Romanian Biotechnological Letters *Vol. 23, No. 6, 2018*

ORIGINAL PAPER

The assesment of the effect induced by LED-s irradiation on garlic sprouts (*Allium sativum* L.)

DOI: 10.26327/RBL2018.212

Received for publication, June, 2, 2018
Accepted, September, 13, 2018

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Abstract

The goal of our paper was to evaluate the influence exercised by LED-s emitted light treatments on the garlic (Allium sativum L.) sprouts. The sprouts were illuminated with four types of LED-s spectrum variants, respectively:white (white), red (R), blue (B) and green (G). Experimental results indicated that ***blue (B)*** *light LED-s determined the best level of the rate of garlic sprouts. While,* ***white (W)*** *light LED-s induced the best level of the fresh weight of garlic sprouts. The polyphenols content, antioxidant activity (determined by DPPH assay) and proteins concentration were evaluated in garlic sprouts. The content of polyphenols and proteins was significantly higher by treatment with red (R) light LED-s. The antioxidant capacity was determinated for the variant illuminated with red light LED.*

Key words: garlic sprouts, LED-s, proteins, antioxidant capacity, polyphenols

1. Introduction

Garlic (*Allium sativum* L.), is an important crop from the *Allium* Genus, *Amaryllidaceae* Family (http://www.theplantlist.org/1.1/browse/A/Amaryllidaceae/Allium/[1]). This species is one of the most commercially available worldwide (average 2006 - 2016 production share of garlic by region: Asia 91.2%, Europe 3.4%, Americas 2.9%, Africa 2.5% - http://www.fao.org/faostat/en/#data/QC/visualize[2]). The economic importance of this species (J. DE LA CRUZ MEDINA & H. S. GARCÍA [3]), is mainly based on its use in food in various forms (in fresh or preserved foods, fresh or dried, like leaf, stem or bulb, fragmented or powdered). Garlic is also used in both traditional (J. DE LA CRUZ MEDINA & H. S. GARCÍA, [3]) and modern human medicine. The trend of recent years is to use garlic as a functional food[4], because medical research shows the importance of organosulfuric compounds for human health - e.g., antioxidants, anti-inflammatory, immunomodulatory and antiaging actions with effects in prophylaxis of cardiovascular diseases, neurodegenetive disorders, diabetes, etc. (N. GONCHAROV & al. [5]; S. N. BATCHU & al.[6]). For example, allicin was present in whole plant green leaf extracts, shoots and leaves (M. ARZANLOU & S. BOHLOOLI[7]), and are effective in protection against various chronic disease conditions - e.g., atherosclerosis and hypertension (N. GONCHAROV & al. [5]; S. N. BATCHU & al. [6]).

The trend of increasing demand for both, functional foods and new cultivation methods, generates the need to identify innovative treatments of functional foods irrespective of limiting physical factors (light, temperature, etc.).

Recent papers (A. ZAHAROVA & al. [8]) proved that despite the health benefits of raw garlic, sprouted garlic presents a higher content in antioxidant compounds and antioxidant activity. Ethanolic extracts from garlic sprouted for different periods had variable antioxidant activities when assessed with in vitro assays. Furthermore, sprouting changed the metabolite profile of garlic: the garlic sprouted for 5 days had the highest antioxidant activity than garlic sprouted for 0 - 4 days.

Phenolic compounds are commonly found in both edible and non-edible plants and they have been reported to have multiple biological effects, including antioxidant activity. According to R. TEGELBERG & al. [9] the concentrations of flavonoids may be varied with the qualitative changes in incident light. The quality of light and irradiation cycles provided by LED-s modifies plant growth and concentration of phenolic compounds. Z. HOSSEN [10] has shown that red-green-blue combination of LED-s affects positively on biosynthesis of major polyphenols in buckwheat sprouts.

In this respect, the purpose of this study was to evaluate the influence of treatments with LED-s illumination (white, red, blue and green) on the rate, the fresh weight, the proteins concentration, polyphenolscontent and antioxidant activity of garlic sprouts.

2. Materials and Methods

The **biological material** was consisted from garlic seeds obtained from commercial source. The seeds sterilization was accomplished after the following protocol: 1 minut immersion in a 70% ethanol and then washed 10 minutes for 3 times with sterile distilled H_2O (E.M. BADEA & D. SĂNDULESCU [11]; D. CACHIȚĂ-COSMA & al. [12]). The seeds inoculation and incubation were realised on sterile gauze soaked with 15 ml sterilized distilled H_2O in transparent recipients (I.M. ENACHE & O. LIVADARIU [13]). The seeds were carried out in the dark for 24 h. After 7 days was added 5 ml sterilized distilled H_2O in each transparent recipients.

