The Response of Baby Leaf Lettuce to Selenium Biofortification under Different Lighting Conditions †

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† Presented at the 1st International Electronic Conference on Agronomy, 3–17 May 2021; Available online: https://sciforum.net/conference/IECAG2021.

Abstract: Selenium (Se) is an essential microelement for human health and has antioxidant and anticancerous properties. One of the ways to increase its concentration in plants is biofortification through various agronomic practices including artificial lighting. The aim of this study was to determine the responses of baby leaf lettuce to various Se content in hydroponic solution at different ratios of blue (B) and red (R) light of light-emitting diodes (LED) lighting. Lettuce (Lactuca sativa, ‘Little Gem’) was grown hydroponically under B:R light ratios–10%B:90%R, 75%B:25%R. The photon flux density (PFD), photoperiod, temperature, and relative humidity in the growth chamber were maintained at 220 µmol m−2 s−1, 18 h, 21/17 ± 2 °C, and 60 ± 5%, respectively. Two experiments with Se were performed using natrium selenate (Na2SeO4). Results of the first experiment (Se–0, 1, 3 ppm) showed that the content of Se in lettuce was about 15 times higher at 3 ppm compared to 1 ppm. Similar trends were observed for both B and R ratios. However, even the lowest dose of Se in hydroponic solution inhibited lettuce growth and reduced photosynthesis and chlorophyll content. Therefore, a second experiment was performed with lower Se doses (0, 0.5, 1 ppm) at different growth stages (11th and 17th days after sowing (DAS)). It was found that, when Se exposure was initiated at the 17th DAS, the lettuce accumulated a lower content of Se compared to the 11th DAS, but this did not have a negative effect on their growth. The B:R ratio of 10B:90R resulted in a higher content of Se in the leaves. Overall, these results suggest that properly composed doses of Se, LED lighting and application time could be a suitable way for cultivation of selenium-biofortified baby leaf lettuces without any adverse effects on growth.

Keywords: selenium; biofortification; blue and red light ratio; lettuce

1. Introduction

Selenium (Se) is an essential microelement for human health and has antioxidant and anticancerous properties. The Recommended Dietary Allowance (RDA) of Se is 55–70 µg Se day−1 for adults. It is estimated that over 15% of the world’s population are Se deficient [1–5]. One of strategies for improving Se status is the biofortification of plants through various agronomic practices [1,4,5]. Hydroponic nutrient solution enriched with Se is useful for the enhancement of Se. Studies with leafy vegetables showed that properly selected doses allow the increase of Se content without negative effect on biomass and quality of plants [1,4–8].

On other hand, leafy vegetables are widely cultivated in controlled environment agriculture (CEA), where artificial lighting is used [9]. The application of light-emitting diode (LED) lighting for the regulation of light quality and quantity could be a tool for the biofortification of various mineral nutrients including Se. Many studies are related to plant
cultivation under LEDs of blue (B) and red (R) light as they have the highest photon efficiency. Some of them have demonstrated the positive effect of short-term monochromatic blue light or its higher percentage in different light spectrum compositions on the mineral nutrient content in plants [10–16]. Others have reported that red LED or its higher percentage in blue–red lighting increased various mineral nutrients in marigold [15], lettuce [16], and basil [17]. However, there is a lack of information about how the manipulation of the light spectrum affects changes in the Se content of various leafy vegetables. We found information from two studies concerning Se-enrichment in leafy vegetables under different lighting conditions. Bian and co-authors investigated the effects of monochromatic blue and red light, their ratio, and Se forms on Se uptake, nitrate content and photosynthesis in hydroponically grown lettuce [3]. He and co-authors [4] evaluated the combination of Se and different ratios of blue, red and green LEDs light on growth, biomass, phytochemicals and mineral nutrients in broccoli sprouts. The aim of this study was to determine the responses of baby leaf lettuce to various doses of Se in hydroponic solution at different ratios of blue and red light in light-emitting diodes lighting.

