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Organic Waste management As Compost To Improving Germination And Sweet Corn Production

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ABSTRACT

The study aimed to analyze the quality of the compost from various organic wastes and its effect on germination, growth and production of sweet corn. Four organic waste (e.g. bagasse, filter cake, market organic-waste, and water hyacinth) were chosen as raw materials of compost. The composting method uses an open windrow system. Differences in raw materials of compost resulted a different in compost quality. In addition, compost from filter cake, market organic-waste, and water hyacinth have good qualities, indicated by C/N ratio 8,06-11,00, pH 7,86-8,70, nutrient content ($N+P_2O_5+K_2O$) > 2 %, and water content 10-15%. In addition, compost from market place tended to accelerate percentage of germination and speed of growth sweet corn as compared to the other compost and control (pure water). Application of market waste compost with a dose of 10 t/ha had the highest average for plant height (165 cm) and the number of leaves (11 strands). Meanwhile, the application of bagasse compost with a dose of 5 t/ha had the highest level of sweetness, which is 12%.The study found the benefit of organic waste to speed up germination, growth, and quality of sweet corn, with composting process.

Keywords: organic waste management, compost quality, seed germination, sweet corn production

1. INTRODUCTION

Along with the increase in population, changes in consumption patterns and people's lifestyles, as well as human activities, have an impact on increasing the amount, diversity of types and characteristics of the waste produced. According to the Indonesian Law no. 18, 2008 about waste management and the guideline of the Environment Protection Act 1993, the waste defined as any discarded, abandoned, unwanted or surplus matter of human daily activities and / or natural processes in solid form, whether for sale or for recycling, reprocessing, recovery or purification by a separate operation from that which produced the matter. Then, Rahayu (2013) explained that waste is material which is considered useless anymore but needs to be managed so as not to endanger the environment and public health. Based on the material content, waste is divided into two types, namely organic waste (a type of waste that is mostly composed of organic compounds derived from plant, animal, or feces, and is easily broken down by microorganisms) and inorganic waste (a type of waste that is composed of inorganic compounds or mineral materials such as metal, glass or plastic, and very difficult to be broken down by microorganisms (Taufiq, 2015).

The predominant component of solid waste in Asian developing countries is decomposable organic waste, which accounts for 42 to 80 percent of total garbage (Dhokhikah & Trihadiningrum, 2012). Organic waste comprises a variety of organic elements, including carbohydrates, proteins, lipids, vitamins, and minerals, making it easier to decompose (D. K Maheshwari et al., 2014). Residential areas, commercial, industrial, agricultural operations, and other sources account for the majority of solid waste in both urban and rural locations (Abdel-Shafy & Mansour, 2018).

The rate of solid waste generation in cities in developing countries, like Indonesia, is quite complex. Until date, waste management has been one of the primary unresolved issues in Indonesia. The disparity between trash generation and owned storage capacity, or the inappropriate handling of waste in the shelter, is one of the challenges (Mahyudin, 2017). According to Jain (2017), the final waste treatment or disposal options in emerging Southeast Asian countries were frequently open dumping and sanitary landfill. The approaches compared were open dumping (more than 50%), sanitary landfilling (10-30%), incineration (2-5%), and composting (less than 15 percent). Composting is used sparingly. Additionally, this demonstrates gaps in recycling infrastructure as well as limitations in the utilization of technologies for solid waste volume reduction.

One of area in Indonesia that solid waste production over the processing capacity is the Greater Malang. The Directorate General of Human Settlements (2016) stated that solid waste in the Greater Malang areas reached 588,54 m^3/year, whereas the capacity of the Final Processing Site was 570,00 m^3/year. Therefore, it is possible to practice waste disposal in any place that can pollute the environment and disturb aesthetics. In general, the pattern of city waste handling in Indonesia applies the collection method - transport - discard, so that in the end they just pile up without following technical provisions and are prone to landslides (open dumping). The accumulation of garbage in the landfill can cause leachate contamination of the surface and groundwater, invite various pests and diseases, and produce greenhouse gases (Sharma et al., 2018).

The other wastes that are abundant are agricultural waste, including agro-industrial waste. One of the agricultural industries that produces organic waste is sugar mill. In the production process, one of the by-products of the sugar mill is solid waste in the form of bagasse, filter cake or press sludge, boiler ash, and sugarcane shoots litter. In one production process the sugar mill produces bagasse around 30-40% of the weight of milled sugarcane and filter cake of about 3,8% of the weight of milled sugarcane during the sugarcane milling process and sap refining (Ismayana et al., 2012). Based on data obtained from the Indonesian Sugar Experts Association (IKAGI) in 2020 there are 60 sugar factories in Indonesia, where two of them are located in the Greater Malang area, namely PG Krebet Baru and PG Kebon Agung. In 2019, the realization of mills in both of them reached 4,5 million tons, so it is estimated that the production of bagasse and filter cake will reach 1,5 million tons and 0,2 million tons. About 60-90% of the bagasse is reused by sugar mill as boiler fuel in the following grinding year, but the rest has not been used optimally.

