INNSPUB

International Journal of Biosciences | IJB |
ISSN: 2220-6655 (Print) 2222-5234 (Online)
http://www.innspub.net
Vol. 3, No. 2, p. 141-145, 2013

SHORT COMMUNICATION OPEN ACCESS

Anthocyanin content of coriander (*Coriandrum sativum* L.) leaves as affected by salicylic acid and nutrients application

Abdol Rahman Rahimi[1*], Sirwan Babaei[2], Kambiz Mashayekhi[3], Asad Rokhzadi[1], Sheno Amini[4]

[1]*Department of Agronomy and Plant Breeding, Sanandaj Branch, Islamic Azad University, Sanandaj, Iran*

[2]*Department of Agronomy and Plant Breeding, University of Tehran, Karaj, Iran*

[3]*Department of Horticultural Science, Gorgan University of Agricultural Sciences and Natural Resources, Gorgan, Iran*

[4]*Member of young researchers club, Islamic Azad University, Sanandaj Branch, Sanandaj, Iran*

Key words: Anthocyanin, coriander, nutritional minerals, salicylic acid.

doi: http://dx.doi.org/10.12692/ijb/3.2.141-145 Article published on February 25, 2013

Abstract

A field experiment was conducted to assess the influence of salicylic acid and some important macro and micro elements on anthocyanin content of coriander (*Coriandrum sativum* L.) leaves as antioxidant, at the experimental field of Gorgan University, Golestan, Iran, in 2007. Based on the soil analysis nitrogen, phosphorus, potassium and zinc fertilizers were added to the experimental field with 75, 45,170 and 30 kg/ha, respectively. Salicylic acid at the rate of 10^{-4} molar, iron, magnesium, molybdenum and boron in a rate of 2-3 g/L were sprayed on foliage part two times at 40^{th} and 47^{th} days after sowing. Other plots were sprayed with distilled water. Results showed that application of zinc and nitrogen significantly increased and decreased anthocyanin content in coriander leaves as compared with control and led to the highest and the lowest rates of anthocyanin, respectively. Also other treatments did not show significant difference than control but phosphorus and potassium had negative effect on anthocyanin content, while other treatments increased it insignificantly.

* **Corresponding Author:** Abdol Rahman Rahimi ✉ abdolrahmanrahimi60@gmail.com

Introduction

Coriander (*Coriandrum sativum* L.), is an annual herb of the Apiaceae family and native to the Mediterranean region has been cultivated since human antiquity (Telci et al., 2006). Both foliage and fruits contains essential and green foliage of coriander contain anthocyanin (Omidbaigi, 2005). Coriander is economically important since it has been used as a flavouring agent in food products, perfumes and cosmetics. Moreover, its essential oils and various extracts have been shown to possess antibacterial (Burt, 2004), antioxidant (Wangensteen et al., 2004) antidiabetic (Gallagher et al., 2003), anticancerous and antimutagenic (Chithra and Leelamma, 2000) activities.

Anthocyanins are bioactive flavonoid compounds that have been recognized to be beneficial to human health against many chronic diseases (Routray and Orsat, 2011). Furthermore, increment of anthocyanin in foliage of coriander as antioxidant is important for improvement of nutrition value and can be beneficial for human health. Anthocyanin accumulation in the plant is stimulated by several factors such as high-intensity light, low temperature, drought, nitrogen and phosphorus deficiency (Meyer et al., 1973; Hopkins, 1999), uv (Reddy et al., 1994), Pathogens (Hipskind et al., 1996), cytokinin (Deikman and Hammer, 1995), gibberellins (Mealem- Beno et al., 1997), ethylene (Woltering and Somhorst, 1990) methyl jasmonate (Franceschi and Grimes, 1991) and salicylic acid (Latunde-Dada and Lucas, 2001). There is little information available concerning the response of coriander to microelements. In this subject, the available data about micro elements are scarce and many of studies limited by nitrogen, potassium and phosphorus. Thus the aim of this study was to determine the effects of salicylic acid and some micro and macro elements on the anthocyanin content of coriander leaves.

