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The Effect of White Rot Fungus (*Ganoderma sp*) as Decomposers on Composting Using Combination of Cattle Feces and Water Hyacinth (*Eichhornia crassipes*) as Organic Matter

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Abstract:

In Indonesia, cattle feces (CF) and water hyacinth (WH) plants are abundant but have not been widely revealed. The use of microorganisms as decomposers in the fermentation process has not been widely applied, so researchers are interested in studying further. This study was to evaluate the effect of the combination of CF with WH on composting by applying white-rot fungal (WRF) (*Ganoderma sp*) microorganism as a decomposer. A number of six types of treatment compared to R_1(ratio of CF:WH)(25%:75%)+WRF; R_2(ratio of CF:WH)(50%:50%)+WRF; R_3(ratio of CF:WH)(75%:25%)+WRF; R_4(ratio of CF:WH)(25%:75%) without WRF; R_5(ratio of CF:WH)(50%:50%) without WRF; R_6(ratio of CF:WH)(25%:75%) without WRF. The results showed that the use of WRF decomposers and organic matter (CF and WH) at different ratios affected the properties of compost such as pH value, C-organic, N-organic, C/N ratio, P_2O_5 and K_2O compounds. The WRF decomposer significantly decreases to the pH value, and the C/N ratio, but increases the value of C-organic, N-organic, P_2O_5 and K_2O. The properties of the compost produced are in accordance with the standards set by the Indonesian National Standard (INS) and the regulation of the Ministry of Agriculture of the Republic of Indonesia. The WRF was needed to consider as a decomposer in producing compost. Based on the results of the study, it was concluded that the R1(CF: WH)(25%:75%)+WRF treatment was the best ratio combination to produce compost using WRF **(*Ganoderma sp*)** as a decomposer with the best properties.

Keywords: Cattle feces, Decomposer, Fermentation, Fungi, Water hyacinth.

Introduction:

Fertilizer is one of the essential products widely used in agricultural systems in the world. Chemical fertilizers have been widely applied in agriculture, but their use is very worrying [1]. This is thought to be harmful to the environment and humans. The increase in livestock population of America has the consequence of increasing waste production. This raises concerns for the community [2]. Since the start of the green revolution, the use of chemical fertilizers has begun [3].

One of the impacts caused is the process of soil degradation; plant genetic diversity is lost, disturbed soil microbial diversity and increased groundwater pollution [4,5]. In Indonesia, the dairy farming industry is one source of pollutants that has a huge influence on the environment [6]. Fertilizer is one of the efficient solutions to increase agricultural production. That is safe and do not damage the soil structure. One type of fertilizer is compost. Compost is the product of a composting process. The composting process is one solution to reduce solid waste production [7-9]. Compost is one product that can be used to improve soil structure. The ratio of material organic affects the quality of compost. In addition, the use of decomposers also significantly affects the quality of compost. The use of commercial decomposers needs to be considered because the price is high and difficult to obtain, especially farmers in rural areas. One type of microorganism that has the potential to be used as a decomposer in the composting process is fungi. In addition, *Bacillus subtilis* is a microorganism that has been applied as a fermentation agent in livestock waste [10].

One of them can have a positive and desirable effect on the basidiomycetes group. As many as 90% of the genera that produce gas easily are gram-negative, and pathogens and have a detrimental effect [11]. The fungi are used widely in the process of biopulping. The fungi can eliminate the main components in the ingredients simultaneously, while other types break down lignin faster than cellulose or hemicellulose. There are three types of fungi that have the potential to be used are soft-rot fungi, white-rot fungi, and brown-rot fungi. White rot fungi (WRF) (*Ganoderma sp*) quickly and extensively decompose lignin was compared to the other two fungal groups. White rot fungi can degrade lignin and polysaccharides. Microorganisms have an important role in soil stability. Microorganisms can influence de-nitrifrication, nitrification and nitrogen fixation processes [12,13].

The utilization of livestock wastes in the form of cattle feces (CF), urine and wild plant waste has been widely developed as a base for organic fertilizers. In addition, livestock by-product is not only used as organic fertilizer, but also food. Utilization for the food is collagen raw materials [14]. Livestock waste contains several organic materials needed by plants. Urine from rabbit has the potential to be used as a liquid fertilizer [15]. Some types of microorganisms play an important role in the process of decomposition of organic matter [16]. The CF can be used as a source of N for decomposer microorganisms. Water hyacinth (WH) is a type of weed that grows in many waters. The eutrophication process is one of the causes of the increasing population of water hyacinth plants. Some other types of algae that are toxic can allow it to grow by the influence of eutrophication. Microcystins are a family of hepatotoxins produced by cyanobacteria species [17]. This poison can cause liver damage and cancer [18,19]. The WH plants can cover the surface of the water and are very difficult to remove because of speedy growth. One effort to reduce weed production is to convert it to compost raw material. Composting activities in agricultural waste promise environmentally friendly alternatives. This activity benefits and has a positive impact on land and plants [20]. The WH plants can be used as a carbon source of decomposer microorganisms. This plant has sources of nitrogen (N), phosphorus (P), and potassium (K) which are needed by plants to grow. Organic farming systems have a higher level of functional microbial diversity than conventional farming systems [21]. Soil microbes are one of the indicators to assess land quality. This parameter is essential in the process of managing agricultural land [22].

