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Antimicrobial activity of essential oils of three herbs against *Listeria monocytogenes* on chicken frankfurters

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ABSTRACT

Listeria monocytogenes is a foodborne pathogen responsible for listeriosis. The inhibitory effect of essential oils (1% v/w) of *Thymus daenensis* Celak (Lamiaceae), *Thymbra spicata* L. (Lamiaceae) and *Satureja bachtiarica* Bunge (Lamiaceae) applied to the surface of chicken frankfurters was determined on *L. monocytogenes* inoculated at low (10^3 CFU/g) and high (10^6 CFU/g) populations and stored for seven and 14 days. The results showed that *L. monocytogenes* populations increased during seven and 14 days of storage at 4 °C on control frankfurters without essential oil. The application of 1 % essential oil (v/w) of herbs to frankfurter surfaces can significantly reduce ($p<0.05$) the *L. monocytogenes* populations as compared to control in two inocula treatments after seven and 14 days of storage at 4 °C.

Key words: Iranian medicinal herbs, *Listeria monocytogenes,* chicken frankfurters, essential oil

IZVLEČEK

PROTIMIKROBNA AKTIVNOST ETERIČNIH OLJ TREH ZELIŠČ PROTI PATOGENU *Listeria monocytogenes* V PIŠČANČJIH HRENOVKAH

Listeria monocytogenes je povzročitelj listerioze, ki se pojavlja v živilih. Proučevan je bil inhibitorni učinek eteričnih olj (1% v/w) zelišč *Thymus daenensis* Celak (Lamiaceae), *Thymbra spicata* L. (Lamiaceae) in *Satureja bachtiarica* Bunge (Lamiaceae), nanešenih na površino piščančjih hrenovk, ki so bile inokulirane z nizko (10^3 CFU/g) oziroma visoko populacijo (10^6 CFU/g) listerije ter shranjene za 7 oziroma 14 dni. Rezultati so pokazali, da se populacije *L. monocytogenes* povečajo tekom 7 oziroma 14 dni shranjevanja pri 4 °C na primerjalnih hrenovkah. Uporaba 1 % (v/w) eteričnih olj zelišč pri hrenovkah lahko značilno ($p<0.05$) zmanjša populacijo *L. monocytogenes* v primerjavi s kontrolo.

Ključne besede: iranska zdravilna zelišča, *Listeria monocytogenes,* piščančje hrenovke, eterična olja

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1 INTRODUCTION

Foodborne illness resulting from consumption of food contaminated with pathogenic bacteria has been of vital concern to public health. *Listeria monocytogenes* is a Gram-positive bacterium responsible for the severe foodborne illness listeriosis. This disease is primarily transmitted through various foods, fish, dairy products, cured or processed meat, egg, poultry, seafood, salad, fruits and vegetables (Garcia et al., 2004). A severe infection, listeriosis has been associated with a mortality rate as high as 30-40% (Datta, 2003).

Ready-to-eat (RTE) meat products have been introduced for the convenience of consumers; however, many have few barriers to microbial growth. Frequently, refrigeration is the only barrier for these types of foods, and temperature abuse at any of the links of the supply chain from the processing plants to the consumer's refrigerator could accelerate the growth of *L. monocytogenes*. Most RTE foods receive little or no final heat treatment before being consumed because such foods are assumed to be and are often labelled as fully cooked (Hao et al., 1998). There have been reported illnesses resulting when supposedly RTE foods were not reheated before consumption (Pinner et al., 1992; Schuchat et al., 1991). There have also been a large number of recalls of RTE meat due to contamination by *L. monocytogenes* (Kathariou, 2000).
To reduce health hazards and economic losses due to foodborne bacteria, the use of natural products as antibacterial compounds seems to be an interesting way to control the presence of pathogenic bacteria and to extend the shelf life of processed food (Dorman and Deans, 2000). Essential (volatile) plant oils occur in edible, medicinal and herbal plants and have been widely used as flavouring agents in foods since the earliest recorded history. It is well-established that many essential oils have antimicrobial activity against a wide range of spoilage and pathogenic bacteria (Deans and Ritchie, 1987; Alzoreky and Nakahara, 2003; Kim *et al*., 1995).