Material and methods

A field experiment was conducted at the Gorgan University of Agriculture Sciences and Natural Resources, Research Farm, Gorgan (36°51'N, 54°16'E and 13 m above sea level) during the 2007growing season. The soil was characterized as a silty clay loam containing 1.7% organic matter, 0.84% organic carbon and absorbable potassium, phosphorus, magnesium, iron, zinc, boron, molybdenum in a range of 11.3, 186, 457, 14.1, 1.3, 1.2, 0.001 ppm, respectively (0-30 cm of soil profile). The soil Ph was measured 7.9.

The experiment was laid out in randomized complete block design with 10 treatments including: nitrogen, potassium, phosphorus, magnesium, iron, zinc, boron, molybdenum, salicylic acid and control (distilled water spraying) in three replications. Seeds were sown at a 25 cm row distance and 5 cm into row plots, consisting of nine rows 3 m long (2.5 m × 3 m = 7.5 m2) on April 9, 2007. Until plant establishment irrigation was performed every 5 days and the next additional irrigation times were done dependent on the weather conditions. The plots were kept weed-free by hand.

According to soil testing nitrogen, phosphorus, potassium and zinc fertilizers were added to the experimental field with 75, 45,170 and 30 kg/ha, respectively. One third of nitrogen and total amount of phosphorus, potassium and zinc were applied at sowing time and the remaining N was applied after thinning and shooting phase. Salicylic acid at the rate of 10^{-4} molar, iron, magnesium, molybdenum and boron in a rate of 2-3 g/L were sprayed on foliage part two times at 40th and 47th days after sowing. Other plots were sprayed with distilled water.

Anthocyanin contents of leaves of coriander were measured according to Wanger (1979) at flowering time. Then 0.5 gr of petals tissue were extracted via 5 ml methanol containing 1% HCl, and incubated overnight at 4°C in darkness. Then absorbance was determined by spectrophotometer at 520nm. Data were analyzed using SAS software (2001) and the mean values were compared using the LSD test at 5%.

Results and discussion

The results of variance analysis in our study demonstrated that content of anthocyanin in leaves of coriander at 1% probability were significantly influenced by applied treatments (Table 1).

Table 1. Variance analysis of the effect of salicylic acid and some micro and macro elements on the anthocyanin content of coriander leaves.

Sources	degree of freedom	anthocyanin
Blocks	2	6481.9*
Treatments	9	5330.7**
Errors	18	1411.0
CV (%)	-	13.4

* and ** significant at 5 and 1 % respectively.

Table 2. Mean values of the effects of salicylic acid and some micro and macro elements on the anthocyanin content of coriander leaves.

Treatments	anthocyanin (absorbance at 520 nm)
nitrogen	202.5 [e]
phosphorus	238.0 [de]
potassium	258.8 [cde]
magnesium	288.6 [abcd]
zinc	354.8 [a]
boron	272.5 [bcd]
molybdenum	289.4 [abcd]
iron	315.8 [abc]
salicylic acid	323.3 [ab]
control	271.2 [bcd]

Means with the same letters do not significantly differ by LSD tests ($p < 0.05$).

The present study has indicated that zinc is more effective in increasing of anthocyanin content in coriander leaves and significantly increased it than control. Although, salicylic acid, magnesium, iron, molybdenum and boron increased the content of anthocyanin, but no significant ($p \leq 0.05$) differences were found with control. In contrast, nitrogen significantly decreased the anthocyanin content to its lowest rate. Also, phosphorus and potassium had a negative effect on anthocyanin content and insignificantly decreased it (Table 2). These results are in agreement with those obtained by Jeppsson (2000), who showed that with the increase of nitrogen, phosphorus and potassium concentration, anthocyanin content in *Aronia melanocarpa* was decreased. Peng et al (2002) found that the application of nitrogen decreased anthocyanin in *Malus domestica*. On the other hand, Dedaldechamp et al. (1995) reported that, Dihydroflavonol reductase [dihydrokaempferol 4-reductase] (DFR) activity and anthocyanin accumulation enhanced by phosphate deprivation in Cell suspensions of grape.

