LED lighting in vertical farming systems enhances bioactive compounds and productivity of vegetables crops

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1. Introduction

LEDs opens opportunities for vertical farming

- ✓Full control of production process
- ✓Limited area
- ✓Anywhere
- ✓Independent of enviroment
- ✓Sustaintable, but high electrical consumption
- ✓Guarantee on quantity and quality
- ✓2-3 times higher costs

1. Introduction

Advantages of vertical farming

- ✓Optimize nutrients and water consumption
- ✓Hygiene = no pesticides needed
- ✓Very little nutrients use
- ✓Short chains production
- ✓Products with added value: guarantees, quality, healthy, special product, marketing concept (e.g. local (Km 0), hygienic, etc)
- ✓Less food waste
- ✓Circular economy (reuse of outputs)

2. Materials and Methods

Data from the 2013-2022 period

- ❖ Smart tools and Boolean: AND, OR, and NOT
- ❖ Proximity: PRE/and W/

key- or co-words:
'**Vertical farming**' AND **led**

'Article title, Abstract, and Keywords'

64 articles and 476 keywords

<u>47 articles</u> was extracted that analyzed effects bioactive compound and 2018-2022 period

Data of interest of each article:

- ✓ Plant species
- ✓ The main goal
- ✓ Geographic location
- ✓ Nutritional parameters
- ✓ Spectra, light intensity and photoperiod
- ✓ Conclusions

