

Effect of Ultraviolet (UV) Radiation Bands on Growth and Chlorophyll Content of *Dracocephalum moldavica* L Herb

Ahandani EA^{1*}, Fazilati M¹, Boghozian A¹ and Ahandani MA²

¹Biochemistry Department, Payame Noor University, Isfahan Branch, Isfahan, Iran; ²Health Department, Medical University of Ardebil, Ardebil, Iran

ABSTRACT

Dracocephalum Moldavica L, Lamiaceae is commonly consumed as a food-related product and as an herbal plant. According to new ways in UV effects on live organisms, this research was studied. It deals with the effect of UV-A and UV-C bands on the herbaceous drug. The plants were grown in a uniform environment in the culture room and exposed to UV rays (20 minutes UV-A daily and UV-C for 10 minutes) after 10 days in six weeks. Indices of fresh and dry weight of aerial and root organs, leaf area, chlorophyll a, b and total chlorophyll content were investigated. The results of the comparison of the mean of the studied traits showed that there was a significant difference between treatments, so that the highest amount of each of the traits was related to the control treatment and the least amount was related to treatment of UV-C bands. This study shows the sensitivity of the plant to the UV rays and the sensitivity of the plant to UV-C bands is higher than the UV-A bands.

Keywords: Ultraviolet radiation; *Dracocephalum moldavica*; Chlorophyll content and growth indices

INTRODUCTION

Dracocephalum moldavica is an herbaceous, annual plant originating from southern Siberia and Iran northern (Lahijan, Ahandan Amlash and Rasht). The herbaceous material is sedative and appetizing. It's essential oil has antibacterial properties and is suitable for stomach ache and bloating and it is also used in health, cosmetics and food industries. Moldavian balm (*Dracocephalum moldavica* L, Lamiaceae is commonly consumed as a food-related product and as an herbal preparation because of its reputed medicinal properties. Despite its importance, few reports exist in the literature regarding the chemistry or antioxidant activity of this species [1]. The Moldavian dragon's head (*Dracocephalum moldavica* L.) is an annual, herbaceous, essential oil-producing, spicy aromatic medicinal plant of the deadnettle family (Lamiaceae), which reaches 25-75 cm in height [2]. Its use was reported in West Azerbaijan (Iran) folk medicine as a general tonic, stomachic, digestive, antiemetic, sedative and diaphoretic [3]. Tincture of the dry herb has been used for ages in Uyghur folk medicine to treat heart disease, blood pressure, angina, tracheitis, atherosclerosis, neuralgia, migraine and headache and toothache [4]. Since the 1970s, 246 compounds, including terpenoids, steroids, flavonoids, alkaloids, lignans, phenols, coumarins, and cyanogenicglucosides, have been identified from the genus *Dracocephalum* and Terpenoids are the dominant constituents within the genus [3,5]. *D. moldavica* contains 0.06-0.92% essential oil, with the maximal

level during flowering. Its lemon-like scented essential oil consists mainly of oxygenated acyclic monoterpenes, e.g. geraniol, geranyl acetate, geranial, neral and nerylacetate [6]. Plants sensitive to UV may also respond by accumulating UV-absorbing compounds in their outer tissue layers, which presumably protect sensitive targets from UV damage. The key enzymes in biosynthetic pathways of these compounds have been shown to be specifically induced by UV irradiation via gene activation [7]. UV radiation above ambient may inhibit plant growth, development and reproduction and depress photosynthesis. It has been reported that the plant possesses antibacterial, antioxidant and cardioprotective effects [8,9]. A recent study showed that *D. moldavica* also has sedative effect. Although, the *D. moldavica* was popularly used in traditional medicine for pain relief, there have been no published reports regarding its antinociceptive effect. As a result of the increase in greenhouse gases, surface temperature will increase in the near future between 4.18 and 4.1°C. This will lead to increase in the temperature of the planet and will also increase the concentration of the atmospheric carbon dioxide, such as chlorofluorocarbons (CFCs), reduce the ozone layer and thereby increase the transmission of ultraviolet radiation [10]. UV-A (390-320 nm), although not absorbed by the ozone layer, causes the least damage to living organisms. UV-C bands (280-245 nm) have deleterious effects on living organisms. The harmful effects of this radiation on plants include reducing the photosynthesis process, decomposing proteins and nucleic

