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The Effect Of Chicken Egg Shell Compost On The Growth Of Tomato (Solanum lycopersicum)

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ABSTRACT
Chicken eggshells are one of the household solid wastes that are wasted in nature. Utilization of eggshells into compost is one way to reduce the pollutant load in the environment. The purpose of this study was to analyze the potential of chicken egg shell compost on the growth of tomato plants (Solanum lycopersicum). The experiment was carried out on a laboratory scale using a completely randomized design with three replications. The factor tested was the weight of chicken egg shell compost per polybag with variations of 0, 25, 50 and 75 g. The parameters analyzed were the growth of tomato plants by measuring plant height, stem diameter and leaf width. Observational data were analyzed using ANOVA α 5%, if there is a significant difference then proceed with the Least Significant Difference (LSD) α 5% test. Composted chicken egg shells have a quality according to SNI 19-7030-2004 concerning Specifications for Domestic Organic Waste Compost. Based on the analysis of diversity, it is proven that chicken eggshell compost has a very significant effect on the vegetative growth of tomato plants. The LSD test of α 5% showed that the best weight of chicken egg shell compost for plant height, stem diameter and leaf width were 50 g, 75 g and 25 g, respectively.
Keywords: *tomatoes, growth, shells, compost*

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I. INTRODUCTION

Eggs are one of the practical and healthy menus for consumption. Eggs are one of the cheapest and most widely used sources of animal protein by the public because they are easy to find anywhere. Eggs have many benefits for the body including strengthening the immune system, forming body tissues, etc. Many domestic and industrial activities use chicken eggs as raw materials, such as restaurants, hotels, food industries, and so on.

In recent years, egg production of purebred chickens in Indonesia tends to increase. Based on data from the Central Statistics Agency (BPS), the increase in purebred chicken egg production in 2020 was 6.12% to 5.04 million tons from 4.75 tons in 2019 (Dihni, 2021). This condition has consequences for increased eggshell disposal behavior. The eggshell has hard physical properties and fishy aroma, so it is not in demand for processing. The handling of eggshells so far is still very lacking, due to limited public knowledge about the management and utilization of eggshells. Meanwhile, the natural decomposition of eggshells takes a long time, therefore it is very possible to accumulate in nature which results in disturbed environmental aesthetics.

Some studies have obtained the results that inside the eggshell still contains some important organic compounds. According to Hadisuwito (2007), the chemical composition contained in eggshells is protein by 1.71%, fat by 0.36%, water by 0.93%, crude fiber by 16.21% and ash by 71.34%. The results of other studies say the largest content in eggshells is calcium carbonate by 97% (Nursiam, 2011)

Given the potential of eggshells that are still quite large, it is appropriate to use them so that the burden of pollutants in nature is reduced, one of which is by composting. Through the composting process, organic compounds contained in eggshells can be broken down by microbes into nutrients available to plants.

The principle of composting is to reduce the C/N ratio of organic matter to close to or equal to the soil C/N ratio, which is 15-25 (Irfan *et al.*, 2017). Organic carbon levels will decrease after the composting process is complete, this happens because Carbon (C) is used by most microbes to process the decomposition of organic matter (Ratna *et al*., 2017). During the decomposition process of organic matter, CO2 undergoes evaporation so

that C-organic levels decrease, this happens continuously until the decomposition process of organic matter has been completed. Setyorini (2006) explained that in aerobic composting, approximately two-thirds of the carbon element (C) evaporates into CO2 and the remaining one-third part reacts with Nitrogen in microbial living cells.