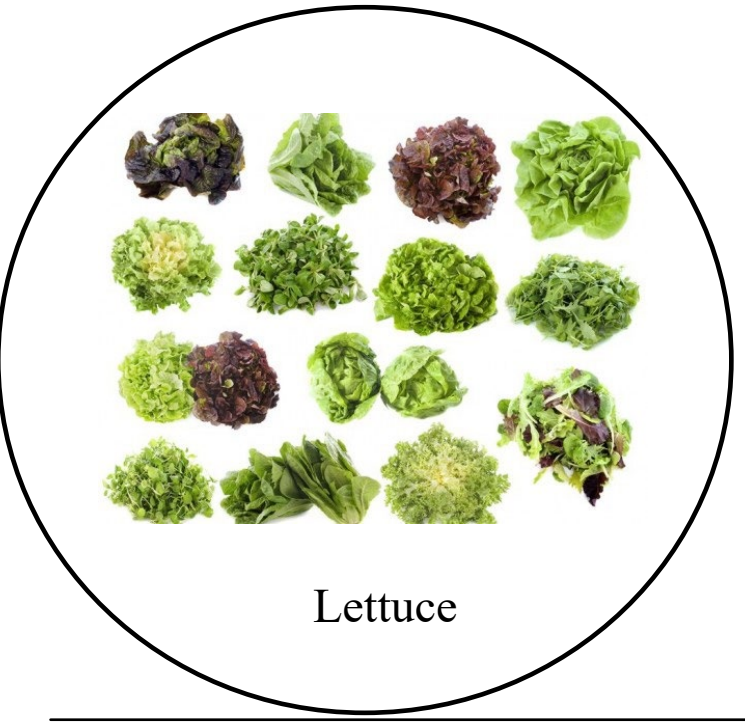
Bibliometric map

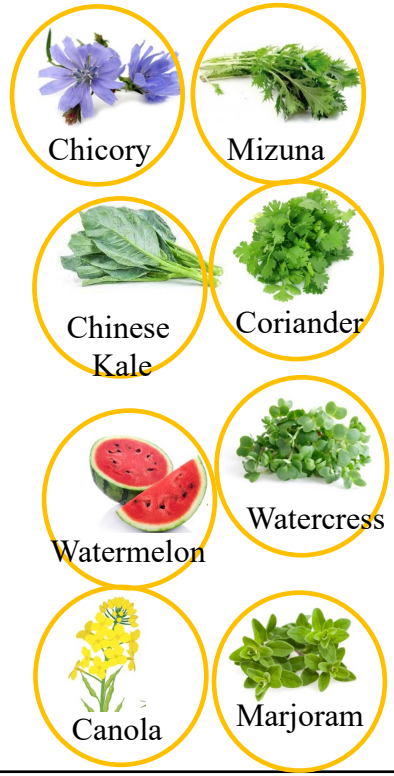
keyword co-occurrence ratio

Clustering algorithm of the VOSviewer®

3. Results

3.1. Crops





37 22 19 16 6

% used

3. Results

3.2. Clustering

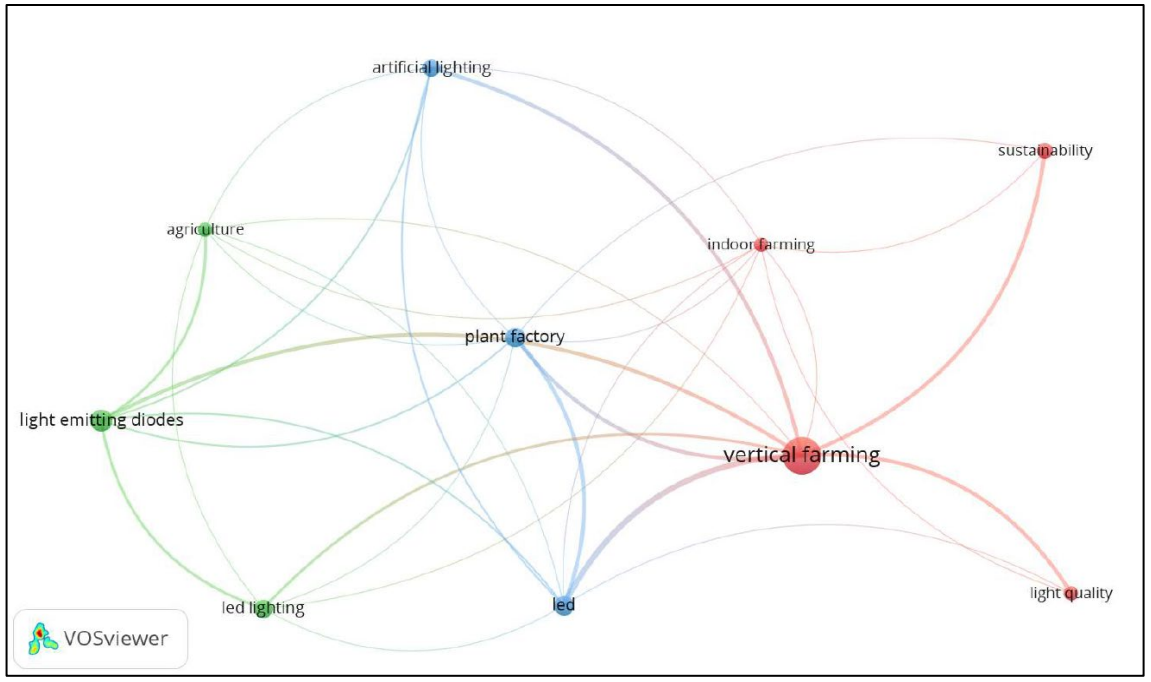


Figure 1. Bibliometric map generated from an analysis of the most repeated keywords in articles published during period 2013-2021. Different colours represent the diversity of thematic clusters found and the associated keywords: Red (cluster 1), green (cluster 2) and blue (cluster 3).