2. Materials and Methods

Experiments were performed in closed controlled environment walk-in growth chambers (length 4 m × 6 m) in the phytotron complex at the Institute of Horticulture (IH), Research Centre for Agriculture and Forestry, Lithuania. Lettuces (Lactuca sativa, ‘Little Gem’) (CN Seeds Ltd., Pymoor, Ely, Cambridgeshire, UK) grown as baby leaf were used in the experiments. One lettuce seed was sown in rockwool cubes (2 × 2 × 3.5 cm) soaked with deionized water. Seeds were germinated and seedlings were grown under high pressure sodium lamps (HPS–SonT Agro 400 w, Philips, Eindhoven, Netherlands) in an 18-hour photoperiod with day/night temperatures (±SD) of 21/17 ± 2 °C and a relative air humidity of 60 ± 5%. Nutrient solution was added at the cotyledon stage. Similar size lettuce seedlings were transplanted into 9-L hydroponic containers at 11th day after sowing (DAS). The experiments were repeated twice. Modified Hoagland nutrient solution with the average concentration of nutrients of [mg L–1] N, 120; P, 20; K, 128; Ca, 88; Mg, 40; S, 53; Fe, 1.6; Mn, 0.08; Cu, 0.08; B, 0.16; Zn, 0.8; Mo, 0.2 were used from seedling stage until the end of experiments. The pH was 5.5–6.5, and the electrical conductivity (EC) was 1.3–1.7 mS cm–1 (GroLine HI9814, Hanna Instruments, Woonsocket, RI, USA).

Transplanted lettuces were cultivated under a controllable lighting fixture (HLRD, Hortiled, Lithuania), consisting of blue (B–447 nm) and red (R–660 nm) light-emitting diodes (LED). In experiments, red and blue LEDs were used at different PFD ratios: 10%B:90%R, 75%B:25%R (treatments code B10R90, B75R25). All lighting treatments delivered the same total photon flux density (TPFD) of 220 µmol m–2 s–1. The photon distributions of all lighting treatments were measured using a portable photometer-radiometer at the tray surface level (RF-100, Sonopan, Poland).

Two experiments with selenium (Se) were performed using natrium selenate (Na2SeO4). The first experiment (EXP1): Se of 0, 1, 3 ppm were applied at 11th DAS and lasted till 21st DAS. The second experiment (EXP2): Se of 0, 0.5, 1 ppm were applied at the 11th DAS and the 17th and lasted until the 23rd DAS.

Lettuces were harvested at the ground level. Six plants were randomly selected from each container and were used for biometric measurements and the determination of fresh and dry weights. Samples of lettuces used for elemental composition analysis as well as for dry weight were washed with deionized water and dried at 70 °C for 48 h in a drying oven (Venticell 222, MBT, Brno, Czech Republic). Samples for elemental composition were stored in tightly closed 50 mL plastic bags until analysis. The dry and fresh weight of lettuces was determined by the gravimetric method using an electronic analytical balance (Mettler Toledo AG64, Columbus, OH, USA) and the leaf area was measured using the WinDIAS meter (Delta-T Devices Ltd., Cambridge, UK).

Nondestructive measurements of leaf chlorophyll (CHL) and flavonol (FLA) indexes were performed using the Dualex 4 Scientific® (FORCE-A, Orsay, France) meter. Photosyn-
thetic rate (Pr, μmol CO₂ m⁻² s⁻¹) was measured using a portable photosynthesis system (LI-COR 6400XT, Lincoln, NE, USA).

The contents of mineral nutrients in lettuces were determined using a modified microwave-assisted digestion technique combined with ICP-OES methods as described by Araújo et al. [18] and Barbosa et al. [19]. The Se bioconcentration factor (BCF) and transfer factors (TF) of the roots and shoots were calculated according to Bian et al. [3].

Statistical analysis was performed using Microsoft Excel 2016 and Addinsoft XLSTAT 2019.1 XLSTAT statistical and data analysis (Long Island, NY, USA). Two-way analysis of variance (ANOVA) followed by Tukey’s honestly significant difference test (*p < 0.05) for multiple comparisons was used to evaluate the differences between means of measurements.