The light LED-s treatments were performed using four types of irradiation, respectively: cold white, deep red, green and high blue. The treatments LED-s irradiated light have been applied during the 16 h photoperiod, for 4 days, with incubation at a temperature of 23°C ± 2°C / photoperiod and the temperature of 20°C ± 2°C / dark period.

The experimental plan consisted of four variants:

- V1 / W = treatment by cold whitecolor LED-s – emitted light(W);
- V2 / R = treatment by deep red color LED-s – emitted light (R);
- V3 / B = treatment by high blue color LED-s – emitted light (B) and
- V4 / G = treatment by green color LED-s – emitted light (G).

1. The protein extraction was performed by grinding the sprouts tissue in 50 mM potassium phosphate buffer, 0,05% β-mercaptoethanol, 0,5 mM (DIFP) diizopropil fluorophosphat – protease inhibitor, pH = 6.8, (1 g / 0.5 ml, dry weight / buffer) at 4°C for 24 hours. The extract was centrifuged 18.000 rpm for 20 min and the supernatant was used for protein assay. The protein concentration was carried out using Bradford method (M.M. BRADFORD [14]), based on binding of protein by Coomassie Blue and measurement the absorbance of protein-dye complex at 595 nm.

2. Preparation of methanolic extracts. 3 ml of 100% methanol were added to 1g of sprout and grounded in a mortar with pestle. The extract was maintained overnight to 4ºC. After centrifugation 20 minutes at 15.000 rpm the supernatant was used for determination of phenolic compounds, antioxidant capacity and flavanoids content.

3. The polyphenol contentin methanolic extracts was evaluated using a modified method with Folin-Ciocalteu reagent (V. MIHAILOVIĆ & al. [15]). The reaction mixture consisted from 0.5 ml methanolic extract, 2.5 ml Folin-Ciocalteu diluted 1:10 and 2 ml 7.5% Na_2CO_3. The mixture was incubated for 30 minutes at room temperature. The absorbance was measured

at 765 nm. The calibration curve was prepared with different concentrations of gallic acid. The results are expressed in mg equivalent gallic acid /g fresh weight.

4. The antioxidant capacity of methanolic extracts was carried out according to Marxen and al. (K. MARXEN & al. [16]), using DPPH (2,2-diphenyl-1-picrylhydrazyl) and a calibration curve with Trolox as antioxidant standard. The mixture was incubated at room temperature for 30 minutes and spectrophotometrically detected at 517nm. The antioxidant capacity was expressed in mMTrolox/g fresh weight.

Statistical procedures. The each variant was consisted from 15 garlic seeds. The analysis were realised in triplicate. The data have been statistically analysed. The standard deviation of mean was calculated. The rate, the fresh weight of sprouts (**A**), antioxidant activity, polyphenols and proteins content (**B**) were accomplished.

3. Results and Discussions

A. Determination of the rate and the fresh weight of garlic (*Allium sativum* L.) sprouts by irradiation with white (W), red (R), blue (B) and green (G) LED-s

A1. Determination of **therate** of *Allium sativum* L. sprouts (**Figure 1**), releved the lowest value in the case of variant V4 / G (13.33) and the highest value for variants V3 / B (14.33). The values of the rate from others two sprout variants (V1 / W and V2 / R were similar (13.66).

Thus, the treatment with blue LED-s (V3 / B), induced a superior rate of sprouts in comparison with others variants. The blue LED-s treatment was the only one treatment which determined a higher rate of sprouts in comparison with white LED-s treatment. While the red LED-s treatment was equally and the green LED-s treatment was smaller in comparison with white LED-s treatment.

