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Analysis of the Impact of Black Tea Waste on The Fertility Quality of Rainbow Chili Plants (*Capsicum annum* L.)

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Abstract: Black tea is a drink commonly consumed in Indonesia, so it is not uncommon for dregs to be found to be wasteful. Waste is a serious problem that, if not handled properly, will have specific environmental impacts. Many people use tea waste as fertilizer without knowing the danger it causes to plants without further processing. This research aimed to analyze the effects of black tea waste on the fertility quality of rainbow chili plants (*Capsicum annum* L.). The type of research is qualitative research. The method used in this research is qualitative observation to observe the maximum height, the time to reach the maximum height, the entire leaf width, the time when the first flower appears, the time when the first fruit appears when the first fruit matures, the length of the first fruit, and the middle circumference of the first fruit of the rainbow chili plants (*Capsicum annum* L.) which were planted in potting soil given black tea waste with different ratio. From all the parameters observed, it was found that the best quality of rainbow chili plants (*Capsicum annum* L.) was in potting soil with a definite ratio of not too much but also not too little. From this fact, black tea waste can fertilize plants, but with a specific maximum level limit. Excessive amounts of tea waste can trigger alkalinity in the soil, which reduces plant fertility, and the presence of active substances such as polyphenols in it can kill decomposing bacteria, which causes new problems for the soil. Further research is still needed, especially in overcoming alkalinity and the content of active substances that can kill decomposing bacteria in the soil in black tea waste before it can be made into a commercial product like planting medium.

Keywords: Black Tea Waste; *Capsicum annum* L.; Observation; Qualitative Parameter; Plant Height.

Introduction

Black tea is one of the favorite drinks in Indonesia. The habit of drinking tea in Indonesia is widespread. In 2015, Indonesian people were recorded to consume 0.18 kg/capita/year of tea [1]. By using data on the total population at the time of the last census, namely in 2022, which was 275.77 million people, where per capita families were an average of 4.2 people [2], it can be estimated that if this value for tea consumption in Indonesia remains, so tea consumption for just one year in Indonesia is around 11818.71 tons.

Tea waste, especially black tea, which is the most popular in Indonesia, is generally thrown into the outside and will accumulate in the soil. This black tea waste has a pH of 6.64 – 6.86 [3]. Many people use tea waste as a plant fertilizer because tea contains various essential metals needed for plant growth [4 – 5].

The average optimum pH for growing plants is 5.5 – 6.5 [6]. For rainbow chilies themselves, they have an optimum growth pH of 6.0 – 6.8 [7]. This will, of course, cause problems because the presence of tea waste will disrupt plant fertility by increasing the soil pH, which causes essential metal ions needed for plants not to be able to dissolve properly in the soil [8]. Besides that, tea contains polyphenols [9], which inhibit the growth of bacteria in the soil, which are needed for plant growth and development. In other words, instead of being fertilized, tea waste can potentially be toxic to the fertility of rainbow chili plants (*Capsicum annum* L.).

Tea waste cannot simply be substituted into the soil. It is necessary to consider efforts first so that tea waste can be processed by lowering its pH to a safe range and degrading its antibacterial compounds, which can disrupt the habitat of bacteria in the soil before being thrown into the ground.

Based on this description, this research aims to examine the effect of mixing used black tea dregs in the soil on the growth fertility of rainbow chili plants (*Capsicum annum* L.). It is essential to do this because we need to find the proper application for using waste, which is black tea dregs waste, and not make mistakes that lead to detrimental results.

Research Methods

This research is qualitative research used a qualitative approach by observing the maximum height and maximum leaf width when the first flower appears when the first fruit appears, when the first fruit matures, the length of the first fruit, and the middle circumference of the first fruit of the rainbow chili (*Capsicum annum* L.) planted in planting pot given black tea waste with a ratio of black tea waste to soil of 0:1, 1:20, 1:1, and 1:0.

The research design used in this research is analytical descriptive to determine the influence of adding

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tea dregs in soil on variables mentioned previously, whether its impact is positive or negative.

The sampling technique used in this research is incidental sampling, where the average of each sample determines each variable's value in each sample group.

The subject used in this research is rainbow chili (*Capsicum annum* L.) planted from seed in Graha Alam Sutra Housing Block B14 Sude Kau Street, Hutuo Village, Limboto District, Gorontalo Regency.

The tools used in this research include a C16 brand kitchen scale with a maximum of 3 kg with an accuracy of 10 grams and a Deli brand cloth meter with a maximum of 150 cm with an accuracy of 0.1 cm. The materials used in this research include black tea waste taken from used waste from the community of Mattoangin Village, Bira Village, Tamalanrea District, Makassar City, agricultural land taken from the yard land located in Graha Alam Sutra Housing Block B14 Sude Kau Street, Hutuo Village, Limboto District, Gorontalo Regency which is processed by adding rice husks and ready-to-use chicken manure purchased from the Makassar City Flower Seed Shop which is mixed using specific techniques and ratios [10], as well as a pot with a top diameter of 20 cm and bottom diameter of 14 cm purchased from Gembira Houseware Store of Gorontalo City.