3. Results and Discussion

Literature data showed that the supplement of Se can significantly increase its content in leafy vegetables, such as lettuce, spinach, basil without a negative effect on their yield. However, higher doses of Se result in toxicity in plants, and there is a narrow boundary between beneficial and toxic Se concentrations [1,3,5,6,8]. Our EXP1 results revealed that even a 1 ppm Se dose in nutrient solution negatively affected the growth parameters of baby leaf lettuce under both lighting conditions (Table 1). A 3 ppm Se dose decreased leaf area and shoot fresh weight by more than double in comparison to plants without Se application. Meanwhile, lower Se doses and different its application time did not affect the number of lettuce leaves (EXP2) (Table 2). There was an observed trend that after the application of Se at 17DAS, the above mentioned indices and root lengths were slightly higher in comparison with 11DAS. The light most affected the leaf area and shoot fresh weight. A higher percentage of blue light (B75R25) in LED lighting resulted in a decrease of such indexes. According to the literature, such a blue light effect was found for other plants as well [10,17].

| Variables | Treatment Source of Variance |
|-----------|-----------------------------|
|           | L | Se | L × Se |
| LN        | 7.00 ± 0.00 | 6.67 ± 0.29 | 6.00 ± 0.00 | 7.3 ± 0.58 | 6.00 ± 0.00 | 5.00 ± 0.00 | * | * | * |
| LA        | 157.8 ± 15.5 | 124.2 ± 9.1 | 70.5 ± 7.7 | 120.6 ± 14.6 | 98.2 ± 4.8 | 435 ± 54 | * | * | * |
| SFW       | 5.04 ± 0.09 | 3.70 ± 0.23 | 2.08 ± 0.28 | 3.7 ± 0.46 | 2.67 ± 0.27 | 1.15 ± 0.15 | * | * | * |
| RL        | 24.78 ± 1.10 | 22.57 ± 2.68 | 17.12 ± 2.36 | 26.15 ± 5.85 | 25.52 ± 3.19 | 14.65 ± 1.34 | * | * | * |
| Pr        | 17.76 ± 1.21 | 14.05 ± 0.7 | 7.46 ± 0.33 | 16.77 ± 6.2 | 16.76 ± 0.67 | 7.68 ± 0.55 | * | * | * |
| CHL       | 25.26 ± 0.88 | 23.02 ± 1.05 | 19.07 ± 0.31 | 25.77 ± 0.85 | 25.85 ± 1.25 | 24.81 ± 3.52 | * | * | * |
| FLA       | 0.26 ± 0.02 | 0.55 ± 0.06 | 0.34 ± 0.05 | 0.66 ± 0.02 | 0.48 ± 0.05 | 0.41 ± 0.15 | * | * | * |
| P         | 6.37 ± 0.70 | 8.95 ± 1.69 | 7.61 ± 0.31 | 14.47 ± 0.61 | 14.36 ± 0.45 | 10.13 ± 0.75 | * | * | * |
| K         | 12.75 ± 0.36 | 15.67 ± 0.27 | 21.38 ± 0.32 | 22.09 ± 0.21 | 21.96 ± 0.21 | 27.05 ± 1.07 | * | * | * |
| Ca        | 2.53 ± 0.87 | 5.96 ± 2.11 | 8.95 ± 0.16 | 10.14 ± 0.21 | 10.34 ± 0.13 | 9.67 ± 0.64 | * | * | * |
| Mg        | 2.31 ± 0.41 | 3.23 ± 0.32 | 4.84 ± 0.14 | 4.23 ± 0.03 | 4.29 ± 0.08 | 4.96 ± 0.25 | * | * | * |
| S         | 0.76 ± 0.04 | 0.72 ± 0.09 | 0.88 ± 0.06 | 0.48 ± 0.01 | 0.48 ± 0.02 | 0.68 ± 0.04 | * | * | * |
| Mn        | 0.02 ± 0.004 | 0.03 ± 0.007 | 0.035 ± 0.004 | 0.049 ± 0.0002 | 0.039 ± 0.004 | 0.048 ± 0.002 | * | * | * |
| Fe        | 0.046 ± 0.007 | 0.081 ± 0.033 | 0.098 ± 0.011 | 0.123 ± 0.010 | 0.140 ± 0.026 | 0.160 ± 0.034 | * | * | * |
| Zn        | 0.037 ± 0.002 | 0.064 ± 0.018 | 0.066 ± 0.002 | 0.100 ± 0.005 | 0.101 ± 0.002 | 0.081 ± 0.004 | * | * | * |
| Se        | - | 0.029 ± 0.001 | 0.527 ± 0.008 | - | 0.038 ± 0.001 | 0.542 ± 0.041 | * | * | * |
| BCFSe     | - | 136.3 ± 41.5 | 65.2 ± 13.7 | - | 185.2 ± 54.2 | 122.6 ± 7.4 | * | * | * |
| TFSe      | - | 0.22 ± 0.07 | 2.78 ± 0.60 | - | 0.22 ± 0.07 | 1.48 ± 0.20 | * | * | * |