A lot of references on anti-*listeria* and antibacterial efficiency of essential oils are available in the literature (Chauhan et al., 2007; Rasooli et al., 2006; Stonsaovapak et al., 2000). For example, Ghasemi Pirbalouti et al., 2009 reported that the essential oil of *Thymus daenensis* and *Thymus* sp. flowers exhibited antibacterial activities against *L. monocytogenes in vitro*.

The Iranian medicinal plants, including *Thymbra spicata, Satureja bachtiarica* and *Thymus daenensis* have been utilised as spice and culinary plants by the indigenous people of west provinces, Iran (Ghasemi Pirbalouti, 2009).

However, no study investigating the antimicrobial effect of *Thymus daenensis, Thymbra spicata* and *Satureja bachtiarica* on *L. monocytogenes* on RTE chicken frankfurters could be found in the literature surveyed. The objective of this study was to determine the growth inhibition of *L. monocytogenes* (isolated from chicken meat) on chicken frankfurters and the efficacy of essential oils in inhibiting *L. monocytogenes* growth on chicken frankfurters.

2 MATERIALS AND METHODS

2.1. Plant material

The *Thymus daenensis* Celak (Lamiaceae), *Thymbra spicata* L (Lamiaceae) and *Satureja bachtiarica* Bunge (Lamiaceae) were collected from mountain areas of Zagross, West-South Iran, during May–Nov, 2008. Their identity was confirmed by Ghahraman (1987–1989), Mozaffarian (2007), and Rechinger (1963-1998), and voucher specimens were deposited at the Researches Centre of Medicinal Plants, Islamic Azad University-Shahrekord Branch, Iran.

2.2. Preparation of Extracts

The leaves and flowers of plants were powdered (200 g) and subjected to hydro-distillation (2000 ml distilled water) for 4 h using a Clevenger-type apparatus according to the method recommended in British Pharmacopoeia (British Pharmacopoeia, 1988). The extracts were filtered using Whatman No. 1 filter paper and then were stored in universal bottles and refrigerated at 4 °C prior to use.

2.3. Food sample preparation

Chicken frankfurters were purchased at a local supermarket and brought immediately to the laboratory. The frankfurters were cut into 10 g portions, and the surface of each sample was exposed to UV light (λ = 260 nm) for 10 min to kill surface contaminants.

2.4. Preparation of Listeria monocytogenes

The strain of *L. monocytogenes* was isolated from chicken meat and kindly provided by the Department of Microbiology, Faculty of Veterinary Medicine Faculty, Islamic Azad University- Shahrekord, Iran. Bacterial cultures were maintained frozen in broth at -20 °C until use. Prior to use, the

cultures were activated in at 37 °C for 24 h. The contents of the tube were transferred to a 100-ml flask containing sterile BHI broth (Merk, Germany) at log phase (OD_{600}=0.4-0.5) to scale up the bacterial suspension volume. An initial bacterial suspension containing $1x10^6$ CFU/ml was made from the flask broth culture.

2.5. Treatments of food samples

The inhibitory effect of essential oils (1% v/w) of *Thymus daenensis*, *Thymbra spicata* and *Satureja bachtiarica* applied to the surface of chicken frankfurters (10g of each) was determined after *L. monocytogenes* was inoculated (100 µl with 10^3 CFU/g and 100 µl with 10^6 CFU/g) and stored for seven and 14 days at 4°C. The treated samples were contaminated with *L. monocytogenes* on the surface using a pipette, and then the bacterium was spread with a sterile bent glass rod. A control consisted of chicken frankfurters inoculated with *L. monocytogenes* with no essential oil. Inoculated samples in Petri-dishes were left undisturbed for 30 min to allow residual moisture to be absorbed. The number of *L. monocytogenes* on the frankfurters was determined with plate count method at seven and 14 (at 4 °C) days of storage. Three replications of the treatments were performed.

2.6. Microbial analysis

Three samples from each inoculation level of *L. monocytogenes* at seven and 14 days of storage were assayed (at 4 °C). Corresponding control samples were also assayed. Samples were serially diluted (1:10), and 100 µl was spread plated onto BHI agar (Merk, Germany). The plates were incubated at 37 °C for 24 h to determine the population of *Listeria*. Selected presumptive colonies of *L. monocytogenes* were confirmed by Henry illumination and biochemical tests (Mytle et al., 2006).

