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Diurnal Changes in Essential Oil Content of Coriander (*Coriandrum sativum* L.) Aerial Parts from Iran

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Abstract: Iranian Coriander (*Coriandrum sativum* L.) is one of the most commonly collected from cultivated Coriander species in Iran. In this study, the diurnal variability of the essential oil content in *Coriandrum sativum* L. grown in the ecological conditions of Shiraz was studied during 2008. The seed of coriander were sown in April 2008 by hand in rows of 55 cm apart and spaced 35 cm distances between every plant in the row at the experimental farm of Shiraz University in a complete plot design with 3 replications. Shoots in green fruit stage of life cycle of this species including green fruit and leaves were collected 4 times a day (at 6, 12, 18 and 24 o'clock). The content of the essential oil were obtained in the aerial parts samples by using an all glass Clevenger-type apparatus, for 3 h. The results of this experiment indicated that essential oil content changed according to the hour of day and night. Essential oils in 12 h was more than other hours so that yields of essential oil (w w^{-1}%) at different times were in the order of 6 (0.432%), 12 (0.436%), 18 (0.404%) and 24 (0.319%) treatments. The significant differences were obtained between these hours in 1% level. According to these results, we conclude that for obtaining of more yields of essential oil and other volatile compounds, harvesting of matter plants must be accomplished at special hour in one day.

Key words: Essential oil, *Coriandrum sativum* L., diurnal variation, Iranian coriander

INTRODUCTION

Coriander (*Coriandrum sativum* L.) is a culinary and medicinal plant from the *Umbelliferae* family. This plant is of economic importance since it has been used as flavoring agent in food products, perfumes and cosmetics. As a medicinal plant, *C. sativum* L. has been credited with a long list of medicinal uses. Powdered seeds or dry extract, tea, tincture, decoction or infusion have been recommended for dyspeptic complaints, loss of appetite, convulsion, insomnia and anxiety (Emamghoreishi *et al*., 2005). Moreover, the essential oils and various extracts from coriander have been shown to possess antibacterial (Burt, 2004; Cantore *et al*., 2004; Kubo *et al*., 2004), antioxidant (Wangensteen *et al*., 2004), antidiabetic (Gallagher *et al*., 2003), anticancerous and antimutagenic (Chithra and Leelamma, 2000) activities such as geranyl acetate, linalool, dihydrocarvone, anethole, camphor, α-pinene, phellandrene, linalyl acetate, limonene, para-cymene, Decanal the main components, content of the essential oils are considered as a quality criterion (Grosso *et al*., 2008; Zheljazkov *et al*., 2008) that is shown in Fig. 1.

Numerous studies have been conducted on this species (Zheljazkov *et al*., 2008; Anitescu *et al*., 1997), particularly on their volatile compounds (Bandoni *et al*., 1998; Carruba and la Tore, 2002; Eyres *et al*., 2005; Grosso *et al*., 2008; Msaada *et al*., 2007).

Although synthesis of volatile compound in medicinal plants control by genetic processes, but those productions obviously influenced by environmental factors so that environmental factors cause changes in growth of medicinal plant, quantity and quality of them volatile compound (Alkaloids, Glycosides, Steroids, essential oils, Flavonoides, Phenols, Terpenoides, Tannins, Azotoides, Carbohydrates, Keton, Saponin, Biter matters, Mucilage, Salicilic acid, etc). The environmental factors as light (quality, intensity and duration), temperature, irrigation, elevation, soil and nutrition elements alone or in combination with to have main