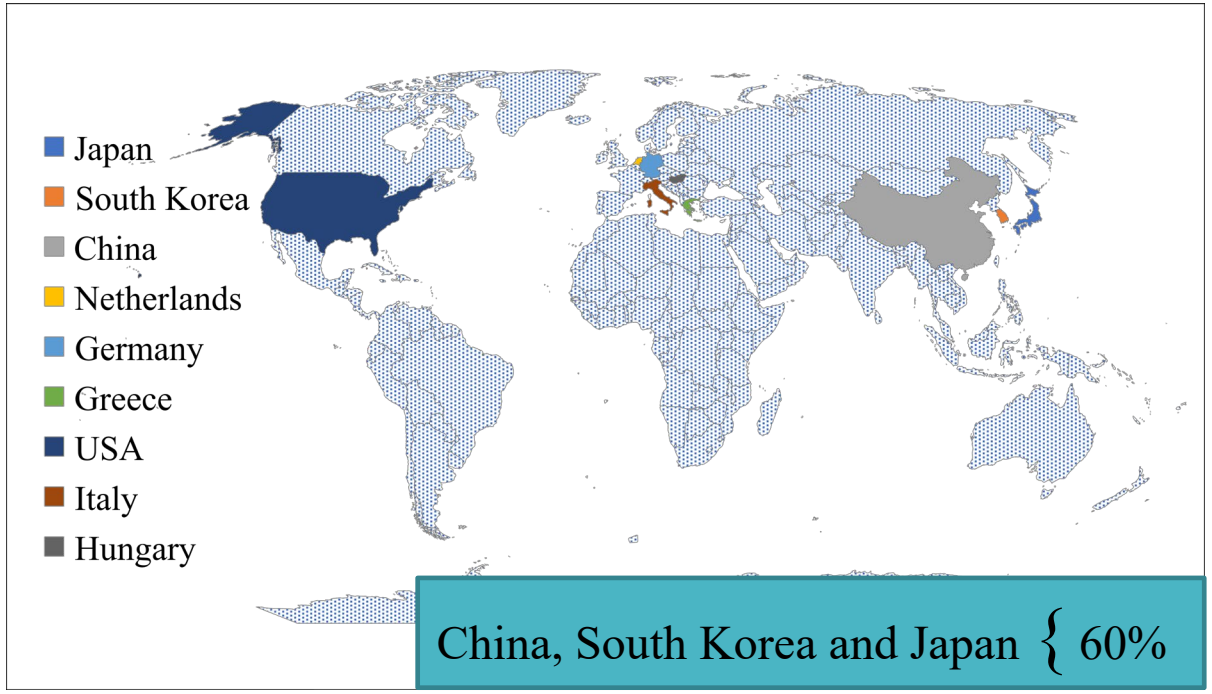


Figure 2. Global distribution of the main countries in which researchers have used the vertical farming and bioactive compounds in vegetables crops studies.

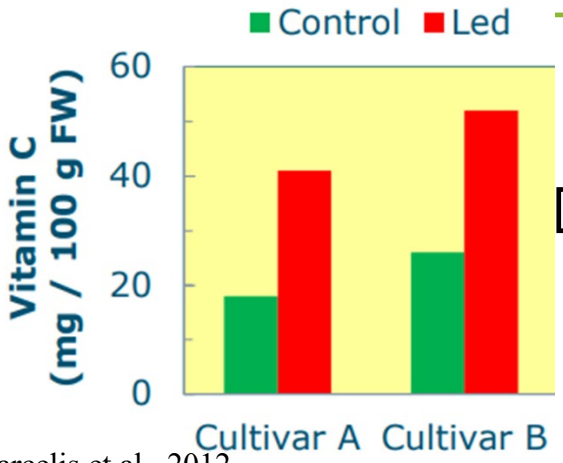
3. Results

3.3. Nutritional Parameters

Nitrate is highly correlated with chlorophyll content in plants.

