Original research article

PRELIMINARY RESEARCH RESULTS OF CUMIN CULTIVATION UNDER SERBIAN ENVIRONMENTAL CONDITIONS

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SUMMARY

Commercial cumin (*Cuminum cyminum* L.) seeds were sown on the field in village Mošorin, Serbia, in early April of 2014. The vegetation period lasted 98 days. The average height of the cultivated cumin plants was 18.5 cm, with 13 umbels 2.75 cm in diameter, containing 19.33 seeds per umbel. Plant weight was 1.26 g, yielding 0.54 g fruit per plant. Plants from India had essential oil content of 3.32%, while the plants grown in Serbia contained 5.31% essential oil. Essential oil obtained from the fruits of Indian cumin plants consisted of 19 compounds, while 30 compounds were found in essential oil obtained from cumin grown in Serbia. Essential oils were primarily composed of: γ-terpinen-7-al, cuminaldehyde, β-pinene, γ-terpinene and α-terpinene-7-al.

KEYWORDS: *Cuminum cyminum* L, essential oil, growth and development, morphological traits

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INTRODUCTION

Throughout the world there has been a rising interest in alternative medicines, assuming fewer negative effects compared to the synthetic, pharmaceutical products. Medicinal, aromatic plants and spices are popular for their positive effects on human health, and used in nutrition due to their specific smell and aroma. As a result of many years of experience, modern medicine often justifies the use of medicinal plants as adjuvants or in therapeutic purposes. Moreover, new knowledge regarding the prevention and therapy of modern illnesses has also been acquired.

Cumin (*Cuminum cyminum* L.) is a traditional Indian spice with a sharp, spicy flavor. One of the main ingredients of curry and garam masala, this spice is also used as a condiment in salads, pastry, side dishes, rice, legumes and dairy products, and for seasoning cooked and roast meat, especially lamb and chicken (Bettaieb et al., 2010).

Indian traditional medicine uses cumin as a diuretic and treatment for irritable colon and digestive flatulence. Research confirmed that cumin intake may prevent kidney damage (Mahesh et al., 2010); commercial cumin-based formulations have therefore been prepared according to traditional Indian recipes as an alternative treatment of kidney stones (Dinesh et al., 2013). Research has shown that the strong and specific smell of cumin increases the excretion of saliva and digestive enzymes, thereby stimulating appetite and aiding digestion (Nalini et al., 2006; Milan et al., 2008). Furthermore, cumin intake relaxes smooth muscles of the digestive tract and thus reduces stomach cramps (Dhandapani et al., 2002).

The pharmacological activity of cumin has been confirmed, mainly relating to antimicrobial (Iacobellis et al., 2005; Jirovetz et al., 2005; Gachkar et al., 2007; Hajlaoui et al., 2010) anti oxidative (Milan et al. 2008; Bukhari et al., 2009;

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Allaghadri et al., 2010; Bettaieb et al. 2011), anticancer (Aruna & Sivaramakrishnan, 1992; Gagandeep et al., 2003; Nalini et al., 2006) and immunomodulatory activity (Chauhan et al., 2010). Studies involving the possible role of cumin in treating diabetes (Willatgamuva et al., 1998; Dhandapani et al., 2002; Srinivasan, 2005; Lee, 2005; Jagtap & Patil, 2010) and epilepsy (Sayyah et al., 2002; Janahmadi et al., 2006) have also been conducted.

Cumin is mostly grown in arid and semiarid regions (Meghdadi & Kamar, 2011). Originally from the Eastern Mediterranean, nowadays it is grown in Iran, China, India, Morocco, southern parts of Russia, Japan, Indonesia, Algiers, Tunisia, Turkey, Spain, Egypt, Bulgaria and other countries (Bettaieb et al., 2010). At the moment, there is no data on cumin cultivation in our country. The aim of this study was to represent the properties of cumin introduced in agro-ecological conditions of Serbia.

MATERIAL AND METHODS

Commercial cumin seed (produced by Jishan, India) was sown on the field located in village Mošorin, Serbia (45°18′N, 20°09′E), in early April 2014. Mošorin is situated in southern Bačka, in the zone of temperate continental climate. However, significant discrepancies in weather conditions (precipitation and average daily temperatures) occurred during the 2014 cumin vegetation period (April-July), as compared to long-term (1981-2010) averages (Figure 1).