Nitrogen levels have decreased due to metabolic influences which result in Nitrogen being assimilated and lost through volatilization as ammonia or lost due to the denitrification process (Nur *et al*., 2016) The decrease in C levels and the increase in N levels is what causes the C/N ratio to fall. Based on research by Saputra & Hariyono (2022), that eggshell feeding has an effect on the C/N ratio. Composting cow dung as much as 1 ton / ha plus egg shells of 1 ton / ha produces the highest C/N ratio, which is 11.47, and K 0.50%, while those without egg shells C/N are lowest with a value of 6.87, and K 0.48%. The availability of nutrients contained in eggshell compost is a source of nutrients for plants, including tomato plants. Tomato plants are plants of high economic value, can grow in all conditions, from highlands to lowlands. Tomatoes are plants of the Solanaceae family, undergo a short life cycle, and can grow one to three meters tall.

In order for the growth of tomato plants to be good, it is necessary to provide sufficient nutrients in the growth medium. Compost of chicken eggshells can be an option for fertilizing tomato plants. Thus, the use of egg shells that are processed into fertilizer through composting, not only reduces pollution in nature, but can also help the growth of tomato plants that have economic value.

On this occasion, research has been conducted to test the potential of chicken eggshell compost on the growth of tomato plants at various doses.

II. RESEARCH METHODS

This study was conducted on a laboratory scale using a randomized design complete with three repeats. The factor tested was the weight of chicken eggshell compost consisting of 0, 25, 50, and 75 g for each *polybag*. The parameters measured are plant height, stem diameter, and leaf diameter. The observed data were analyzed statistically using Anova α 5%, if there was a real difference followed by the BNT test α 5% (Gomez &; Gomez, 1995)

Stages of composting chicken eggshells

Eggshells weighing 1 kg are formed into powder by blending, then mixed evenly with EM4 that has been activated for 7 days using water and molasses. All ingredients are put in a composting container and left for 2 weeks. The mature compost is then chemically analyzed, including total N, C/N ratio, P available, K available, and moisture content.

Stages of testing shell compost for the growth of tomato plants

Each treatment is done in *polybags* that are given soil weighing 5 kg, then mixed evenly with shell compost according to the dose variations, Each *polybag* is planted one seedling with an average height of 4 cm. To maintain the water content of the soil, every two days watering is carried out using well water to the capacity of the field. Tomato plants are grown up to 8 MST. The parameters measured are plant height, stem diameter and leaf width.

III. RESULTS AND DISCUSSION

Characteristics of eggshell compost

Composting is a method of making organic fertilizer by converting organic materials into simple ingredients using microbial activity. In this study, composting eggshells was carried out using EM4 bioactivators and molasses as additional nutrients. The characteristics of compost of chicken eggshells that undergo a composting process for 2 weeks are presented in Table 1.

Table 1 illustrates that all parameters measured have met the Compost Quality Standard based on SNI 19-7030-2004 concerning Compost Specifications for Domestic Organic Waste. These results explain that many organic compounds in chicken egg shells are decomposed by microbes contained in EM4. According to Hasibuan *et al*., (2021), if fertilizer is added EM4, it can produce higher nutrient content of Nitrogen, Phosphorus, and Potassium than compost without the addition of EM4. This statement is supported by Yee Van et al., (2018) *and* Subandriyo et al., (2012) *that the use of EM4 in the manufacture of liquid organic fertilizer (POC) can increase the nutrient content of fertilizer.*

Table 1. Characteristics of chicken eggshell compost

No	Parameter	Unit	Indonesian Standart (SNI)	Test Results
1	Nitrogen	%	>0,40%	1.51
	C Organic	%	9.80 – 32%	17.37
2	Phosphor (P)	%	>0,10%	1.57
3	Kalium (K)	%	>0,20%	1.06
4	C/N Ratio	-	10-20	11.52
5	Moisture content	%	< 50%	0.52

Source: Primary Data, 2023

The number of fermented microbes in EM4 ranges from 80 genera. There are five main groups, namely photocentetic bacteria, *Lactobacillus sp.*, *Streptomyces sp.*, yeast (yeast), and *Actinomycetes*. In the process of fermentation of organic matter, microbes will work well when the conditions are suitable. The fermentation process will take place in semi-anaerobic conditions, low pH (3-4), high salt and sugar content, medium water content of 30-40%, the presence of fermentation microbes, and temperatures around 40-50oC (Indriani, 2002).