B10R90, B75R25—a percentage of blue (B) and red (R) light. Se0, Se1, Se3—selenium doses 0, 1, 3 ppm respectively. L—blue and red light. LN—leaf number; LA—leaf area, cm²; SFW—shoot fresh weight, g; RL—root length, cm; Pr—photosynthetic rate, μmol CO₂ m⁻² s⁻¹; CHL—chlorophyll index, FLA—flavonols index; Mineral nutrients P, K, Ca, Mg, S, Mn, Fe, Zn, Se expressed as LL (dry weight); BCFSe—bioconcentration factor of Se; TFSe—translocation factor of Se. All values in the table are expressed as mean ± standard error (n = 6). Means with different letters are significantly different at the p < 0.05 level by Tukey’s honestly significant difference test. * Significant at p < 0.05.
Table 2. Effect of different blue-red light ratio in LED lighting, selenium doses and their application time on baby leaf lettuce.

| Variables | B10R90 | B75R25 | Source of Variance |
|-----------|--------|--------|--------------------|
|           | 11 DAS | Se0    | L | Se | DAS | L | Se | DAS | L | Se | DAS |
| LN        | 6.82 ± 0.29 a | 6.00 ± 0.08 a | 6.63 ± 0.29 a | 6.67 ± 0.56 a | 6.17 ± 0.28 a | 6.53 ± 0.58 a | 6.50 ± 0.98 a | 6.00 ± 0.05 a | 6.00 ± 0.05 a | 6.17 ± 0.29 a |
| LA        | 133.7 ± 11.6 a | 120.1 ± 7.1 a | 158.3 ± 8.2 a | 137.0 ± 8.4 a | 140.2 ± 8.6 a | 169.4 ± 16.8 a | 70.0 ± 7.2 b | 79.3 ± 7.3 b | 79.2 ± 8.4 b | 63.1 ± 9.3 b |
| SFW       | 4.23 ± 0.31 b | 3.78 ± 0.26 b | 5.23 ± 0.27 b | 3.95 ± 0.27 b | 4.20 ± 0.34 b | 2.53 ± 0.18 b | 2.28 ± 0.26 c | 2.64 ± 0.31 c | 1.62 ± 0.31 d | 2.37 ± 0.2 c d |
| RL        | 25.62 ± 4.30 ab | 25.63 ± 2.36 ab | 29.25 ± 0.86 a | 22.26 ± 0.73 ab | 27.53 ± 0.45 ab | 23.30 ± 2.31 ab | 23.62 ± 4.17 ab | 26.75 ± 1.83 ab | 20.06 ± 2.46 ab | 26.60 ± 1.49 ab |
| Pr        | 14.80 ± 0.72 d | 16.01 ± 1.31 bcd | 18.79 ± 0.96 ab | 15.04 ± 1.72 cd | 14.11 ± 1.70 d | 17.98 ± 1.12 abc | 14.92 ± 0.23 cd | 20.06 ± 0.46 a | 16.24 ± 0.48 bcd | 18.07 ± 0.75 bcd |
| CHL       | 24.02 ± 0.16 ab | 24.40 ± 0.16 cde | 26.01 ± 0.61 bc | 23.09 ± 1.36 a | 25.03 ± 1.36 b | 25.57 ± 0.14 bcd | 27.38 ± 0.27 ab | 28.40 ± 0.51 a | 23.75 ± 0.83 da | 26.21 ± 0.10 bc |