As shown in the figure, precipitation recorded during April was at a multiannual level, while temperatures were slightly above the average values. Changeable, slightly colder weather with fewer sunlight hours and extreme precipitation was recorded in May. Temperatures recorded in June were consistent with the multiannual average, with less precipitation which was mainly in the form of showers. Unstable weather conditions were recorded in July, with rain occurring daily and temperatures within the average values.

The trial was set up on a calcareous soil (8.4% $CaCO_3$), with a low alkali reaction (pH 7.3), low humus content (2.7%), and medium total nitrogen content of 0.18%. Contents of easily accessible phosphorus (81.6 mg

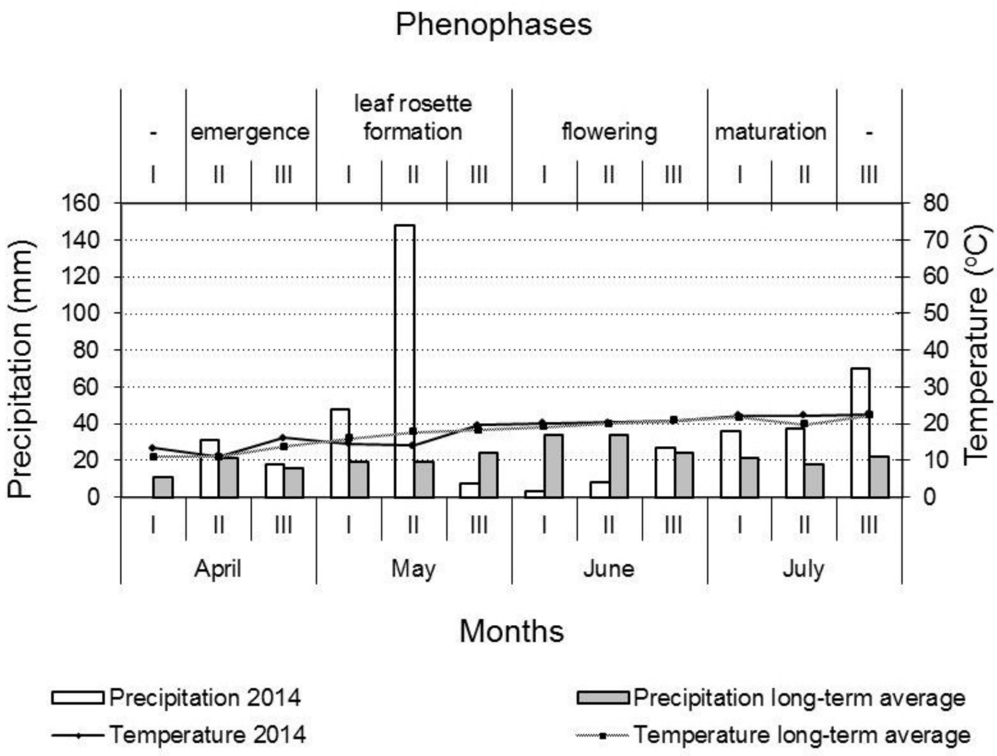

Figure 1. Decade values of average daily air temperatures (°C) and sum of precipitation (mm) for 2014 cumin vegetation period (April-July) and long-term (1981-2010) averages

P_2O_5/100 g soil) and potassium (75.1 mg K_2O/100 g soil) were exceedingly high.

Seed was sown in rows with inter-row spacing of 35 cm, and intra-row spacing of 2-3 cm. Experimental plot was 6.3 m^2 (six rows each 3 m long). Hoeing and weeding were the only cultivation practices applied during the vegetation period.

Plant development, morphological (plant height, number of umbels per plant, umbel diameter, umbel seed number, plant weight and fruit weight per plant) and qualitative characteristics (essential oil content and composition) of the cultivated cumin plants were analyzed. Plant growth and development were monitored daily. The plants were sampled and preserved in herbarium, every two weeks from the stage of first true leaf formation to the fruit development. Plant morphological traits were estimated after the measurement of 10 plants from the center rows, in four replications. Essential oil was extracted from the ground fruits during a 3 hour period, using the method of hydro-distillation according to Clevenger, while the essential oil components were determined according to gas chromatography and mass spectrometry. Both starting material from India and the seeds obtained from the trial were analyzed.

Main descriptive statistical parameters were determined for all morphological traits in the study: arithmetic mean, standard deviation, coefficient of variation, minimum and maximum value.

