; PBK1 = 90% cow dung + 10% snail shells; PBK2 = 80% cow dung + 20% snail shells; PBK3 = 70% cow dung + 30% snail shells.

mussel treatment with worm populations reduced by -3.17 ± 0.67 worms during the study. This is related to the condition of the maintenance media which has lots of coarse grains and dries more easily. Hartono *et al*. (2021) stated that population decline could occur because humidity and food availability could affect the death rate of earthworms. The 10% green mussel treatment was the treatment with the highest population increase, this was caused by the conditions and availability of food on media that were suitable for the maintenance and breeding of *Pheretima* sp. earthworms. Putra *et al.* (2018) stated that media with a good level of friability makes it easier for oxygen to enter the media for worm respiratory activities so that they can carry out normal production activities.

The results of data analysis in Table 4 show significantly different results regarding the average cocoon production of the earthworm *Pheretima* sp. ($P<0.05$). The Tukey test results showed that the 10% green mussel treatment produced the most average cocoons (59.06 ± 6.74 eggs), while the 30% green mussel treatment produced the fewest (3.28 ± 0.19 eggs). The 10% green mussel treatment produced the most cocoons, which corresponded to an increase in earthworm population in the highest group. Average cocoon production is also related to other worm productivity parameters, namely worm weight. Pheretima sp worm weight. which is lower indicates that the availability of nutrients in the media is not sufficient for the needs of earthworms or that earthworms have difficulty digesting the media. Pangestika *et al*. (2016) stated that the supporting factor for growth and cocoon production in earthworms is the availability of nutritional content in the rearing media.

Treatment with various media can impact maintenance media loss ($P < 0.05$). According to Tukey test results, the 10% green mussel treatment resulted in the most media loss (373.00 ± 12.58 g), whereas the 30% snail treatment resulted in the least loss (137.00 ± 35.59 g). These findings are related to body weight gain, indicating that the 10% green mussel therapy was included in the treatment with the greatest rise in body weight. In accordance with Liberty *et al.* (2022), the increase in body weight is influenced by the large consumption of earthworms in the maintenance media. Hartono et al. (2021) stated that earthworms need nutrition in the form of organic carbon material in the form of carbohydrates, proteins and fats. Likewise, the 30% green mussel treatment which had the lowest increase in body weight, population increase and cocoon production was proven to influence the media loss that occurred.

Vermicompost Quality and Performance

The macro nutrient content of vermicompost from 10 treatments shows that all treatments meet the standards for good solid organic fertilizer according to SNI 7763:2018, namely having a carbon (C) content of at least 15% (Table 5).

The highest carbon content was found in the vermicompost control treatment at 42.10%, while the lowest carbon content was found in the shellfish shell treatment at 30% and 20.73%. According to Liberty *et al.* (2022), the highest C-organic content is caused by the low activity of microorganisms as decomposers of organic matter and the lowest C-organic content indicates that microorganisms work more. The C-organic content at the end of composting is still high, indicating that the microorganisms in the compost cannot break down organic compounds (Komang *et al*. 2021).

Based on the data in Table 5, there are only 2 treatments that meet SNI 7763:2018 with a maximum C/N ratio of 25%, namely the clam shell treatment 30% and the green mussel treatment 30%. The 10% snail treatment had a high C/N ratio of 28.17 and the 30% green mussel treatment had a low one with 22.55. Liberty *et al.* (2022) stated that the higher the C/N ratio value in compost indicates that the compost has not decomposed completely or is not yet mature.

Table 5. Macro nutrient content of vermicompost

Treatment	Organic C (%)	N-Total (%)	C/N Ratio	P2O5 (%)	K2O (%)	NPK (%)	Water Content (%)
PKL0	42.10	1.47	28.64	1.17	0.32	2.96	40.25
PKH1	34.31	1.28	26.80	1.01	0.26	2.55	37.71
PKH2	29.36	1.14	25.75	0.86	0.25	225	30.61
PKH3	23.68	1.05	22.55	0.74	0.23	2.02	29.49
PKS1	31.68	1.23	25.76	0.99	0.29	2.51	37.02
PKS2	25.35	0.90	28.17	0.82	0.23	1.95	28.38
PKS3	20.73	0.85	24.39	0.75	0.20	1.80	22.49
PBK1	34.19	1.19	28.73	1.07	0.28	2.54	38.57
PBK2	28.62	1.11	25.78	1.11	0.27	2.49	34.23
PBK3	23.98	0.88	27.25	1.01	0.19	2.08	32.21
SNI 7763:2018	Min. 15	-	Max. 25	-	-	Min. 2	Aug-25

Note: PKL0 = 100% cow dung (control); PKH1 = 90% cow dung + 10% green mussel shells; PKH2 = 80% cow dung + 20% green mussel shells; PKH3 = 70% cow dung + 30% green mussel shells; PKS1 = 90% cow dung + 10% clam shells; PKS2 = 80% cow dung + 20% clam shells; PKS3 = 70% cow dung + 30% clam shells; PBK1 = 90% cow dung + 10% snail shells; PBK2 = 80% cow dung + 20% snail shells; PBK3 = 70% cow dung + 30% snail shells.

