Microgreen Quality of Broccoli Plants (*Brassica oleracea L.*) and Correlation between Parameters

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Abstract. Micro greens are vegetables harvested at a very early age, harvesting is done when cotyledon leaves and a pair of new leaves appear. Plant growth phases include germination, micro greens, baby greens, and mature in greens. This research aimed to determine the quality of microgreens broccoli (*Brassica oleracea L.*) that are water content, total chlorophyll, and dietary fiber due to the influence of planting media and coconut water nutrition. Broccoli microgreens are planted at the Green House of the Faculty of Agriculture, UPN "Veteran" East Java in November-December 2018. Analysis of water content using drying method (thermogravimetry), chlorophyll analysis using spectrophotometry method, and analysis of fiber content with Enzymatic-Gravimetric method. The data were analyzed using Completely Randomized Design (CRD) with the post hoc test LSD 5% and HSD 5% and correlation regression between parameters. The results of the study showed an increase in the quality of parameters and there was a close correlation between parameters. Correlation value of water content and total chlorophyll (r = 0.81) with a regression equation y = 1.907 x - 143.2, water content and fiber content (r = 0.84) with regression equation y = 2.628 x - 235.3 and total chlorophyll and fiber content (r = 0.88) with the regression equation y = 1.178 x - 32.05.

Keywords: Quality, Microgreen, Broccoli, Brassica oleracea L., Correlation

1. Introduction

Broccoli (*Brassica oleracea L.*) is one type of vegetable plant that belonging to the cabbage family (*Brassicaceae*). Broccoli is often referred to as "Super Vegetable" because it has a high nutrient content which contains folate, vitamin C, vitamin K, iron, potassium, and antioxidant compounds such as sulforafan, beta-carotene, indole, quercetin, and glutathione [1].

Micro greens are vegetables that harvested at a very early age, harvesting is done when cotyledon leaves and a pair of new leaves appear. Micro greens are different from sprouts because micro greens are harvested at 7-14 days, while sprouts are harvested at 3-10 days [2, 3].

The quality of micro greens needs further study. The quality of micro greens cannot be separated from the intake of nutrients that absorbed and the growing media. Media for planting like rockwool, cocopeat, paper straw, and hydroton are suitable for growing micro greens because they have nutrition that provides enough growth and good quality for micro greens products.
The quality of micro greens can be indicated by the presence of water content, total chlorophyll, and fiber content. Micro greens must be organic. Addition of coconut water can be used as an alternative because it contains various minerals including K, Ca, Na, Mg, Fe, Cu, S, sugar and protein and natural hormones, which are auxin and cytokine [4]. The hormones auxin and cytokine act as supporters of cell division.

This study aims to determine the quality of micro greens due to differences in planting media and the provision of coconut water and regression correlation between parameters.

2. Methods
The study was conducted in November 2018 until December 2018 in the Greenhouse of the Faculty of Agriculture, UPN "Veteran" East Java.

The experiment was arranged according to the Factorial Completely Randomized with the post hoc test HSD 5% and LSD 5% and correlation regression between parameters where Factor I: The planting media consisted of 4 levels (M1: Rockwool, M2: Cocopeat, M3 : Merang Paper, M4: Hydroton. Factor II: Nutrition consists of 2 levels (S1: Plain water, S2: Coconut water concentration of 100%). Analysis of water content using drying method (thermogravimetric), chlorophyll analysis using spectrophotometric methods, and food fiber analysis with Enzymatic - Gravimetric method.

Planting broccoli micro greens is done in a plastic tub the size of 17x13x4 cm. The seeds that needed for each plastic tub are 50 seeds, and watered according to the treatment with a volume of 100 ml/tub. Harvesting criteria for broccoli micro greens that have grown the first cotyledon leaves and true leaves, which have 2 cm width and 10 cm length.

3. Results
Qualitative analysis of broccoli micro greens includes water content, total chlorophyll leaf micro greens, and dietary fiber content. Data from the qualitative analysis of broccoli plant micro greens were then analyzed statistically by variance analysis (ANOVA) with the post hoc test HSD 5% and LSD 5%. The results of the qualitative analysis showed that various planting media and coconut water giving different effects on the results of qualitative analysis of broccoli micro greens.

