



Growth of Red Spinach (*Amaranthus tricolor L.*) Hydroponically using POC Tomatoes and Moringa Leaves

Sepbrie Mulia Bingah Pranata ^{1*}, Suparti ¹

- ¹ Department of Biology Education, Universitas Muhammadiyah Surakarta Jl. A. Yani Tromol Pos I, Pabelan, Kartasura, Surakarta, Central Java, Indonesia, 57162
* Correspondence: sepbriemulia@gmail.com

Abstract

Background: Red spinach (*Amaranthus tricolor L.*), one of the plants, contains several important elements with high nutritional value, is liked by the community, and is easy to cultivate with hydroponics. To determine the growth of red spinach, namely by giving POC as a nutrient needed by plants. This study aimed to find out how red spinach plants grow in POC of a mixture of tomato extract and moringa leaf extract with the addition of coconut water hydroponically and at what concentration the most effective POC. This research was conducted at the Biology Green House FKIP UMS. **Methods:** This study used an experimental method with a completely randomized design (CRD) with two factors, namely factor 1, the type of POC extract mixture, and factor 2, the difference in the volume of POC so that from both factors six treatments were obtained with three replications for each treatment. **Results:** Data analysis using Two Way ANOVA showed that the results of the C2V2 treatment had a plant height of 2.13 cm, root length of 1.96 cm, and the highest number of leaves with four strands. The C1V3 treatment produced the lowest plant height, namely 1.07 cm, and the C2V3 treatment produced the lowest root length, namely 0.73 cm, and the C1V1, C1V3, C2V1, C2V3 treatments showed the lowest number of leaves, only two leaves. **Conclusions:** The POC of tomatoes and Moringa leaves which were given the same treatment, showed that the POC of Moringa leaves were effectively used as red spinach growth nutrients.

Keywords: Growth, POC, Red Spinach, Treatment Volume

Introduction

Red spinach (*Amaranthus tricolor L.*) is a vegetable plant that belongs to the Amaranthaceae family. Salt, minerals, protein, vitamins A and C, fat, carbohydrates, iron, and phosphoenol antioxidants are some of the red spinach's main ingredients, rich in nutritional stimulating nutrients. Two species are generally cultivated: *Amaranthus tricolor* and *Amaranthus hybridus*, but red amaranth species grow wild. Compared to green spinach, red spinach is less popular even though it has nutrition and benefits. Red spinach contains anthocyanin pigments with a total dissolved solids of 5.8 degrees Brix and 18.94 mg/ml of anthocyanin content. This anthocyanin pigment is a purplish red pigment that marks red in red spinach and acts as an antioxidant.

More advanced technology will make it easier for people to find various information, and the benefits of red spinach can open up promising business opportunities. But so far, the production of red spinach is still relatively low and unstable. Red spinach production in Indonesia still varies. According to data compiled by BPS (Central Statistics Agency), in 2016, 160 thousand tons, then decreased to 148 thousand tons in 2017 and increased again in 2018 to 162 thousand tons, then decreased again in 2019 and 2020 to 157 thousand tonnes, and experiencing a slight increase to 171 thousand tonnes in 2021. Based on the red spinach production data obtained, it can be concluded that red spinach production still requires efforts to increase the crop. Communities can increase their access to healthier and



Article history

Received: 31 May 2023
Accepted: 01 Aug 2023
Published: 31 Aug 2023

Publisher's Note:

BIOEDUSCIENCE stays neutral with regard to jurisdictional claims in published maps and institutional affiliations.

Citation: Pranata, S.M.B. & Suparti. 2023. Growth of Red Spinach (*Amaranthus tricolor L.*) Hydroponically using POC Tomatoes and Moringa Leaves. *BIOEDUSCIENCE*, 7(2), 200-208. doi: [10.22236/jbes/11688](https://doi.org/10.22236/jbes/11688)



©2023 by authors. Licence Bioeduscience, UHAMKA, Jakarta. This article is open-access distributed under the terms and conditions of the Creative Commons Attribution (CC-BY) license.

cleaner food by growing vegetables using a hydroponic system. The demand for clean, chemical-free vegetables and hydroponics can improve Indonesia's agricultural prospects. When planting red spinach, the planting environment must be considered. Rock wool is a different planting medium from soil because it can support plant growth, has pores for aeration, does not clog hydroponic equipment, and does not affect nutrition.