2.7. Analysis of data

The numbers of *L. monocytogenes* was statistically analysed by one ways ANOVA, and statistical significance between treated and control groups was analysed by means of Student's *t*-test (*P-values < 0.05*) by the program "SAS version 6.12 full".

3 RESULTS AND DISCUSSION

During seven and 14 days of storage of frankfurters, the control samples had higher levels of bacteria than the treated samples (5.3×10^4 CFU/g to 7.7×10^5 CFU/g) (Table 1). The amount of bacteria on the controls was not "increased," but rather, the essential oils prevented bacterial growth on the treated frankfurters. The treatment group had inhibited bacterial growth relative to the growth observed in the control group.

The results indicated that after seven days of storage at 4 °C, essential oil treatments were able to significantly reduced ($p<0.05$) to 3.2 x 10 to 6.6 x 10^2 CFU/g, as compared to control (5.3×10^4 CFU/g) in the frankfurters with low inoculum (Table 1.). The essential oil of *Satureja bachtiarica* was least efficient in decreasing the *L. monocytogenes* count with low inoculum after 7 and 14 days at 4 °C, whereas, nitrite and essential oils of *Thymus daenensis* and *Thymbra spicata* were highly efficient in decreasing the *L. monocytogenes* count with low inoculum after 7 and 14 days at 4 °C.

Table 1. Comparison of *L. monocytogenes* populations in frankfurters treated with different essential oils/plant extracts

Treatments	N (cfu/g)			
	Low inoculum		High inoculum	
	7 days	14 days	7 days	14 days
Control	5.3×10^4a	7.7×10^5	5.3×10^7	5.7×10^8
Thymus daenensis	3.2×10 *	4.7×10 *	3.7×10^3 *	3.8×10^2 *
Thymbra spicata	6.5×10 *	3.1×10 *	6.5×10^3 *	5.4×10^3 *
Satureja bachtiarica	6.6×10^2 *	4.8×10 *	4.9×10^4 *	6.1×10^4 *

a: Statistically significant by Student's *t*-test*, N=3* samples.
**: P≤0.05* levels of significance.

During 7 and 14 days of storage of control frankfurters (without essential oil) with high inoculum at 4 °C, *L. monocytogenes* reached to 5.3 x 10^7 to 5.7 x 10^8 CFU/g (Table 1.).

The results showed that essential oil treatments were able to significantly reduced ($p<0.05$) to 3.7 x 10^3 to 4.9 x 10^4 CFU/g, as compared to control (5.3 x 10^7 CFU/g) with high inoculum after 7 days of storage at 4 °C. After 7 and 14 days at 4 °C, the essential oil of *Satureja bachtiarica* was least efficient at decreasing the *L. monocytogenes* count on frankfurters that received the high inoculum treatment, whereas the essential oil of *Thymus daenensis* was highly efficient at decreasing the

L. monocytogenes count on frankfurters with high inoculum.

The most active constituents (essential oils) of many spices have a wide spectrum of antimicrobial activity including aromatic phenolic compounds, such as thymol and carvacrol in oregano and thyme, eugenol in clove and cinnamon, and cinnamic aldehyde in cinnamon (Beuchat and Golden, 1989). These bioactive principles in the related dietary spices and medicinal herbs were also identified in other studies (Chauhan et al., 2007; Zampini et al., 2005). Some studies claim that the phenolic compounds present in spices and herbs might also play a major role in their antimicrobial effects (Hara-Kudo et al., 2004).

Shan et al. (2007) showed that many herb and spice extracts contained high levels of phenolics and exhibited antibacterial activity against foodborne pathogens. Gram-positive bacteria such as *L. monocytogenes* were generally more sensitive to the tested extracts than Gram-negative ones. Also, Shan et al. (2007) reported a highly positive relationship (R^2=0.73) between antibacterial activity and phenolic content of the tested extracts against *L. monocytogenes*. According to a report of Rasooli et al. (2006), various concentrations of essential oils from *Thymus eriocalyx* and *Thymus x-porlock* tested on agar plates and in broth tubes showed very strong anti-*listeria* properties. Also, they reported that *Thymus x-porlock* was a stronger bactericidal agent than *Thymus eriocalyx* oil. Rožman and Jeršek (2009) confirmed that antimicrobial activity of rosemary (*Rosmarinus officinalis* L.) extracts was depended on selected rosemary extract, concentration of extracts, different species of *Listeria* and different strains of *Listeria monocytogenes.*