For the research stage, 12 pieces of planting pot, each grouped into four groups, were prepared, referred to as groups A, B, C, and D, where each group consisted of 3 pieces. Group A was given control treatment, which was filled with soil without adding tea dregs. Group B was filled with soil plus tea dregs in a ratio of 20:1. Group C was filled with soil plus tea dregs in a ratio of 1:1. Meanwhile, group D was filled with tea dregs without mixing any soil at all [11 – 14]. About six seeds of each rainbow chili (*Capsicum annum* L.) seed was put into the planting medium, and then their growth was observed where the first plant to grow in each planting medium would be treated as a sample, and the rainbow chili (*Capsicum annum* L.) plant the next ones that increase will be discarded. Its development is then observed for approximately 150 days, starting from plant height, when it reaches maximum height, leaf width, the appearance of flowers and fruit, when the first fruit ripens, and the size of the first fruit. Data collection took place at the researcher's residence in Graha Alam Sutra Housing Block B14 Sude Kau Street, Hutuo Village, Limboto District, Gorontalo Regency, which was carried out for 150 days starting from April 29, 2023, to September 25, 2023, involving observations of 4 sample groups of rainbow chili plants (*Capsicum annum* L.) which each of has variations in the composition of the planting medium between agricultural soil and tea dregs respectively for samples A to D of 1:0, 20:1, 1:1, and 0:1 with the focus of observation including maximum height, time to reach maximum height, maximum leaf width, a time when the first flower appears, when the first fruit appears, when the first fruit matures, length of the first fruit, and the middle circumference of the first fruit of the rainbow chili plants (*Capsicum annum* L.).

Data collection methods are done by direct observation from May 3rd until September 29, 2023. Data analysis was carried out by directly comparing qualitatively related aspects of observations between one sample group and the others.

Results and Discussion

Maximum Height and Time to Reach Maximum Height

In general, chili plants experience two growth phases: the vegetative and the generative phases. The vegetative phase occurs at plant age from 0 to 40 days and is divided into two phases: vegetative phase I and vegetative phase II. In the vegetative phase I, growth occurs, leading to shoots and root development. This phase ends between the 10th and 14th days after planting. In vegetative phase II, growth tends to lead to the growth of leaves and stems, whereas cell enlargement causes the stems and leaves to become broader in this phase. This phase ends around the age of the plant, reaching 40 days. The generative phase occurs after the plant reaches 40 days of age. Growth has reached flowering, fruiting, development, and fruit ripening in this phase. However, sometimes, some differences between chili plants of the same species are influenced by several factors, both internal and external. Internal factors include enzymes and hormones, while external factors include environmental factors such as humidity, temperature, soil pH, soil water content, sunlight, and so on [15].

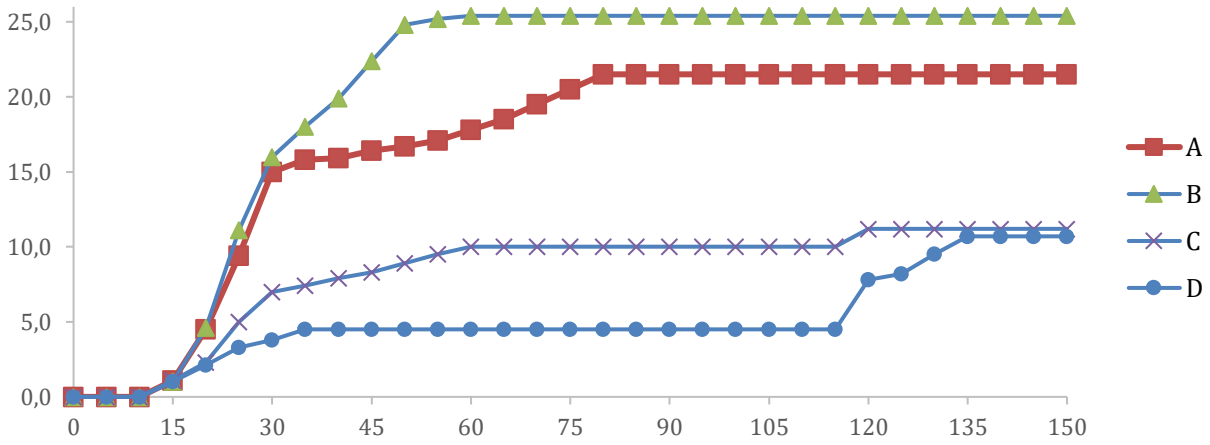

Figure 1. Line Diagram of Plant Height (in cm) for a Certain Planting Period (in Days after Planting)

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The time when chilies reach their maximum height is not the optimal measurement for determining whether they grow well. Still, at least, it is one of the factors determining whether chili plants thrive. The optimum time for plants to reach maturity is 60 – 80 days [16]. However, the optimum period in the highlands can change to 120 – 150 days [17]. Chilies that grow too quickly produce unhealthy fruit that is too watery, not spicy enough, or even has whitish parts without taste. At the same time, if they grow too long, the resulting chili fruit tends to be stunted, hardened, and unpalatable to consume.