This research is significant to obtain the ratio of the use of the right compost raw material (CF and WH) and the role of the WRF decomposer in the composting process. The study aims to evaluate the effect of the ratio of CF waste and WH as a raw material in the composting process by applying WRF microorganism as a decomposer.

Materials and Methods:

Materials:

The cattle feces (CF), water hyacinth (WH) (*Eichhornia crassipes*) and water rot fungi (WRF) (*Ganoderma sp*) decomposers have been used as the main materials in this study. The CF from Bali cattle was used as raw material for composting process obtained from the Beef Cattle Laboratory, Faculty of Animal Science, Hasanuddin University, Makassar, Indonesia. The CF used as material was a dry sample with a collection period of 3 days after leaving the body of a cattle. The WH plants were obtained from around artificial lakes at Hasanuddin University, Makassar, Indonesia. The part used in water hyacinth plants was the whole body of the plant (leaves, flowers and roots). The entire plant part was made into a composite to be applied in the treatment. The WRF decomposers were obtained from the Laboratory of Waste and Biomass Valorization, Faculty of Animal Science, Hasanuddin University, Makassar, Indonesia. The supporting equipment used in the study was buckets (*PVC*), shovels (*KENMASTER*), scales (*KENMASTER*), pans (*PARAMOUNT*), gas stoves (*RINNAI*), plastic polybags (*HDPE standart*), scissors (*GUNINDO/Stainless steel*), ropes (*Polietilen*), thermometers (*HANNA*) and pH meters (*ATC 2011*).

Methods:

a. Sterilization process

A number of 10 kg of each raw material (CF and WH) were pasteurized using the steaming method of the steamed pan at 80ºC for 15 minutes. This process aimed at in-activating several microorganisms that can affect the fermentation process (23). The WRF (*Ganoderma sp*) decomposers in flour form were prepared.

b. Preparation of raw materials

First of all, The CF in dry conditions was filtered to produce homogeneous particles. The WH plants in fresh condition were cut short for 3-5 cm in size. Next, The WH was ground using a blender until smooth. The compost raw materials formula was prepared for the composition as in Table 1.

Table 1. The staple of compost, composition and ratio of CF and WH organic matter with uses of WRF (*Ganoderma sp*) as decomposers

Raw Materials	Treatment					
	R_1	R_2	R_3	R_4	R_5	R_6
Cattle Feses (CF) (g)	250(25%)	500(50%)	750(75%)	250(25%)	500 (50%)	750(75%)
Water Hyacinth (WH)(g)(%)	750(75%)	500(50%)	250(25%)	750(75%)	500(50%)	250(25%)
White Rot Fungi (WRF) (*Ganoderma sp*) Decomposer	+	+	+	-	-	-

Note : (+) The use of WRF decomposer is 5% of the total raw material (1000g)(CF and WH)

c. The fermentation process of raw materials

A total of 18 sheets (15x20 cm size) of clear plastic polybag (HDPE standard) were prepared. Each polybag was filled with raw materials in the form of a CF mixture of WH according to the formula. WRF (*Ganoderma sp*) decomposer isolates in the form of white flour were prepared. Each polybag was then sprinkled with 50g WRF decomposing isolates (5% of the total volume of raw material). The mixture of material and WRF is homogeneously stirred and then tied with rope. The fermentation process is done semi--aerobically [24]. The polybags are then stored at room temperature and fermented for 30 days.

d. Research design

The study was used as a Factorial pattern by Completely Randomized Design (CRD). The research consists of the first factor. The ratio was (CF:WH): 1) (25%:75%); 2) (50%:50%); 3) (75%:25%). The second factor was the use of decomposers (1) WRF and (2) without WRF. Each treatment was repeated three times. Based on the design, 6 types of treatment interactions were obtained, namely: (R_1)(CF:WH)(25%:75%)+WRF; (R_2)(CF:WH)(50%:50%)+WRF;(R_3)(CF:WH)(75% :25%)+WRF; (R_4)(CF:WH)(25%:75%) without WRF; (R_5)(CF:WH)(50%: 50%) without WRF; and (R_6)(CF:WH)(75%:25%)+without WRF.

e. Sample testing methods

pH analysis [25]. The compost heap took a total of 100g of compost sample from 3 points. The pH meter was adjusted with a buffer of pH 7.0 and pH 4.0 to verify the test results. The tip of the electrode was inserted into the sample and then the results were read.

<u>C-organic analysis</u> [25]. Samples of the compost fertilizer (50g) were placed into volumetric flasks of 100 mL. $K_2Cr_2O_7$ 2 N (5 mL) and H_2SO_4 98% percent (p.a) (7 mL) were applied to subsequent tests. By shaking, the mixture was homogenized. They allowed the mixture to stand for 30 minutes. A regular solution with 250 ppm C was prepared. A standard 5000 ppm (5 mL) solution was put into a 100 mL (volumetric) flask. The flask was filled with a solution of 5 mL and 7 mL each of H_2SO_4 + $K_2Cr_2O_7$ 2N (as in the previous process). As normal solution a standard solution (0 ppm C) was used. Single specimen was diluted with aquadest. A minimum of 100 mL was then shaken and allowed to stand for 1 night until homogeneous. The results were measured by spectrophotometer at $\lambda = 651$ ηm. C-organic (%) = ppm curve x 100/mg sample x Fk, where ppm curve = normal regression curve; Fk = water quality correction factor = 100/(100-water content).

