EFFECTS OF CULTIVARS ON THE YIELD AND CONTENTS OF SOME BIOACTIVE COMPONENTS OF BASIL

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Original scientific paper

Summary

Basil (*Ocimum basilicum* L.) is an annual plant from Lamiaceae family. The quality and yield of basil depends on its cultivar, environmental factors and growing technology. The aim of this paper was to examine the impact of different cultivars on the quality of basil in the environmental conditions of central Bosnia and Herzegovina. A field experiment was conducted at a private farm in Kakanj. In this study, the yield of fresh and dry mass, total phenol, flavonoids, essential oil content and antioxidant activity were determined. Experimental results showed a significant impact of cultivars on the researched traits. The fresh mass yield ranged from 134.2 (Red rubin) to 298.7 g per plant (Green). The lowest total phenol contents were recorded in the cultivar Minimum (33.78 mg GAE/g) and the highest in the cultivar Green (38.84 mg GAE/g). The antioxidant activity was also significantly dependent on basil cultivar. It ranged from 22.56 (Red rubin) to 52.73 µM Fe^{2+}/g (Minimum).

Key words: *basil, cultivar, essential oil, total phenol, antioxidant activity*

INTRODUCTION

Basil (*Ocimum basilicum* L.) is an annual plant from the Lamiaceae family. It is native to the tropics of India, but nowdays is spread all over the world (Bucktowar *et al.*, 2016). It is mostly grown and used in Mediterranean region (Hiltunen i sur., 1999), where is used as a spice, medicinal and aromatic plant. It is mostly used as a spice plant in the household to flavour marinades, pastas, soups, sauces, meats and cured meats, cheeses, canned foods and liqueurs (Frąszczak *et al.*, 2015; Majkowska-Gadomska *et al.*, 2017). It is characterized by a strong aroma with a slightly sour taste that has the property of enriching the taste of various dishes (Majkowska-Gadomska *et al.*, 2017). Due to specific content of bioactive ingredients in the essential oil, basil is also considered as medicinal species. It is often used in traditional medicine because it is believed to help treat many diseases (Singh and Majumdar, 1999; Venâncio *et al.*, 2011). The quality of basil, ie its aromaticity and healing properties depends on the content of various bioactive compounds (Gavrić *et al.*, 2018). Abiotic factors such as temperature and precipitation during cultivation can have

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a significant impact on the synthesis of these components (Gavrić *et al.*, 2021). On the other hand, different agronomic practices such as cultivar, sowing date, crop nutrition, irrigation can also have a significant impact on the quality and yield of basil (Svecova and Neugebauerová 2010; Rakic and Johnson 2008; Al-Huqail *et al.*, 2020). Given the fact that the cultivar can have a significant impact on quality and yield, the aim of this paper was to examine the impact of different varieties on the quality of basil in the environmental conditions of central Bosnia and Herzegovina.

MATERIALS AND METHODS

The research was conducted through three segments: weather analysis, field and laboratory experiment.

Weather condition analysis

An automatic meteorological station type (WH2900) was used to collect weather data. The meteorological station was located 100 m from the experiment. The collected data for average air temperature / month, amount of precipitation and air humidity were used in the research.

Field experiment

A field experiment was conducted at a private farm Gavrić in Kakanj (the experiment field coordinates have been listed as follows: latitude 43°49’34”N and longitude 18°19’18” E, altitude 505 m). The treatments of the experiment had six basil cultivars: Green, Red rubin, Minimum, Citriodorum, Genovese (*Ocimum basilicum* L.) and Pilosum (*Ocimum americanum* L.). Basil seedlings for transplanting were grown in a greenhouse. Seedlings were raised in polystyrene containers (104 cells) using a commercial substrate “Klasmann potground H”. The basil seedlings were transplanted into the open field on July 15, 2021. Basil seedlings were planted at 50 cm × 30 cm plant density. Harvest was carried out during the beginning of flowering (September 20, 2021). The fresh mass yield was measured during the harvest.

Laboratory experiment

Dry mass yield, essential oil content, total phenol content, flavonoid content and antioxidant activity were determined in laboratory at Faculty of Agriculture and Food Sciences at the University of Sarajevo. Dry mass yield was measured after drying herbs in a dark room at room temperature for 20 days. The content of essential oil in basil (*Basilici herba*) was measured using the Clevenger-type apparatus (Clevenger, 1928). The content of total phenols was determined by spectrophotometric method (Bystrická i sur., 2010),

The content of total flavonoids was determined by spectrophotometric method (Velić *et al.*, 2011). Antioxidant activity was determined by FRAP spectrophotometric method (Benzie and Strain, 1996).