Further, the organic material that has not been maximally managed is the biomass of water hyacinth. This plant considered as aquatic weed causing the disruption equilibrium of aquatic organisms. Water hyacinth has a very fast growth rate due to eutrophication and cause degradation of water quality (Lemley & Adams, 2018). One water hyacinth is able to grow 1 m^2 in 52 days, so it is estimated that it can cover an area of 7 m^2 for one year (Soedarsono et al., 2013). Within six months, the growth of water hyacinth in an area 1 hectare can reach a weight of 125 tons.One of the reservoirs in the Greater Malang area that has a water hyacinth population that exceeds the normal threshold is the Selorejo reservoir, with growth reaching 20% and producing biomass of 18 tons/month, where in 2013 the density of this weed reached 100 hectares from a total reservoir area of around 650 hectare. So far, the use of this biomass as raw material for handicrafts by the community around the reservoir.

The abundance of organic waste certainly requires proper, systematic, comprehensive and sustainable management which includes waste reduction and handling. Several studies were conducted in the context of organic waste management(Zurbrügg, Gfrerer, Ashadi, Brenner, & Küper, 2012; Hendra, 2016).The results of this study reveal five main aspects of sustainable organic waste management, namely institutional and regulatory, financing (economy), technical operations, environment and health, as well as community and private participation (social). The goal of organic waste management is not only to improve public health and to maintain environmental quality, but also to make a waste as a resource that has added value and can be reused (Lo & Woon, 2015). Technically, among various organic waste treatments so far, composting technology is considered the right and cheap solution. Several studies related to organic waste management through composting have been carried out (Andrade et al., 2018; Ayilara et al., 2020; Graça et al., 2021; Kadir et al., 2016; Lalremruati & Devi, 2021; Lin et al., 2018; Loan et al., 2019; Shah et al., 2014). The biodegradation product of organic matter by the activity of microorganisms (i.e., bacteria, fungi, actinomycetes) and worms that is safe for the environment and useful agronomically, named as a soil amendment and organic fertilizer (Gonawala & Jardosh, 2018). The studies reported that the application of compost from organic waste in agricultural land improved soil physical, chemical and biological properties, as well as increase plant production and control pathogenic microorganisms (Adugna, 2016; Martínez-blanco et al., 2013; Sayara et al., 2020). These positive effects are influenced by the quality of the compost produced and the characteristics of the raw material (Argun et al., 2017).

Previous research on organic waste management as compost concentrated on physical and chemical properties (Tang et al., 2006). When applying compost to agricultural land, the level of maturity and stability of the compost must also be considered. Immature compost degrades soil quality and interferes with germination and plant growth (Wu et al., 2000). The physical, chemical, and biological features of the compost can be used to identify its maturity and quality (AYCAN DÜMENC et al., 2021; Bernal et al., 2009; Cesaro et al., 2019; Cui et al., 2017; Meena et al., 2021; Sahu et al., 2020; Siles-Castellano et al., 2020; Wang et al., 2020; Xue et al., 2019; Young et al., 2016). However, no research on the maturity level and stability of compost have been conducted utilizing phytotoxicity assessment based on germination and root extension, as well as scanning electron microscopy (SEM) of corn seeds. As a result, the purpose of this research is to determine how to manage organic waste from sugarcane bagasse, filter cake, market organic waste, and water hyacinth into organic fertilizer that can be re-applied to plants in order to increase seed germination and plant yield and productivity. The goal of this research is to examine the quality of compost made from various organic wastes and its effect on sweet corn germination, growth, and production.

2. MATERIAL AND METHODS

2.1 Composting

The compost was produced from organic waste which was came from the Karangploso market, by-product of PG Kebon Agung (in the form of sugarcane bagasse and filter cake), and water hyacinth in the Selorejo reservoir. For market organic waste, organic and inorganic fractions are sorted at the composting site, then chopped. Whereas the water hyacinth did not sorted but directly chopped using a grass chopper. The composting method of organic waste uses an open windrow system, namely making compost in an open roof (not in a closed reactor) with natural aeration (Fatin et al., 2014). The experimental design used was a completely randomized design (CRD) which was repeated six times for each type of waste, namely: K1 (bagasse), K2 (water hyacinth), K3 (market waste) and K4 (filter cake). The amount of organic waste used in each treatment is 100 kg wet weight with an initial moisture content range of 54,7-90,2 %.