N-organic analysis [25]. In the Kjeldahl flask, a total of 5 mg of compost sample was added with 0.25-0.50g selenium mixture + 3 mL H_2SO_4 (p.a). By shaking, the solution was homogenized. They allowed the mixture to stand for 2-3 hours. Instead, the solution was heated on a hotplate (150-350 ºC) for 3-3.5 hours. The process was conducted in stages until a clear solution was arrived at. The solution was diluted and refrigerated. The solution was moved into a volumetric (250 mL) flask. Then apply aquadest to half the volume of the volumetric flask. The boiling stone was put into a volumetric flask. A total of 10 mL of 1% boric acid as a distillate reservoir was prepared in Erlenmeyer (100 mL). The solution was given on the Conway indicator with 3 drops. Through applying 20 mL of 40 percent NaOH solution, the distillation process was carried out. This cycle was completed when liquid volume exceeded 75 mL in Erlenmeyer. The results of the distillation were titrated with H^2SO_4 0.05N, to the end point (the color of the solution ranges from green to pink) = A mL, while blanks were calculated = A1 mL. The formula used, N-organic (%) = total titration blank (mL)- titration sample x N x BST N/sample weight (mg) x 100, where BST N = equal nitrogen weight.

C/N ratio analysis (Agus, 2005). Determination of the C/N ratio value was achieved by comparing the C-organic value with the N-organic value. The formula was used, ratio C/ N = C-organic/N-organic value.

P_2O_5 analysis [25]. A total of 100 mL of compost sample was injected in then heated into a beaker bottle. The precipitate was then filtered and washed in hot aquadest with 3 x 10 mL. The filtrate was accommodated and supplemented with magnesia mixture of 10 mL NH_4Cl 2 M and 10 mL. HCl 1:1 was applied to cloudy solution until dissolved. Furthermore, it was excessive applied with the PP predictor and precipitated with NH_4OH (1:10). The precipitate was cooled in ice, then filtered and washed to chloride-free with NH_4OH (1:20). Then the precipitate was washed, incandescent, and weighed till the weight was set. The result was then determined by the formula K_2O_5 (%) = Cf x Aw/Sw x 100 percent, where, Cf = correction factor = Mr of P_2O_5/Mr of MgP_2O_5; Aw = ash weight; Sw = sample weight; Mr = relative of the molecular.

K_2O analysis [25]. Determination of K_2O content using the P05-020A protocol (*Bibby Scientific*) flame-photometer (Jenwey) method. A total of 2.5 mL of compost was poured into 400 mL of glass and 125 mL of aquades were applied, and 50 mL of ammonium oxalate solution was added. They heated the solution for 30 minutes. The solution was then refrigerated and a small amount of ammonium hydroxide solution was added. The solution was diluted to a line mark and placed into a 250 mL flask. The solution was filtered into a 250 mL drying glass with Whatman filter No. 30. A total of 25 mL of the solution was piped and put into a 500 mL pitcher and diluted until the line marks were reached with aquadest. The solution was shaken till it was homogenous. The solution has been transferred to a 100 mL powder flask until it contains around 16 ppm of K_2O content. The solution was diluted up to 100 mL with aquades, and then stirred until homogeneous. Standard solutions were produced with the 10, 12, 14, 15, 16, 17, 18 and 20 ppm K_2O series. Using a flame photometer, the content of K_2O was measured. They used formula, K_2O (%) = A x 20/B, where, A = ppm. Using a flame photometer, the content of K_2O was measured. The formula used, K_2O (%) (= A x 20/B, where A = ppm K_2O in the sample solution; B = titration volume (mL).

f. Data analysis

The data obtained were analyzed by ANOVA based on a Complete Randomized Design (CRD) of factorial patterns of the help of the SPSS statistical program. The treatment that showed a significant effect then performed a significant difference tested for Duncan'S Multiple Range Test (DMRT) at the level of 5% [26].

Results and Discussions:

pH

pH value is one of the critical factors of the composting process. This is pH dramatically influences the growth performance of microorganisms [27]. The pH parameters are measured using a pH meter. First of all, the calibration process uses standard pH (pH 4, pH 7 and pH 11). The pH measurement process is carried out at 3 different places from each polybag. The average value of the measurement results is used as the actual pH value. Production of organic acids from organic matter was carried out by microorganisms affects the pH value of compost. The description of the difference in pH values of the compost using the WRF decomposer and the ratio of different organic materials wads presented in Fig.1.