| FLA       | 0.32 ± 0.04 bc | 0.25 ± 0.06 bc | 0.27 ± 0.04 c | 0.40 ± 0.03 bc | 0.36 ± 0.04 bc | 0.43 ± 0.02 b | 0.42 ± 0.07 a | 0.67 ± 0.03 a | 0.43 ± 0.04 bc | 0.44 ± 0.08 a |
| P         | 12.12 ± 0.17 cd | 12.35 ± 0.27 c | 10.31 ± 0.23 a | 10.99 ± 0.48 cde | 10.97 ± 0.41 de | 14.23 ± 0.26 b | 16.03 ± 0.90 a | 15.77 ± 0.65 ab | 11.29 ± 0.14 cde | 16.06 ± 1.04 a |
| K         | 23.91 ± 0.07 ab | 22.04 ± 0.62 ab | 20.91 ± 0.14 a | 23.43 ± 0.70 ab | 21.66 ± 0.86 ab | 25.21 ± 0.39 a | 22.72 ± 0.42 ab | 22.04 ± 0.54 ab | 23.50 ± 0.06 a | 23.39 ± 0.07 a |
| Ca        | 8.99 ± 0.07 bcd | 8.27 ± 0.10 bcd | 7.90 ± 0.05 a | 8.29 ± 0.27 ccd | 7.92 ± 0.07 d | 9.01 ± 0.50 ab | 11.16 ± 0.27 a | 11.17 ± 0.19 ab | 8.61 ± 0.45 bcd | 11.23 ± 0.46 a |
| Mg        | 3.65 ± 0.35 bc | 3.78 ± 0.11 abc | 3.55 ± 0.07 bc | 3.40 ± 0.01 c | 3.52 ± 0.11 ab | 4.12 ± 0.22 ab | 4.19 ± 0.13 ab | 4.41 ± 0.32 a | 4.14 ± 0.19 ab | 4.41 ± 0.25 a |
| S         | 0.44 ± 0.02 abc | 0.46 ± 0.01 abc | 0.40 ± 0.01 bc | 0.44 ± 0.01 ab | 0.40 ± 0.01 b | 0.47 ± 0.08 a | 0.52 ± 0.01 b | 0.52 ± 0.01 bc | 0.52 ± 0.01 b | 0.54 ± 0.01 b |
| Mn        | 0.038 ± 0.003 abc | 0.043 ± 0.001 abc | 0.041 ± 0.003 bc | 0.042 ± 0.003 bc | 0.042 ± 0.003 bc | 0.053 ± 0.004 abc | 0.062 ± 0.003 a | 0.058 ± 0.011 abc | 0.099 ± 0.015 abc | 0.099 ± 0.015 abc |
| Fe        | 0.14 ± 0.05 a | 0.15 ± 0.02 a | 0.12 ± 0.02 a | 0.10 ± 0.01 a | 0.10 ± 0.01 a | 0.15 ± 0.02 a | 0.18 ± 0.07 a | 0.17 ± 0.02 a | 0.15 ± 0.02 a | 0.15 ± 0.02 a |
| Zn        | 0.082 ± 0.004 bcd | 0.073 ± 0.004 d | 0.076 ± 0.008 cd | 0.078 ± 0.005 cd | 0.072 ± 0.004 d | 0.084 ± 0.004 abc | 0.104 ± 0.012 b | 0.098 ± 0.035 ab | 0.074 ± 0.025 d | 0.095 ± 0.016 ab |
| Se        | - | 0.004 ± 0.000 c | 0.014 ± 0.000 d | 0.052 ± 0.000 b | 0.052 ± 0.000 b | - | 0.004 ± 0.001 d | 0.009 ± 0.002 d | 0.019 ± 0.003 c | 0.021 ± 0.001 c |
| BCFe0     | - | 244.2 ± 1.30 b | 91.2 ± 3.43 b | 147.2 ± 26.73 a | 142.6 ± 45.37 a | - | 264.7 ± 5.51 c | 394.8 ± 37.9 b | 269.5 ± 76.8 abc | 195.3 ± 44.5 cde |
| BCFe1     | - | 0.031 ± 0.011 c | 0.311 ± 0.033 ab | 0.361 ± 0.083 a | 0.241 ± 0.082 b | - | 0.022 ± 0.004 ab | 0.044 ± 0.012 c | 0.070 ± 0.035 c | 0.196 ± 0.011 c |