Correspondence to: Ahandani EA, Biochemistry Department, Payame Noor University, Isfahan Branch, Isfahan, Iran, E-mail: ebi.alinia@gmail.com

Received: January 16, 2019, **Accepted:** January 30, 2019, **Published:** February 07, 2019

Citation: Ahandani EA, Fazilati M, Boghozian A, Ahandani MA (2019) Effect of Ultraviolet (UV) Radiation Bands on Growth and Chlorophyll Content of *Dracocephalum moldavica* L Herb. J Biomol Res Ther, 8: 172. doi: 10.35248/2167-7956.19.8.172

Copyright: © 2019 Ahandani EA, et al. This is an open access article distributed under the term of the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

acids, oxidative stress, and reducing the amount of photosynthetic pigmentation [11]. UV radiation not only affects physiological and biochemical processes, but also affects the structure of plants. In most plants, altitude reduces leaf area loss, which is a protective mechanism against UV-damaged injuries. The purpose of this study was to investigate the effects of UV-A and UV-C banding on growth indices, photosynthetic pigmentation rates in herbaceous plant. To achieve maximum heterosis, the researchers searched for the varieties or accessions which were far, in genetic traits, from each other for finding the best parents in each crossing [1].

MATERIALS AND METHODS

The seeds of the plant were collected from the Agricultural and Natural Resources Research Center of Guilan province in Rasht city which cultured from Lahijan and Ahandan regions in Guilan eastern and disinfected with 10% sodium hypochlorite and planted in ductile beds in a bed of sand and soil mixture of 5 to 1. The pots in growth chambers with light period of 16 hours of light and 8 hours of darkness and temperatures between $27 \pm 2^\circ\text{C}$ per day and $16 \pm 2^\circ\text{C}$ at night were fed daily with a half-strength Hoagland solution. After 6 weeks, the radiation required for UC-A treatment by two lamps (F20T9 / BL-Hitachi, Japan) and the radiation required for UV-C treatment by a lamp (TUV/G30T8-Philips, Holland) for 10 days and Daily (UV-A for 20 minutes and UV-C for 10 minutes). After removing the specimens, the shoot and root were separated and the weight of each one was measured in grams. The leaf area of the plants was calculated using a scan machine

Table 1: Analysis of variance of the effect different bands of UV on plant measured characteristics.

df	Mean of squares							
	Fresh Weight		Dry Weight		Chlorophyll			Leaf Area
	Stem	Root	Stem	Root	a	b	Total	
Treatment								
Error CV (%)	22.75	19.75	2.17	0.04	2.47	0.91	7.27	51600
8	1.16	0.91	0.067	0.002	0.056	0.13	0.099	700
	12.22	17.95	16.58	13.52	11.70	17.88	11.53	9.79

and computer software Flächenberechnung-einer0sw-Grafik. Chlorophyll a, b and total leave of control and treated plants. The method of Lichtenthaler and Wellurm (1983) was measured. Data analysis was performed by way of ANOVA and the comparison of the mean of the treatments based on Duncan's multi-domain test using SAS software version 9.2 [11-13].

RESULTS AND DISCUSSION

The results of variance analysis of the studied traits showed that the effect of UV treatment on the measured traits was significant at the probability level of 1% (Table 1). Investigation of UV-treated samples showed that fresh weight of root and shoot in UV-C significantly decreased (Figure 1A-D). Also, dry weight measurements of treatments and control plants showed that this radiation reduced the dry weight of the air and root organs. This decrease in airship was significant especially in UV-C treatment (Figure 1). The weight loss of plants exposed to UV radiation has previously been reported in bean plants and *Impatiens capensis* [14,15]. Reducing the photosynthetic process in plants exposed to UV rays is the main cause of dry weight loss. Reduction in dry matter production in rice has been reported due to reduced leaf area and photosynthesis Analysis of variance of the effect different bands of UV on plant measured characteristics and mean significant at 5% and 1% probability levels, respectively and respectively represents a significant level at the probability level of 5 and 1 percent (Table 1). Based on the results obtained in this study, UV rays reduced the leaf area of treated plants that significantly decreased UV-C treatment (Figure 1). The highest leaf area was obtained from control treatment and the lowest leaf area was obtained from UV-C treatment. Reduction of leaf area for cotton leaves [9] and *Fagopyrum tataricum* has also been reported [10]. The main cause of the decrease in leaf area is that UV radiation prevents cell division, and the reduction in cell division due to UV-induced oxidation of tubules is delayed in the formation of microtubules and reduced levels of division, or prevents the transcription of histone proteins and thereby prevents cell division. Plants sensitive to UV may also respond by accumulating UV-absorbing compounds in their outer tissue layers, which presumably protect sensitive targets from UV damage. The key enzymes in biosynthetic