The composting activity begins with the preparing of organic waste, watering the bio-activator (EM4 + molasses + water), and stirring the pile. Stirring and watering activities during the composting process are carried out based on observations of temperature and humidity in the pile which are carried out every four days using a thermometer and soil tester (Takemura DM15). The check is carried out from three different points (surface, middle and bottom) of each pile. Composting is ended after six weeks, when the compost pH is close to neutral, the temperature decreases and is relatively stable (close to ambient temperature), has no strong odor and dark color (close to soil color), and the particle size is more crumbly.

As the final step, the ripe compost drying is carried out, then mashed and filtered to further determine the chemical characteristics which include: organic carbon, total nitrogen, C/N ratio, and macro nutrients. The water content is determined by the gravimetric method, as a decrease in the weight of the material after being oven at 60 °C until its weight is constant. The C-organic was measured using the Walkley and Black methods (Walkley and Black, 1934), while the total N used the Kjeldahl method (Kjeldahl, 1883). Determination of macro and micro nutrients was extracted using HNO_3 and $HClO_4$ which were then measured using a spectrophotometer for P, flame photometer for K and Na, and atomic absorption spectrophotometer for other nutrients. The pH analysis was carried out in a 1: 2,5 (w/v) compost extract in distilled water. In general, the quality of the mature compost produced refers to the requirements in Minister of Agriculture Republic Indonesia's Decree no. 261 of 2019 as a organic soil amendment.

2.2 PhytotoxicityAssessment

The compost phytotoxicity assessment used was modified from the seed germination test used by Zucconi et al. of 1981. The firstly step taken was to prepare a compost solution extract by shaking 10 grams of compost sample into 100 ml of distilled water (1:10 m/v) for one hour. Then centrifuged at 3000 rpm for 15 minutes before being filtered using filter paper (Mengistu et al., 2017). The seeds used in the germination test were sweet corn seed (Zea mays saccarata L.). The seeds used are pre- moistened with water and soaked for one night before starting the experiment to accelerate germination.

The planting medium used in the test was tissue paper coated with filter paper at the very top and placed in a petri dish. A total of 10 ml of compost liquid extract was poured evenly on the planting medium and five maize seeds were placed on it. Then the petri dishes were closed using filter paper and incubated in a dark room for seven days at room temperature. All treatments were repeated in four times using a completely randomized design (CRD). Seed germination in distilled water was used as a control. Observations on the parameters of the number of seeds that germinated normally and the length of the plant roots were carried out on days 1, 3, 5 and 7 after sowing (DAS). The relative percentages of seed germination and root elongation, as well as the germination index (GI) are determined by eq (Chaudhary & Mishra, 2019):

$$\text{Seed germination (\%)} = \frac{\text{No. of seeds germinated compost extract}}{\text{No. of seeds germinated in control}} \text{x100\%}$$

$$\text{Root elongation(\%)} = \frac{\text{Mean root length in compost extract}}{\text{Mean root length in control}} \text{x100\%}$$

$$\text{Germination Index} = \frac{\text{Seed germination(\%)x Root elongation (\%)}}{100}$$

Bagur-gonzález, Estepa-molina, Martín-peinado, & Morales-ruano (2010)added that the normalized percentage of the germinated seeds and the normalized elongation of the root can also be used to establish two toxicity indices, which is calculated by eq:

$$\text{SG} = \frac{\text{Average number of normal germinated seed (extract} - \text{control)}}{\text{Average number of normal germinated seed in control}}$$

$$\text{RE} = \frac{\text{Average length of the seed root (extract} - \text{control)}}{\text{Average length of the seed root in control}}$$

Apart of those parameters, during the seed germination test, the parameters of the seed growth rate and the hypocotyl ratio were also determined by eq (Komalasari & Arief, 2013):

$$\text{KT} = \frac{\sum(\text{X}_\text{i} - \text{X}_{\text{i}-1})}{\text{T}_\text{i}}$$

where:

KT = Germination rate(%/etmal)

Xi = Percentage of normal sprouts in etmal-i

Ti = Time of observation (etmal)

On the other hand, the hypocotyl ratio is the average shoot length (top) and primary root length (bottom) measured from normal growth sprouts.

2.3 Compost Aplication

Compost application of various organic wastes as a soil amendment was also carried out to see their effects on the growth and production of sweet corn plants. This study used a completely randomized factorial design with two replications. Compost type as the first factor and compost doses as the second factor. The compost type treatment were K0 (without compost), K1 (bagasse compost), K2 (water hyacinth compost), K3 (market waste compost) and K4 (filter cake compost). While the compost dosage treatment consisted of two levels, namely: D1 (5 t/ha) and D2 (10 t/ha). Compost applied a week before planting by placing it in each row near the planting hole.