Specific plant substances, including growth regulators, are needed based on the plants' needs. POC tomato extract, moringa leaf extract, and coconut water are added as phytonutrients. Tomato extract is a natural ingredient that contains nutrients that plants in tissue culture can use and also contains Nitrogen (N) = 0.04%, Phosphate (P) = 0.01%, Potassium (K) = 0.07%, and regulatory substances. Growing on tomato extract affects plants' chlorophyll formation (Nadeak et al., 2020). Moringa leaves are one of the plants widely found in Indonesia, commonly known as plants that are beneficial from all parts of the plant. Nutrients and various active substances contained in moringa can be utilized for the benefit of plants. Moringa leaves contain cytokinin, a plant hormone that induces cell division and growth, promotes new cell growth, and slows cell aging. Zeatin is a powerful antioxidant with anti-aging properties (Sari & Purba, 2019). Moringa leaves also contain chemical compounds such as calcium 603.77 mg/100 g Moringa leaves, magnesium 2.68 mg/100 g Moringa leaves, phosphorus 12.84 mg/100 g Moringa leaves, iron 20.49 mg/100 g Moringa leaves, sulfur 23.45 mg/100 g moringa leaves (Bandang et al., 2021).

Applying POC from tomato extract and moringa leaf extract with the addition of coconut water in the growth of red spinach is done in several ways. This POC is a nutritional substitute for environmentally friendly growth regulators, and the price is relatively low. Coconut water is added as an additional nutrient because it contains minerals such as sodium (Na), calcium (Ca), magnesium (Mg), phosphorus (P), ferum (Fe), sulfur (S), and cuprum (Cu). (Sari et al., 2021). Based on the background above, it is important to conduct research experiments to find out how red spinach plants grow in a mixture of tomato extract and Moringa leaf extract with the addition of coconut water hydroponically and at what concentration the mixture of tomato extract and Moringa leaf extract with the addition of coconut water is the most effective.

Method

The research was conducted at the Biology Green House FKIP UMS, and this research started from March to May 2023, from preparation, sowing, and planting seeds, making hydroponics, to concluding. The tools used in this study were blenders, filters, tablespoons, knives, funnels, pans, measuring cups, 20x2 cm flannel cloth, 600 ml drinking bottles, 1.5 L used bottles, 15 L used gallons, hoses, scissors, cutter, Rockwool 2.5 x 2.5 cm, toothpick, used dark cloth or black plastic, tray, net pot, Styrofoam, box, pH stick, ruler, stationery, documentation tool. The materials needed in this study were tomatoes, moringa leaves, coconut water, red spinach seeds, water, palm sugar, EM4, and label paper. This research is quantitative research with experimental methods. The experimental design to be used in this study was a completely randomized design (CRD) with two factors: factor 1 in the form of the type of extract used and factor 2 in the form of the difference in volume given to red spinach. There were six treatments with three replications, so 18 trials were obtained. The provision of POC consists of 6 treatments with three replications so that 18 trials were obtained. The provision of POC consists of 6 treatments with three replications so that 18 trials were obtained. The provision of POC consists of:

- C1V1 (150ml volume of Tomato Extract and Coconut Water Mixture)
- C1V2 (200 ml volume of Tomato Extract and Coconut Water Mixture)
- C1V3 (250 ml volume of Tomato Extract and Coconut Water Mixture)
- C2V1 (150 ml volume of Moringa Leaf Extract and Coconut Water Mixture)
- C2V2 (200 ml volume of Moringa Leaf Extract and Coconut Water Mixture)
- C2V3 (250 ml volume of Moringa Leaf Extract and Coconut Water Mixture).

The way of working in this research is to manufacture hydroponic growing media, plant nurseries, planting, making POC, and giving POC according to experimental treatments,

observations, and calculations. The nursery was done from seeds placed on rock wool placed in trays and watered. After the nursery is ready, cover it with a dark cloth and transfer the seedlings to the hydroponic growing medium if it produces 2-4 true leaves. Preparation of POC was carried out based on giving the POC volume of the two extracts tested when the red spinach plants had finished moving into the hydroponic media container. Observations were made once a week for three weeks; after completion, calculations were carried out by finding the average for each week.