The essential oil and extract of some aromatic plants (for example, the mint family, *Lamiaceae*) with a higher percentage of carvacrol and thymol have a higher efficacy against bacterial strains (Rasooli et al., 2006). The essential oils of *Thymus daenensis* (Nickavar *et al*., 2005), *Thymbra spicata* (Hanci et al., 2003) and *Satureja bachtiarica* (Sefidkon et al., 2007) contained high levels of phenolics monoterpenes (thymol and carvacrol) and exhibited antibacterial activity. They could be a potential source of inhibitory substances against some foodborne pathogens as well as a source of antioxidant agents.

Hao et al. (1998) applied extracts of various plants, including clove oil, to cooked chicken to determine their antimicrobial activity against the Scott A strain of *L. monocytogenes*. They reported no growth of the test strain of *Listeria* at 5 °C in untreated samples when a high population of 10^5 CFU/g inoculum was applied. In our study, the essential oil treatments significantly reduced the final *L. monocytogenes* populations after 7 and 14 days of storage at 4 °C as compared to the control.

Yuste and Fung, 2002 determined that 0.1% cinnamon reduced 10^4 CFU/g of *L. monocytogenes* Scott A in pasteurised apple juice (pH= 5.0) to undetectable cell numbers within 1 h of storage at 5 °C and 20 °C. In this study, the inhibitory effect of species of thyme on *L. monocytogenes* varied during storage for the same treatment. Mytle et al. (2006) reported that the application of 1% clove oil (v/w) to frankfurter surfaces or the inclusion of cloves or clove oil in the frankfurters, coupled with low temperature storage, can reduce the potential of *L. monocytogenes* contamination and growth without significantly changing flavour.

4 CONCLUSIONS

In conclusion, the *L. monocytogenes* populations in frankfurters treated with essential oils were significantly lower than in control samples throughout the storage period. The application of 1% thyme oil (v/w) applied to the surface of chicken frankfurters coupled with low temperature storage can reduce the potential of *L. monocytogenes* contamination.
In this study, the essential oils with high anti-*listeria* activity may be candidates for future studies of synergism, compatibility, and activity in foods or food-processing systems and mechanisms of activity against specific pathogens. The tested plant extracts may contain antimicrobial constituents, and further phytochemical and pharmacological studies will be necessary to isolate the active constituents and evaluate the antimicrobial activity against a wide range of microbial populations.

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Dynamics of polyphenolics formation in different plant parts and different growth phases of selected buckwheat cultivars

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ABSTRACT

The changes of dynamics of total polyphenolics formation in various anatomical parts (stems, leaves, flowers and seeds) of common buckwheat (*Fagopyrum esculentum* Moench.) during vegetation period were surveyed. Six cultivars were analysed: Pyra, Spacinska, Emka, Kasho, Jana C1 and Hrusowska. The content of total polyphenolics was evaluated in growth phase I. (formation of buds), in phase II. (at the beginning of flowering), in phase III. (full blossoming) and in phase IV. (full ripeness). The total polyphenolics content was assessed by using Folin-Ciocalteau assay spectrophotometrically on Shimadzu UV-1800. When evaluating all four anatomical parts of common buckwheat we can state that the flowers contained the highest concentration of total polyphenolics where the values were in range from 14.93 to 25.16 mg.g^{-1}. In last phase (IV. phase) where stems, leaves, and seeds were evaluated, buckwheat leaves exerted the highest content of these compounds, and the values were in range from 68.74 to 90.27 mg.g^{-1}. Maximal increase of total phenolics content was manifested in each variety in phase IV., i.e. at the end of the vegetation period. From the standpoint of the content of total polyphenolics in individual anatomical parts the cultivars Pyra, Hrusowska and Emka were the most suitable ones as functional foods.