The results demonstrated that nitrogen significantly decreased the anthocyanin production in coriander. So it could be related to the effects of high N supply on the metabolic pathway of anthocyanins in different ways, such as delaying the quantitative and qualitative biosynthesis and enhancing their degradation (Hilbert et al., 2003), or by decreasing the rate of phenylalanine deamination of phenylalanine and synthesis of Dihydroflavonol reductase. In this case Bongue-Bartelsman and Phillips (1995) reported that steady-state mRNA levels for chalcone synthase (CHS), DFR and anthocyanins production, increased under nitrogen stress, in tomato leaves. They also cleared that deamination of phenylalanine under nitrogen deficiency conditions led to ammonia recycling for protein synthesis and the cinnamic acid can be converted to flavonoids.

Furthermore, our results indicated that application of micro element had a positive effect on anthocyanin accumulation in coriander leaves. In this case Zn treatment significantly increased anthocyanin content and led to the highest accumulation rate of this antioxidant compound. These results are similar to those of Zare Dehabadi (2007) for *Mentha spicata* L.; they showed that anthocyanin contents increased gradually with increase of Zn concentration. Oren-shamir (2003) found that the application of Mg (NO3)2, increased anthocyanin concentration in *Aster sp, Anigozanthos sp and Chrysobalanus icaco* plants. The mechanisms of the effect of micro elements on anthocyanin biosynthesis are poorly understood for us, but DeMan (1999) cleared that many of anthocyanins contain organic acids and metal cations such as Mg, Al and Fe. The increase of anthocyanins after the application of micro-nutrients may be attributed to the role of some of them in anthocyanin structure.

Our findings showed that salicylic acid following of zinc, enhanced anthocyanin content in coriander. On the other hand Khavarinezhad *et al* (2004) reported that application of salicylic acid increased the anthocyanin content in *Bellis perennis*. They also noted that salicylic acid led to induce the expression of involved genes in anthocyanin biosynthesis enzymes (phenylalanine ammonia-lyase and chalcone isomerise).

In conclusion, our results suggest that salicylic acid and micro elements, especially zinc can be effective in improving anthocyanin biosynthesis in coriander.

References

Latunde-Dada AO, Lucas JA. 2001. The plant defense activator acibenzolar-s-methyl primes cowpea [*Vigna unguiculata* (L.) Walp] seedlings for rapid induction of resistance. Physiological and Molecular Plant Pathology **58(5)**, 199-208, http://dx.doi.org/10.1006/pmpp.2001.0327

Bongue-Bartelsman M, Phillips DA. 1995. Nitrogen stress regulates gene expression of enzymes in the flavonoid biosynthetic pathway of tomato. Plant Physiology and Biochemistry **33**, 539-546.

Burt S. 2004. Essential oils: their antibacterial properties and potential application in food-a review. International Journal of Food Microbiology **94**, 223-253, http://dx.doi.org/10.1016/j.ijfoodmicro.2004.03.022

Chitra V, leelama S. 2000. *Coriandrum sativum*-effect on lipid metabolism in 1, 2-dimethyl hydrazine induced colon cancer. Journal of Ethnopharmacology **71(3)**, 457-463, http://dx.doi.org/10.1016/S0378-8741(00)00182-3

Dedaldechamp F, Uhel C, Macheix JJ. 1995. Enhancement of anthocyanin synthesis and dihydroflavonol reductase (DFR) activity in response to phosphate deprivation in grape cell suspensions. Phytochemistry **40(5)**, 1357-1360, http://dx.doi.org/10.1016/0031-9422(95)00480-U

Deikman J, Hammer PE. 1995. Induction of anthocyanin accumulation by cytokinins in *Arabidopsis thaliana*. Plant Physiology **108**, 47-57, http://dx.doi.org/10.1104/pp.108.1.47

DeMan JM. 1999. Principles of Food Chemistry. 3rd edition. Aspen Publishers, Inc. Gathersburg, Maryland.

Franceschi VR, Grimes HD. 1991. Induction of soybean vegetative storage proteins and anthocyanins by low-level atmospheric methyl jasmonate. Proceedings of the National Academy of Sciences 88, 6745-6749.