Data analysis used a parametric test, namely the Two-way ANOVA test, to test the hypothesis. The Two-way ANOVA test was used to determine the difference in sample means using two factors in a completely randomized design (CRD) using the SPSS 20.0 application. The parameters observed in this study were red spinach plant height, red spinach root length, and the number of red spinach leaves. Plant height can be measured from the time the plant is moved from the seeding growing media into the hydroponic circuit with the help of a ruler measuring tool from the surface of the rock wool to the base of the highest leaf vein on each plant (Abdullah & Andres, 2021). Observation of root length can be measured using a measuring ruler or by disassembling sample plants. Then measurements are taken every time from the base of the stem to the tip of the longest root. Root length was observed after the plants finished the planting period in hydroponic media (Rahmawati et al., 2018). Observation of the number of leaves began after the plants were two weeks after planting. The number of leaves was observed at intervals once a week by counting all the leaves that had fully opened (Pohan & Oktojournal, 2019).

Result

This study aims to find out how red spinach plants grow in a mixture of tomato extract and Moringa leaf extract with the addition of coconut water hydroponically and at what concentration the most effective mixture of tomato extract and Moringa leaf extract with coconut water. Based on the results of research carried out in the utilization of tomato extract and moringa leaf extract with the addition of coconut water on the growth of red spinach, different averages were obtained for the parameters of plant height, root length, and number of leaves.

Table 1. Average growth of red spinach given tomato extract and moringa leaves with the addition of coconut water for three weeks

Treatment	Red Spinach growth average		
	Plant Height (cm)	Root Length(cm)	Number of Leaves (strands)
C1V1	1.86	1.37	2.00
C1V2	1.43	1.86	3.00
C1V3	1.07*	1.26	2.00*
C2V1	1.20	1.00	2.00
C2V2	2.13**	1.96**	4.00**
C2V3	1.34	0.73*	2.00

Description: highest (**) and lowest (*)

Red Spinach Plant Height

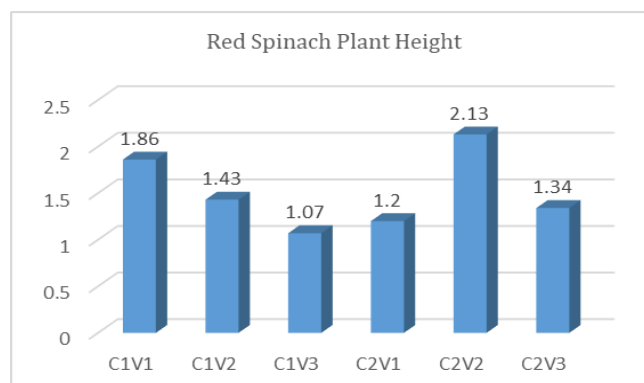


Figure 1. Diagram of the Mean Height of Red Spinach Plants

This study's plant height observations were carried out once a week for three weeks after the seeding and planting periods were over. Then the observed data is averaged every week. The results of measuring the height of red spinach plants obtained different results in each treatment. **Table 1** and **Figure 1** show that the average height of red spinach plants was obtained in C2V2 treatment (a mixture of Moringa leaf extract with the addition of 200 ml of coconut water) with an average plant height of 2.13 cm and the lowest average in C1V3 treatment (a mixture of tomato extract with the addition of 250 ml coconut water volume) with an average plant height of 1.07 cm.

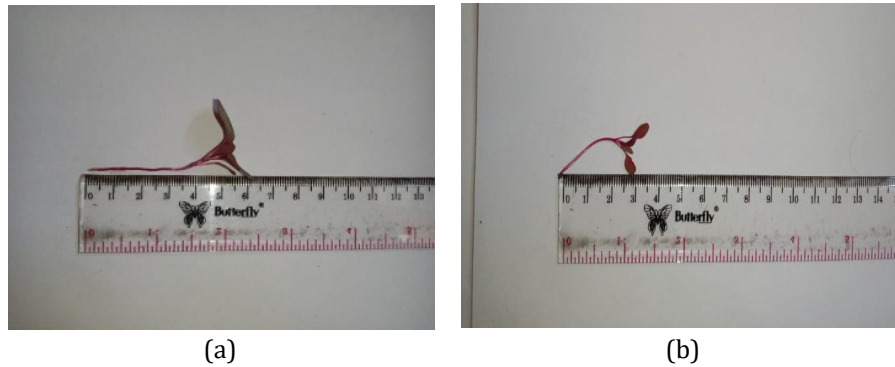


Figure 2. Differences in the height growth of red spinach plants

Description: (a) The best C2V2 treatment (a mixture of Moringa leaf extract and coconut water at a volume of 200 ml), (b) The worst C1V3 treatment (a mixture of tomato extract and coconut water at a volume of 250 ml).

