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Abstract. Chloride (Cl_2^-) plays an essential role in the photosynthesis process. Electric shock to the ground is intended to maximize the local potential of the soil through electrical stimulation so that all local potentials such as organic matter, microorganisms, and nutrients absorbed in soil colloids can be optimized. This study aimed to find out the effect of electric shock on the media and Cl_2^- treatment on the nutritional and bioactive content of lettuce. The research was conducted at the greenhouse, consisting of 2 factors analyzed using Factorial Random Block Design. The first factor was the electric shock interval consisting of four levels (0, 3, 5, and 7 days interval application). The second factor was the concentration level of $CaCl_2$ consisting of three levels (0%, 1%, and 2%). All the treatment combinations were replicated three times, and each treatment consisted of 3 samples. The observed variables included leaf water content, vitamin C content, crude fiber (%) and ash content (%), total soluble solids (°brix). The results showed that total soluble solids are not affected by electric shock and spraying of $CaCl_2$. Electrical shock of 5 days interval and the application of 1% of $CaCl_2$ (I_2C_1) can increase the vitamin C content. Electric shock of 5 days interval and the application of 2% $CaCl_2$ fertilizer (I_2C_2) can increase the leaf water content. Electric shock of 7 days interval with the combination of 2% $CaCl_2$ (I_3C_2) was able to increase the ash content and crude fiber of lettuce.

1. Introduction

Lettuce (*Lactuca sativa* L.) has a high economic value after cabbage, cauliflower, and broccoli. The nutritional content in lettuce is fiber, calcium, vitamin C, vitamin A and beta-carotene, which serves as an essential antioxidant [1]. It also contains phenol, carotenoids, tocopherol, and glucosinolate. Those are known to have a protective effect on cancer and cardiovascular problems [2, 3]. One of the factors that influence the quality of the lettuce is an element of chloride (Cl_2).

Calcium (Ca) is an essential macronutrient for plant growth, and it performs some functions within the plant cell according to its concentration and location. Ca is observed in the cell wall as a structural component, in the cytosol as a secondary messenger and the vacuole as a counterion [4-6]. Ca plays a role in photosynthesis, increased cell volume and division, cytoplasmic movements, cytoskeletal functions and plasma membrane stabilization [4].

Soil electric shock is meant to maximize local soil potential by way of balancing of positive and negative charges in the soil. It plays an essential function in the process of nutrients absorption in the soil. The electric shock ought to be carried out in wetlands. Through these techniques, It is predicted

that all the local soil potential such as organic materials, microorganisms, and nutrients are absorbed into the soil colloids can be optimized. It will provide an advantageous impact on crop production [7]. This study aimed to determine the extent of electrical shock to the media and giving Cl_2 effect on the content of nutrients and bioactive plant lettuce.

2. Materials and Methods

The study was conducted in the greenhouse of Agriculture Faculty, University of Islam Malang, East Java, Indonesia. The study consisted of two factors analyzed using a factorial randomized design group. The first factor is the interval electric shock (I) consisting of a control (media without being given electric shock), the media electric shock treatment (every 3, 5 and 7 days since the planting time). The second factor was the level of concentration of $CaCl_2$ (C) consists of 0%, 1%, and 2%. All the combination treatment was repeated three times, and each treatment contained 3 sample. The lettuces were planted in 5 kg polybags size. Electric shock treatment and $CaCl_2$ foliar application was began at 14^{th} days after planting and continued until the time of harvesting (50 days after planting).

The quality variables measured in this study were leaf water content (%), vitamin C (titration), crude fiber (%) using the method of extraction, ash content (%) and total dissolved solids (^{o}Brix). Leaf water content was observed using gravimetry methods [8]. The following steps conducted vitamin C analysis [9]: 5 g of fresh sample was added with distilled water in 50 ml flask. The mixture was homogenised and filtered using filter paper. The sample filtrate was added with 0.4 ml of a 1% soluble starch solution, titrated with 0.01 N iodine. The color change of the solution into blue tinge marked as the titration endpoint 1 ml of 0.01 N iodine is equal to 0.88 mg ascorbic acid. Total dissolved solids were measured by a refractometer (^{o}brix). Ash content and crude fiber were determined using AOAC method [8]. The crude fiber was measured by hydrolysing the samples using an acid solution continued by a base solution.