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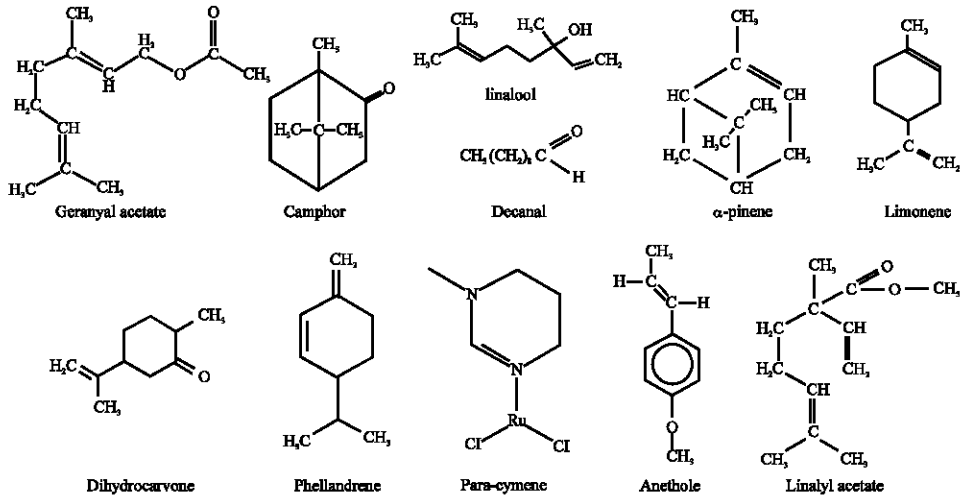

Fig. 1: Structures of the major compounds identified in the essential oil of coriander (*Coriandrum sativum* L.) in previous investigations

influence on secondary metabolite situation of plants. The temperature in day duration usually is variable from morning to night. The temperature has more effect on essential oil in medicinal plants. My previous research demonstrated that essential oil content of Eucalypt, Rosemary, White Cedar and Lawson Cypress were varying during time of day (Ramezani, 2007; Ramezani *et al*., 2009).

There are no data concerning the diurnal variation of composition and yield of the essential oil in this species especially growing in Iran during specific hours of the day and night. Thus, this study reports for the first time diurnal variation of the essential oil content isolated from the aerial parts of Iranian Coriander (*C. sativum* L.) cultured at Shiraz, Iran.

MATERIALS AND METHODS

Site information: The experiment was carried out in 2008 at the Experimental Farm of Agricultural Faculty, Shiraz University in Shiraz, located in the Badjgah, Fars province, Iran (Table 1).

The soil of experimental plots was a clay silt loam with pH of 7.6. The daily climatic data during this study were obtained from the agro-meteorological station of irrigation department located in a state farm about 1 km far from the experimental site. The mean values for maximum and minimum temperature (°C) for the months of April, May, June and July 2008 were 24.61 and 4.72, 29.68 and 8.7, 35.11 and 12, 35.65 and 15.2, respectively. The average relative humidity and total rainfall of the months of April, May, June and July 2008 were 39.93% and 3.5 mm; 19.2% and 0 mm; 28.76% and 0 mm and 29.74% and 0 mm, respectively.

Table 1: Geographical situation and weather condition of the field under coriander

Characteristics	Results
Latitude	29°36'N
Altitude	52°32'E
Sea level	1810 m
Min. Temp*. In recent 10 year period	-9°C
Max. Temp. In recent 10 year period	38°C
Rain fall in recent 10 year period	400 mm
Climate class	Semi arid moderate

*Temp. = Temperature

Plant material: Seeds of the Iranian natural population of coriander were provided by the horticultural department of Shiraz University and then were sown in April 2008 by hand in rows of 55 cm apart and spaced 35 cm distances between every plant in the row. Furrow Irrigation was applied 2 times a week during the early stage of growth increasing to up to three times a week during the stages prior to harvest so that was not any water stress. Fertilizer was not applied before sowing and during growth of plant up to harvest so that coriander plants were grown as organic culture.

Coriander shoots were collected from cultivated plants at different time of day during July 2008. According to my previous resaerch on the coriander, we collected aerial parts at green fruits (immature) stage.

The aerial parts were harvested on numerous representative plants and the material was taken immediately to the laboratory to be shade-dried at room temperature (25°C), with ventilation. Under this condition in experiment, 3-5 days typically was required to complete the drying process.