3.1. Water Content of Micro greens (%)
The results of ANOVA shows there is no significance between planting media and the giving of coconut water on the percentage of water content of micro greens. Factors of planting media and giving coconut water showed very significant results. The effect of planting media and the provision of coconut water each on the percentage of water content of micro greens of broccoli plants can be seen in Table 1.

| Treatment                  | Water Content (%) |
|----------------------------|-------------------|
| Growing Media Rockwool    | 90,34 c           |
| Growing Media Cocopeat    | 90,49 d           |
| Growing Media Merang Paper| 90,18 b           |
| Growing Media Hidroton    | 90,08 a           |
| LSD5%                     | 0,07              |
| Water                     | 90,14 a           |
| Coconut water             | 90,41 b           |
| LSD 5%                    | 0,09              |

a, b, c, d Significantly Different at LSD 5% Test
Planting media and giving of coconut water showed a very significant effect on the moisture content of broccoli plant micro greens. Planting media that showed the highest water content of micro greens were cocopeat planting media (M2), while the highest treatment of give coconut water (S2). Cocopeat planting media has the ability to bind water because it has the nature of crumbs so that air, water, and roots easily enter the planting media and can bind water. Cocopeat essential nutrient content such as calcium (Ca), magnesium (Mg), potassium (K), sodium (N), and phosphorus (P) [5]. Cocopeat is one of the growing media that results from the destruction of coconut fiber, the process of destruction of coir produced by fiber or fiber which is able to bind and store water so that nutrients in coconut water can be transported [6].

The highest water content of broccoli micro greens is 90.58% and the lowest is 89.91%. Vegetables generally have high water content, which is around 70-95%, but low in fat and protein levels [7]. Water content is the amount of water contained in the material expressed in percent. Water content is also one of the most important characteristics of food, because water can affect appearance, texture, and taste in food. Water content in food ingredients also determines the freshness and durability of the food, high water content results in easy bacteria, molds, and yeast to multiply, so that changes will occur in food ingredients [8].

3.2. Total Chlorophyll in the Leaves of Micro greens (mg/kg)

The results of ANOVA showed significance between planting media and giving of coconut water on total chlorophyll in the leaves of micro greens (Table 2). Table 2 shows that provision of coconut water can increase the total chlorophyll of leaf micro greens in broccoli plants on all planting media.

Giving coconut water gives a positive response to chlorophyll in the total leaf of broccoli plant micro greens on various planting media tested. Cocopeat planting media gave the best response, followed by rockwool, hydroton, and merang paper growing media. Giving of water gives the same response to the total chlorophyll of leaves of broccoli plant micro greens on merang paper and hydroton growing media.

| Treatment                  | Total Chlorophyll in the Leaves of Broccoli Micro greens (mg/kg) |
|----------------------------|---------------------------------------------------------------|
|                            | Water            | Coconut Water       |
| Growing Media Rockwool     | 28.56 b          | 29.54 d, e          |
| Growing Media Cocopeat     | 28.63 b, c       | 29.61 e             |
| Growing Media Merang Paper | 28.24 a          | 28.80 c             |
| Growing Media Hidroton     | 28.38 a          | 29.41 d             |
| HSD 5%                     | 0.17             |

Table 2. Total chlorophyll in the leaves broccoli micro greens (Brassica oleracea L.) In treatment of planting and giving coconut water

Cocopeat planting media is responsive to the supply of coconut water and the effect of total chlorophyll on the leaves of broccoli micro greens. This is because the cocopeat planting media and the provision of coconut water contain essential nutrients that play a role in the formation of cells and chlorophyll. Nutrients of Mg and N are found in coconut water solution. The chlorophyll content consists of nutrients Mg and N, which one Mg atom binds four atoms [9]. There are 3 main functions of chlorophyll in photosynthesis to utilize solar energy, second triggers fixation of CO2 into carbohydrates and the third provides an energetic basis for the ecosystem as a whole [10].

The elements Mg and N are constituents of chlorophyll for photosynthesis [11, 12]. Adequate chlorophyll in the leaves can cause leaves to be able to absorb sunlight so photosynthesis takes place which then produces the energy needed by cells to carry out cell division and enlargement activities found in leaves. The results showed that watering coconut water can meet the nutrient needs of broccoli micro greens, so that it can support the metabolic process and provide a good influence on plant growth and development as well as in the process of photosynthesis.
Chlorophyll is formed from the condensation of succinyl CoA along with the amino acid glycine into a compound, after going through several reaction stages in the presence of phytol and chlorophyllase enzymes converted into chlorophyll [13]. Elements of iron (Fe) and other minerals are essential for the formation of chlorophyll in living cells, but magnesium (Mg) is the only metal element which is a component of chlorophyll [14]. Chlorophyll can experience decomposition both as long as it is in plant cells (the operation of the chlorophyllase enzyme) and when it has been dissolved (after the addition of HCL acid), this occurs because of the release of Mg atomic compound bonds at its center [15].