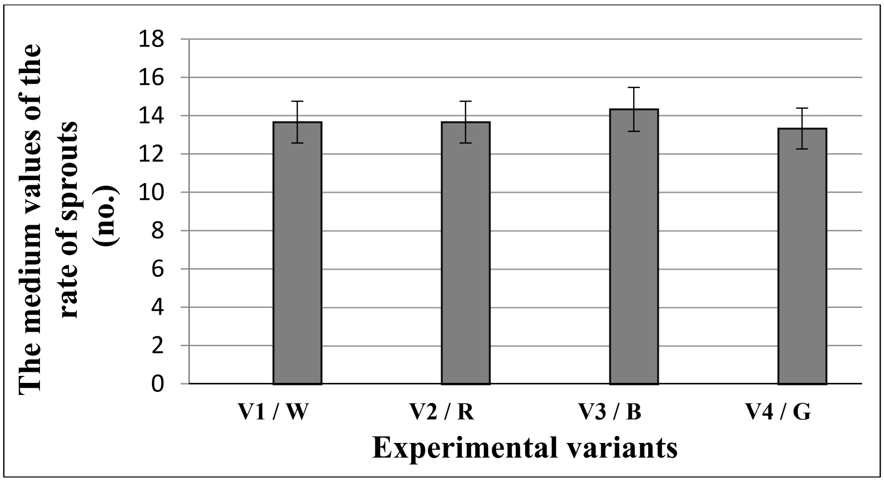

Figure 1. The medium values of **the rate** of *Allium sativum* L. sprouts (no.), for experimental variant (V1-V4)

A.2. Determination of **the fresh weight** of *Allium sativum* L. sprouts (**Figure 2**), emphasized that the lowest value for both variants V3 / B (0.24 g) and V4 / G (0.24 g), and the highest value for variant V1 / W (0.52 g).

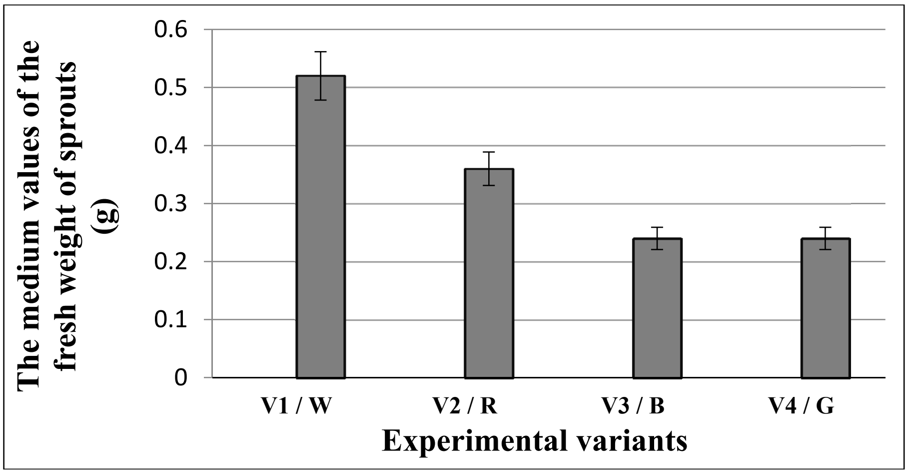

Figure 2. The medium values of **the fresh weight** of *Allium sativum* L. sprouts (g), for experimental variant (V1-V4)

The treatment with white LED-s (V1 / W), induced the highest fresh weight of sprouts in comparison with other variants. The blue and green LED-s treatments induced reduced values of fresh weight sprouts in comparison with white (W) LED-s treatment. The values of fresh weight sprouts were equal in case of treatment with blue and green light LED-s.

B. Biochemical analyses

B.1. **The proteins concentration** of garlic sprouts illuminated with white, red, blue and green LED-s **(Figure 3)**.

The illumination with red light LED-s (V2/R) produced the highest protein concentration for garlic sprouts. The white LED-s illumination induced a protein concentration lower than blue light LED-s but higher than green (V4/G). The lowest protein concentration was induced by green light LED-s treatment. Our previous studies revealed that protein concentration varied with experimented species: the protein concentration was higher for treatment with red (R) light LED for S1 wheat variety while blue (B) light LED-s induced the better response in protein biosinthesys in S2 wheat variety (D. RAICIU & al. [17] - in press).

The studies on hemp sprouts emphasized that the blue (B) light LED-s produced an enhanced protein concentration (O. LIVADARIU & al. [18]- in press).