Table 2. Two-way ANOVA analysis of plant height test results

Source of Variation	F-Count	Probability (Sig.)	Decision
POC type	1,381	0.284	Ho accepted
Treatment	0.836	0.478	Ho accepted

The calculation of the hypothesis test from the Two-way ANOVA test analysis obtained the value of Sig. > 0.05, then the decision H0 is accepted, which means there is no effect on the height of the red spinach plant.

Long Root of Red Spinach

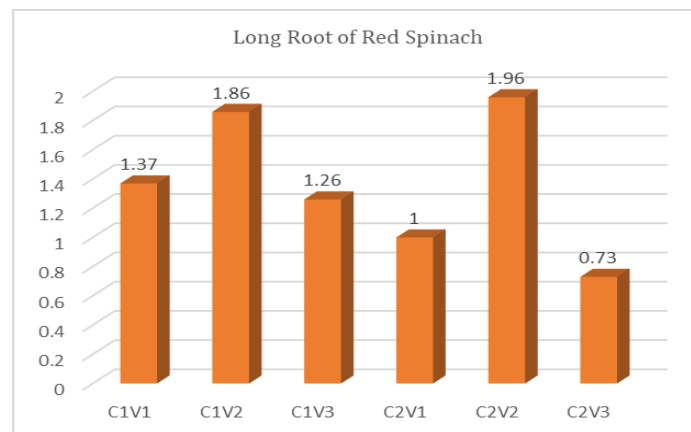


Figure 3. Diagram of the Mean Length of Red Spinach Roots

Observations on plant root length in this study were also carried out once a week for three weeks after the seeding and planting periods were over. Then the observed data is averaged every week. The results of measuring the root length of red spinach plants obtained different results for each treatment. Based on **Table 1** and **Figure 2** show that the average root length of red spinach plants obtained the highest average yield in C2V2 treatment (a mixture of Moringa leaf extract with the addition of 200 ml of coconut water)

with an average root length of 1.96 cm and the lowest average in C2V3 treatment (a mixture of Moringa leaf extract with the addition of 250 ml coconut water volume) which has an average root length of 0.73 cm.

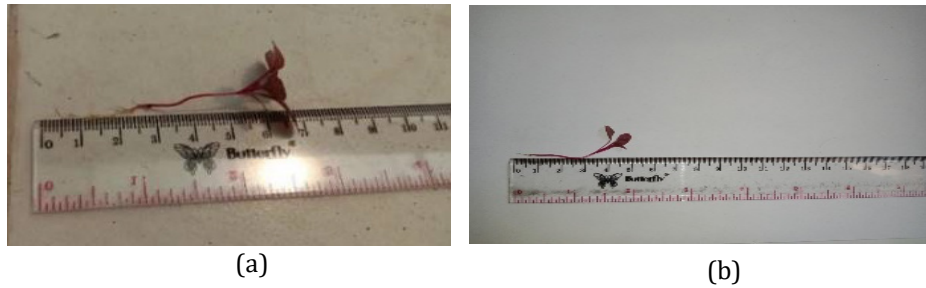


Figure 4. Differences in the growth of red spinach root length
 Description: (a) The best C2V2 treatment (a mixture of Moringa leaf extract and coconut water at a volume of 200 ml) (b) The worst C2V3 treatment (a mixture of moringa leaf extract and coconut water at a volume of 250 ml)

Table 3. Results of the Two-way ANOVA analysis of plant root length test

Source of Variation	F count	Probability (Sig.)	Decision
POC type	8061	0.030	Ho was rejected
Treatment	33,032	0.001	Ho was rejected

The calculation of the hypothesis test from the analysis of the Two-way ANOVA test obtained the probability value (Sig.) for the type of extract mixture; the treatment volume has a sig. Value < 0.05. Ho's decision was rejected, meaning that there was an effect of giving volume on the root length of red spinach.