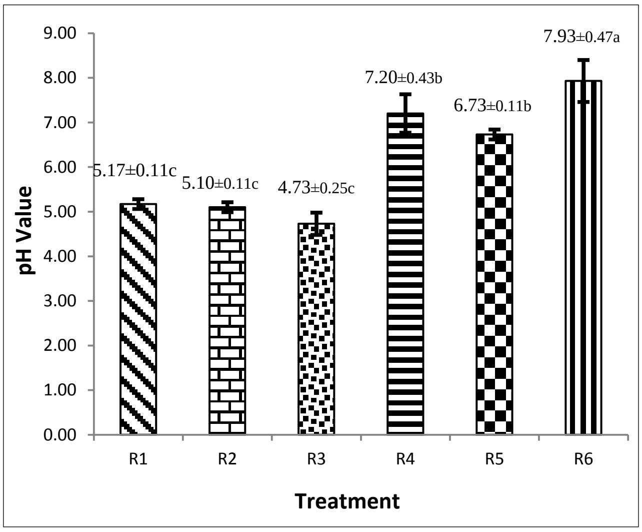

Figure 1. Characteristics of the pH value of compost using a combination of CF with WH in different ratios and WRF (*Ganoderma sp*) as decomposer;

(R_1)(CF:WH)(25%:75%)+WRF; (R_2)(CF:WH)(50%: 50%)+WRF; (R_3)(CF:WH)(75%:25%)+WRF; (R_4)(CF:WH)(25%:75%) without WRF; (R_5)(CF:WH)(50%: 50%) without WRF; and (R_6)(CF:WH)(75%:25%)+without WRF; [a,b,c] Different scripts show significant differences (p<0.05); Fermentation time=30 days; CF=cattle feces; WH=water hyacinth (*Eichhornia crassipes*); WRF= white rot fungi (*Ganoderma sp*)

The results of the research in Fig.1 show that the application of the WRF decomposer in the compost production process had a significant effect ($p<0.05$) on the pH parameters of compost. Meanwhile, the difference in the ratio of use of CF and WH did not show a significant effect ($P>0.05$). The test results obtained showed that on average the pH value of R_1 treatment (5.17±0.11); R_2(5.10±0.11) and R_3(4.73±0.25) were lower than R_4(7.20±0.43); R_5(6.73±0.11) and R_6(7.93±0.47). The result that shows a low pH value was caused by the presence of WRF decomposer activity which works in fermenting organic substances. The results obtained were acid. The pH value of compost obtained was lower than the research by [28] and [29,30].

Compost was produced using organic matter from biochar (corn stalks, bamboo, wood, manure, and coir) with pH in the range of 7.5-7.8 and 8.1 (control). Another impact that occurs was the decline in NH_3 value but does not affect pH value of the compost [31]. The standard pH value of compost was 6.80-7.49. This shows that compost without a WRF decomposer can be used directly on plants. However, for compost using the WRF decomposer, you should consider using lime (base) to increase the pH value and neutralize the acidic atmosphere on the compost. The initial stage in the decomposition process will form organic compounds and convert into organic acids. This will stimulate the growth of bacteria and fungi. Organic acids will be neutral with a pH range of 6-8 during the fermentation process [32]. The initial stage of a composting process was a decrease in pH value. The decrease in pH values reaches 5-6; also, the temperature will increase slowly to the range of 35-70 ºC. The pH value can accelerate the decomposition rate of organic matter and cause pathogenic microorganisms to become inactive. The microbial activity of WRF (treatments R_1, R_2 and R_3) caused a decrease in pH values with a pH range of 4.73±0.25-5.17±0.11. This activity causes the formation of organic acids.

Furthermore, these organic acids will be reused by other microbes so that the pH will again increase to near-neutral pH. pH values that are too high can cause an increase in oxygen consumption. This will undoubtedly provide a bad environment for other organic activities. Besides, it can cause the conversion to nitrogen to ammonia (NH_3). Conversely, deficient pH conditions can cause death in microorganisms (decomposers). The fungi microorganisms develop fairly well under conditions of lower pH (acid). A low pH value at the beginning of the decomposition process shows the decomposition processes to take place without an increase in temperature. pH will decrease to the beginning of the composting process [33].

C-Organic

White rot fungi (WRF) are one of the essential elements in the forest ecosystem and plays an essential role in carbon circulation. The levels of C-organic compost produced using the WRF decomposer with different ratios of organic matter was shown in Fig.2.

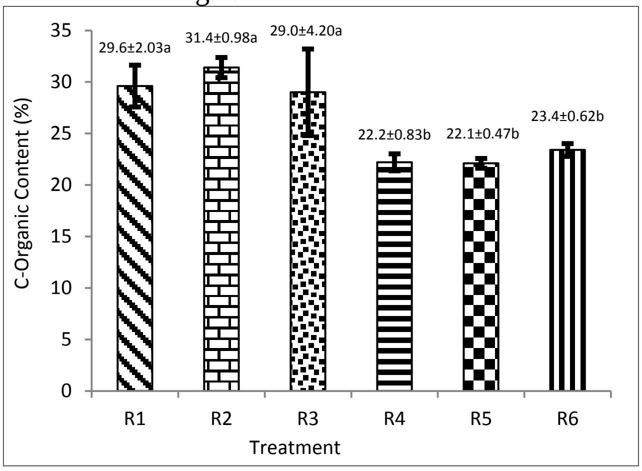

Figure 2. Characteristics of C-organic content of compost using a combination of CF with WH in different ratios and WRF (*Ganoderma sp*) as decomposer;
(R_1)(CF:WH)(25%:75%)+WRF; (R_2)(CF:WH)(50%: 50%)+WRF; (R_3)(CF:WH)(75%:25%)+WRF; (R_4)(CF:WH)(25%:75%) without WRF; (R_5)(CF:WH)(50%: 50%) without WRF; and (R_6)(CF:WH)(75%:25%)+without WRF; [a,b] Different scripts show significant differences (p<0.05); Fermentation time=30 days; CF=cattle feces; WH=water hyacinth (*Eichhornia crassipes*); WRF= white rot fungi (*Ganoderma sp*)

WRF is one of the most active basidiomycetes groups of degrading lignin from wood. This type of fungus was also the most effective in the process of initial biological degradation in ingredients of lignocellulose. This fungus was capable of producing a series of enzymes that are directly involved in lignin reformation. Organic matter in compost was related to the availability of carbon elements needed by plants. Organic materials available on compost will be utilized by plants as a source of nutrition for growth activities.

