The Nutritional Treasure of Leafy Vegetable *Perilla frutescens*

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Perilla frutescens (L.) Britt.

Perilla syn. beefsteak plant or Shiso (Lamiaceae) is an Asian herbaceous plant native to mountainous areas from India to China, but mainly cultivated and consumed in Korea, Japan, Thailand, and Vietnam. Scientific nomenclature of genus *Perilla* is quite confusing. Several varieties can be distinguished, mostly cultivated are var. crispa and var. frutescens. *Perilla* is annual plant, adopted to warm, humid climates and grows well in semi-shade or sun. Light intensity can affect the leaf colour, which varies from green to purple. There are different chemotypes of *Perilla*, the most cultivated and the only one with culinary use is the 'PA chemotype', (PA=perillaaldehyde).
Except for culinary use, its fresh leaves and seeds are well-known for treatments of various diseases like tumour, heart disease, diabetes, anxiety, depressions, infections and intestinal disorders. The health promoting effects of *Perilla* have been attributed to its high content of secondary metabolites such as polyphenols, flavonoids and anthocyanins.

Type: Korean
Polyphenol:
127-180 mg/100g FM:
Anthocyanin:
20 mg Quercitin/100g FM

Type: Vietnamese
Polyphenol:
250-320 mg/100g FM:
Anthocyanin:
31-202 mg Quercitin/100g FM

Type: Japanese
Polyphenol:
180-280 mg/100g FM:
Anthocyanin:
17-36 mg Quercitin/100g FM

Background

The quantity of consumed fresh Asian herbs is increasing in Europe but so far intensive cultivation systems are rarely investigated.
One limiting factor could be to light intensity in temperate regions, because also the synthesis of bioactive compound is dependent on the light intensity.

Aim of research

This study was conducted to investigate whether it is possible to affect plant growth and secondary metabolites in *Perilla* plant cultivated in greenhouse by application of blue, green and red spectra using LED light.

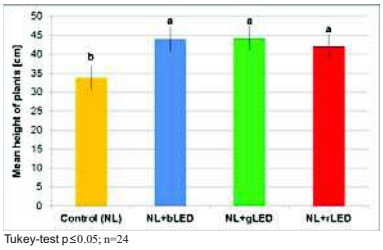
Experimental design

Plant material: *Perilla frutescens,* Vietnamese type
Substrate: Gramoflor (white peat 65%, black peat 20%, perlite 15%)
Light conditions: Sunlight for 16 h/day with averaged PAR of 154 µmol $m^{-2}s^{-1}$
LED bars: providing additional light 16 h/day, one bar 1m long, input 18W; 4 bars fixed on wooden frame (100W m^{-2}), one frame for each light spectrum:
- blue (peak at 443 nm) provided 11 µmol $m^{-2}s^{-1}$
- green (peak at 515 nm) 7 µmol $m^{-2}s^{-1}$
- red (peak at 629 nm) 12 µmol $m^{-2}s^{-1}$

Cultivation: in Mitscherlich pots (volume 6l); four plants per pot; six pots per treatment
Nutrient solution composition (mg/l): N (160), K (210), Ca (110), Mg (70), P (40); pH 5,8, EC 1,5 mS
Experiment duration: May-June 2014, four weeks including one week acclimatisation, T 27.4°C, RH 48.6%
Location: Research greenhouse Berlin Dahlem at the Humboldt University of Berlin,
Data collection: pH-, EC-value, T, RH and PAR daily measured; plant height and determination of secondary metabolites once a week; leaf fresh mass at the end of the experiment

Results

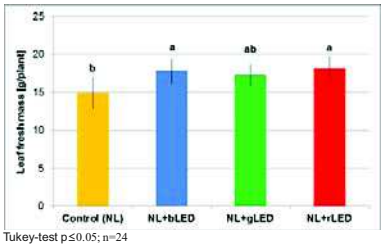
Plant height



Tukey-test p≤0.05; n=24

- Additional LED lighting showed positive influence on plant height without significant differences between LED treatments.
- Comparing to control blue and green light increased plant height up to 30%, while additional red light increased it up to 24%.

Yield



Tukey-test p≤0.05; n=24

- Supplemental LED lighting influenced the yield up to 34% in blue treatment and up to 33% in red treatment respectively.
- Green light didn't significantly differ from any of treatments.

Secondary metabolites

Secondary metabolites	References	Control (mg/100 g FW)	blue LEDs (mg/100 g FW)	green LEDs (mg/100 g FW)	red LEDs (mg/100 g FW)
Polyphenols	727 mg/100 g FW (*Sato et al. 2002*)	880.20	420.33	322.18	353.61
Flavonoids	7.23 mg/g DW (*Hong and Kim 2010*)	412.58 b	500.23 b	718.84 a	458.19 b
Anthocyanins	100-400 mg/100 g FW (*Park et al. 2013*)	201.34 a	44.45 b	23.31 c	26.36 bc

Tukey-test p≤0.05; n=4

- The light spectra influenced secondary metabolites differently.
- Polyphenol content did not show any significant difference among treatments also it was reduced by LED treatments.
- The highest flavonoid content was obtained under the supplemental green light.
- Anthocyanin content was the highest in control, differing significantly from LED treatments.
- It can be assumed that the low light condition, low nutrient supply or infections influence the flavonoid synthesis.

Conclusion

- Cultivation of *Perilla* with high nutritional value is possible in greenhouses in temperate regions
- This study showed that even small intensities of supplemental LED lighting could be use to enhance fresh mass and plant height of *Perilla* cultivated in greenhouse.
- The concentration of secondary metabolites as polyphenols, anthocyanins and flavonoids was not clearly affected by additional LED lighting, although results found in control were comparable with references.
- In future influence of specific wavelengths on concentration of secondary metabolites should be researched more in detail, whether they are applied alone or as a mixture.