Isolation of the essential oil: One hundred grams of dried aerial parts (stems, leaves flower and fruits), wooden parts

were separated and hydro-distilled for 3 h, using an all glass Clevenger-type apparatus 2. The oil volume was measured directly in the extraction burette. Yield percentage was measured as volume (mL) of essential oil per 100 g of plant dry matter. The distilled essential oils were dried over anhydrous sodium sulphate, filtered, weighed and stored in sealed vials at 4°C.

Statistical analysis: The experiments were arranged as a Completely Randomized Design (CRD) with three replications of each treatment. The significance of differences ($p<0.01$) between treatments was determined by tukey multiple range tests. All the statistical analysis was performed using SPSS/PC software version 13.

RESULTS AND DISCUSSION

Differences in the yield of the essential oils under the influence of the harvest time have been reported for several plants (Ramezani, 2007; Ramezani *et al*., 2009; Lopes *et al*., 1997; Duschatzky *et al*., 1999; Moudachirou *et al*., 1999; Schwob *et al*., 2004; Msaada *et al*., 2007; Argyropoulou *et al*., 2007; Hussain *et al*., 2008; Angelopoulou *et al*., 2002; Marcum and Hanson, 2006; Ebrahimi *et al*., 2008; Chericoni *et al*., 2004; Callan *et al*., 2007). Also our results indicated that various hours of diurnal have much influence on amount of coriander essential oils.

In this study, the essential oil content of coriander varied from 3.1-4.36 mL kg^{-1} dry matter according to the time of day (Table 2). The maximum content of coriander essential oils from aerial parts was obtained in 12 h treatment (4.36 mL kg^{-1} dry matter) so that was significant difference at 1% level in comparing with 6, 18 and 24 h treatments (4.32, 4 and 3.1 mL kg^{-1} dry matter, respectively). Also, there was significant difference observed between 6, 18 and 24 h treatment so that base on these results, optimum time for harvesting of Coriander aerial parts is 12 h (Fig. 2).

Means followed by the same letter within each column are not significantly different, as indicated by Tukey test at $p<0.01$.

We previous research demonstrated that essential oil content of Eucalypt, Rosemary, white cedar and Lawson Cypress were varying during hour of day so that maximum amount of essential oil of these species obtained at 12, 18 and 7, respectively (Ramezani, 2007; Ramezani *et al*., 2009).

The harvest hour of these species is very important for all kinds of usage. It is known that genetic constitution and environmental conditions influence the yield and composition of volatile oil produced by medicinal plants. (Ramezani *et al*., 2009; Omidbaigi, 2007).

Table 2: The effect of harvest time in day and night duration on essential oil yield of coriander species in Iran

Harvest (h)	Essential oil content (mL/100 g dry matter)
6	0.432b
12	0.436a
18	0.404c
24	0.319d
Average	0.397

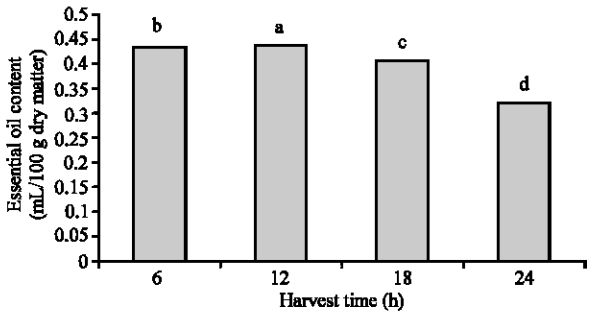

Fig. 2: Different harvest time effect on essential oil content of coriander in southwest of Iran in 2008 year. Means followed by the different letter are significantly difference, as indicated by Tukey multiple range test ($p = 0.01$)

Volatile compounds in various plant species are different that this is resulted in variation yield of essential oils to environmental factors such as temperature and light, so that synthesis of these compound in various hours of diurnal will be vary (Ramezani *et al*., 2009).

CONCLUSION

As a conclusion of the present study, it could be stated that harvest at 12 of coriander may result in higher values of essential oil content.

REFERENCES

Angelopoulou, D., C. Demetzos and D. Perdetzoglou, 2002. Diurnal and seasonal variation of the essential oil labdanes and clerodanes from *Cistus monspeliensis* L. leaves. Biochem. Systemat. Ecol., 30(3): 189-203. DOI: 10.1016/S0305-1978(01)00074-6.