B10R90, B75R25—a percentage of blue (B) and red (R) light. Se0, Se1, Se3—selenium doses 0, 1, 3 ppm respectively. DAS—days after sowing. LN—blue and red light. LN—leaf number; LA—leaf area, cm²; SFW—shoot fresh weight, g; RL—root length, cm; Pr—photosynthetic rate, μmol CO₂ m⁻² s⁻¹; CHL—chlorophyll index, FLA—flavonols index; Mineral nutrients P, K, Ca, Mg, S, Mn, Fe, Zn; Se expressed as mg g⁻¹ DW (dry weight); BCFe—a bioconcentration factor of Se; TFsa—translocation factor of Se. All values in the table are expressed as mean ± standard error (n = 6). Means with different letters are significantly different at the p < 0.05 level by Tukey’s honestly significant difference test.

* Significant at p < 0.05.
An Se dose of 3 ppm (EXP1) significantly decreased the photosynthetic rate (Pr) and the chlorophyll index (CHL) in comparison to lettuces grown without Se, except CHL under B75R25 (Table 1). The application of Se 0.5 ppm at 17DAS (EXP2) had a positive effect on these indexes in comparison with 11DAS (Table 2). Moreover, a trend was found that a higher percentage of blue light (B75R25) in LED lighting resulted in a positive effect on them. These results are consistent with other studies showing that a lower concentration of Se is beneficial for the photosynthesis process, while excessive doses could cause a damaging effect on it [1,3,5,8].

Some literature data indicated that Se doses had no impact on phenolic compound content, but positively affected anthocyanin content in basil [1]. Meanwhile, others reported an increase of phenolic compounds in lettuce and spinach [6,8] and flavonoids in lettuce [6]. Our results revealed that the effect of Se doses on the flavonols index (FLA) depended on the B:R light ratio. The B10R90 resulted in the highest FLA when a 1 ppm Se dose was applied and B75R25 without Se at EXP1 (Table 1). Generally, a higher percentage of blue light caused a higher FLA value in both experiments (Tables 1 and 2). He and co-authors reported that Se supplementation under a higher blue and red light ratio significantly increased total phenolic and flavonoids content in broccoli sprouts [4]. Though DAS had no significant effect on FLA, a 1 ppm Se dose applied at 17DAS resulted in a significantly higher FLA in comparison to 11DAS under B75R25 (Table 2).