The data were analysed using ANOVA with a 5% significance level of 5%. The variables with significant impact will be analysed using Duncan Multiple at 5% level to see the difference among the treatments.

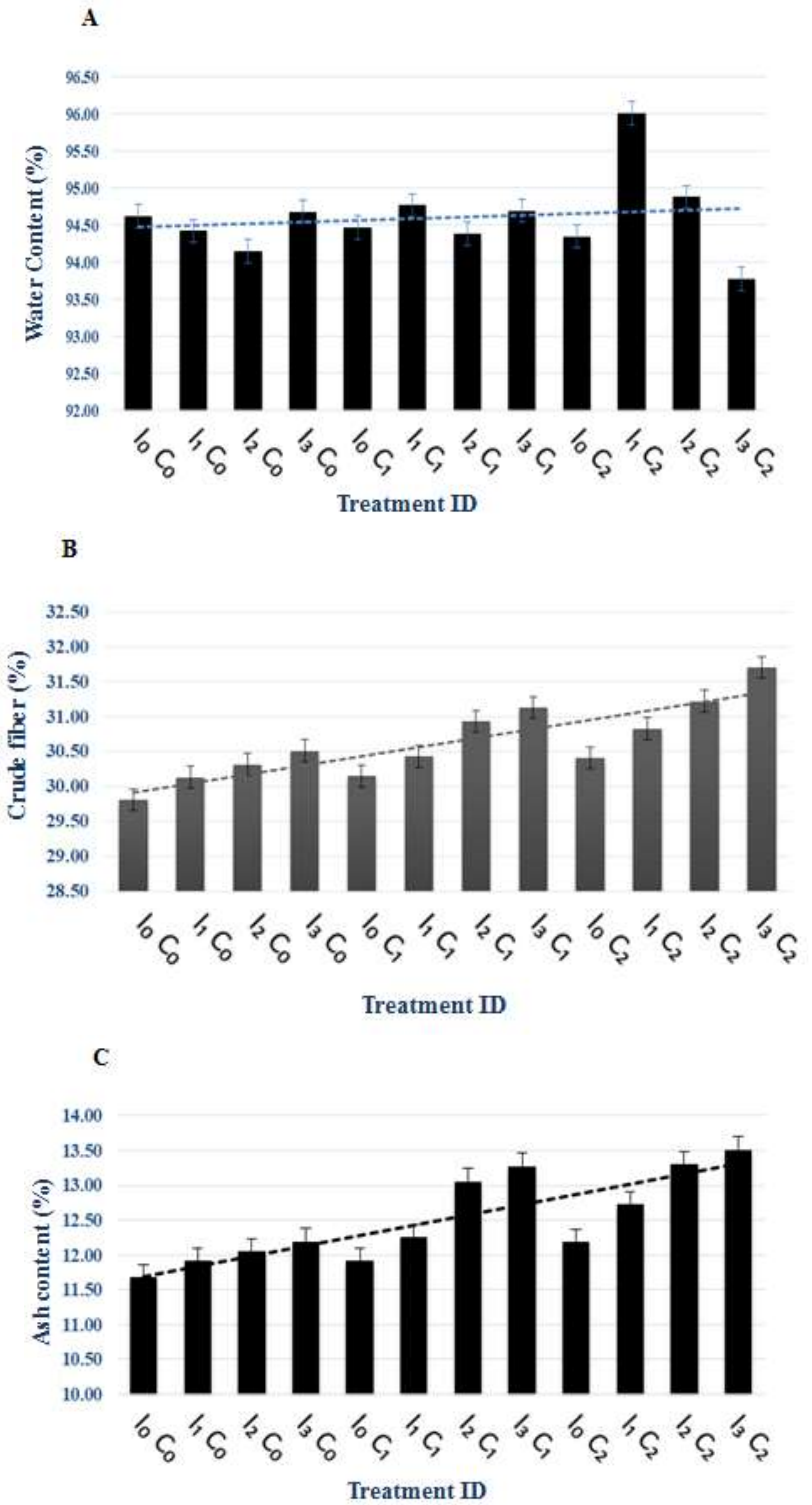
3. Results and Discussion

The results showed that there is a significant interaction between treatment spraying $CaCl_2$ and electric shock to the content of the leaves water content, crude fiber, ash and vitamin C. Total dissolved solids were not affected by electric shock and $CaCl_2$ foliar treatment.