RESULTS AND DISCUSSION

Plant growth and development

Under environmental conditions of Serbia, cumin vegetation period lasted 98 days. Seeds germinated after three days, and the plantlets started to form spiky blue-green leaves soon after. The plants started flowering one month after sprouting. The tiny pink flowers were arranged into small blossoms. The flowering period lasted 10 days. The fruit is a schizocarp which spontaneously splits up into two 4-5 mm long, yellowish-brown mericarps. Maturation period lasted three weeks. Growth and development of the plants is shown in Picture 1.

Cumin plants have short vegetation period, lasting 70-91 days. Under Iranian environmental conditions, the period from sowing to sprouting lasts 10-17 days, from sprouting to 50% flowering 44-54 days, while the period from flowering to harvesting lasts 16-19 days (Mirshekari et al., 2011). Vegetation period was slightly longer (7 days) under Serbian environmental conditions,

Picture 1. Growth and development of cumin (*Cuminum cyminum*) plants cultivated under Serbian environmental conditions

Table 1. Morphological traits of cumin grown in Serbia

Traits	Mean	SD	Min	Max	CV (%)
Plant height (cm)	18.50	2.38	16.00	21.00	12.87
Number of umbel per plant	13.00	2.71	11.00	17.00	20.83
Umbel diameter (cm)	2.75	0.22	2.50	3.00	7.91
Number of seed per umbel	19.33	1.42	17.30	20.60	7.32
Whole plant weight (g)	1.26	0.12	1.10	1.40	9.90
Seed weight per plant (g)	0.54	0.07	0.46	0.62	13.15

and all phenological stages were several days longer than those recorded in Iran.

Morphological traits

The results of the six examined morphological traits of cumin plants are shown in Table 1. As depicted, the average plant height of cumin grown in Mošorin was 18.5 cm. The height of cumin plants varied between 16 cm and 21 cm. Research conducted in Iran showed that plant height ranged from 15.29 cm to 24.42 cm, depending on the ecotype (Rostami-Ahmadvandi et al., 2013). Study of the effects of He-Ne laser application on the morphological traits of cumin plants confirmed that plant height can be increased from 18.25 cm (control) to 32.59 cm by this method (El-Tobgy et al., 2009).

The plants formed between 11 and 17 umbels, on average 13 umbels per plant. Research conducted in India reports 9.80 to 20.10 umbels per plant after the application of different fertilizers (Singh & Rao, 2006). On the other hand, the plants grown in Iran formed significantly more umbels, from 28.24 to 42.34 depending on the quantity of applied nitrogen fertilizer and crop density (Azizi & Kahrizi, 2008).

Average cumin umbel diameter was 2.75 cm. There are no data in the literature on this parameter. Usual reports state that cumin plants develop an umbel diameter of 3.5 cm, consisting of 5-7 small umbels (Divakara-Sastry & Anandaraj, nd). The experimental plants formed 19.33 seeds per umbel. Iranian study including 9 cumin ecotypes report the development of 13.75 to 15.50 seeds per umbel (Motamedi-Mirhosseini et al., 2011), while 18.25 to 23.14 seeds per umbel were developed in India, depending on fertilization type (Mehta et al., 2012).

Cumin plant weight was 1.26 g at harvest. This parameter, recalculated as biomass yield per surface unit, ranged from 21.90 to 67.00 g/m^2 depending on crop density and sowing time (Zolleh et al., 2009). Fruit yield per plant was 0.54 g in our research. Significantly higher fruit yields were reported in India, ranging from 0.88-1.57 g (Mahajan et al., 2012) and 1.06-1.89 g per plant (Mehta et al., 2012).

Qualitative traits

Essential oil content of 3.32% was determined in cumin plants from India, which were used in our research as the starting material. Fruits of cumin plants grown in Serbia exhibited a significantly higher essential oil content of 5.31%. As stated by the referential sources, essential oil content in cumin fruits mostly varies between 2.5 - 4.5% (Nadeem & Riaz, 2012). However, with modern methods application, such as He-Ne laser, essential oil yield can be significantly increased; from 3.82% in control plants to the impressive 9.17%, obtained when seeds are submitted to laser treatment prior to sowing under high moisture conditions for 20 minutes (El-Tobgy et al., 2009).