Anitescu, G., C. Doneanu and V. Radulescu, 1997. Isolation of coriander oil: Comparison between steam distillation and supercritical CO_2 extraction. Flavour Frag. J., 12: 173-176.

Argyropoulou, C., D. Daferera, P.A. Tarantilis, C. Fasseas and M. Polissiou, 2007. Chemical composition of the essential oil from leaves of *Lippia citriodora* H.B.K. (*Verbenaceae*) at two developmental stages. Biochem. Systemat. Ecol., 35 (12): 831-837. DOI: 10.1016/j.bse.2007.07.001.

Bandoni, A.L., I. Mizrahi and M.A. Juarez, 1998. Composition and quality of the essential oil of coriander (*Coriandrum sativum* L.) from Argentina (average analysis of 6 oils). J. Essential. Oil Res., 10: 581-584.

Burt, S., 2004. Essential oils: Their antibacterial properties and potential applications in foods: A review. Int. J. Food Microbiol., 94: 223-253. DOI: 10.1016/j.ijfoodmicro.2004.03.022.

Callan, N.W., D.L. Johnson, M.P. Westcott and L.E. Welty, 2007. Herb and oil composition of dill (*Anethum graveolens* L.): Effects of crop maturity and plant density. Indust. Crops Prod., 25 (3): 282-287. DOI: 10.1016/j.indcrop.2006.12.007.

Cantore, P.L., N.S. Iacobellis, A. De Marco, F. Capasso and I.F. Senatore, 2004. Antibacterial activity of *Coriandrum sativum* L. and *Foeniculum vulgare* Miller var. *vulgare* (Miller) essential oils. J. Agric. Food Chem., 52: 7862-7866. DOI: 10.1021/jf0493122.

Carruba, A. and R. la Tore, 2002. Statistical analyses on the essential oil of Italian coriander (*Coriandrum sativum* L.) fruits of different ages and origins. J. Essential. Oil Res., 14: 389-396.

Chericoni, S., G. Flamini, E. Campeol, P.L. Cioni and I. Morelli, 2004. GC-MS analyses of the essential oil from the aerial parts of *Artemisia verlotiorum*: variability during the year. Biochem. Systemat. Ecol., 32 (4): 423-429. DOI: 10.1016/j.bse.2003.10.002.

Chithra, V. and S. Leelamma, 2000. *Coriandrum sativum* effect on lipid metabolism in 1, 2-dimethyl hydrazine induced colon cancer. J. Ethnopharmacol., 71: 457-463. DOI: 10.1016/S0378-8741(00)00182-3.

Duschatzky, C., P. Bailac, A. Carrasull, N. Firpo and M. Ponzi, 1999. Essential oil of *Lippia affJuneliana* grown in San Luis, Argentina. Effect of harvesting period on the essential oil composition. J. Essential. Oil Res., 11 (4): 104-106.

Ebrahimi, S.N., J. Hadian, M.H. Mirjalili, A. Sonboli and M. Yousefzadi, 2008. Essential oil composition and antibacterial activity of *Thymus caramanicus* at different phenological stages. Food Chem., 110 (2): 927-931. DOI: 10.1016/j.foodchem.2008.02.083.

Emamghoreishi, M., M. Khasaki and M.F. Aazam, 2005. *Coriandrum sativum*: Evaluation of its anxiolytic effect in the elevated plus-maze. J. Ethnopharmacol., 96: 365-370. DOI: 10.1016/j.jep.2004.06.022.

Eyres, G., J.P. Dufour, G. Hallifax, S. Sotheeswaran and P.J. Marriott, 2005. Identification of character-impact odorants in coriander and wild coriander leaves using Gas Chromatography-Olfactometry (GCO) and comprehensive 2 dimensional Gas Chromatography-Time Of-Flight Mass Spectrometry (GC-TOFMS). J. Sep. Sci., 28: 1061-1074. DOI: 10. 1002/jssc.200500012.