Figure 1 shows that the electric shock treatment with intervals of 3 days and the application of Cl_2^- 2% (I_1C_2) produces leaves with the highest water content. Lettuce plants that are electrically shocked at seven days intervals and Cl_2^- 2% (I_1C_2) has a high fiber and high ash. It shows that the higher the concentration of calcium given to plant lettuce, the more the bond between the calcium with pectin compounds that occur so that the rate of infiltration of oxygen would be inhibited. Therefore, I_1C_2 is the best treatment to maintain water levels in lettuce leaves.

The higher transpiration from the leaves or fruit causes on leaves, or fruit freshness will decrease. The presence of calcium in the leaves or fruit flesh can inhibit respiration and transpiration because the bond between the calcium with pectin compounds present in the cell wall. The higher levels of calcium in the leaves or fruit flesh, the closer the bond is formed. This condition will decrease the rate of oxygen uptake and CO_2 release. Low oxygen will decrease the rate of respiration and transpiration so that it can reduce the water loss of the leaves.

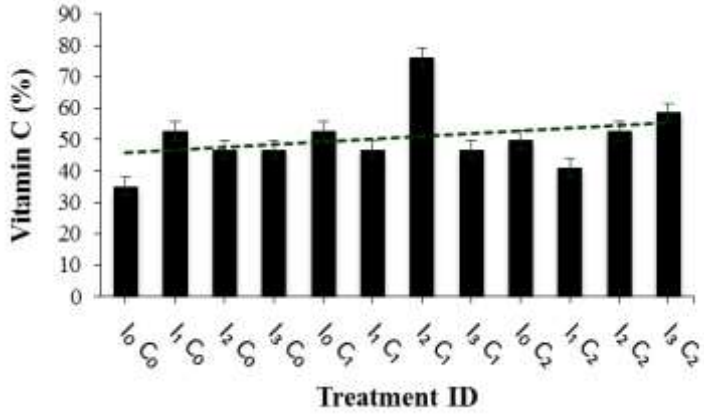
The ash content indicates the total mineral of plants. Electric shocks every 7 days with the addition of $CaCl_2$ 2% (I_3C_2) can increase levels of ash and crude fiber of leaves lettuce. The ash content correlated with the crude fiber content. The higher $CaCl_2$ given, the higher ash and crude fiber on a lettuce leaf. It means that there were more minerals contained in the plants. The ash content related to the efficiency of water used in the passive transport of minerals, accumulation during growth, and transpiration network. The higher the rate of transpiration, the higher the level of mineral transport so that the ash content of plants will increase [10].



Note: Media without being given electric shock (I_0), the media electric shock treatment every three (I_1), five (I_2) and seven (I_3) days since the planting time.
Concentration of $CaCl_2$ (C) consists of 0% (C_0), 1% (C_1), and 2% (C_2).

Figure 1. Effect of Electric Shock (I) and Foliar Spray of Cl_2^-(C) on water content (A), crude fiber (B) and ash (C).

The analysis of Vitamin C content in the lettuce, it is known that electric shock treatment of 5 days interval and 1 % $CaCl_2$ foliar application were able to increase the content of vitamin C (Figure 2). It was significantly different from the other treatments. The electric shock of five days interval can improve the soil mobility so that the nutrient element becomes more available to plants. According to [11] the availability of $CaCl_2$ can form crosslinks between Ca^{2+} with pectic acid and polysaccharides other thereby limiting the activity of enzymes such as polygalacturonase softening and respiration. It can decrease the rate of respiration and minimize degradation of ascorbic acid. Calcium helps to maintain the firmness of the fruit, increasing the content of vitamin C, as well as preventing decay and browning in apples [12].



Note: Media without being given electric shock (I_0), the media electric shock treatment every three (I_1), five (I_2) and seven (I_3) days since the planting time.
Concentration of $CaCl_2$ (C) consists of 0% (C_0), 1% (C_1), and 2% (C_2).