The test results data onto Fig.2 show that the application of WRF decomposers in the compost production process has a very significant effect (P<0.01) on C-organic levels. However, differences in the ratio of use of organic matter (CF and WH) and their interactions did not show a significant effect (P>0.05). These results indicate that WRF decomposers play a significant role in overhauling the structure of organic compounds in organic matter (CF and WH) and using carbon as an energy source in the process of compost decomposition. The highest C-organic content (31.4%±0.98) was obtained in the compost R_2 treatment using a WRF decomposer with a ratio (CF: WH) (50%:50%). The results of this process showed that the balance of the ratio of the use of organic matter greatly determines the quality of compost products. In contrast, the lowest C-organic level (22.1%±0.47) was obtained in the R_5 treatment. This treatment for without WRF decomposer and with use of the ratio of organic matter (CF: WH) (50%:50%). These results provide an indication that the carbon content (C) in organic materials was able to compensate for the content of feces raw materials. Decomposer WRF was able to degrade compost by producing certain enzymes to break down for compost organic matter. This can cause the supply of carbon elements to be limited. As a result, microorganism activity will also decrease [34,35].

Water hyacinth (WH) has a cellulose content of 64.51% and lignin of 7.69%. Combining organic and inorganic elements can increase the nutrient content of compost. This organic material can be used as biochar. Biochar can increase temperature, pH, oxygen content in the compost pile and eventually accelerate the fermentation process [36]. In addition, it has also been developed as a source of biohydrogen energy because the lignin content is quite low [37,38]. The WH has unique characteristics, namely cellulose content and high organic matter. The WRP group was widely used as a decomposer. This is due to its ability to degrade lignin and polysaccharides (cellulose and hemicellulose) faster than fungi from other classes [39].

The ligninase enzyme produced by the WRP group can degrade lignin compounds. Therefore, WRP decomposers have a good influence to degrade cellulose and lignin in organic matter WH. Microorganisms will take energy to decompose organic matter from the calories produced in a biochemical reaction. Changes in carbohydrate into CO_2 and H_2O gas which continuously causes the carbon content in organic fertilizer to decline. The use of biomass from plants has also been used as a raw material for liquid smoke. Liquid acid is used as a preservative for processed meat [40,41]. The organic C level in compost shows its ability to improve soil properties. According to SNI 19-7030-2004, the level of C-organic is in the range of 9.80-32%, while according to government regulation standards, the minimum requirement is 15. The results of this study indicate that the terms referred to have been fulfilled.

N-Organic

Nitrogen (N) is one of indicator to determine the feasibility of compost. The N level effects on C/N ratio of compost produced. During the composting process, the N content of compost material was critical. This is because nitrogen was used by microorganisms to synthesize proteins. The amount of N produced from increases in the composting process. Comparison of N levels of compost using WRF decomposers and organic matter (CF and WH) with different ratios was presented in Fig.3.

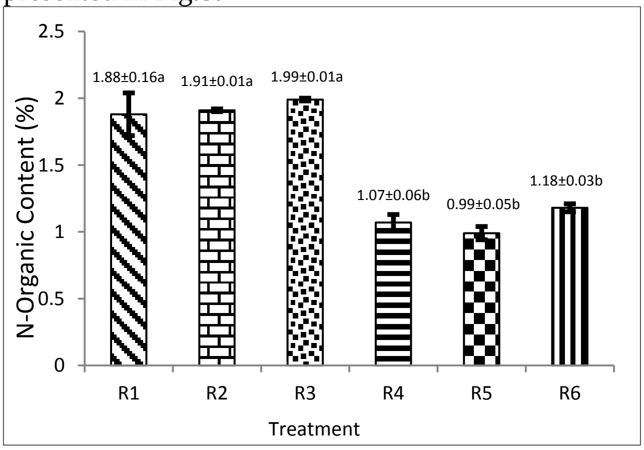

Figure 3. Characteristics of N-organic content of compost using a combination of CF with WH in different ratios and WRF (*Ganoderma sp*) as decomposer;
(R_1)(CF:WH)(25%:75%)+WRF; (R_2)(CF:WH)(50%: 50%)+WRF; (R_3)(CF:WH)(75%:25%)+WRF; (R_4)(CF:WH)(25%:75%) without WRF; (R_5)(CF:WH)(50%: 50%) without WRF; and (R_6)(CF:WH)(75%:25%)+without WRF; [a,b] Different scripts show significant differences (p<0.05); Fermentation time=30 days; CF=cattle feces; WH=water hyacinth (*Eichhornia crassipes*); WRF= white rot fungi (*Ganoderma sp*)

Based on the data, (Fig.3) shows that the application of WRF decomposers in the compost production process has a very significant effect ($p<0.01$) on the levels of N-organic compost. However, differences in the ratio of organic matter (CF and WH) and their interactions did not show a significant effect ($p>0.05$). The data shows that compost produced using a decomposer (R_1, R_2 and R_3 treatment) has higher levels of N-organic than without the WRF decomposer (R_4, R_5 and R_6 treatment). The N-organic value is treated with R_3(1.99%±0.01), while the lowest is with R_5(0.99%±0.05). In addition, the data shows that the increase in the proportion of organic matter using CF in compost composition (from 25% to 75%) tends to increase the value of N-organic. However, it does not show tangible results.