Cancerogenic nitrosamines

75% of the nitrates consumed are supplied by vegetables



Marcelis et al., 2012

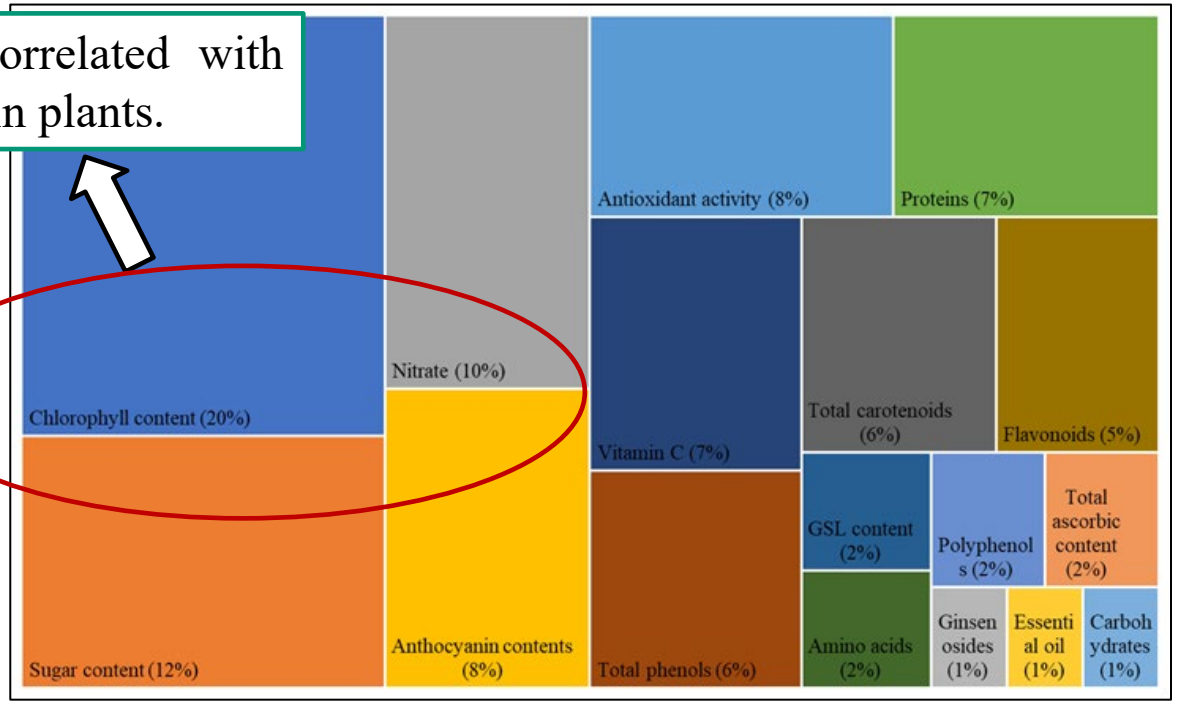


Figure 3. Research topics in the vertical farming on nutritional parameters. Values are expressed as percentages (n = 100)

Two hypotheses

- ➢ Sugar availability
- ➢ Direct light effect
- ● Electron transport
- ● Light signalling: biosynthesis pathway