Figure 2. Effect of electric shock (I) and foliar spray of Cl_2^- (C) on vitamin C.

Application of $CaCl_2$ on lettuce leaves will increase the calcium content that can change the pectin that serves as microfibril cellulose cell walls into Ca-pectic through esterification reaction. Calcium (Ca^{2+}) has been extensively reviewed as both an essential element and its potential role in maintaining the postharvest quality of fruit and vegetable crops. Pre- and postharvest application of calcium may delay senescence in fruits with no detrimental effect on consumer acceptance [1]. Application of calcium chloride improved characteristics like Fruit Firmness, Peroxidase activity and ascorbic acid content (Vitamin C). The post-harvest calcium chloride treatment prevented weight losses percentages and fruit decay percentage during cold storage at 1°C for 60 days.

Components of solids and liquids in the soil consists of cation (+) and anion (-) elements and compounds, which at the time of electricity flow from point + to the point - through a liquid medium, will emerge the magnetic field that affects the mobility of ions/colloids as nutrient source for plant growth [13]. Thus, the electric shock in the media will provide the availability of plant nutrients more efficiently.

4. Conclusion

The combination of electric shock and $CaCl_2$ on vitamin C content, leaf water content, crude fiber content and ash gave significant influences. Total soluble solids are not affected by electric shock and spraying of $CaCl_2$. Electrical shock of 5 days interval and the application of 1% of $CaCl_2$ (I_2C_1) can increase the vitamin C content. Electric shock of 5 days interval and the application of 2% of $CaCl_2$ (I_2C_2) can increase the leaf water level. Electric shock of 7 days interval with the combination of 2% $CaCl_2$ (I_3C_2) was able to increase the ash content and crude fiber of lettuce.

References

[1] Lester G E, Grusak M A 2004 Field application of chelated calcium: postharvest effects on cantaloupe and honeydew fruit quality *Hort. Technol.* **14** 29-38.
[2] Nicolle C, Cardinault, Gueux N, Jaffrelo E, Rock L, Mazur E, Amouroux A, Rémésy P C 2004 Health effect of vegetable-based diet: lettuce consumption improves cholesterol metabolism and antioxidant status in the rat *Clin. Nutr.* **23** 4 605-614.
[3] Llorach R, Martínez-Sánchez, Tomás-Barberán A, Gil F A, Ferreres F 2008 Characterisation of polyphenols and antioxidant properties of five lettuce varieties and escarole *Food Chem.* **108** 3 1028-1038.
[4] Hepler P K 2005 Calcium: a central regulator of plant growth and development *Plant Cell* **17** 8 2142-2155.
[5] Hepler P K, Winship L J 2010 Calcium at the cell wall-cytoplast interface *J. Integ. Plant Biol.* **52** 2 147-160.
[6] White P J, Broadley M R 2005 Biofortifying crops with essential mineral elements *Trends in plant science* **10** 12 586-593.
[7] Sugiarto, Sulistiono R, Sudiarso, Soekarno 2013 Local potential intensification system (SIPLO) the sustainable management of soil organic potatoes *Int. J. Eng. Sci.* **2** 9 51-57.
[8] AOAC 1999 Official Method of Analysis. AOAC Washington DC USA.
[9] Suntornsuk L, Gritsanapun, Nilkamhank W, Paochom A 2002 Quantitation of vitamin C content in herbal juice using direct titration *J. Pharm. Biomed. Anal.* **28** 5 849-855.
[10] Glenn D M, Bassett C 2011 Apple $\Delta 1_3$C discrimination is related to shoot ash content *Hort. Sci.* **46** 2 213-216.
[11] Kovácas E 2004 Postharvest treatment of fruits In: Production Practices and Quality Assessment of Food Crops 173-212 Springer Dordrecht Germany.
[12] Kazemi M, Aran M, Zamani S 2011 Effect of calcium chloride and salicylic acid treatments on quality characteristics of kiwifruit (*Actinidia deliciosa* cv. Hayward) during storage *Am. J. Plant Physiol.* **6** 3 183-189.
[13] Syehfani 2014 Electrical Conductivity (EC). http://syekhfanismd .lecture. ub.ac.id /2014/03/konduktivitas-listrik-ec/. Access on June 17th 2018.