Literature data showed a positive effect of blue light on mineral nutrients content [10–16]. Some studies revealed the effect of different Se doses on mineral nutrients content, but it depended on the species and doses [4,7,8]. Our results showed a trend that Se doses positively affected mineral nutrients content under a higher percentage of blue light (B75R25) (Tables 1 and 2). Meanwhile, DAS had no significant effect on mineral nutrients content. Light had no impact on Se content in lettuce leaves when the effects of 1 and 3 ppm were compared (EXP1) (Table 1). The higher Se content was determined at B10R90 and an Se dose of 1 ppm as compared to 0.5 ppm (EXP2) (Table 2). Other studies showed a positive effect of blue light on Se content in leafy vegetables [3,4] and 0.5 ppm Se applied at 17DAS resulted in higher Se content compared to 11DAS. The bioconcentration factor (BCF) indicates the capability of plants to accumulate mineral nutrients in roots and the translocation factor (TF) indicates the capability to accumulate it in the aboveground tissue [4]. BCFSe were higher under B75R25 in both experiments. However, the translocation factors (TF) were the highest under B10R90 (Tables 1 and 2). Bian and co-authors [3] demonstrated the potential role of wider light spectra in Se uptake in plants and suggested further investigations.

4. Conclusions

The content of Se in lettuce was the highest at 3 ppm under both blue and red light ratios. However, such a dose of Se inhibited the growth of lettuce and reduced the rate of photosynthesis and chlorophyll content. When 1 ppm Se was applied at 17th DAS under B:R ratios 10B:90R%, lettuce accumulated a lower Se content compared to the 11th DAS, but this did not have a negative effect on their growth. Overall, these results suggest that properly composed doses of Se, LED lighting and application time could be a suitable way for cultivating selenium-biofortified baby leaf lettuces without any adverse effects on growth.

Supplementary Materials: The conference poster is available at https://www.mdpi.com/article/10.3390/IECAG2021-10010/s1.

Author Contributions: Conceptualization, A.B., J.M., VV.-K., P.D. and G.S.; methodology, A.B., J.M., VV.-K. and G.S.; software, K.L.; validation, A.B., P.D. and G.S.; formal analysis, J.M., VV.-K., R.S., K.L., K.S.; investigation, A.B., J.M., VV.-K., R.S. and K.L.; writing—original draft preparation, A.B.; writing—review and editing, J.M., VV.-K. and G.S.; visualization, A.B., J.M. and VV.-K. All authors have read and agreed to the published version of the manuscript.
Funding: This project has received funding from the Research Council of Lithuania (LMTLT), agreement No. S-MIP-19-2.

Institutional Review Board Statement: Not applicable.

Data Availability Statement: Not applicable.

Conflicts of Interest: The authors declare no conflict of interest.