The sweet corn variety used in this study was Golden Boy, which is one of the hybrid sweet corn seed varieties. The size of the experimental plot was (3 x 2,5) meters with a spacing (75 x 25) cm. In each planting hole, fill in two seeds and sow 2-4 cm deep. Furthermore, sow the fertilizer between a planting hole and mix it lightly with the soil, a week after planting. The fertilizers used are 300 kg/ha urea, 175 kg/ha SP-36 and 100 kg/ha KCl (Tuherkih & Sipahutar, 2008). Watering is done twice a week to keep soil evenly moist. Small caterpillar pest and fungal diseases are controlled using insecticides and fungicides.

From amount plants in each test plot, 10 sample plants were selected in the center of the plot. The parameters observed were the average of plant height, number of leaves, number of cobs, cob diameter, cob length, number of kernel rows, weight of cob with and without husks, and level of corn kernels sweetness.

2.4 Statistical analysis

Data were analyzed using Variance Analysis Method (ANOVA). The post hoc tests was carried out using methods Duncan's Multiple Range Test (DMRT) at the 95% confidence level (α = 0,05).

3. RESULTS AND DISCUSSION

3.1 Physico-chemical characteristics of compost

All compost had a steady temperature range of 25,0 to 29,2 oC at the end of composting, and water content ranged from 45,5 to 82,8%. However, during the drying process (at the conclusion of composting), the average moisture content of the compost reduced to 10-15%, preserving the quality of the compost and allowing the compost storage procedure to last longer. The key elements impacting the aerobic composting process are temperature, moisture content, and oxygen concentration in the airspace, according to most experts. Moisture content affects microbe activity and serves as a channel for transporting dissolved nutrients required by bacteria, according to Kurnia, Sumiyati, and Samudro (2017). The composting moisture content should be between 45 and 65 percent (Zein et al., 2015). In the meantime, temperature is a key composting aspect since it ensures that the process is completed effectively from a microbiological standpoint. The optimum temperature should be around 55-60^{o}C to eliminate pathogens that are harmful to humans and plants (Waszkielis et al., 2013). Changes in temperature have the biggest effect on enzymes and microorganism activity (Keenleyside, 2019).

The moisture level of compost must be in the range of 8-20 percent, according to Minister of Agriculture Republic Indonesia's Decree no. 261 of 2019, which sets out the minimum technical standards for organic soil amendment. This value has been satisfied. Furthermore, it demonstrates that all compost has a color that mimics soil color, specifically brown to blackish brown, has an odor that does not sting and smells like soil, and has a texture that is smoother (crumbly) and does not coagulate for color, odor, and texture criteria.

Table 1 shows the chemical properties of organic waste prior to composting and after composting. The four organic wastes have a neutral pH, with a range of 7,26-7,87, according to table 1. Furthermore, the average pH tends to climb to slightly alkaline at the conclusion of composting, with a range of 7,55-8,70, although the pH still met the quality criterion of organic soil amendment with a pH range of 4-9. The average C/N ratio of organic waste used was found to be extremely variable, ranging from 8,17 to 81,33. Bagasse compost had the highest C/N ratio, whereas market garbage compost had the lowest. The average C/N ratio for compost reaches 8,08-37,91 at the end of the composting process. This value indicates that the bagase compost C/N ratio did not meet the quality standard standards for organic soil amendment (≤ 25). Bagasse also had the lowest P, K, and Ca nutrient content compared to the other materials, both before and after composting.

Table 1. Chemical characteristics of organic waste before and after composting

Parameters	Before composting							
	Bagasse		Water hyacinth		Market waste		Filter cake	
pH	7.62 ± 0.30	ab	7.87 ± 0.04	b	7.26 ± 0.61	a	7.74 ±0.09	b
C (%)	27.06 ± 2.63	c	31.83 ± 5.34	d	14.09 ± 4.29	b	0.82 ± 0.08	a
N (%)	0.34 ± 0.05	b	1.89 ± 0.12	d	1.74 ± 0.20	c	0.04 ± 0.01	a
C/N	81.33 ± 16.60	c	16.67 ± 2.25	ab	8.17 ± 2.64	a	25.00 ± 12.21	b
P (%)	0.1 ± 0.02	a	0.09 ± 0.02	a	0.31 ± 0.10	b	3.31 ± 0.15	c
K (%)	0.17 ± 0.02	a	3.09 ± 0.40	d	2.28 ± 0.33	c	1.38 ± 0.07	b
Ca (%)	1.16 ± 0.14	a	2.11 ±0.24	b	1.90 ± 0.16	b	6.21 ± 0.53	c
Mg (%)	0.12 ± 0.05	a	0.44 ± 0.11	ab	0.38 ± 0.10	ab	0.68 ± 0.80	b
Parameters	After composting							
	Bagasse		Water hyacinth		Market waste		Filter cake	