Based on Figure 1, sample A, namely plants planted in pots without tea dregs, and sample B, plants planted in pots with a ratio of tea dregs and soil of 1:20, grow at the ideal maturity period, which in 80 HST for sample A and 60 HST. for sample B. As for sample C, namely plants planted in pots with a ratio of tea dregs and soil of 1:1, and sample D, which only contains tea dregs, it appears that they have passed the ideal maturity period; to be precise, for sample C it took 120 days. To reach adulthood, sample D took 135 days.

This is by what was previously hypothesized. Black tea dregs reduce soil acidity, which causes essential metal ions needed for plant growth to be unable to be obtained because metals become insoluble in a less acidic atmosphere [8]. On the other hand, it could also be caused by the influence of polyphenols, which are said to be able to kill bacteria in the soil [9]. However, separate research still needs to be carried out to assess the soil quality based on the ideal number of bacteria.

Still, if we drill down between samples A and B, there is a slight discrepancy with the proposed hypothesis. In terms of the period of growth and maturity, both of them are in the ideal realm. However, when we look at the height of the plants, the plants in sample B have an average height that is much higher than sample A; namely, the average height of the plants in sample B is 25.4 cm, while the average height of the plants in sample A is only 21.5 cm. This means that levels of around 5% tea dregs in the soil in sample B may positively influence plant growth.

Let's look again at the results of Sholihah's (2017) research, one of which examined the effect of adding tea dregs on the growth of red chilies, which are closely related to rainbow chilies. This aligns with the fact that red chilies' growth decreases with excess tea dregs [5]. However, if we add it reasonably, as Imran (2016) has done, then positive results can be achieved [4].

Tea dregs waste requires time to decompose to utilize its nutritional elements. However, the presence of polyphenols inhibits this process. That is why tea dregs waste cannot simply be used as a planting medium. This has been proven by research [18], where the height of plants that use tea dregs waste composite becomes stunted.

Giving large amounts of tea dregs to plants does not affect plant productivity because the tea dregs have not been wholly extracted, so soil aggregates have not yet been formed [11].

However, the story is different if the level of tea dregs in the soil is tiny. Bacteria will more easily break this down so the soil returns to its ideal acidity condition. Tea dregs waste, rich in minerals such as organic carbon, copper, magnesium, and calcium [13], can decompose and become good fertilizer for plants.

Maximum Leaf Width

Parameters such as area, length, and width of leaves are often used to determine the level of plant fertility because the more comprehensive, longer, and broader the leaves, the higher the photosynthesis rate of the plant, which indicates that the plant in question is healthier [19]. This is, of course, when we talk about cultivated crops. Minimizing leaf width is sometimes a mechanism for plants to survive in dry environmental conditions when the plant grows in the wild [20].