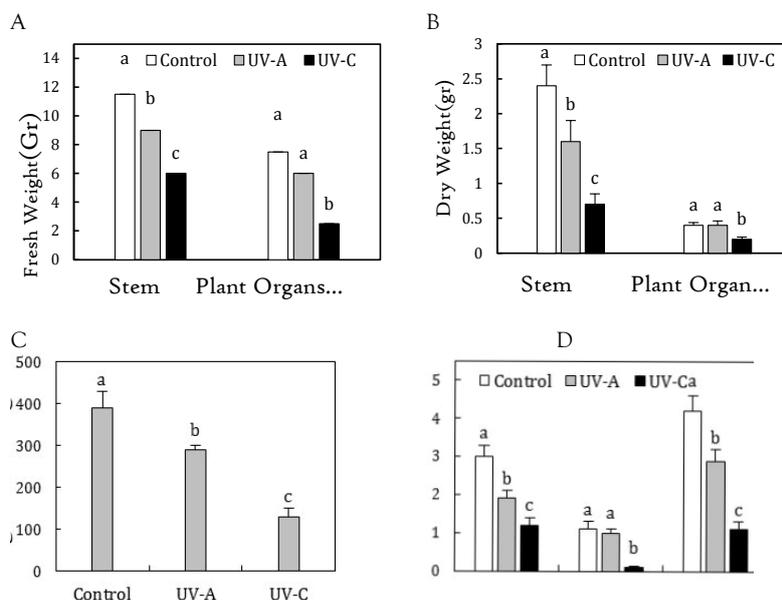


Figure 1: Effect of different bands of ultraviolet radiation on (A) shoot and root fresh weight, (B) shoot and root dry weight (C) leaf area and (D) chlorophyll a, b and Total. Different letters indicate significant differences (P<0.05). Each value is the mean \pm SE of three replicate extractions.

pathways of these compounds have been shown to be specifically induced by UV irradiation via gene activation [7]. The rice plant was affected by the UV-B rays of the chlorophyll a / b ratio, which is due to the fact that UV affects the amount of chloroplast proteins and the permeability of the chloroplast membrane and light-collecting proteins in the PSII reaction center and the ribosome enzyme it affects. It has also been reported that the reduction of photosynthetic pigmentation against UV rays due to chlorophyll degradation by light and the reduction of the chlorophyll synthesis rate is due to a reduction in the gene expression of chlorophyll-bound protein [16,17]. In this study, *Dracocephalum moldavica* L plant was sensitive to various UV bands and its growth indices were affected. Our results also showed that the sensitivity of this plant to UVC radiation is higher than that of UV-A [18-20].

CONCLUSION

We may conclude about the effects of different bands on this kind of medicinal plants which also will be used as essential source of disorders towards humans. This saying informs future researching to improve this herb into the *in vivo* and *in vitro* conditions. The study shows that *Dracocephalum* plants are sensitive to UV-C and UV-A with trend to UV-C and this finding give an insight into the physiological and morphological changes during UV exposure and indicate the sensitivity of these plants to UV-C more than UV-A radiation. For further improvements, we suggest to completely focus on Growth indexes and Chlorophyll to be sureness.