Number of Red Spinach Leaves

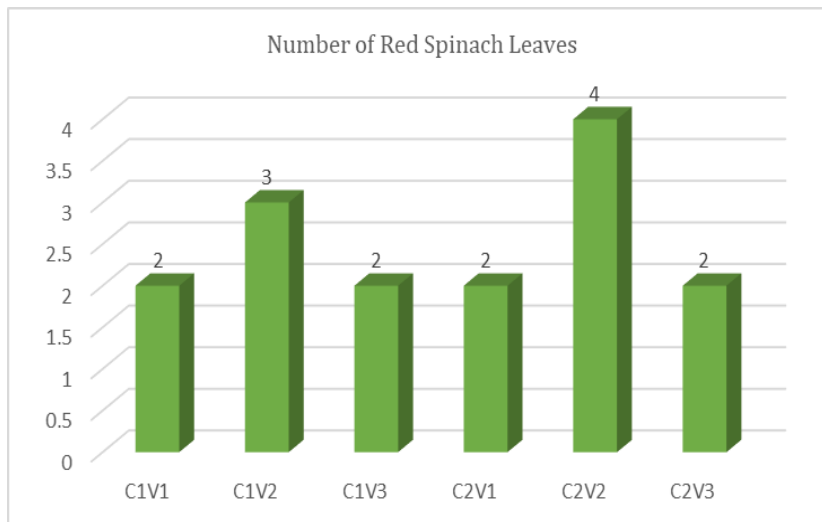


Figure 5. Diagram of the average number of red spinach leaves

Observations on the number of plant leaves in this study were also carried out once a week for three weeks after the seeding and planting periods were over. Then the observed data is averaged every week. The results of measuring the number of leaves of the red spinach plant obtained the same results for each treatment. Table 1 and Figure 3 show that the average number of leaves of the red spinach plant obtained the highest average results, namely in the C2V2 treatment (a mixture of moringa leaf extract with the addition of 200 ml of coconut water), which had an average number of leaves of 4 leaves and the lowest average in the four treatments with an average number of leaves two pieces.

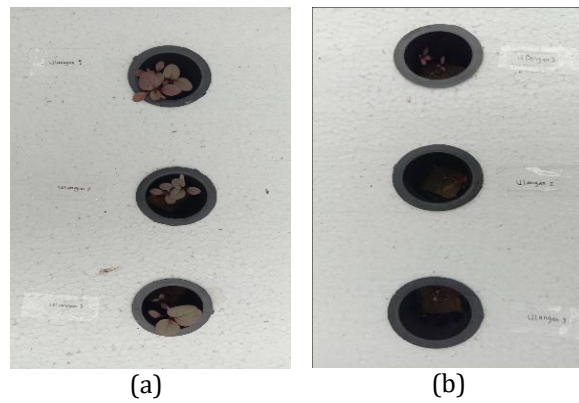


Figure 6. Differences in the growth of the number of red spinach leaves

Description: (a) The best C2V2 treatment (a mixture of Moringa leaf extract and coconut water at a volume of 200 ml), (b) The worst C1V1 treatment (a mixture of tomato extract and coconut water at a volume of 150 ml).

Table 4. Results of the Two-Way ANOVA analysis of the number of leaves test

Source of Variation	F count	Probability (Sig.)	Decision
POC type	0.667	0.445	Ho accepted
Treatment	0.667	0.548	Ho accepted

The calculation of the hypothesis test from the analysis of the two-way ANOVA test probability value (Sig.) In the type of extract mixture, the treatment volume has a sig. value < 0.05. Ho's decision was accepted, meaning there was no volume effect on the number of red spinach leaves.

Discussion

The table and figure above show that the average in the C2V2 treatment (a mixture of moringa leaf extract and coconut water at a volume of 200 ml) was the highest regarding plant height, root length, and number of red spinach leaves. The plant height showed that the average red spinach plant height obtained the highest average yield, namely in the C2V2 treatment (a mixture of moringa leaf extract with the addition of 200 ml of coconut water), which had an average plant height of 2.13 cm and the lowest average in the C1V3 treatment (a mixture of tomato extract with the addition of coconut water volume of 250 ml) which has an average plant height of 1.07 cm.