Gallagher AM, Flatt PR, Duffy G, Abdel-wahab YHA. 2003. The effects of traditional antidiabetic plants on in vitro glucose diffusion. Nutrition Research **23**, 413-424, http://dx.doi.org/10.1016/S0271-5317(02)00533-X

Hopkins WG. 1999. Introduction to plant physiology. John Wiley and Sons, New York.

Hilbert G, Soyer JP, Molot C, Giraudon J, Milin S, Gaudillere JP. 2003. Effects of nitrogen supply on must quality and anthocyanin accumulation in berries of cv. Merlot. Vitis **42**, 69-76.

Hipskind J, Woodand K, Nicholson R.L. 1996. Localized stimulation of anthocyanin accumulation and delineation of pathogen ingress in Maize genetically resistant to *Bipolaris maydis* race O. Physiological and Molecular Plant Pathology **49**, 247-256.

Jeppsson N. 2000. The effects of fertilizer rate on vegetative growth, yield and fruit quality, with special respect to pigments, in black chokeberry (*Aronia melanocarpa*) cv. 'Viking'. Scientia Horticulturae **83**, 127-137.

Khavarinezhad R, Mehranian S, Asadi A. 2004. Effect of salicylic acid on the anthocyanin content in *Bellis perennis* inoculated by fung. Journal of Science of Tarbiat Moalem University **4**, 427-438.

Mealem-Beno D, Tamari G, Leitner- Dagan YL, Borochov A, Weiss D. 1997. Suger-dependent gibberellin-induced chalcone synthase gene expression in *Petunia corollas*. Plant Physiology **113**, 419-424.

Meyer BS, Anderson DB, Bohning RH, Fratianne DG. 1973. Introduction to Plant Physiology. 2nd ed. D. Van Nostrand, New York.

Omidbaigi R. 2005. Production and processing of medicinal plants. Vol 2.Tehran. Astan Quds. In Persian.

Oren-shamir M, Nissim-Levi A, Ovadia R, Kagan S, Shaked-Sachray L. 2003. Increased anthocyanin accumulation in flowers and foliage at elevated temperatures is affected by magnesium treatment. Acta Horticulturae 624, 171-176.

Peng FT, Jiang YM, Gu MR, Shu HR. 2002. Effect of nitrogen on apple fruit development in different load. Scientia Agricultura-Sinica **35**, 690-694.

Reddy VS, Gould KV, Sharma R, Reddy AR. 1994. Ultraviolet-B-responsive anthocyanin production in rice is associated with a specific phase of phenylalanine ammonia lyase biosynthesis. Plant Physiology **105**, 1059-1066.

Routray W, Orsat V. 2011. Blueberries and their anthocyanins: Factors affecting biosynthesis and properties. Comprehensive Reviews in Food Science and Food Safety 10, 303-320.

SAS Institute. 2001. SAS/StaTUserˇıs Guide.Version9. SAS Institute, Cary, NC.

Telci I, Toncer OG, Sahbaz N. 2006. Yield, essential oil content and composition of *coriandrum sativum* varieties (var. vulgare Alef and var. microcarpum DC.) grown in two different locations. Journal of Essential Oil Research **18**, 189-193, http://dx.doi.org/10.1080/10412905.2006.9699063

Wangenesteen H, Samuelesen AB, Malterud KE. 2004. Antioxidant activity in extracts from coriander. Food Chemistry **88**, 293-297, http://dx.doi.org/10.1016/j.foodchem.2004.01.047

Wanger GJ. 1979. Content and vacuole\ extra vacuole distribution of neutral sugars, free amino acids and anthocyanins in protoplasts. Plant Physiology **64**, 88-93.

Woltering EJ, Somhorst D. 1990. Regulation of anthocyanin synthesis in cymbidium flowers: effects of emasculation and ethylene. Plant Physiology **136(3)**, 295-299, http://dx.doi.org/10.1016/S0176-1617(11)80052-0

Zare Dehabadi S, Asrar Z, Mehrabani M. 2007. Effect of zinc on growth and some physiological and biochemical parameters of spearmint (*Mentha spicata* L.). Journal of Iranian Biology **20**, 230-241. In Persian.