Key words: total polyphenolics, buckwheat, anatomic parts

IZVLEČEK

RAZLIKE PRI NASTAJANJU POLIFENOLOV V DELIH RASTLIN IN FAZAH RASTI PRI IZBRANIH KULTIVARJIH AJDE

Proučevane so razlike v vsebnosti skupnih polifenolov v delih rastlin (stebla, listi, cvetovi in semena) pri navadni ajdi (*Fagopyrum esculentum* Moench.) med rastjo. Proučevanih je bilo šest kultivarjev: Pyra, Spacinska, Emka, Kasho, Jana C1 in Hrusowska. Koncentracija skupnih polifenolov je bila raziskana v rastni fazi I. (formiranje socvetij), v fazi II. (začetek cvetenja), v fazi III. (polno cvetenje) in v fazi IV. (polna zrelost). Koncentracija skupnih polifenolov je bila analizirana spektrofotometrično z uporabo reagenta Folin-Ciocalteau na aparaturi Shimadzu UV-1800. Najvišja koncentracija polifenolov je bila v cvetovih (14,93 do 25,16 mg.g^{-1}). V zrelosti (IV. faza) je bilo največ polifenolov v listih (68,74 do 90,27 mg.g^{-1}). Vsebnost polifenolov se je pri vseh kultivarjih povečala v fazi IV., to je na koncu rasti. Glede na vsebnost skupnih polifenolov v posameznih delih rastlin so kultivarji Pyra, Hrusowska in Emka najbolj primerni za uporabi pri pripravi funkcijskih živil.

Ključne besede: skupni polifenoli, ajda, deli rastlin

1 INTRODUCTION

Buckwheat (*Fagopyrum esculentum* Moench.) has been traditionally used as a human food source in the world. This crop was very popular in 17th-19th centuries in western countries, but later in 20th century was substituted by wheat (Cawoy et al., 2009)**.** At present times buckwheat is precious crop throughout the world with regard to recently found nutritive traits. It has been the most versatile functional food of 21st century (Zhang and Chen, 2004) not only as the food or forage, but also as medicine and melliferous plant (Bonafaccia et al., 2003; Christa and Soral-Smietana, 2008; Tang et al., 2009). Nutritional studies have demonstrated potential

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benefits of buckwheat (Kreft et al., 1996). Many of health benefits of buckwheat have been attributed to its high level of polyphenol compounds, which exhibit antioxidant activity (Wijngaard and Arendt, 2006). Polyphenol compounds have been extensively researched in the last decade for health promoting properties such as their role in the prevention of degenerative diseases, which include cancer and cardiovascular diseases (Scalbert et al., 2005). Besides, many polyphenol compounds stimulate the immune system and slow aging processes (Chuah et al., 2008; Podsedek, 2007).

Buckwheat is rich in vitamins, especially those of the B group (Fabjan et al., 2003), and is also an important source of trace elements (Zn, Mn, Cu, Se) as well as macroelements (K, Na, Ca, Mg) (Stibilj et al., 2004). Buckwheat is a potentially important source of rutin, a natural flavonoid with antihyperglycemic, antihypertensive and antioxidative properties (Lee et al., 2007), too. Buckwheat is considered as important functional food (Kreft et al., 2006). Its leaves and young parts of the plant are consumed in some countries as a vegetable, that's why the dynamics polyphenol compounds formation in different growth phases and various anatomic parts was the objective of our work.

2 MATERIALS AND METHODS

Materials:
Six cultivars of common buckwheat (*Fagopyrum esculentum* Moench.) Pyra (P), Spacinska (S), Emka (E), Kasho (K), Jana C1 (J) and Hrusowska (H) were obtained from Plant Production Research Centre in Piešťany.

The content of total polyphenolics was evaluated in growth phase I. (formation of buds), in phase II. (at the beginning of flowering), in phase III. (full flowering) and in phase IV. (full ripeness).

Determination of total polyphenols content (TPC)
Folin-Ciocalteau reagent and gallic acid were purchased from Merck (Germany). Sodium carbonate, methanol, ethanol were obtained from Sigma (USA) and 2,2-diphenyl-1-picrylhydrazyl radical from Organics (USA).

The total polyphenol content was assessed by the method used by Lachman et al. (2003) employing the reduction of a phosphowolframate-phosphomolybdate complex to blue products by phenolic compounds. Briefly, an aliquot of the extract, blank or standard was placed in a 50 mL flask, where the Folin-Ciocalteu assay (2.5 mL) was added and the mixture was allowed to react for 3 minutes under continuous stirring before a solution of sodium carbonate (7.5 mL) was added and mixed thoroughly. The volume was then made up to 50 mL with distilled water and left standing at room temperature for 2 h. The absorbance was measured at 765 nm using Shimadzu UV-1800 spectrophotometer (Japan). Results were expressed as mg gallic acid equivalents (GAE) per kg fresh weight (FW).