3. Results

3.4. Light and Spectral Parameters

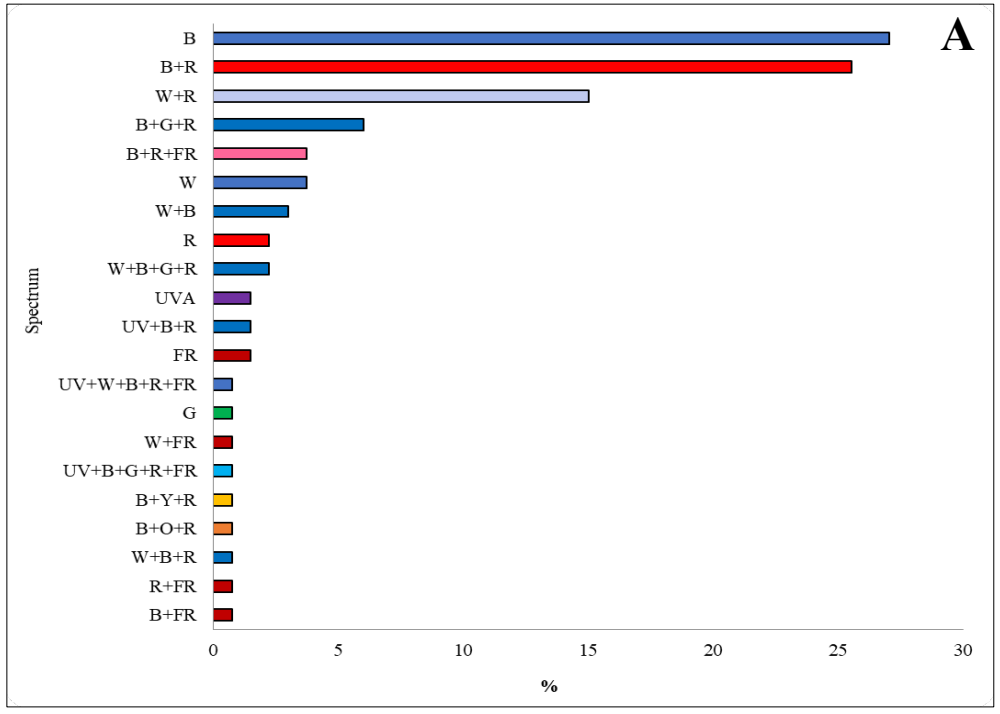
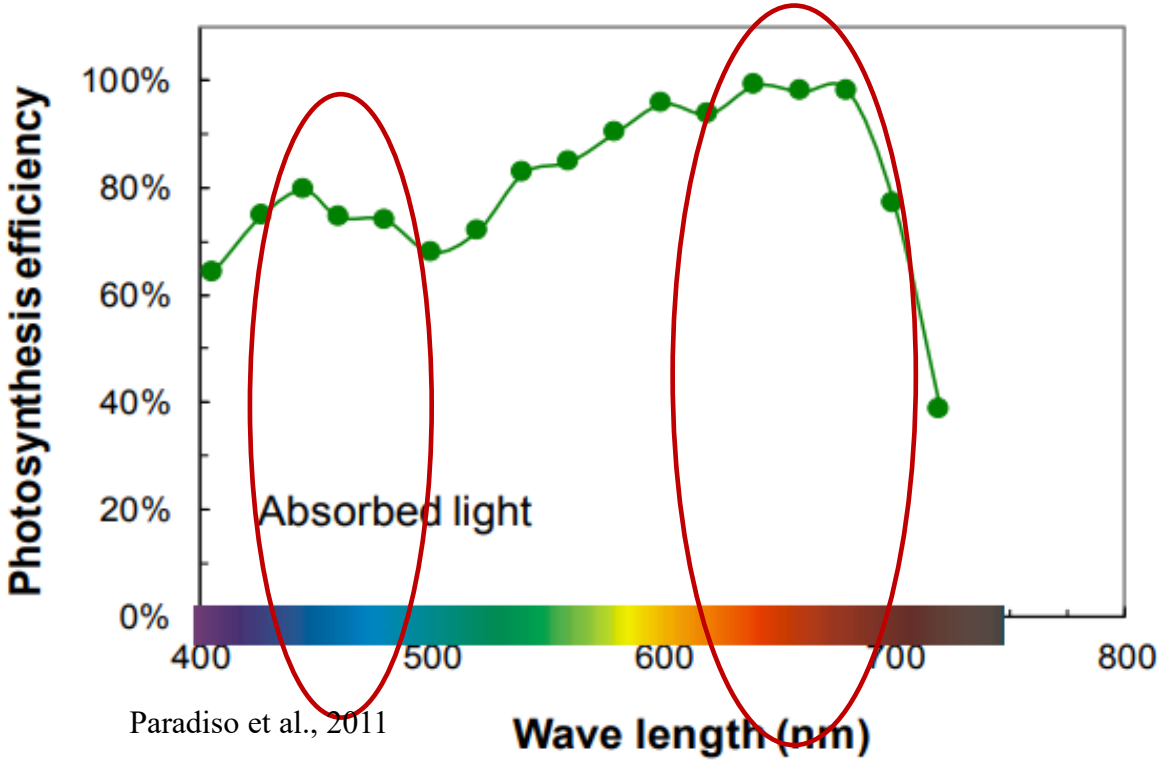


Figure 4. Type of spectra and color (A) used in the analized research. Data are expressed as percentage (n = 118). B (Blue 450-495 nm); R (Red 620-700 nm); FR (Far-red 700-800 nm); G (Green 500-560 nm); O (Orange 600-630); UV (380-450).