Chemical composition

A total of 19 compounds were identified in essential oil from cumin fruits obtained from India, while cumin fruits grown in Serbia had a significantly higher number of compounds (30). Eleven compounds, which were not found in samples from India, were detected in smaller amounts in Serbian samples ($\geq$ 0.1%). Chemical

Table 2. Chemical composition of cumin grown in India and Serbia

Compound	RT	RI	India	Serbia
α-thujene	5.588	926	0.2	0.3
α-pinene	5.779	933	0.8	0.8
sabinene	6.861	973	0.8	1.0
β-pinene	6.980	977	16.7	16.6
myrcene	7.345	991	0.6	1.0
α-phellandrene	7.811	1006	trag	trag
δ-3-carene	8.008	1011	nd	trag
α-terpinene	8.215	1017	nd	trag
p-cymene	8.633	1023	4.9	9.3
β-phellandrene	8.723	1027	0.3	0.5
1,8-cineole	8.763	1031	0.1	0.1
γ-terpinene	9.724	1059	11.8	12.8
cis-sabinene hydrate	10.031	1062	nd	trag
terpinolene	10.858	1088	nd	trag
trans-sabinene hydrate	11.228	1099	nd	trag
trans-pinocarveol	12.905	1038	nd	trag
pinocarvone	13.923	1161	nd	trag
NI	14.063	1162	nd	0.1
NI	14.128	1163	nd	0.1
terpinene-4-ol	14.558	1176	nd	trag
1,3-cyclohexadiene-1-methanol, 4-(1-methylethyl)	15.275	1194	0.4	0.4
cuminaldehyde	17.349	1241	26.2	24.5
α-terpinene-7-al	19.253	1284	6.8	5.5
γ-terpinene-7-al	19.623	1292	30.2	26.8
p-mentha-1,4-diene-7-ol	21.269	1331	trag	0.1
daucene	23.519	1381	trag	trag
trans-cariophyllene	25.243	1422	0.1	trag
trans-β-farnesane	26.859	1461	trag	0.1
10-epy-β-acoradiene	27.598	1478	nd	trag
carotol	32.633	1601	0.1	trag
Number of identified compounds			19	30

NI – compound not identified, trag – compound present with less than 0.1%, nd – detected
RT – retention time, RI – retention index

composition of the tested samples is shown in Table 2.

Most frequently found compounds in essential oils of the fruits from India and Serbia were γ-terpinene-7-al (30.2% and 26.8%, respectively), cumin-aldehyde (26.2%, 24.5%), β-pinene (16.7%, 16.6%), γ-terpinene (11.8%, 12.8%) and α-terpinene -7-al (6.8%, 5.5%). Other compounds were present in the amount less than 1%.

According to the results of other authors, essential oil of cumin from India mostly consists of α-pinene (29.1%), limonene (21.5%), 1,8-cineol (17.9%) and linalool (10.4%) (Gachkar et al., 2007), while essential oil of cumin from Tunisia consists of -terpinene (25.58-34.16%), cumin aldehyde (13.22-23.53%), β-pinene (9.72-16.33%) and 1- phenyl-1.2 ethanediol (8.25-23.16%) depending on plant water availability during vegetation (Bettaieb-Rebey et al., 2012).

CONCLUSION

Based on the obtained results it can be concluded that cumin grown in Serbia has a high percentage of essential oils in fruit. Further research should be focused on determining yields per surface unit as well as yields of essential oil. The objective of further research is examining the effect of weather conditions on yield stability.

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SAŽETAK

PRELIMINARNI REZULTATI GAJENJA KUMINA U AGROEKOLOŠKIM USLOVIMA SRBIJE

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Komercijalno seme začinskog kumina (*Cuminum cyminum* L.) posejano je u Mošorinu, početkom aprila meseca 2014. godine. Vegetaciononi period kumina je trajao 98 dana. Prosečna visina biljaka je bila 18,5 cm, jedna biljka je formirala u proseku 13 štitova, prečnika 2,75 cm, sa 19,33 zrna u štitu. Masa cele biljke u proseku je bila 1,26 g, a prinos ploda po biljci 0,54 g. Nakon žetve određene su kvalitativne karakteristike kako početnog semenskog materijala, tako i dobijenog semena, pri čemu je ustanovljeno da je sadržaj etarskog ulja u plodovima kumina iz Indije bio 3,32%, a iz Srbije čak 5,31%. U etarskom ulju plodova kumina iz Indije identifikovano je 19 komponenti, dok je u etarskom ulju iz Srbije ustanovljen značajno veći broj komponenti (30). Najzastupljenije komponente u oba etarska ulja su bile: -terpinen-7-al, kumin-aldehid, -pinen, -terpinen i -terpinen-7-al.
KLJUČNE REČI: *Cuminum cyminum*, rast i razvoj, morfološke karakteristike, etarsko ulje