Table 6. Agronomic characteristics of water spinach plants grown in vermicompost

Treatments	Parameters			
	LC (unit)	LW (cm)	LL (cm)	SH (cm)
KT0	6.62±2.10cde	0.85±0.55abc	4.27±1.30d	10.75±6.18cde
KN0	6.70±2.02cde	1.25±0.69abcd	6.46±2.85bc	12.68±7.87bcd
KV0	5.45±1.80e	0.78±0.56abc	4.07±1.20d	8.34±5.50de
PKH1	7.73±2.22bc	1.35±0.64abc	7.45±3.13ab	16.59±9.91ab
PKH2	8.84±3.52ab	1.68±1.09a	9.17±4.14a	17.78±13.31a
PKH3	9.43±4.90a	1.70±1.33a	7.52±3.49ab	17.62±11.94a
PKS1	7.65±2.75bc	1.41±0.79ab	7.71±3.34ab	14.76±9.29abc
PKS2	7.08±2.57cd	1.06±0.51abcd	6.54±2.79bc	12.95±8.38abcd
PKS3	6.86±2.31cde	0.64±0.18cd	5.31±1.77cd	10.90±6.75cde
PBK1	6.64±2.01cde	1.16±0.48abcd	6.93±2.69bc	13.95±8.62abc
PBK2	6.44±2.35cde	0.68±0.33abc	5.33±2.21cd	8.87±5.84de
PBK3	5.94±1.67de	0.54±0.12d	3.92±1.12d	6.80±4.01e

Note: LC: Leaves count; LW: Leaf width; LL: Leaf length; SH: Stem height. Different superscripts on the same column show significant ($P < 0.05$); KT0= 100% soil; KN0= Soil + fertilizer NPK 16-16-16; KV0= Soil + vermicompost control; PKH1 = 90% cow dung + 10% green mussel shells; PKH2 = 80% cow dung + 20% green mussel shells; PKH3 = 70% cow dung + 30% green mussel shells; PKS1 = 90% cow dung + 10% clam shells; PKS2 = 80% cow dung + 20% clam shells; PKS3 = 70% cow dung + 30% clam shells; PBK1 = 90% cow dung + 10% snail shells; PBK2 = 80% cow dung + 20% snail shells; PBK3 = 70% cow dung + 30% snail shells.

Organic fertilizer standards are in accordance with SNI 7763:2018 for N + P2O5 + K2O levels, namely a minimum of 2%. The growth of plant stems is greatly influenced by potassium levels in compost, because potassium has an important role in the photosynthesis process in the formation of protein and cellulose which functions to strengthen plant stems (Ekawandani and Kusuma 2018). Liberty *et al*. (2022) stated that symptoms of potassium deficiency in plants will cause brown leaf edges.

Vermicompost performance was measured in terms of plant growth and agronomic characteristics including number of leaves, leaf width, leaf length, plant height which are presented in Table 6. All parameters showed significantly different results between treatments ($P<0.05$). The 30% green mussel treatment showed the best results on the parameters of number of leaves, leaf width, leaf length and stem height. This is thought to occur because the C-organic content in this treatment is relatively low compared to other treatments, indicating that the vermicompost in this treatment is mature or completely decomposed (Liberty *et al*. 2022). According to Pramitasari *et al*. (2016), the nitrogen element in a fertilizer can influence plant growth, appearance, color and plant growth, especially on stems and branches, as well as influence the width and length of leaves. According to Sintia (2011), stem height will influence the number of stem segments from which leaves emerge, so that if a plant has a long stem, the number of leaves on that plant will also be greater.

Vermicompost resulting from 30% green mussel treatment was the best treatment for the agronomic characteristics of water spinach plants during the research because it has number of leaves, leaf width, leaf length, and best stem height. The treatment of 30% green mussels contains vermicompost which meets the organic fertilizer standards SNI 7763:2018. Hayati (2010) states that nitrogen, phosphorus and potassium as well as other nutrients are needed in sufficient and balanced quantities for plant growth. This also proves that stem height, number of leaves and leaf width are closely related to the photosynthesis process which influences plant growth.

CONCLUSIONS

The maximum combination of shell flour in cow dung for *Pheretima* sp. living media was at the level of 10%. The best treatment to get the highest productivity of *Pheretima* sp. which includes body weight increase, population increase, cocoon production and media shrinkage was a combination of 10% green mussel shell flour in cow dung media. The best results of vermicompost application were found in a combination of 30% green mussel shell flour in cow dung.

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