Based on the analysis of the Two-way ANOVA test results by calculating using the SPSS application, the Two-way ANOVA test is used to determine the difference in the sample averages using two factors and see which one is effective. From this test, it was obtained that the results of giving different treatment volumes obtained a Sig value of 0.478 so that H_0 was accepted, indicating that the results of statistical analysis had no significant effect on plant height, according to Figure 1. The difference in the average plant height shows different results, where the POC mixed with moringa leaf extract with added coconut water has a higher average plant height when compared to the POC mixed with tomato extract with the addition of coconut water so that the effective results for plant height are POC from Moringa leaf extract with the addition of coconut water (Azzahra et al., 2022). Moringa leaves used to make liquid organic fertilizer must be made from fresh Moringa leaves and processed correctly, such as extracting, because fresh moringa leaf extract can effectively increase plant growth and yield 25-30%. In addition, Moringa leaf extract contains more chemical compounds than tomatoes, such as natural cytokinin hormones that can stimulate plant growth. Cytokinins are plant hormones that induce cell division, and growth encourage new cell growth, and delay cell aging, and zeatin is a strong antioxidant with anti-aging properties (Sari & Purba, 2019). It also contains chemical compounds such as calcium 603.77 mg/100 g Moringa leaves, magnesium 2.68 mg/100 g Moringa leaves, phosphorus 12.84 mg/100 g Moringa leaves, iron 20.49 mg/100 g Moringa leaves, sulfur 23.45 mg/100 g leaves moringa

(Bandang et al., 2021). Meanwhile, tomato extract contains Nitrogen (N), = 0.04%, Phosphate (P) = 0.01 %, and Potassium (K) = 0.07% (Nadeak et al., 2020).

Giving too little POC also cannot meet nutritional needs until finished. However, giving too much POC to red spinach plants can also damage the plants and cause osmosis because the fertilizer is hypertonic. This is supported by research by Puspita et al. (2021) that the provision of nutrition must be effective and meet the needs. If too much nutrition is given, it can inhibit plant growth and can cause poisoning. However, if given in small amounts, it can inhibit the work of the roots in absorbing nutrients.

Based on the two-way ANOVA test analysis for root length, a value of Sig 0.001 was obtained so that H_0 was rejected, indicating that the statistical analysis results significantly affected root length. From Figure 2, the POC variety of Moringa leaf extract mixed with coconut water added to a volume of 200 ml has a higher average root length when compared to the POC variety mixed with Moringa leaf extract added to coconut water to a volume of 250 ml. This is supported by research by Kustiani & Ayuningtyas (2021), which stated that excess nitrogen given to plants would cause pressure on plants because red spinach plants are succulent and susceptible to pests and diseases. In addition, giving too much POC will weaken plant tissue, so plants are sensitive to pests and diseases.

Based on the research results, which stated that it had a significant effect on root length, it was supported by research by Shekarriz et al. (2014) that the addition of coconut water to the regeneration medium significantly or significantly increased root length because coconut water could promote the growth and development of shoots, root length, and plantlet weight. Coconut water added to the media can be a source of amino acids, organic acids, vitamins, a source of sugar, and also hormones, both auxins and cytokinins. The content of old coconut water is believed to increase the growth of all plants, including red spinach. Its nutritional content includes vitamin C, sodium, thymine, phosphorus, calcium, and riboflavin. Coconut water is also rich in minerals such as sodium (Na), calcium (Ca), magnesium (Mg), phosphorus (P), ferum (Fe), sulfur (S), and cuprum (Cu). Besides minerals, coconut water contains many vitamins, such as citric acid, nicotinic acid, folic acid, riboflavin, and thiamin.

Based on the two-way ANOVA test analysis results, the number of leaves from the test obtained a value of Sig 0.469 so that H_0 was accepted, indicating that the statistical analysis results had no significant effect on the number of leaves. From Figure 3, POC mixed with Moringa leaf extract added with coconut water with a volume of 200 ml has a higher average number of plant leaves when compared to POC mixed with Moringa leaf extract added with coconut water with a volume of 150 ml, 250 ml, and POC mixed with tomato extract added coconut water with a volume of 150 ml, 250 ml. So POC mixed with Moringa leaf extract is more effective than POC mixed with tomato extract. This is supported by research Ambarwati et al. (2021) that the administration of cytokinins contained in tomato extract was able to induce budding and increase the rate of plant multiplication, where cytokinins were involved in cell division activity, thus causing red spinach plants to experience growth although slightly slower when compared to red spinach treated with POC moringa leaves.

In addition, it is also supported by research by Kustiani & Ayuningtyas (2021) that the number of red spinach plant leaves varies due to the treatment of POC volume. The number of leaves formed is also influenced by the presence of nutrients or nutrients plants need. The nitrogen source contained in POC will support the growth of the number of leaves. Plants that get sufficient nitrogen elements, namely not too little or too much, will increase the absorption of sunlight, forming the process of photosynthesis. Leaf blades grow a lot and can be broad to determine a plant's growth speed, where the wider the leaf, the more growth will increase.