Gallagher, A.M., P.R. Flatt, G. Duffy and Y.H.A. Abdel-Wahab, 2003. The effects of traditional antidiabetic plants on *in vitro* glucose diffusion. Nutr. Res., 23: 413-424. DOI: 10.1016/S0271-5317(02)00533-X.

Grosso, C., V. Ferraro, A.C. Figueiredo, J.G. Barroso, J.A. Coelho and A.M. Palavra, 2008. Supercritical carbon dioxide extraction of volatile oil from Italian coriander seeds. Food Chem., 111 (1): 197-203. DOI: 10.1016/j.foodchem.2008.03.031.

Hussain, A.I., F. Anwar, S.T.H. Sherazi and R. Przybylski, 2008. Chemical composition, antioxidant and antimicrobial activities of basil (*Ocimum basilicum* L.) essential oils depends on seasonal variations. Food Chem., 108 (3): 986-995. DOI: 10.1016/j.foodchem.2007.12.010.

Kubo, I., K.I. Fujita, A. Kubo, K.I. Nihei and T. Ogura, 2004. Antibacterial activity of coriander volatile compounds against *Salmonella choleraesuis*. J. Agric. Food Chem., 52: 3329-3332. DOI: 10.1021/jf0354186.

Lopes, P.N., J.M. Kato, A.H.E. Andrade, S.G.J. Maia and M. Yoshida, 1997. Circadian and seasonal variation in the essential oil from *Virola surinamensis* leaves. Phytochemistry, 46 (4): 689-693. DOI: 10.1016/S0031-9422(97)00324-5.

Marcum, D.B. and B.R. Hanson, 2006. Effect of irrigation and harvest timing on peppermint oil yield in California. Agric. Water Manage., 82 (1): 118-128. DOI: 10.1016/j.agwat.2005.07.022.

Moudachirou, M., J.D. Gbenou, J.C. Chalchat, J.L. Chabard and C. Lartigue, 1999. Chemical composition of essential oil of eucalyptus from Beunin: *Eucalyptus citriodora* and *E. camaldulensis*. Influence of location, harvest time, storage of plants and time of steam distillation. J. Essential. Oil Res., 11 (2): 109-118.

Msaada, K., K. Hosni, M.B. Taarit, T. Chahed, M.E. Kchouk and B. Marzouk, 2007. Changes on essential oil composition of coriander (*Coriandrum sativum* L.) fruits during three stages of maturity. Food Chem., 102: 1131-1134. DOI: 10.1016/j.foodchem. 2006.06.046.

Omidbaigi, R., 2007. Production and processing of medicinal plants. Behnashr Pub. Mashhad, Iran, 1: 346.

Ramezani, S., 2007. Effect of various harvest time on essential oil content of some medicinal plants. Proceeding of the 5th Iranian Horticultural Science Congress. Shiraz University, Shiraz, Iran, pp: 523.

Ramezani, S., F. Ramezani, F. Rasouli, M. Ghasemi and M.H. Fotokian, 2009. Diurnal variation of the essential oil of four medicinal plants species in central region of Iran. Res. J. Biol. Sci., 4 (1): 103-106.

Schwob, I., J.M. Bessiere, V. Masotti and J. Viano, 2004. Changes in essential oil composition in Saint John's wort (*Hypericum perforatum* L.) aerial parts during its phenological cycle. Biochem. Systemat. Ecol., 32 (2): 735-745. DOI: 10.1016/j.bse.2003.12.005.

Wangensteen, H., A.B. Samuelsen and K.E. Malterud, 2004. Antioxidant activity in extracts from coriander. Food Chem., 88: 293-297. DOI: 10.1016/j.foodchem.2004.01.047.

Zheljazkov, V.D., K.M. Pickett, C.D. Caldwell, J.A. Pincock, J.C. Roberts and L. Mapplebeck, 2008. Cultivar and sowing date effects on seed yield and oil composition of coriander in Atlantic Canada. Industrial Crops Prod., 28 (1): 88-94. DOI: 10.1016/j.indcrop.2008.01.011.