During the composting process, nutrient dynamics occur. Organic carbon levels will decrease after the composting process is complete. This happens because Carbon is used by most microorganisms to process the decomposition of organic matter (Ratna *et al*., 2017). Nitrogen levels have decreased due to metabolic influences which result in Nitrogen being assimilated and lost through volatilization as ammonia or lost due to the denitrification process (Nur *et al*., 2016). The decrease in C levels and the increase in N levels is what causes the C/N ratio to fall.

In addition to remodeling, microbes also use Potassium for their life metabolism, thus affecting the levels of Potassium in the material. Shobib, (2020) explained that Potassium is used by microbes as a catalyst, so that the presence of bacteria and their activities can affect the increase in potassium content. Suswardany & Kusumawati (2012) said in the composting process some of the phosphorus is sucked by microorganisms to form egg white substances in the body. More and more microbes will make the compost mature quickly so that microbes have the opportunity to suck Phosphorus in the mature compost.

The effect of chicken eggshell compost on the growth of tomato plants

The response of tomato plants to the feeding of chicken eggshell compost can be known from its growth. Growth is the event of increasing the size of living cells, either in mass, height, or volume. Plant growth is influenced by soil, nutrients in the soil, water, and sunlight. In this study, the potential of chicken eggshell compost has been investigated as a source of nutrients or fertilizer for tomato plants.

As written in Table 1, that composted chicken egg shells have qualities that meet compost quality standards. The elements contained in this compost play a role in adding or replacing elements lost from the soil, with the aim of increasing crop production (Widawati &; Kusumastuti, 2017). Compost of chicken eggshells can improve soil quality. Rahayu *et al*., (2016) explained that organic matter from manure or compost added to the planting media in addition to adding nutrients, also reduces the weight of the contents and increases soil porosity. More pore space can increase soil porosity so that roots easily penetrate the soil to absorb water and nutrients.

Kemampuan akar menyerap air dan unsur hara dipengaruhi oleh ketersediaannya dalam tanah, dan atau jangkauan akarnya. Kompos cangkang telur yang ditambahkan ke dalam tanah pada berbagai takaran memberikan efek yang bervariasi terhadap pola pertumbuhan tanaman tomat sampai dengan usia 8 MST. Tabel 2 menunjukkan keragaman tinggi tanaman, diameter batang serta lebar daun tomat pada berbagai takaran kompos cangkang telur ayam.

Table 2. Measurement of plant height, stem diameter and width of tomato leaves at various doses of chicken eggshell compost at the age of 8 MST

Compost weight	Plant height (cm)	Trunk diameter (cm)	Leaf width (cm)
0 g	15,33	0,60	1,53
25 g	19,67	0,62	2,00
50 g	22,33	0,85	2,13
75 g	24,00	1,12	2,27

Table 2 shows that tomato plant growth is better in the amount of chicken eggshell compost given in large quantities. The plants grew taller, the diameter of the stem and leaves wider than the controls. Plant height was a difference of 4.34 – 8.67 cm, stem diameter was 0.02-0.52 cm and leaf width was 0.47-1.74 cm from control. A large difference occurs in the treatment of shell compost with a large dose. This proves that a large amount of compost has consequences for large nutrient content, so that its potential for the growth of tomato plants is high as well. In this case, Asnijar *et al*., (2013) stated that the adequacy of nutrient content in the soil can support the vegetative growth period of plants. Furthermore, Salim & Sriharti, (2008) explained that to get optimal fertilization efficiency, the fertilizer must be given in sufficient quantities for plant needs. If given too much fertilizer can cause poisoning for plants. Conversely, if there is too little fertilization effect for the plant, it may not be visible.