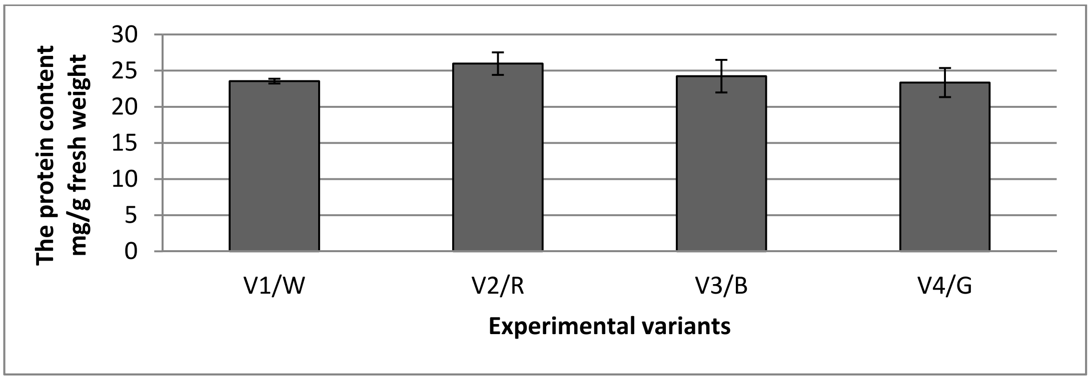

Figure 3. The **proteins concentration** of *Allium sativum* L. sprouts for experimental variants (V1-V4)

B.2. **The antioxidant capacity** of garlic sprouts illuminated with green, blue, red (R) LED-s or sunlight.

The antioxidant capacity of garlic sprouts illuminated with red (R) light LED-s had a value of 690 mMTrolox/g fresh weight while the other variants illuminated with white, green and blue light LED-s had no antioxidant activity.

B.3. The **polyphenols concentration** of garlic sprouts illuminated with white, red, blue, green LED-s **(Figure 4)**

The red (R) light LED-s induced the highest polyphenols concentration in garlic sprouts. The white (W) light LED-s determined the lowest concentration of polyphenols. The illumination with green light LED produced an increased polyphenols concentration than illumination with blue (B) light LED-s.

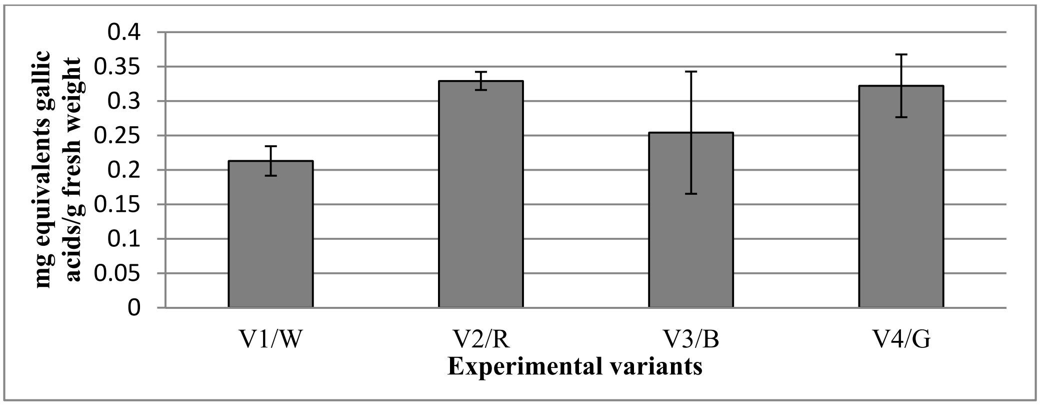

Figure 4. The **polyphenols concentration** of *Allium sativum* L. sprouts for experimental variant (V1-V4)

Other authors (A. ZAHAROVA & al. [8]), investigated whether sprouting enhanced the antioxidant activity of garlic and identified metabolites whose concentrations were significantly altered during sprouting that might contribute to the bioactivity of sprouted garlic.

4. Conclusions

Experimental results demonstrate that influence exercised of treatments with LED-s emitted lighton the rate and the fresh weight of *Cannabis sativa* L. sprouts, was depended from color of light LED-s. Actually, **the rate of sprouts** was increased by illumination with LED-s emitted blue light (V3 / B), while **the fresh weight of sprouts** was smaller by illumination with LED-s emitted white light (V1 / W).

The treatments with red (R) light LED-s determined an increasing of **polyphenolsand proteins concentration** and magnify the metabolic pathways for biosynthesis of proteins and polyphenols. The red (R) light LED-s treatment produced an increasing of **antioxidant capacity**. Therefore, these results are justifying to conclude that the consuming of garlic sprouts treated with LED-s light and generally LED-s treated crops can have health benefits.

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