Paradiso et al., 2011

3. Results

3.4. Light and Spectral Parameters

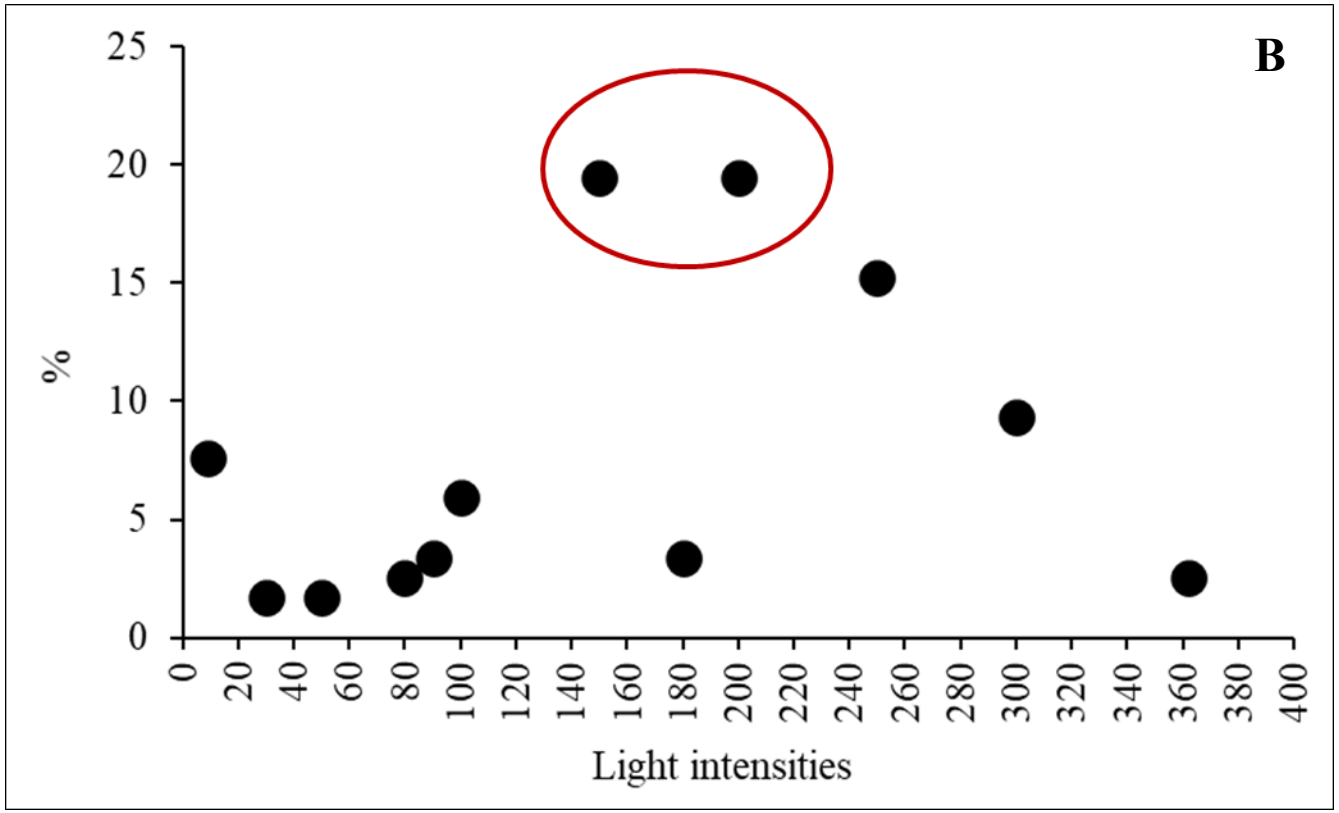
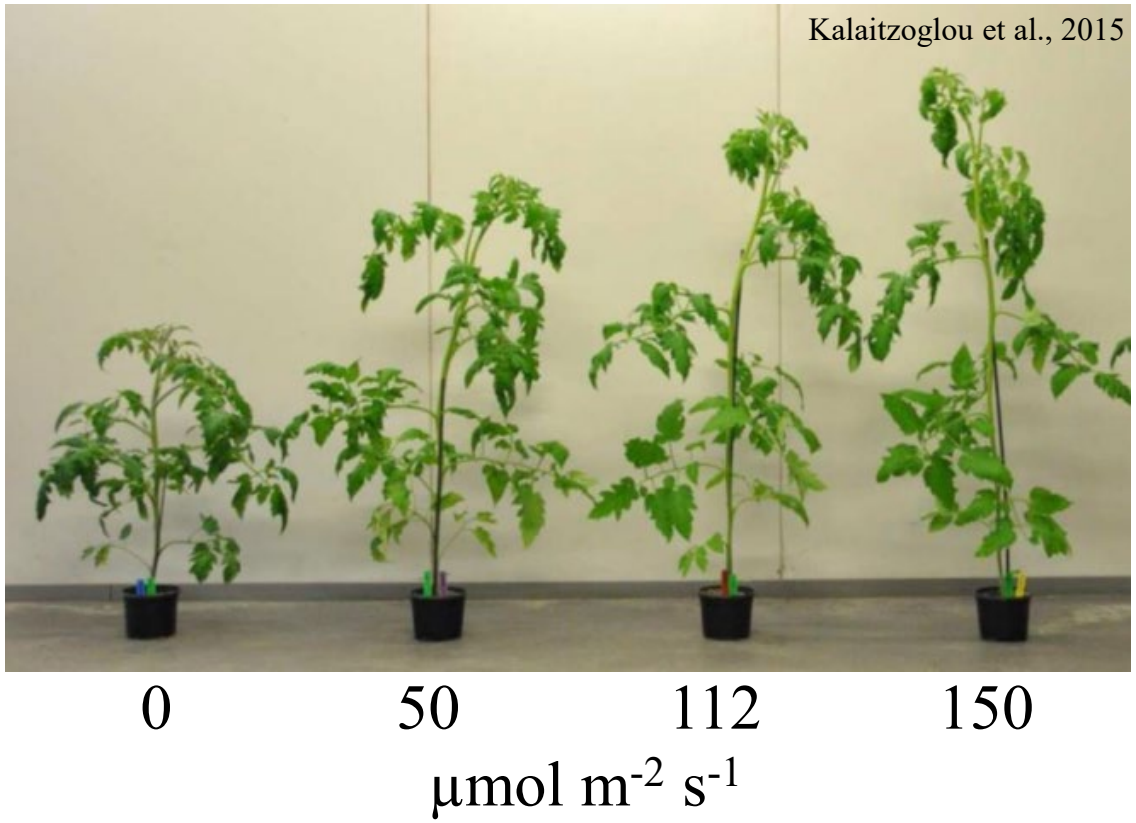


Figure 4. Light intensity (µmol m^{-2} s^{-1}) (B) used in the analized research. Data are expressed as percentage (n = 118). B (Blue 450-495 nm); R (Red 620-700 nm); FR (Far-red 700-800 nm); G (Green 500-560 nm); O (Orange 600-630); UV (380-450).



Conclusions

- ✓ The use of specific spectra fitting within the ranges of maximum photosynthetic efficiency significantly enhances the nutraceutical quality of a wide range of vegetables species.
- ✓ The recommended intensity light for vegetables crops is in the range of 150 and 200 µmol m^{-2} s^{-1}.
- ✓ The combined effect of LED lighting throught vertical farming systems is an alternative to increase the nutritional parameters and productivity of vegetables crops and optimising the raw resources use, such as water and energy.

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