The composting process can increase N-organic bioavailability [42]. N-organic formation comes from the results of the degradation of organic matter by the activity of microorganisms. The mineralization processes that occur to compost using WRF decomposers are thought to be able to increase the decomposer activity to produce higher levels of N-organic. During composting, organic material undergoes a rapid decay process. This is caused by the activity of microorganisms. The C/N/P element is directly involved in the microorganism cycle that determines the dynamics of mineralization and nutrition [43].

Cellulotic organisms (fungi) have the ability to process nitrogen overhaul. This can lead to an increase in the process of nitrogen mineralization in a stable form such as nitrate (NO_3). The higher nitrogen content causes the organic matter to decompose rapidly. This is because microorganisms that decompose compost materials require nitrogen for their development. Microorganisms are single-cell proteins, that is mostly awakened from proteins, whereas, one of the components that make up a protein molecule is N unsure.

C/N Ratio

C-organic levels were related to organic N levels. During the composting process, microorganisms use carbon (C) as an energy source of the decomposition process by producing CO_2. This causes C levels to decrease and increase levels to N. The comparison of the C/N ratio of compost using WRF decomposers and the ratio of organic matter (CF and WH) was presented in Fig.4.

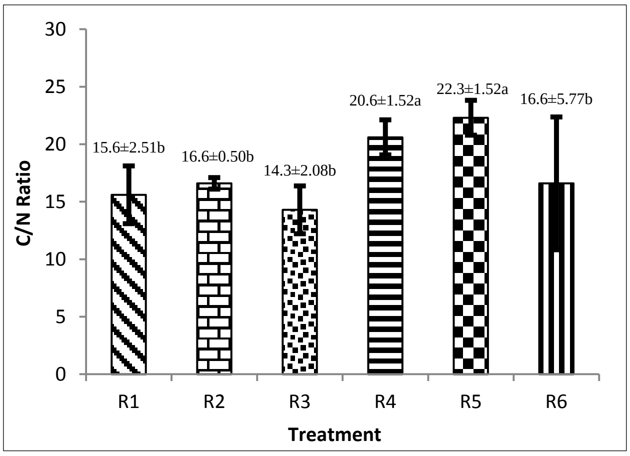

Figure 4. Characteristics of C/N ratio of compost using a combination of CF with WH in different ratios and WRF (*Ganoderma sp*) as decomposer; (R_1)(CF:WH)(25%:75%)+WRF; (R_2)(CF:WH)(50%: 50%)+WRF; (R_3)(CF:WH)(75%:25%)+WRF; (R_4) (CF:WH)(25%:75%) without WRF; (R_5) (CF:WH) (50%: 50%) without WRF; and (R_6)(CF:WH) (75%:25%)+without WRF; [a,b] Different scripts show significant differences ($p<0.05$); Fermentation time=30 days; CF=cattle feces; WH=water hyacinth (*Eichhornia crassipes*); WRF= white rot fungi (*Ganoderma sp*)

The ANOVA results (Fig.4) show that the application of WRF decomposer had a very significant effect ($p<0.05$) on the compost C/N ratio, while the differences in the ratio of the application of CF and WH and their interactions had no significant effect ($p>0.05$). Differences in the ratio of CF and WH to compost compositions without WRF decomposers (R_4, R_5 and R_6) were significantly different ($p<0.05$) with a range of values (16.6±5.77-22.3±1.52), whereas, on compost using the WRF decomposer (R_1, R_2 and R_3) did not show a significant effect ($p>0.05$) with a range of values (14.3±2.08-16.6±0.50). This shows that the availability of organic material as a carbon source to obtain energy and N in the composting process has a vital role.

The C/N ratio of composts treated with a ratio of different organic matter (CF and WH) is quite varied, both composts using the WRF or without the WRF decomposer. The highest C/N ratio was in treatment R_5 (22.3±1.52), while, the lowest was in treatment R_3(14.3±2.08). These results have met the requirements of the standard C/N compost ratio according to SNI 19-7030-2004, which is 10-20. Furthermore, according to government regulations, the ratio of C/N to solid organic fertilizer was 15-25.

The compost which has a C/N 22 ratio shows the most effective immobilization of the P element. This occurs because it produces the most significant polymerization rate of the mixture of organic fertilizer from livestock with straw in the C/N ratio of 15-27. This value does not show a negative effect on the quality and maturity level of compost. Composting reduces the risk of Cu, Zn and P released by changing the cellular fraction to a stable fraction [44].