Nitrogen in chicken eggshell compost of 1.51% plays an important role in plant vegetative growth, such as the growth of leaves, branches, stems, and roots as well as meristim development and protein formation Wijayanti *et al*., (2013).Mukhlis (2017), said that Nitrogen has the main function as a synthetic material chlorophyll, proteins, and amino acids, therefore the element Nitrogen is needed in large enough quantities,

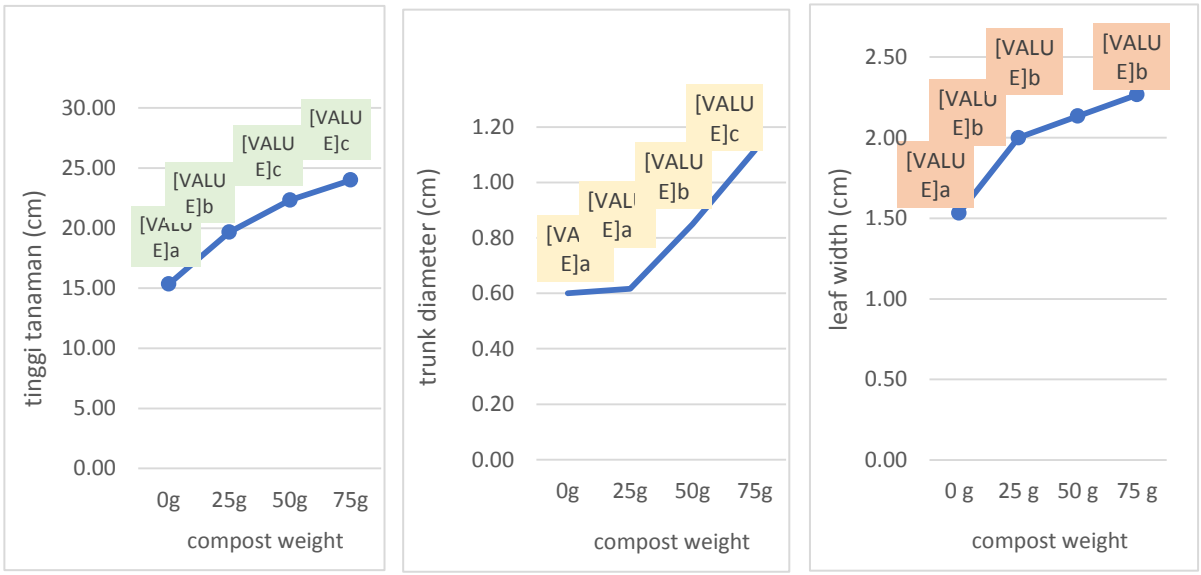
especially when growth enters the vegetative phase. Together with elemental Phosphorus (P), this Nitrogen is used in regulating overall plant growth.

Further explained by Mukhlis (2017), there are 2 forms of Nitrogen, namely Ammonium (NH4) and Nitrate (NO3). Based on a number of expert studies, proving Ammonium should be no more than 25% of the total concentration of Nitrogen. If excessive, the plant physique becomes large but susceptible to disease attacks. Nitrogen derived from ammonium will slow growth because it binds carbohydrates so that the supply is small. Thus food reserves as capital for flowering will also decrease, as a result of which the plant is not capable of flowering. If nitrates are dominant, then plant cells will be compact and strong so that they are more disease resistant. Nitrogen deficiency can be seen from the yellowing of the lower leaves due to chlorophyll deficiency. In further processes, the leaves will dry out and fall off. The bones below the surface of young leaves will appear pale. Plant growth slows down, stunted and weak. Excess amount of Nitrogen leads to too green leaf color, lush plants with leaves. The disposal process becomes long.