References

1. Puccinelli, M.; Malorgio, F.; Pezzarossa, B. Selenium enrichment of horticultural crops. *Molecules*. 2017, 22, 933. [CrossRef] [PubMed]
2. Gupta, M.; Gupta, S. An overview of selenium uptake, metabolism, and toxicity in plants. *Front. Plant Sci.* 2017, 7, 2074. [CrossRef] [PubMed]
3. Bian, Z.-H.; Lei, B.; Cheng, R.-F.; Wang, Y.; Li, T.; Yang, Q.-C. Selenium distribution and nitrate metabolism in hydroponic lettuce (*Lactuca sativa* L.): Effects of selenium forms and light spectra. *J. Integr. Agric.* 2020, 19, 133–144. [CrossRef]
4. He, R.; Gao, M.; Shi, R.; Song, S.; Zhang, Y.; Su, W.; Liu, H. The combination of selenium and LED light quality affects growth and nutritional properties of broccoli sprouts. *Molecules* 2020, 25, 4788. [CrossRef] [PubMed]
5. Hawrylak-Nowak, B. Comparative effects of selenite and selenate on growth and selenium accumulation in lettuce plants under hydroponic conditions. *Plant Growth Regul.* 2013, 70, 149–157. [CrossRef]
6. Rios, J.J.; Rosales, M.A.; Blasco, B.; Cervilla, L.M.; Romero, L.; Ruiz, J.M. Biofortification of Se and induction of the antioxidant capacity in lettuce plants. *Sci. Hortic.* 2008, 116, 248–255. [CrossRef]
7. Rios, J.J.; Blasco, B.; Leyva, R.; Sanchez-Rodriguez, E.; Rubio-Wilhelmi, M.M.; Romero, L.; Ruiz, J.M. Nutritional balance changes in lettuce plant grown under different doses and forms of selenium. *J. Plant Nutr.* 2013, 36, 1344–1354. [CrossRef]
8. Saffaryazdi, A.; Lahouti, M.; Ganjeali, A.; Bayat, H. Impact of selenium supplementation on growth and selenium accumulation on spinach (*Spinacia oleracea* L.). *Plants Not. Sci. Biol.* 2012, 4, 95–100. [CrossRef]
9. Rouphael, Y.; Kyriacou, M.C.; Petropoulos, S.A.; Pascale, S.; Colla, G. Improving vegetable quality in controlled environments. *Sci. Hortic.* 2018, 234, 275–289. [CrossRef]
10. Mitchell, C.A.; Dzakovich, M.P.; Gomez, C.; Burr, J.F.; Hernández, R.; Kubota, C.; Christopher, J.; Currey, C.J.; Meng, Q.; Rinkle, E.S.; et al. Light-emitting diode light in horticulture. *Hortic. Rev.* 2015, 43, 1–88. [CrossRef]
11. Zhang, X.; Bian, Z.; Yuan, X.; Chen, X.; Lu, C. A review on the effects of light-emitting diode (LED) light on the nutrients of sprouts and microgreens. *Trends Food Sci. Technol.* 2020, 99, 203–216. [CrossRef]
12. Kopsell, D.A.; Sams, C.E. Increases in shoot tissue pigments, glucosinolates, and mineral elements in sprouting broccoli after exposure to short-duration blue light from light emitting diodes. *J. Am. Soc. Hortic. Sci.* 2013, 138, 31–37. [CrossRef]
13. Kopsell, D.A.; Sams, C.E.; Barickman, T.C.; Morrow, R.C. Sprouting broccoli accumulate higher concentrations of nutritionally important metabolites under narrow-band light-emitting diode lighting. *J. Am. Soc. Hortic. Sci.* 2014, 139, 469–477. [CrossRef]
14. Brazaiytė, A.; Vaštakaitė-Kairienė, V.; Jankauskienė, J.; Viršilė, A.; Samuoliene, G.; Sakalauskienė, S.; Novičkovas, A.; Mili- auskienė, J.; Duchovskis, P. Effect of blue light percentage on mineral elements content in Brassica microgreens. *Acta Hortic.* 2020, 1271, 119–126. [CrossRef]
15. Sams, C.E.; Kopsell, D.; Morrow, R.C. Light quality impacts on growth, flowering, mineral uptake and petal pigmentation of marigold. *Acta Hortic.* 2016, 1134, 139–146. [CrossRef]
16. Amoozgar, A.; Mohammadi, A.; Sabzalian, M.R. Impact of light-emitting diode irradiation on photosynthesis, phyto-chemical composition and mineral element content of lettuce cv. Grizzly. *Photosynthetica* 2017, 55, 85–95. [CrossRef]
17. Pennisi, G.; Blasioli, S.; Cellini, A.; Maia, L.; Crepaldi, A.; Braschi, I.; Spinelli, F.; Nicola, S.; Fernandez, J.A.; Stanghellini, C.; et al. Unraveling the role of red/blue LED lights on resource use efficiency and nutritional properties of indoor grown sweet basil. *Front. Plant Sci.* 2019, 10, 305. [CrossRef] [PubMed]
18. Araújo, G.C.L.; Gonzalez, M.H.; Ferreira, A.G.; Nogueira, A.R.A.; Nóbrega, J.A. Effect of acid concentration on closed-vessel microwave-assisted digestion of plant materials. *Spectrochim. Acta Part B At. Spectrosc.* 2002, 57, 2121–2132. [CrossRef]
19. Barbosa, J.T.P.; Santos, C.M.M.; Peralva, V.N.; Flores, E.M.M.; Korn, M.; Nóbrega, J.A.; Korn, M.G.A. Microwave-assisted diluted acid digestion for trace elements analysis of edible soybean products. *Food Chem.* 2015, 175, 212–217. [CrossRef] [PubMed]