P_2O_5

The phosphate, nitrogen and potassium elements are one of the elements needed by plants. The P_2O_5 is a compound that expected to be available in fertilizers and is a compound derived from phosphate, nitrogen and potassium elements. The availability of these elements in organic fertilizers is essential and determines the quality of compost fertilizer. The animal feces contain a number of P elements that have the potential to be used in plant [45]. Comparison of levels of P_2O_5 organic compost (CF and WH) fermented using WRF decomposers at different ratios are shown in Fig.5.

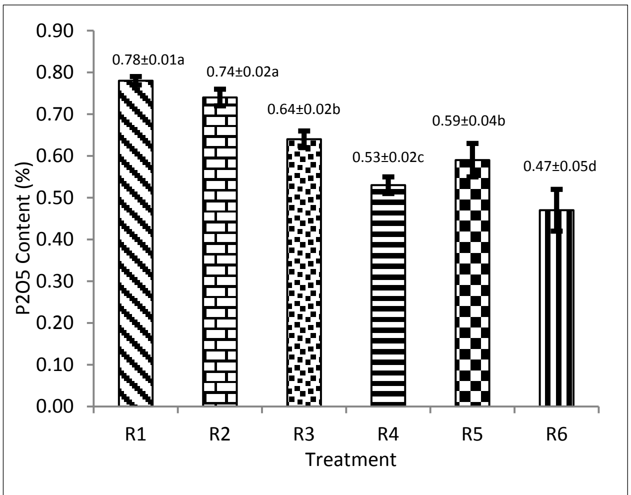

Figure 5. Characteristics of P_2O_5 of compost using a combination of CF with WH in different ratios and WRF (*Ganoderma sp*) as decomposer; (R_1)(CF:WH)(25%:75%)+WRF; (R_2)(CF:WH)(50%: 50%)+WRF; (R_3)(CF:WH)(75%:25%)+WRF; (R_4) (CF:WH)(25%:75%) without WRF; (R_5) (CF:WH)(50%: 50%) without WRF; and (R_6) (CF:WH)(75%:25%)+without WRF; [a,b,c,d] Different scripts show significant differences ($p<0.05$); Fermentation time=30 days; CF=cattle feces; WH=water hyacinth (*Eichhornia crassipes*); WRF= white rot fungi (*Ganoderma sp*)

The results of statistical analysis on the data (Fig.5) show that the use of WRF decomposers had a very significant effect ($p<0.05$) on P_2O_5 compost levels. In addition, differences in the ratio of use of organic matter (CF and WH) showed a significant effect ($p<0.05$) on P_2O_5 levels. Based on the data (Figure 5), it was seen that the compost fermented using WRF decomposers produced P_2O_5 levels in the range (R_1-R_3) (0.64%± 0.02-0.78%±0.01). The results of this test were higher than compost without WRF decomposers with a range of values (R_4-R_6) (0.47%±0.05-0.59%±0.04). Phosphate compounds were marketed with various P_2O_5 content, which is 4-42%.

Phosphate fertilizer testing was determined by the amount of N (nitrogen), P (phosphate or P_2O_5), and K (liquid potassium or K_2O). Posfor elements were difficult to obtain and substituted for other resources. Therefore, phosphorus-producing materials [46,47]. are needed. The use of excess phosphorus elements in waters causes eutrophication. This causes phosphorus to be considered a pollutant that requires handling [48]. Phosphorus is part of organic and inorganic phosphates.

Organic phosphate sources are plants and animals, while organic phosphates come from water and soil. The composting process converts P elements from cellular fractions of a more stable fraction. The level of degradation of organic matter (content of organic matter and *humic acid*/*fulvic acid*) is an indication of changes in bioavailability for P during composting [44].

K_2O

Potassium element is the main element forming K_2O compound. Availability of this element was needed to improve the quality of organic fertilizers. This compound plays the role of plants as a growth booster and plant to support. WH plants are one of the water plants that are widely used in phytoremediation because they have very high affinity and accumulated capacity of metals [49]. The description of the quality of compost produced using the WRF decomposer on different ratios of organic material uses (CF and WH) was presented in Fig.6.

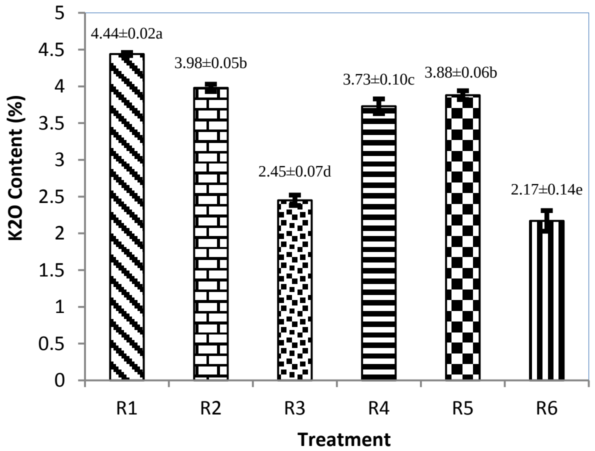

Figure 6. Characteristics of K_2O of compost using a combination of CF with WH in different ratios and WRF (*Ganoderma sp*) as decomposer; (R_1)(CF:WH)(25%:75%)+WRF; (R_2)(CF:WH)(50%: 50%)+WRF; (R_3)(CF:WH)(75%:25%)+WRF; (R_4)(CF:WH)(25%:75%) without WRF; (R_5)(CF:WH)(50%: 50%) without WRF; and (R_6)(CF:WH)(75%:25%)+without WRF; [a,b,c,d,e] Different scripts show significant differences ($p<0.05$); Fermentation time=30 days; CF=cattle feces; WH=water hyacinth (*Eichhornia crassipes*); WRF= white rot fungi (*Ganoderma sp*)