3.3. Fiber on Micro greens (%)
The results of the analysis of the variety of factors of planting media and the provision of coconut water showed a very significant effect on the levels of fiber on micro greens. Table 3 shows that the provision of coconut water provides a positive response to the levels of fiber on micro greens in various planting media tested. Cocopeat planting media gave the best response, followed by rockwool, hydroton, and merang paper growing media. Giving coconut water gives the same response to the levels of food fiber micro greens of broccoli plants in rockwool and hydroton growing media.

| Treatment                 | Fiber of Broccoli Micro greens (%) | Water | Coconut Water |
|---------------------------|-----------------------------------|-------|---------------|
| Growing Media Rockwool   | 1.53 b                            | 2.38  |
| Growing Media Cocopeat   | 1.81 c                            | 3.42  |
| Growing Media Merang Paper | 1.03 a                         | 2.08  |
| Growing Media Hidroton   | 1.43 b                            | 2.23 d,e |

HSD 5%

0.16

a, b, c, d, e, f Not Significance

The interaction between cocopeat growing media and the giving of coconut water supports the high levels of fiber. The highest yield of fiber content of broccoli micro greens in cocopeat and coconut water planting media (M2S2) was 3.42%. The results of this study are greater than the levels of broccoli vegetable fiber in general. Broccoli vegetables contain 2.4% of dietary fiber or broccoli containing 2.4 g of food fiber every 100 g [16]. The level of fiber in broccoli plant micro greens is related to the resulting photosynthesis in the form of carbohydrates. High photosynthesis results in increased fiber content produced by micrograms of broccoli plants.

Food fiber is an edible part of plants or analogous carbohydrate which is resistant to digestion and absorption in the small intestine with complete or partial fermentation of the large intestine [17]. Dietary fiber (DF) contains sugars and sugar acids as the main building materials and functional groups that can bind and bond or form DF and provide color and flavor [18].

3.4. Inter-parameter correlation
The results of the correlation analysis (Table 4) show a positive correlation on the parameters of observing water content, total chlorophyll, and fiber content. The source of decision making in correlation analysis can use the r table value as a comparison for the calculated r value or correlation coefficient value. Comparing the value of r count with the value of r table if the value of r count > r table then there is a correlation between the variables that are connected, if the value of r count < r table then there is no correlation between the variables connected. Comparing the significance value (sig.) with a value of α 0.05 [19]. Correlation analysis between several characters showed a significant correlation of 5% (Table 4.10). Significant correlation between parameters is shown in the character of water content with total chlorophyll (0.81), water content with food fiber content (0.84), water content with sulforaphane (0.91), total chlorophyll with food fiber content (0.88).
Table 4. Correlation Value between Observation Parameters Water Content, Total Chlorophyll, and Food Fiber Levels

| Correlation        | Water Content | Chlorophyll Total | Fiber  |
|--------------------|---------------|-------------------|--------|
| Water Content      | 1.00          |                   |        |
| Chlorophyll Total  | 0.81*         | 1.00              |        |
| Dietary Fiber      | 0.84*         | 0.88*             | 1.00   |

* Significantly Different at 5% test

The results of the correlation between parameters (Table 4.) show that the percentage of moisture content has a significant positive correlation with total chlorophyll and fiber content. Total chlorophyll has a positive correlation with dietary fiber levels. This indicates that the higher the water content, the higher the total chlorophyll and fiber content. Increased the total chlorophyll can increase the fiber levels. Photosynthesis is a process of preparing carbohydrate substances with light as its energy, these organic substances arranged in photosynthesis are carbohydrates (Cn(H2O)n) derived from molecules of CO2 and H2O [20]. The high water content supports the process of photosynthesis. The higher the water content, the greater the photosynthetic results that can be used to support the growth of cell activity so that growth can be maximized.

High levels of chlorophyll support high levels of fiber. Chlorophyll functions as a light catcher as the source of energy for the photosynthesis process that can support the metabolic process. It can provide a good influence on plant growth and development as well as in the process of photosynthesis. Adequate chlorophyll in leaves can cause leaves to be able to absorb sunlight so photosynthesis can occur which then produces the energy needed by cells to carry out cell division and enlargement activities found in leaves [21].

4. Conclusion

- Micro greens quality can showed in the water content, total chlorophyll content and fiber content
- The quality of broccoli micro greens can be improved by adding coconut water on all planting media.
- The best micro green quality is that growth on cocopeat media with provision of coconut water
- There is a positive correlation between water content and total chlorophyll (r = 0.81) with a regression equation y = 1.907 x - 143.2, water content and fiber content (r = 0.84) with regression equation y = 2.628 x - 235.3 and total chlorophyll and fiber content (r = 0.88) with the regression equation y = 1.178 x - 32.05.

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