pH	7.55 ± 0.11	a	8.70 ± 0.28	d	8.29 ± 0.18	c	7.86 ± 0.02	b
C (%)	18.42 ± 4.58	c	23.44 ± 1.03	d	9.81 ± 1.66	b	0.70 ± 0.22	a
N (%)	0.52 ± 0.10	b	2.62 ± 0.21	d	1.21 ± 0.13	c	0.07 ± 0.01	a
C/N	37.91 ± 17.96	b	9.12 ± 0.89	a	8.06 ± 1.55	a	11.00 ± 4.98	a
P (%)	0.05 ± 0.02	a	0.47 ± 0.21	a	0.42 ± 0.20	a	2.84 ± 1.36	b
K (%)	0.19 ± 0.10	a	2.40 ± 0.44	c	2.12 ± 2.60	bc	0.63 ± 0.03	ab
Ca (%)	1.35 ± 0.10	a	3.88 ± 0.41	c	2.37 ± 1.03	b	4.24 ± 0.27	c
Mg (%)	0.97 ± 0.14	bc	0.73 ± 0.42	ab	0.49 ± 0.25	a	1.20 ± 0.34	c

Note: The numbers followed by the same letters in the same in the same row showed no significant differences based on the DMRT Test at α = 0,05

In the common composting process, at the beginning of the composting process the pH tends to decrease to be slightly acidic due to the formation of carbon dioxide and simple organic acids, then increases as long as increasing incubation period due to protein breakdown and ammonia release (Zakarya et al., 2018). Changes in pH indicate the activity of microorganisms in degrading organic matter (Goyal et al., 2005). The pH value of compost which is in the neutral range is useful for increasing the pH of acidic soil so as to increase the availability of some soil nutrients (Domínguez et al., 2019).

The properties of the raw material (organic waste) have an effect on the decomposer microorganisms' activity and the quality of the compost generated. The ratio of organic carbon to nitrogen (C/N ratio) is one of the parameters that impact the length of the decomposition process and the availability of nutrients in compost (Sadaka& El-Taweel, 2013). According to Table 1, bagasse compost has the highest C/N ratio, whereas market waste compost has the lowest value. Due to the high C/N ratio, the process is extremely sluggish, as there is an excess of substrate to be destroyed by microbes (Satisha & Devarajan, 2007). The C/N ratio reduced marginally in all treatments towards the conclusion of composting, except for bagasse, which decreased dramatically but required the longest process, up to 90 days. Except for bagasse compost, the C/N ratios of water hyacinth compost, market waste compost, and filter cake compost all met the requirements of the quality standard.

During the biodegradation phase, carbon dioxide (CO_2), hydrogen dioxide (H_2O) and ammonia (NH_3) are released by oxidation during composting (Li, Q., Wang, X. C., Zhang, H. H., Shi, H. L., Hu, T., & Ngo, 2013). Microorganisms use organic compounds as a source of energy (C-organic which can be decomposed) and N for their development and activity. The metabolic process of microorganisms utilizes about 30 parts of carbon for each part of nitrogen, that is about 20 parts of carbon are oxidized to CO_2 and 10 parts are used to synthesize protoplasm (Diaz & Savage, 2007). In contrast to C-organic, during the decomposition process the total N tends to increase due to mineralization of organic N to inorganic N (Ayed et al., 2007). Mineralization of N-organic to inorganic N (N-NH_4^+ and N-NO_3^-) is known as the ammonification and nitrification processes, in which both forms of N are readily absorbed by plants(Zhu, L., Zhao, Y., Zhang, W., Zhou, H., Chen, X., Li, Y. & Wei, 2019). At the end of composting, the total compost N average reaches 0,07-2,62%. The highest value was found in water hyacinth compost, which was in line with the raw material content where it had the highest N content (1,89%). In general, macro nutrients (P, K, Ca and Mg) increase compared to the raw materials after composting (Soobhany, 2018).The mean range of these nutrients is 0,05-2,84 % for P, 0,19-2,40% for K, 1,35-4,24% for Ca, and 0,49-1,20% for Mg (Table 1). Larney, Sullivan, Buckley, & Eghball (2006), reported that the increasing of nutrient content in compost was caused by the use of large quantities of carbon in raw materials and the transformation of organic compounds into inorganic forms of these elements.

3.2 Phytotoxicityassessment of compost extract

Table 2 shows the response of maize seeds to a phytotoxicity assessment using the germination index. The investigation was unable to discover significant changes in germination parameters between various composts. At the end of the incubation period, the mean value index GI of all compost extract treatments ranged between 125 and 188 percent. Additionally, the values of normalized seed germination index (SG)>0 and normalized root elongation (RE)>0 were classed as very low toxicity on the index scale.