In previous studies, some used Moringa leaves as POC for plant nutrition, starting from vegetable and fruit plants, based on research Anzila & Asngad (2022), who used pakcoy mustard plants as experimental material using the hydroponic method had different volume sizes, namely from a volume of 150 ml, 200 ml, 250 ml by applying to plants every three days and once every six days according to the dosing interval. So, the results of this study indicate that the use of moringa leaf POC effectively increases the growth and productivity of mustard

greens grown hydroponically. The optimal administration dose treats 200 ml of POC with an interval of giving every six days. In addition, according to research by, [Agustin & Putra \(2020\)](#), they added various concentrations of different tomato extracts in their research, for example, 50 g/L, 100 g/L, 200 g/L, and 250 g/L. However, adding tomato extract with a low concentration has a special, stimulating effect on plants, allowing them to grow optimally. At the same time, adding high concentrations of tomato extract has an inhibitory effect. Therefore, a suitable and effective concentration is used at 200 g/L tomato extract.

Based on the picture of the difference between the best and the worst red spinach growth apart from the treatment given, using a starter kit hydroponic system with a wick system has advantages and disadvantages. The advantage of this hydroponic wick system is that because the plants are in the same hydroponic container, all plants can take the same nutrients with the same nutritional quality. So, this wicked system is very good for beginners because it is very easy to use ([Arini, 2019](#)). The disadvantage of using a hydroponic wick system is that plants grown with this installation will grow slowly because nutrients will not move due to a lack of pumps, so the plants do not get enough oxygen and nutrients because the working principle of this technique includes passive hydroponic techniques. The flow of nutrients depends on capillary forces, and the growing media comes from the axis as a reservoir that connects the nutrient tanks and planting media. As the axis, the flannel cloth is attached to the bottom of the net pot, which channels the fertilizer water to the roots ([Nugroho, 2017](#)). Thus, giving the highest treatment is expected to test the nutritional content of the POC mixture between tomato extract and Moringa leaf extract with the addition of coconut water to find the nutrients adapted to plant needs. It is hoped that further research, can provide the right POC volume concentration so that plant growth is maximized.

Conclusions

Based on the research results, it can be concluded that there was an increase in the growth and yield of red spinach plants due to the treatment of POC tomato extract and moringa leaf extract added with coconut water. Plant height 2.13 cm, root length 1.96 cm, number of leaves four leaves showed the highest yield in the C2V2 treatment (a mixture of moringa leaf extract and coconut water in a volume of 200 ml). At the same time, the C1V3 treatment (a mixture of tomato extract and coconut water at a volume of 250 ml) showed the lowest plant height, namely 1.07 cm. The C2V3 treatment (a mixture of moringa leaf extract and coconut water at a volume of 250 ml) showed the lowest root length, namely 0.73 cm. The C1V1 treatment showed the lowest number of leaves, only 2.

Declaration statement

The authors reported no potential conflict of interest.

References

- Abdullah, A., & Andres, J. (2021). Pengaruh Pemberian Pupuk Organik Cair Terhadap Pertumbuhan Tanaman Selada (*Lactuca Sativa* L) Secara Hidroponik. *Jurnal PENDAS: Pendidikan Dasar*, 3(1), 21–27.
- Agustin, R., & Putra, R. R. (2020). Pengaruh Ekstrak Tomat Terhadap Pertumbuhan Embrio Anggrek Phaius Tankervilleae Khas Gunung Galunggung Kabupaten Tasikmalaya The Effect Of Tomato Extract To The Growth Of Orchid Embryo Phaius tankervilleae Typically Of Mount Galunggung, Tasikmalaya Abstra. *Bioma*, 9(2), 264–279. <https://doi.org/10.26877/bioma.v9i2.7064>
- Ambarwati, I. D., Alfian, F. N., & Dewanti, P. (2021). Respon Anggrek *Dendrobium* sp., *Oncidium* sp., dan *Phalaenopsis* sp Terhadap Pemberian Empat Jenis Nutrisi Organik yang Berbeda pada Tahap Regenerasi Planlet. *Jurnal Agrikultura*, 32(1), 27–36. <https://doi.org/10.24198/agrikultura.v32i1.32366>
- Anzila, S. M., & Asngad, A. (2022). Efektivitas Kombinasi POC Bonggol Pisang Dan Daun Kelor Terhadap Pertumbuhan Dan Produktivitas Tanaman Sawi Pakcoy (*Brassica rapa* L.) Dengan Metode Hidroponik. *Bio-Lectura : Jurnal Pendidikan Biologi*, 9(2), 168–178. <https://doi.org/10.31849/bl.v9i2.10754>
- Arini, W. (2019). TINGKAT Daya Kapilaritas Jenis Sumbu Pada Hidroponik Sistem Wick Terhadap Tanaman Cabai Merah (*Capsicum Annum* L.). *JURNAL PERSPEKTIF PENDIDIKAN*, 13(1), 23–34. <https://doi.org/10.31540/jpp.v13i1.302>
- Azzahra, N. A., Nasichah, D., Dewi, E. T., Harianto, H. A., & Diana, L. (2022). Pemanfaatan Limbah Daun Kelor Sebagai Bahan Dasar Pembuatan Pupuk Organik Cair (POC). *Jurnal Pengabdian Kepada Masyarakat*, 2(3), 188–189.