Statistical analysis
Statistical processing of the results was carried out in program Statistica 6.0, where the significance of differences between monitored parameters in individual anatomical parts of common buckwheat plants with the T- test at $\alpha < 0.05$ were evaluated.

3 RESULTS

The rate of formation of polyphenol compounds during vegetation (4 taking of samples) in individual anatomic parts of common buckwheat (stems, leaves, flowers and seeds) were observed. In the phase I. (formation of buds) stems and leaves were analysed. When evaluating total content of polyphenolic compounds (TPC), leaves of each cultivar contained significantly higher amount of polyphenol compounds. In leaves of variety Pyra there was recorded 7.7-fold higher concentration of (TPC) in comparison to stems, namely 9.33 $mg.g^{-1}$.

In the phase II. also flowers were analysed. The highest concentration of TPC was found in flowers of each variety, followed by the leaves and the lowest level of polyphenol compounds was recorded in stems of common buckwheat. In flowers there was recorded in average 10-times higher concentration than in stems and the highest concentration of (TPC) was recorded again in variety Pyra (18.05 $mg.g^{-1}$). In the phase III. all anatomical parts (stems, leaves, flowers and seeds) were analysed. In this phase, on the basis of obtained results we could state that the total polyphenols contents in individual anatomic parts of common buckwheat were in followed order: flowers > leaves > seeds > stems. In leaves there were 10-11.5-fold higher values than in stems and the highest value was recorded in variety Pyra (22.83 $mg.g^{-1}$). All values were 14-fold higher in flowers in the phase III. when compared to tested stems and the variety Hruszowska was the richest one in total polyphenol compounds (25.16 $mg.g^{-1}$). The content of TPC in the seeds was recorded from 7.36 $mg.g^{-1}$ (Emka) to 15.48 $mg.g^{-1}$ (Pyra). In the last phase the stems, leaves and seeds were analysed. There were in average 26.7-fold higher concentrations of TPC in leaves in comparison to stems and the highest concentration was recorded again in variety Pyra a presented 90.27 $mg.g^{-1}$. On the basis of TPC we can state that anatomic parts in this phase had decreasing tendency as following: leaves >seeds > stems.