Table 2. Percentage of seed germination, root elongation, and index of maize seed germination in various compost extraction treatments

Treatment	%G		%I		%GI		SG		RE	
Bagasse	113 ± 25	a	113 ± 60	a	136 ± 84	a	0.13 ± 0.25	a	0.13 ± 0.60	a
Water hyacinth	106 ± 13	a	118 ± 19	a	125 ± 25	a	0.06 ± 0.13	a	0.18 ± 0.19	a
Market waste	125 ± 0	a	151 ± 15	a	188 ± 19	a	0.25 ± 0.00	a	0.51 ± 0.15	a
Filter cake	106 ± 13	a	161 ± 47	a	167 ± 36	a	0.06 ± 0.13	a	0.61 ± 0.47	a

Note: Numbers followed by the same letters in the same column showed no significant differences based on the DMRT Test at α = 0,05;%G = relative seed germination,%I = relative root elongation, GI = germination index, SG = normalized seed germination, RE = normalized root elongation

Phytotoxicity is one of the parameters used to determine if compost may be applied to plants without having a harmful influence on the environment. According to Gariglio, Buyatti, Pilatti, Gonzalez Russia, and Acosta (2002), the phytotoxicity test is frequently used to determine the degree of maturity of compost by seed germination or plant growth testing. The germination test provides a fast summary of phytotoxicity compost, with results that are fairly accurate and trustworthy (Cesaro et al., 2015). According to Table 2, the mean value index GI of all compost extract treatments ranged from 125 to 188 percent. According to Hase and Kawamura (2012), a high GI value (>60 percent) suggests that the compost is stable and mature. The value index GI tends to rise as the composting process of organic waste progresses to maturity (Tiquia, 2010). Based on this, all compost did not include harmful substances that could limit maize seed germination, ensuring that its use in plant cultivation does not interfere with plant growth and development (Priac et al., 2017). Furthermore, the values of index SG and index RE of all compost extract treatments were classed as extremely low toxicity (Table 2), indicating that compost extraction has no hazardous effect but stimulates the growth of sweet corn sprouts (Monda et al., 2018). Previous research has found that the RE indicator is more sensitive than the SG at low concentrations of dangerous substances (Park et al., 2016).

As presented in Table 3, compost extraction significantly affected to seed germination, primary root length, and seed growth rate. However, the compost extraction was not significantly affect to hypocotyl ratios. The highest seed germination rate and seed growth rate were obtained in the market waste compost extract treatment, respectively 100% and 17,0%/etmal. In this treatment, uniformity of seed growth was also seen in each replication (Figure 1).

Table 3. Germination rate, speed of growth, root length and hypocotyl ratio of maize seeds in various compost extraction treatments

Treatment	**DB**		**KT**		**PA**		**Hypocotyl Ratio**	
	%		%/etmal		cm			
Aquades (Control)	80 ± 0	a	13.0 ± 0.0	a	2.61 ± 0.03	a	0.29 ± 0.09	a
Bagasse	90 ± 20	ab	15.3 ± 3.5	ab	2.94 ± 1.51	ab	0.26 ± 0.22	a
Water hyacinth	85 ± 10	ab	14.0 ± 2.0	ab	3.06 ± 0.53	ab	0.21 ± 0.03	a
Market waste	100 ± 0	b	17.0 ± 0.0	b	3.92 ± 0.34	ab	0.38 ± 0.15	a
Filter cake	90 ± 11	ab	15.0 ± 2.3	ab	4.18 ± 1.20	b	0.28 ± 0.17	a

Note: Numbers followed by the same letters in the same column showed no significant differences based on the DMRT Test at α = 0,05;DB = germination; KT = speed of growth; PA = length of primary root

According to the International Seed Testing Association in 1999, a seed is normaly germinate if it has the potential to grow and develop into a complete plant, including roots, hypocotyls, cotyledons, epicotyls, and leaves (Oktiawan et al., 2018). In the case of the germination of a monocotyledonous plant seed, the progress of germination is strictly related with the water uptake rate. Initially, there is a rapid imbibition of water by a dry seed until the seed tissues are fully hydrated (phase I). This is followed by a limited later uptake during phase II, whereas in phase III, there is an increase of water uptake that is related to the completion of germination (Wolny et al., 2018). Adequate water uptake may result in sufficient heat transfer to activate nutritional factors. Water imbibition results in both structural and textural changes in seed. SEM examination of maize seed surface revealed microstructural differences between each seed which had been soaked with compost extract and control (Figure 2). SEM observation of the maize seed of control (soaked in aquadest) shows a relatively smooth surface. Whereas maize seed soaked in compost extract for 24 h was rougher with small clumps sticking on the surface. The differences in seed coat appearance may be a result of water absorption by the seed coat. Water absorption may result in compression of cells in a smooth seed coat to cause apparent roughness.