- Bandang, F., Lestari, N. K. D., & Deswiniyanti, N. W. (2021). Efektivitas Pemberian Pupuk Organik Cair Daun Kelor Kombinasi Air Kelapa Terhadap Pertumbuhan Anggrek Blue Planet (*Dendrobium* sp). *Jurnal Media Sains*, 5(1), 7.
- Kustiani, E., & Ayuningtyas, B. C. (2021). Respon Pertumbuhan dan Hasil Tanaman Bayam Merah (*Amaranthus gangeticus*) Pada Perlakuan Dosis Pupuk ZA. *Jurnal AGRINIKA*, 5(2), 180–188. <https://doi.org/10.30737/agrinika.v5i2.1946>
- Nadeak, Y. A., Chozin, M., & Setyowati, N. (2020). Respon Pertumbuhan Dan Hasil Jagung Manis (*Zea Mays Saccharata* Sturt) Terhadap Konsentrasi Dan Waktu Aplikasi Pupuk Organik Cair Ekstrak Tomat. *Seminar Nasional Virtual*, 73–88.
- Nugroho, B. W. (2017). *Hidroponik Starter*. Jakarta Timur: Penebar Swadaya.
- Pohan, S. A., & Oktojournal. (2019). Pengaruh konsentrasi nutrisi a-b mix terhadap pertumbuhan caisim secara hidroponik (drip system). *Lambung*, 18(1), 20–32. [10.32530/lambung.v18i1.179](https://doi.org/10.32530/lambung.v18i1.179)
- Puspita, M., Laksono, R. A., & Syah, B. (2021). Respon Pertumbuhan dan Hasil Bayam Merah (*Alternanthera amoena* Voss.) Akibat Populasi dan Konsentrasi AB Mix pada Hidroponik Rakit Apung. *Jurnal Ilmu-Ilmu Pertanian*, 19(2), 131–132. <https://doi.org/10.32528/agritrop.v19i2.6048>
- Rahmawati, I. D., Purwani, K. I., Muhibuddin, A., & Persiapan, T. (2018). Pengaruh Konsentrasi Pupuk P Terhadap Tinggi dan Panjang Akar *Tagetes erecta* L. (*Marigold*) Hidroponik. *JURNAL SAINS DAN SENI ITS*, 7(2), 4–8. [10.12962/j23373520.v7i2.37048](https://doi.org/10.12962/j23373520.v7i2.37048)
- Sari, D. I., Gresinta, E., & Noer, S. (2021). Efektivitas Pemberian Air Kelapa (*Cocos nucifera*) Sebagai Pupuk Organik Cair Terhadap Pertumbuhan Tanaman Tomat (*Solanum lycopersicum*). *EduBiologia: Biological Science and Education Journal*, 1(1), 41. <http://dx.doi.org/10.30998/edubiologia.v1i1.8085>
- Sari, S. W., & Purba, D. W. (2019). Pengaruh Pemberian Ekstrak Daun Kelor Dan Nutrisi Ab-Mix Terhadap Pertumbuhan Dan Produksi Tanaman Seledri (*Apium graveolens* L.) Secara Hidroponik Dengan Sistem Wick. *BERNAS Agricultural Research Journal*, 15(3), 22–31.
- Shekarriz, P., Kafi, M., Deilamy, S. D., & Mirmasoumi. (2014). Coconut Water and Peptone Improve Seed Germination and Protocorm Like Body Formation of Hybrid *Phalaenopsis*. *Agriculture Science Developments*, 3(4), 317–322.