Statistical analyses were made using SPSS 22 software programs.

RESULTS AND DISCUSSION

Data collected by the automatic meteorological station (WH2900) were used for the analysis of weather conditions. The data presented in Table 1 show that the average temperatures during the field research were 21.7 (July), 19.9 (August) and 15.4 ºC (September). The recorded average monthly temperatures during the study were relatively lower than those optimal for basil cultivation. Barickman *et al.* (2021) reported optimal temperature for the growth and development of basil is between 25 and 30 ºC. Although a lower temperature was recorded in our study, it was not lower than 10 ºC, which is according to Ribeireo *et al.* (2007) critical temeperature because it stops the growth and development of basil. During field research, 203.9 mm of precipitation was recorded, which was sufficient for the growth and development of basil.

Table 1. Average monthly air temperature, Amount of precipitation and Air humidity
Tabela 1. Srednja mjesečna temperatura, suma oborina i relativna vazdušna vlaga

Month / Mjesec											
I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
Average monthly air temperature / Srednja mjesečna temperatura zraka (ºC)											
2.4	4.2	4.0	7.4	14.9	19.5	21.7	19.9	15.4	8.1	6.0	2.5
Amount of precipitation / Suma oborina (mm)											
37.6	26.5	55.6	43.4	30.9	25.9	121.9	49.5	32.5	121.3	206.9	123.7
Air humidity / Relativna vazdušna vlaga (%)											
83.0	73.0	69.0	67.0	64.0	69.0	72.0	70.0	75.0	85.0	89.0	87.0

The results of the study shown in Table 2 show that basil yield was significantly dependent on the cultivar. Of the six cultivars studied, Red rubin had the lowest yield of green mass (134.2 g per plant), while Green cultivar had the highest yield (298.7 g per plant). The dry matter yield also significantly depended on the cultivar studied. That is, the lowest yield was recorded in the cultivar Red rubin (19.8 g / plant) while the highest yield was recorded in the cultivar Citriodorum (70.4 g / plant).

Table 2. Yield and contents of bioactive components
Tabela 2. Prinos i sadržaj bioaktivnih komponenti

Cultivars	**Fresh mass yield / Prinos zelene mase, g**	**Dry mass yield / Prinos suhe mase, g per plant**	**Essential oil contents / Sadržaj eteričnog ulja, mL 100 g^{-1}**	**Total phenol contents / Sadržaj ukupnih fenola, mg GAE g^{-1}**	**Total flavonoid contents / Sadržaj ukupnih flavonoida, mg CAE g^{-1}**	**Antioxidant capacity / Antioksidativi kapacitet, μM Fe^{2+} g^{-1}**
Pilosum	250.8abc	47.5ab	0.33d	35.77b	20.36d	31.79d
Green	298.7a	54.2ab	1.29a	38.84a	34.15a	40.72b
Red rubin	134.2c	19.8d	0.99b	37.28ab	26.70b	22.56e
Minimum	164.4bc	21.7cd	0.85b	33.78c	14.03e	52.73a
Citriodorum	250.8ab	70.4a	0.23d	36.60b	23.63c	37.43c
Genovese	193.6abc	44.5bc	0.58c	37.23ab	15.31e	23.51e
Average / Prosjek	**215.4**	**43.0**	**0.71**	**36.58**	**22.36**	**34.79**

Different letters indicate significant differences at the 0.05 level; ns: nonsignificant difference.

Analysis of the essential oil content in basil showed there is a significant difference between the studied cultivars (Table 2). Cultivar Green had a significantly higher content of essential oil (1.29 mL 100 g-1) compared to other studied cultivars. Also, Red rubin and Minimum cultivars had a significantly higher essential oil content (0.99 and 0.85 mL 100 g-1) compared to the Genovese, Pilosum and Citriodorum cultivars (0.58, 0.33 and 0.23 100 g^{-1} , respectively). The results of our study suggest that the content of essential oil significantly depended on the basil cultivar, which is consistent with many researchers (Rakic and Johnson 2008; Nurzyńska-Wierdak *et al.*, 2013; Tsusaka *et al.*, 2019) who reported that genetic factors strongly influence the biosynthesis of essential oil.