REFERENCES

- Omidbaigi R. Production and Processing of Medicinal Plants. Astaane Quds Razavi Pub Inst. 2000;3:1-5.
- Ahandani EA, Ramandi HD, Sarmad J. Evaluation of morphological diversity among some Persian walnut accessions (*Juglans regia* L.) in Guilan, northern Iran. *Int J Plant Biol Res.* 2014;2:1015-1022.
- Asadi-Samani M, Kafash-Farkhad N, Azimi N, Fasihi A, Alinia-Ahandani E. Medicinal plants with hepatoprotective activity in Iranian folk medicine. *Asian Pac J Trop Biomed.* 2015;5:146-157.
- Allen DJ, Nogue S, Baker RN. Ozone depletion and increased UV-B radiation: is there a real threat to photosynthesis. *J Exp Bot.* 1998;49:1775-1788.
- Zeng Q, Jin HZ, Fu JJ, Qin JJ, Hu XJ. Chemical constituents of plants from the genus *Dracocephalum*. *Chem Biodivers.* 2010;7:1911-1929.
- Kakasy AZ, LemberkovicsÉ, Simándi B, Lelik L, HéthelyiÉ. Comparative study of traditional essential oil and supercritical fluid extracts of Moldavian dragonhead (*Dracocephalum moldavica* L). *Flavour Fragr J.* 2006;21:598-603.
- Teramura AH, Sullivan JH, Abrol YP, Wattal PWG, Ort DR. Field Studies of Uv-B Radiation Effects on Plants: Case Histories of Soybean and Loblolly Pine. IBH Publishing Co Pvt Ltd. 1991;6:147-161.
- Hopkins L, Bond MA, Tobin AK. Ultraviolet-B radiation reduces the rates of cell division and elongation in the primary leaf of wheat (*Triticum aestivum* L). *Plant Cell Environ.* 2002;25:617-625.
- Jansen MA, Gaba V, Greenberg BM. Higher plants and UV-B radiation: balancing damage, repair and acclimation. *Trends Plant Sci.* 1998;3:131-135.
- Yao Y, Xuan Z, Li Y, He Y, Korpelainen H. Effects of UV-B radiation on crop growth, development, yield and leaf pigment concentration of tatar buckwheat (*Fagopyrum tataricum*) under field conditions. *Europ J Agron.* 2006;25:215-222.
- Reddy KR, Kakani VG, Zhao D, Koti S. Interactive effects of UV-B radiation and temperature on physiology, growth, development and hyperspectral reflectance. *Photochem & Photobiol.* 2004;79:416-427.
- Lichtenthaler HK, Welburn AR. Determination of total carotenoids and chlorophyll a and b of leaf extracts in different solvents. *Biochem Soc Trans.* 1983;11:591-592.
- Martínez-Vázquez M, Estrada-Reyes R, Martínez-Laurrabaquio A, López-Rubalcava C. Neuropharmacological study of *Dracocephalum moldavica* L. (Lamiaceae) in mice: Sedative effect and chemical analysis of an aqueous extract. *J Ethnopharmacol.* 2012;141:908-917.
- Rozema J, Jvan de Staaij, Bjorn LO, Caldwell MM. UV-B as an environmental factor in plant life: Stress and regulation. *Trends Ecol Evol.* 1997;12:22-28.
- Strid A, Chow WS, Anderson JM. UV-B damage and protection at the molecular level in plants. *Photosynth Res.* 1994;39:475-489.
- Barnes PW, Flint SD, Caldwell MM. Morphological responses of crop and weed species of different groups to ultraviolet-B radiation. *Am J Bot.* 1990;77:1354-1360.
- Hollosy F. Effects of ultraviolet radiation on plant cells. *Medchem, Molebio & Pathobio.* 2002;33:179-197.
- Kakani VG, Reddy KR, Zhao D, Mohammed AR. Effects of UV-B radiation on cotton (*Gossypium hirsutum* L.) morphology and anatomy. *Ann Bot.* 2003;91:817-826.
- Takeuchi A, Yamaguchi T, Hidema J, Strid A, Kumagai T. Changes in synthesis and LHCII with leaf age in rice (*Oryza sativa* L.) growing under supplementary UV-B radiation. *Plant Cell Environ.* 2002;25:695-706.
- Teramura AH, Sullivan JH. Effects of UV-B radiation on photosynthesis and growth of terrestrial plants. *Photosynth Res.* 1994;39:463-473.