The ANOVA results of the research data (Fig.6) show that the application of WRF decomposers in the compost production processes using CF and WH as organic material showed a very significant effect ($p<0.05$) on K_2O levels. The difference in the ratio of organic matter (CF and WH) also shows a significant effect on compost K_2O levels and their interactions. Increasing the number of CF ratios (25, 50 and 75%) and decreasing the ratio of WH (75; 50 and 25%) tended to reduce the compost K_2O value, both on compost using WRF decomposers and without WRF decomposers.

The data onto Fig.6 indicates that potassium levels are related to the composition of CF. One of the critical elements contained in CF is K (potassium). This has a direct effect on compost K_2O levels. WH is a floating plant that has a fast and capable of absorbing nutrients [50]. The results showed that compost produced using WRF decomposers (R_1, R_2 and R_3) had higher K_2O levels than without WRF decomposers (R_4, R_5 and R_6). The highest K_2O value was treated by R_1 (4.44%±0.02), while the lowest was R6 (2.17%±0.14). The presence of heavy metal elements, humification and related processes of microorganism degradation during the composting process [51].

Conclusion:

Based on the results of the study, it can be concluded that the application of the formula and the combination of R_1 treatment (CF: WH) (25%:75%)+WRF) in the compost production process using WRF (*Ganoderma sp*) as a decomposer is the best formula compared to other formulas.

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Authors' declaration:

- Conflicts of Interest: None.
- We hereby confirm that all the Figures and Tables in the manuscript are mine ours. Besides, the Figures and images, which are not mine ours, have been given the permission for re-publication attached with the manuscript.
- Ethical Clearance: The project was approved by the local ethical committee in Universiti Putra Malaysia.

Authors' contributions:

1. Muhammad Irfan Said, contributed to leading and fully managing the research project and was responsible for data collection and script writing
2. Effendi Abustam, contributed to data processing and interpreting field data
3. Sitti Nurani Sirajuddin, contributed to the data processing and provision of library resources
4. Jamila, contributed to the process of providing materials, processing data and library resources
5. Tensi, contributing to the process of conducting experiments in the laboratory, collecting field data and analyzing statistical data
6. Abdel Razzaq Al Tawaha and Abdel Rahman M. Al Tawaha, contributed to the article writing process, publication process and translation process

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تأثير فطريات العفن الأبيض كمحللات على التسميد باستخدام مزيج براز الماشية و صفير الماء (*Eichhornia crassipes*) كمادة عضوية

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الخلاصة:

في إندونيسيا ، توجد فضلات الماشية ونبات صفير الماء (WH) بكثرة ولكن لم يتم الكشف عنها على نطاق واسع. حيث انه لم يتم تطبيق استخدام الكائنات الحية الدقيقة كمحللات في عملية التخمير على نطاق واسع، لذلك بالفترة الاخيرة بدا الباحثون بالاهتمام واجراء مزيدا من الدراسة. تهدف هذه الدراسة إلى تقييم تأثير مزيج CF مع WH على التسميد عن طريق تطبيق الكائنات الحية الدقيقة الفطرية العفن الأبيض (WRF) كمحلل. عدد من ستة أنواع من العلاج مقارنة بـ R1 (نسبة 25 (CF: WH ٪75 :٪WRF + (؛ R2 (نسبة (CF: WH ٪50 (50 :٪WRF + (؛ R3 (نسبة 75 (CF: WH ٪25 :٪WRF + (؛ R4 (نسبة 25 (CF: WH ٪75 :٪) بدون WRF ؛ R5 (نسبة 50 (CF: WH ٪50 :٪) بدون WRF ؛ R6 (نسبة 25 (CF: WH ٪75 :٪) بدون WRF. أوضحت النتائج أن استخدام محللات WRF والمواد العضوية (CF و WH) بنسب مختلفة تتأثر بخصائص السماد مثل قيمة الأس الهيدروجيني ، C- عضوي ، N- عضوي ، نسبة C / N، P_2O_5 و K_2O. ينخفض محلل WRF بشكل كبير إلى قيمة الرقم الهيدروجيني ونسبة C / N ، ولكنه يزيد من قيمة C- عضوي ، N- عضوي ، P_2O_5 و K_2O. تتوافق خصائص السماد المنتج مع المعايير التي حددها المعيار الوطني الإندونيسي (INS) ولوائح وزارة الزراعة في جمهورية إندونيسيا. كان من الضروري اعتبار WRF كمحلل في إنتاج السماد. وبناءً على نتائج الدراسة ، تم التوصل إلى أن علاج 25 (CF: WH) R1٪75 :٪WRF + () كان أفضل توليفة لإنتاج السماد باستخدام WRF كمحلل بأفضل الخصائص.

الكلمات المفتاحية: فضلات الماشية ، التحلل ، التخمير ، الفطريات ، صفير الماء