Table 3. The correlation between researched traits
Tabela 3. Koeficijent korelacije između istraživanih osobina

	Fresh mass yield / Prinos zelene mase	Dry mass yield / Prinos suhe mase	Essential oil contents / Sadržaj eteričnog ulja	Total phenol contents/ Sadržaj ukupnih fenola	Total flavonoid contents / Sadržaj ukupnih flavonoida	Antioxidant capacity / Antioksidativi kapacitet
Prinos zelene mase	1					
Prinos suhe mase	0.636**	1				
Essential oil contents / Sadržaj eteričnog ulja	-0.041	-0.319	1			
Total phenol contents / Sadržaj ukupnih fenola	0.424*	0.417*	0.339	1		
Total flavonoid contents / Sadržaj flavonoida	0.151	0.282	0.476*	0.743**	1	
Antioxidant capacity / Antioksidativni kapacitet	-0.121	-0.031	0.199	0.489*	-0.091	1

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

The content of total phenols and flavonoids depends on the cultivar of basil and environmental conditions such as temperature, humidity, altitude, location, and agronomic practices (Gavrić *et al.*, 2018). In our study, it was found that the content of total phenols and flavonoids significantly depended on the studied cultivar. That is, the lowest total phenol contents were recorded in the cultivar Minimum (33.78 mg GAE g^{-1}) and the highest in the cultivar Green (38.84 mg GAE g^{-1}). The highest content of flavonoids was recorded in the variety Green (34.15 mg GAE g-1), while the lowest was recorded in the variety Genovese (15.31 mg GAE g^{-1}). Therefore, our results suggest that the content of total phenols significantly depends on the cultivar, which is in correlation with the results of Bajomo *et al.* (2022). These authors studied twenty-two varieties of basil and found that they differ significantly in the content of phenolic compounds. Observing the data on antioxidant capacity, it can be concluded that this examined trait also significantly depended on the basil cultivar. Antioxidant capacity ranged from 22.56 (Red rubin) to 52.73 µM Fe^{2+} g^{-1} (Minimum). Kwee and Niemeyer (2011) studied 15 different basil cultivars and concluded that the cultivar had a statistically significant effect on antioxidant capacity. In their study, antioxidant capacity ranged from 0.28 (Sweet dani lemon) to 11.46 (Gecofure) 100 M Fe^{2+} g^{-1}.

The results presented in Table 3 showed that there was a positive correlation between some research properties. A strong positive correlation was found between fresh mass and dry mass yield (0.636) and contents total phenolics and contents total flavonoids (0.743). Positive correlation was also recorded between contents total phenolics and fresh mass yield (r=-0.424), contents total phenolics and dry mass yield (r=0.417) and contents total flavonoids and essential oil contents (r=0.476).

The research provided data on the yield and quality of several varieties of basil grown in Bosnia and Herzegovina. However, this research did not provide an answer about the quality of essential oils of some cultivars. In order to eliminate these shortcomings, future research in the environmental conditions of BiH should focus on studying the impact of basil cultivars on the content of constituents in essential oil

CONCLUSIONS

The results of this study showed that the cultivar had a significant impact on all the researched traits of basil. The studied cultivars differed significantly in terms of yield of fresh and dry mass, essential oil content, total phenols, flavonoids and antioxidant capacity. Results of the research showed that the choice of cultivars can affect the quality and yield of basil in the environmental conditions of Bosnia and Herzegovina.

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UTJECAJ SORTE NA PRINOS BOSILJKA I SADRŽAJ NEKIH BIOAKTIVNIH KOMPONENTI

Rezime

Bosiljak (*Occimum basilicum* L.) je jednogodišnja zeljasta biljka iz familije Lamiaceae. Prinos i kvalitet bosiljka zavisi od sorte, okolišnih uvjeta i tehnologije uzgoja. Cilj ovog rada je bio istražiti utjecaj sorte na kvalitet i prinos bosiljka u okolišnim uvjetima srednje Bosne i Hercegovine. Poljsko istraživanje je obavljeno na porodničnom poljoprivrednom gazdinstvu ″Gavrić″ u Kaknju. Tokom istraživanja evidentirani su podaci za prinos zelene i suhe mase (herbe), sadržaj eteričnog ulja, sadržaj ukupnih fenola i flavonoida, te antioksidativna aktivnost. Rezultati istraživanja su pokazali da istraživane sorte imaju značajan utjecaj na istraživane parametre. Prinos svježe mase se kretao u granicama od 134,2 (Red rubin) do 298,7 g po biljci (Green). Najniži sadržaj ukupnih fenola evidentiran je kod sorte Minimum (33,78 mg GAE g^{-1}) dok je najveći zabilježen kod sorte Green (38,84 mg GAE g^{-1}). Istraživane sorte su se značajno razlikovale i u pogledu antioksidativne aktivnosti koja se kretala od 22,56 (Red rubin) do 52,73 µM Fe^{2+} g^{-1} (Minimum).

Ključne riječi: *bosiljak, sorta, eterično ulje, ukupni fenoli, antioksidativna aktivnost*