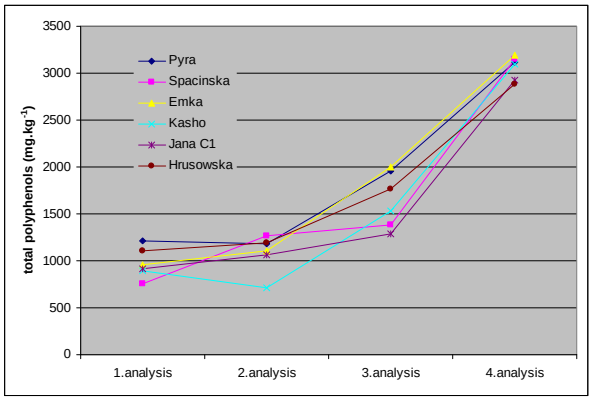

Figure 1. Content of total polyphenolics in stems

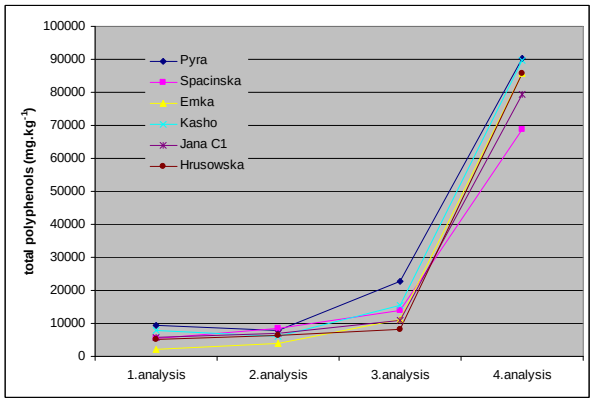

Figure 2. Content of total polyphenolics in leaves

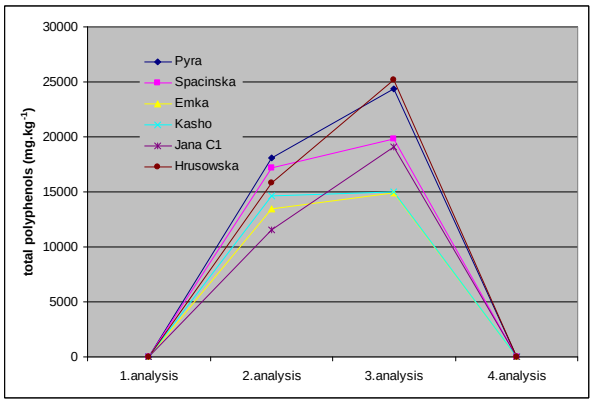

Figure 3. Content of total polyphenolics in flowers

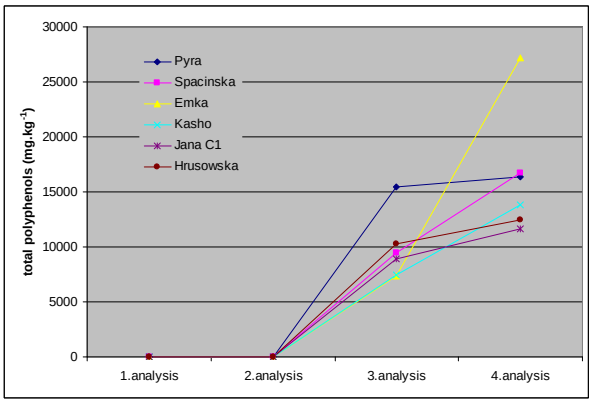

Figure 4. Content of total polyphenolics in seeds

When monitoring of the dynamics of polyphenol compound formation, there was maximal increase of TPC in stems of each variety in phase IV. and the highest increase (by 233 % in comparison to phase I) was observed in variety Spacinska. Similarly also in leaves of common buckwheat there was the highest increase of TPC in IV. phase and in variety Emka there was even 36-fold increase in comparison to phase I. When monitoring the dynamics of formation of TPC in flowers there was maximum increase in III. phase. This increase was in range from 15.2 to 65.7 % in individual cultivars in comparison to TPC in phase I. Also the seeds of common buckwheat are very important for the consumption, and thus they were investigated in phases III. and IV. The increase of TPC was recorded in IV. phase and the highest increase was in variety Emka that presented even 268 % increase in comparison to phase III. Statistical evaluation of obtained results are presented in Table 1.

Table1. Statistical evaluation of differences of total polyphenolics content in observed cultivars

			PYRA						SPACINSKA						EMKA						KASHO						JANA C1						HRUSOWSKA					
			III. phase				IV. phase		III. phase				IV. fáza		III. phase				IV. phase		III. phase				IV. phase		III. phase				IV. phase		III. phase				IV. phase	
			St	L	F	S	L	S	St	L	F	S	L	S	St	L	F	S	L	S	St	L	F	S	L	S	St	L	F	S	L	S	St	L	F	S	L	S
PYRA	III.phase	St	1						x						0						x						x						x					
		L		1						x						x						x						x						x				
		F			1						x						x						x						x						0			
		S				1						0						x						x						x						0		
	IV.phase	L					1						x						0						0						x						x	
		S						1						0						x						x						x						0
SPACINSKA	III.phase	St							1						x						x						0						x					
		L								1						x						0						x						x				
		F									1						x						x						0						x			
		S										1						0						0						0						0		
	IV.phase	L											1						x						x						x						x	
		S												1						x						x						x						0
EMKA	III.phase	St													1						x						x						x					
		L														1						x						x						x				
		F															1						0						x						x			
		S																1						0						x						0		
	IV.phase	L																	1						0						0						0	
		S																		1						x						x						0
KASHO	III.phase	St																			1						x						x					
		L																				1						x						x				
		F																					1						x						x			
		S																						1						x						0		
	IV.phase	L																							1						x						0	
		S																								1						x						0
JANA C1	III.phase	St																									1						x					
		L																										1						x				
		F																											1						x			
		S																												1						0		
	IV.phase	L																													1						x	
		S																														1						0
HRUSOWSKA	III.phase	St																															1					
		L																																1				
		F																																	1			
		S																																		1		
	IV.phase	L																																			1	
		S																																				1

St-stems, L-leaves, F-flowers. S-seeds, x- statistically significant differences, 0-statistically non significant differences

4 DISCUSSION AND CONCLUSION

The present report is a based on the evidence that polyphenols are the most abundant antioxidants in the diet. Experimental studies on animals or cultured human cell lines support a role of polyphenols from plants in the prevention of cardiovascular diseases (Truswell, 2002).