Chicken eggshell compost used to fertilize tomato plants contains 1.57% phosphorus. The element Phosphorus (P) is a constituent component of several enzymes, proteins, ATP, RNA, and DNA. ATP is important for the process of energy transfer, while RNA and DNA determine the genetic properties of plants. Element P also plays a role in the growth of seeds, roots, flowers, and fruits. The influence on the roots is by improving the root structure so that the absorption of plants to nutrients becomes better (Mukhlis, 2017), thus it will help the vegetative growth process of plants.

Potassium element in chicken egg shell compost as much as 1.06%. Potassium acts as a regulator of plant physiological processes such as photosynthetics, accumulation, translocation, carbohydrate transport, opening and closing stomata, or regulating water distribution in tissues and cells. Excess K causes impaired absorption of Ca and Mg. Plant growth is inhibited. so that the plant is deficient. K deficiency appears from the lower leaves that are dry or there are scorched spots. Lack of this element causes leaves to burn and eventually fall (Mukhlis, 2017).

One of the nutrients found in eggshell waste is calcium (Ca). This nutrient is a nutrient that has an important role for plants. Calcium is a secondary macronutrient needed by plants and absorbed by plants in the form of Ca2+ (Fitria *et al.*, 2018).The role of calcium elements for plant growth includes: as a constituent of cell walls, maintaining the integrity and permeability of cell membranes, activating enzymes that play a role in cell division and elongation, and neutralizing heavy metal elements in plants so as to minimize the impact of poisoning, thus calcium elements have a positive influence on plants (Tetelay, 2018).



(a) (b) (c)

Description: The same lowercase letter behind the value, indicating no difference from one another based on the BNT test α 5%.

Figure 1. Average plant height (a), stem diameter (b), and leaf width (c) of tomato plants at various doses of chicken eggshell compost at the age of 8 MST

Based on the BNT test α 5%, it appears that the dose of chicken eggshell compost that produces the best tomato plant height is 50 g (Figure 1 a), for the best stem diameter occurs at a dose of 75 g (Figure 1 b), while the leaves at a dose of 25 g (Figure 1 c). Composting eggshells from 25 g to 75 g produces leaves of the same width (no real difference), except for controls. The same leaf size can actually cause different plant height and stem diameter. But on the stem diameter indicator, the addition of the egg shell compost dose will be followed by an increase in the diameter of the rod.

The response of plants to each treatment can be known especially in root formation. Differences in root capacity formation will affect the opportunity to absorb water and nutrients, so that the process of photosynthesis that produces plant biomass also varies. Applying eggshell compost at doses of 50 and 75 g produces higher plants than giving compost at a dose of 25 g. This condition illustrates that the amount of nutrients in doses of 50 and 75 g has met the nutritional needs of plants. Fertilizer application below 50 g is not sufficient supply of plant nutrients In this case, Jailani (2022) argues that the stem height of tomato plants (*Licopersicum esculantum Mill)* is different due to several factors, such as sunlight, water, hormones. Plant growth will be normal if the amount of nutrients is in sufficient and balanced amounts, and other conditions are favorable. Thus, the application of compost with the right dose can change the physiological atmosphere that is good for plant growth that requires soil reactions and nutrient activity that is suitable for growth.

This result is different from the opinion of Harjadi (1979) who suggested that the number of leaves is closely related to the weight of the tomatoes produced. Leaves are the place where photosynthesis occurs because they contain chlorophyll, so they can convert carbon dioxide and water into carbohydrates and oxygen with the help of sunlight. These carbohydrates are then used to form other compounds needed in the formation of plant cell structures and to support other metabolic activities or accumulated in certain organ cells (Sitompul and Bambang, 1995), as plant biomass that forms roots, stems, leaves, and so on.

IV. CONCLUSION

Compost of chicken eggshells has a very significant effect on the vegetative growth of tomato plants. The best dose of shell compost resulting in tomato plant height, stem diameter and leaf width, respectively is 50 g, 75 g and 25 g.

SUGGESTION

We recommend that this experiment be continued until the generative growth of tomatoes to determine the role of chicken eggshell compost on its production.

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