High viability seeds are intended to generate healthy seeds with rapid and strong root growth, allowing young plants to grow ideally in the field. Seed germination is extremely sensitive to environmental factors such as water and oxygen availability, salinity, light, and temperature, as well as the presence of poisonous compounds that prevent germination (Paiva et al., 2016). The primary root length can be used to estimate the level of seed vigor. Seeds that grow quickly and vigorously frequently yield plants that are more resistant to poor conditions (Mondo et al., 2013). The filter cake compost extract had the longest primary root length, measuring 4.18 cm (Table 3). This implies that a 10% compost extract concentration in the planting media was effective in promoting seed germination. This is most likely because compost extraction contains critical nutrients and other elements required for seed germination and does not contain poisonous compounds that can impede seed germination and plant growth (Da-bing et al., 2012).

Furthermore, based on the correlation test between the nutrient content in the compost and all germination test parameters, it was found that there was a positive relationship (r = 0,35, r table

5% = 0,40) between the P nutrient and the length of the primary roots, but it was negatively correlated (r = -0,44, r table 5% = 0.40) to the C/N ratio. In the germination process, the P contained in the seeds is the only P source available to sustain the initial growth of the seeds. Then, seed P reserves are rapidly mobilized and transferred to root and shoot tissue that emerge after germination. This P source is then supplemented with P uptake by the developing root system (White & Veneklaas, 2012). Phosphorous is an important nutrients in the synthesis process protein, enzymes and cell nucleus. This nutrient also plays a role in the processes of photosynthesis and respiration (Siles-Castellano et al., 2020). In addition, P nutrient also functions to stimulate root growth and the formation of a good root system so that plants can take up more nutrients (Ruhnayat, 2007).

Figure 1. Simultaneous germination and growth rate of maize seeds on phytotoxicity test. A and C) control, B and D) treatment with compost extract

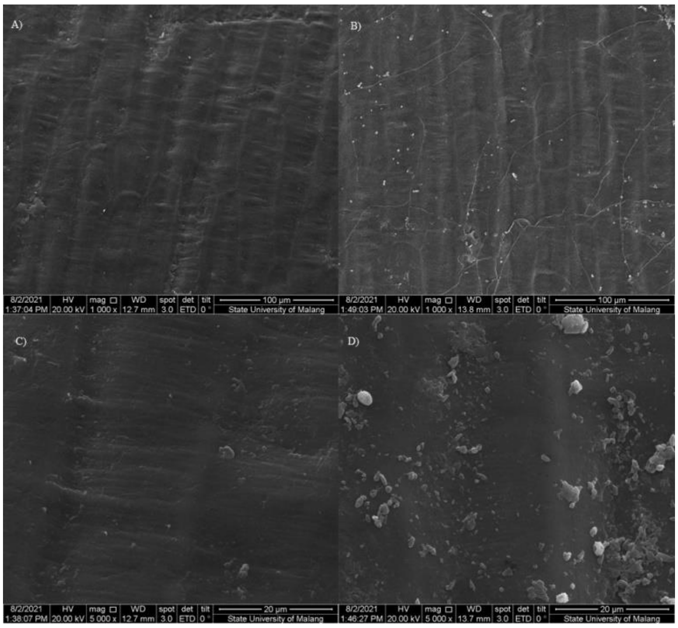

Figure 2. Scanning electron microscopy images of maize seed surface in phytotoxicity test.A and C) control, soaked in aquades and has a smoother surface, B and D) treatment with compost extract,soaked for 24 h and is rougher. Its partially hidden by amorphous debris. Bar = 100 µm and 20 µm

3.3 Growth and Production of Sweet Corn

Effect of compost on the average growth and production parameters of sweet corn are presented in Table 4. The results showed that the application of various kinds of compost with two different doses was not significant effect on number of cobs, cob length, cob diameter, number of kernel rows, weight of cob with and without husks. However, the parameters of plant height, number of leaves and level of sweetness was significantly different ($P \leq 0.05$) among various types and doses of compost application (Table 4). Application of market waste compost with a dose of 10 tons / hectare produced the highest plants (165 cm) and the most leaves (11 strands) at the six weeks after planting. In the parameter of sweetness level, the range of sugar content varies, namely 5-12 %.This value is slightly lower than the potential of this variety, which is around 11,67-14,33%. Treatment of bagasse compost at a dose of 5 t/ha produces sweet corn kernels with the highest level of sweetness, that is 12%, with kernels bright yellow.