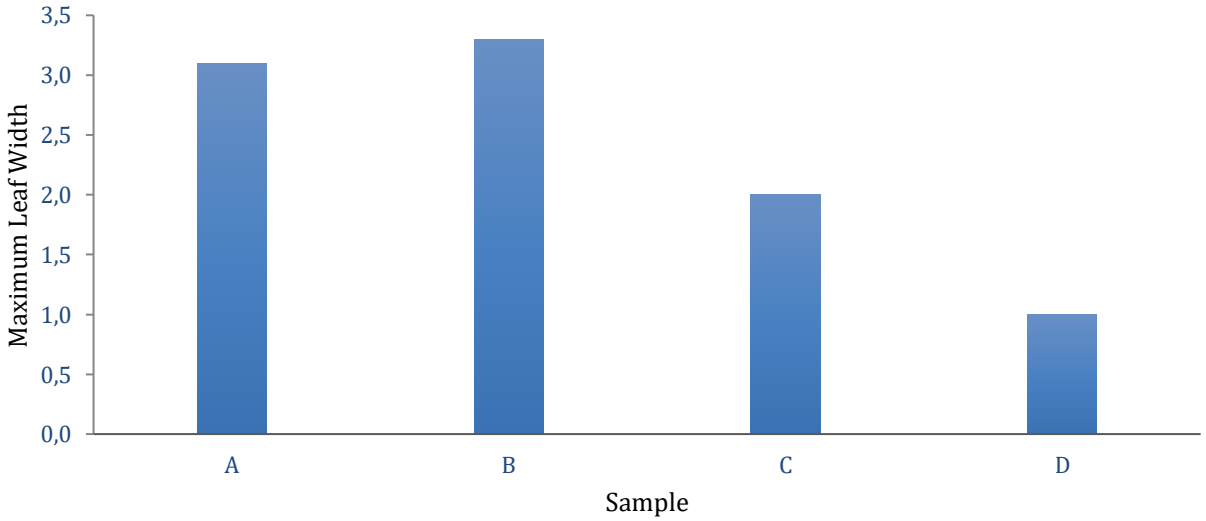

Figure 2. Bar Diagramof Maximum Leaf Width for Each Sample Group

Based on Figure 2, the results are not much different from those obtained for plant height parameters. Sample B looks the healthiest among the other samples, which can be seen from the size of its widest leaves; we know from the

argument above that the wider the plant leaf, the more stomata it has, which indicates the plant's fertility. This suggests that at significant levels, tea dregs waste will reduce soil productivity. Still, at small levels, to a certain extent, tea dregs waste can be used as fertilizer, increasing soil productivity.

The Period of Reaching the Generative Phase (Flowers Appearance, FruitAppearance and Fruit Maturity)

The factor that most influences plant fertility is none other than the quality of the soil itself. One of the ways this can be seen is the state of the plant's generative phase, which is marked by the appearance of flowers accompanied by the appearance of fruit in large quantities [21].

Table 1. State of the Generative Phase of Each Sample

Sample	Time of Flower Appearance (in Days)	Time of Fruit Appearance (in Days)	Flowers Quality
A	85	95	Good and Plenty
B	65	80	Good and Plenty
C	140	145	Good and Plenty
D	140	145	Good and Plenty

Plant nutrition influences how fast or slow a plant flowers and bears fruit. Previously, it has been explained that tea dregs need time to compose before they can be used, so increasing the amount does not guarantee plant fertility; on the contrary, its alkalinity can disrupt plant growth. This happened in samples C and D, which were slow to flower and bear fruit [11, 13, 18].

However, the quality of flowering and fruiting depends more on the treatment given to a plant during its generative period. This is especially strongly influenced by temperature. Providing too high a temperature at the tip of the plant tends to reduce the flowering quality. Even though other parts of the plant are exposed to extreme sunlight, as long as we can keep the tip of the plant at an optimal temperature, the quality of flowering and, of course the impact on the quality of fruiting can be maintained to remain optimal [22].

On the other hand, it is also possible for pest attacks to affect the quality of flowering and fruiting of a plant. However, the soil quality when the plant reaches its generative period seems to play a more critical role. Drought and lack of nutrients, especially potassium, are the leading causes of flower loss faster than usual, indirectly reducing the quality of flowering and fruiting [23].

Unfortunately, from the samples observed in Table 1, there were no significant differences in the quality of flowering and fruiting, where each sample flowered with good quality and lots of flowers. Similar research may be carried out in the future. Still, agricultural land with a minimum of potassium should be used so that the significant impact of the presence of tea dregs on the land planted with rainbow chili plants (Capsicum annum L.) can be observed.

Fruit Quality

Chili fruit that has good quality is fruit that has sharp and fresh color and has no disease. Its texture is not too hard but not too soft, indicating that excessive pectin has been broken down [24].

Table 2. Shape of The First Fruit of Each Sample

Sample	Fruit Length (in cm)	Fruit Circumference (in cm)	Fruit Quality
A	2.9	1.9	Good
B	3.1	2.3	Good
C	-	-	-
D	-	-	-

Unfortunately, until the end of this research, as seen in Table 2, no ripe fruit had been obtained from samples C and D, so they could not be compared. However, if we compare samples between A and B, it can be roughly said that the quality of the fruit between average agricultural land and agricultural land exposed to tea dregs waste is not different, both of which show the characteristics of healthy chili fruit.

As previously explained, this is because potassium levels are not controlled in soil, while tea dregs should be an important source of potassium in the flowering and fruiting process [23].

Conclusion

Based on the research carried out, it was found that tea dreg waste indeed affects plant fertility. A sample treated with excessive amounts of tea dreg waste in the soil will experience decreased fertility. However, if it is given in small doses to a certain level, it is found that the plants will grow more fertile, which can be observed especially from the plant's height and the leaves' width. Further studies still need to be carried out on the quality of bacteria and the content of essential ions for plant growth on agricultural land given tea dregs, which is thought to be the main cause of the decline in soil fertility quality due to the abundant supply of tea dregs waste. There is also a need for more in-depth studies regarding the maximum levels of tea dregs waste that can be provided which will still impact increasing soil fertility and not the other way around.

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