Table 4. Theplant growth and production sweet corn after application of various kinds of compost with different doses

Treatment	TT (cm)		JD		JT		DT (cm)		PT (cm)		JB		BB (kg)		BT (kg)		TK (%)	
K0D1	150	ab	10	a	2	a	5.3	a	17.7	a	16	a	0.92	a	0.61	a	9	bc
K0D2	146	ab	10	ab	2	a	5.3	a	18.4	a	16	a	0.97	a	0.60	a	5	a
K1D1	157	ab	10	ab	2	a	5.2	a	19.5	a	15	a	1.23	a	0.70	a	12	d
K1D2	163	b	10	ab	2	a	5.2	a	18.2	a	16	a	0.85	a	0.53	a	8	b
K2D1	145	ab	11	ab	2	a	5.3	a	19.0	a	15	a	0.89	a	0.56	a	10	cd
K2D2	157	ab	11	ab	2	a	5.4	a	18.9	a	15	a	1.11	a	0.68	a	8	b
K3D1	151	ab	11	ab	1	a	5.5	a	17.9	a	16	a	0.82	a	0.54	a	5	a
K3D2	165	b	11	b	2	a	5.3	a	19.3	a	16	a	0.96	a	0.57	a	9	bc
K4D1	158	ab	11	ab	2	a	5.4	a	19.1	a	16	a	1.07	a	0.64	a	8	b
K4D2	138	a	10	ab	2	a	5.3	a	18.8	a	15	a	1.43	a	0.87	a	9	bc

Note: Numbers followed by the same letters in the same column showed no significant differences based on the DMRT Test at α = 0,05;K = type of compost, D = dose of compost, TT = plant height, JD = number of leaves, JT = number of cobs per plant, PT = cob length, JB = number of kernel rows per cob, BW = fresh weight of corn with husks, BT = fresh weight of corn without husks, TK = level of kernel sweetness

The application of various kinds of compost with two different doses was significantly different (P ≤0.05) on plant height and number of leaves (Table 4). According to Subekti, Syafruddin, Efendi, & Sunarti (2007), on vegetative phase will be produced maximum biomass of the plant. In this phase there will be absorption of N, P and K nutrients by plants of 60-70%, 50%, and 80-90%, respectively. N nutrient plays an important role in increasing the rate of photosynthesis which stimulates the vegetative growth of plants, including spur the leaf formation process (Jafarikouhini et al., 2020). Meanwhile, K nutrient acts as a counter weight to the situation if the plant has excess nitrogen. This element enhances the synthesis and translocation of carbohydrates, thereby increasing cell wall thickness and stem strength (Xu et al., 2018).

On the other hand, the number of cob, cob length and cob diameter were not significantly different between all treatments. However, the mean value obtained from each of these parameters is close to the potential of the sweet corn varieties used, namely has potential to produce two ears per plant, has a ear length of ±20,3 cm and a diameter of about 5,5 cm. Based on Table 4, the highest average fresh weight of sweet corn cobs with husks and without husks was found in the filter cake compost treatment with a dose of 10 t/ha, namely 1,43 kg/plant and 0,87 kg/plant. Meanwhile, the potential yield is 16,8 t/ha. The maize plants that are not too tall or tend to be short can improve the balance between vegetative growth and cob forming, reduce excess photosynthate in the stem and increase the number of kernels, and have a low collapse (Abadi & Sugiharto, 2019). The addition of organic matter to the soil also supply the nutrients needed by plants, thus adding with a dose compost the right one can create the optimal planting medium for plant growth and production (Machado et al., 2020).

The level of sweetness was significantly different among various types and doses of compost application (Table 4). The range of sugar content varies, namely 5-12 %. This value is slightly lower than the potential of this variety, which is around 11,67-14,33 %. One of the reasons for the low sweetness level is thought to be due to the harvesting activity that is too fast, namely 70 days after planting, so that the seeds are still soft and the production level is low. According to Subaedah, Edy, & Mariana (2021), the percentage of sweet corn sugar content is influenced by the variety and harvest time. The selection of the right harvest period affects the level of maturity and guarantees the level of sweetness as an indicator sweet corn quality (Khanduri et al., 2011).

4. CONCLUSION

This research proves that:

1. Differences in raw material of compost affected to the compost quality. The raw compost material from water hyacinth with characteristics having higher carbon, nitrogen, and potassium than the other organic waste (i.e. bagasse, market waste, filter cake) resulted a higher quality of compost (i.e. pH, total C, total N, total K, and total Ca) as compared to compost from baggase and market waste.
2. Compost from market place tended to increase the percentage of germination and growth speed of sweet corn as compared to the three other compost and pure water. While the highest primary root length (4,18 cm) was found in the filter cake compost extract.
3. Differences in types and doses of compost application gave significant effect on plant height, number of leaves and level of sweetness. Market waste compost with a dose of 10 t/ha produces the highest plants (165 cm) and the most leaves (11 strands). While bagasse compost at a dose of 5 t/ha produces the sweetest corn kernels (Brix = 12%) and seeds bright yellow.

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