Buckwheat is one of the best grain sources of polyphenol compounds (Gallardo et al., 2006), where main polyphenols found are glycosides of the flavonol quercetin followed by glycosides of the flavones apigenin and luteolin (Dietrych-Szostak and Oleszek, 1999). Our results are in consistency with results of other authors (Kreft et al., 2006; Kalinova et al., 2006) who also referred about higher content of polyphenol compounds in flowers and leaves than in other anatomic parts of common buckwheat. Also Golisz et al. (2007) identified higher amount of phenolic compounds in flowers (9.14 mg. g^{-1}) and in leaves of common buckwheat (8.90 mg. g^{-1}) when compared to stems (2.46 mg .g^{-1}). Formation of polyphenol compounds is affected by various factors as well as variety and agro-technical conditions (Fabjan et al., 2003) and in formation of polyphenol compounds mainly stresses affect plant during vegetation (Gross, 2003).

The changes of polyphenol compounds formation dynamics during vegetation have been the subject of only few authors. Our results suggest an increase of polyphenol compounds content during vegetation in all tested varieties. Quantity and quality polyphenol compounds according to Hamilton et al. (2001) are strongly determined by genetic factors. Our results confirmed statistically significant differences among cultivars in phase I. when evaluating the content of total polyphenolics in stems as well as in leaves. Similarly statistically significant differences were confirmed in the content of total polyphenolics also in the growth phase II. among all cultivars. Different situation was recorded in phases III. and IV., where inter-varietal statistical significance in the content of total phenolics in individual anatomic parts of common buckwheat plants was not always confirmed. Kraus et al. (2003) also refers that the concentration of polyphenol compounds varies with plant phenology and season. With regard on the dynamics of polyphenol compounds, our results are in consistency with Kalinová and Dadáková (2009) who also found lower content of total polyphenolics at the beginning of vegetation period when compared to the end of vegetation. Content of polyphenol compounds depends on developing phase of tested buckwheat. In common buckwheat the rutin content in leaves increased with the age of the plant, with the maximum at the stage of maturity or at the stage of full flowering in case of dry weather conditions after flowering, and in stems the rutin content slightly decreased (Kalinová et al., 2006).

Our results suggest that flowers and leaves were the richest in total polyphenolics content among the analysed anatomic parts of common buckwheat, followed by the seeds and the lowest content of these health beneficial substances was obtained in stems.

When evaluating the dynamics of total polyphenolics formation the maximal increase of their content was observed in each variety in the phase IV., at the end of vegetation period.

5 ACKNOWLEDGEMENT

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Agris category code: P40, P10, F01

Establishment of agricultural drought monitoring at different spatial scales in southeastern Europe

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ABSTRACT

To detect temporal and spatial variability of drought is one of the most challenging issues of drought monitoring in the specific country or region due to the fact that there is no standard definition of severity and duration of different types of drought. Crop water deficit (CWD) simulated by crop water balance model IRRFIB supplemented with some *in-situ* soil water measurements by Time-Domain Reflectometry (TDR) measurement technique are proposed as tools for local agricultural drought monitoring in this study. Moving to regional drought monitoring the main constraint represents data availability of different sources. Available global data sets are of assistance for preparing regional drought monitoring products. In the study two specific products designed for regional scale are described: preliminary maps of the SPI (Standardized Precipitation Index) and products generated by implementation of numerical weather prediction model. It seems to be a lot of potential in both products for a first overview of key meteorological parameters in the region. The development of drought in the year 2009 was under examination and also yearly results for different periods after 1971. Dry periods in the year 2009 heavily impacted cereals in Slovenia. Maize yield showed best agreement with crop water deficit (r = 0.65) and SPI on the time scale of six months for September (r = 0.61). SPI was not suitable for describing agricultural drought in the periods with higher evapotranspiration rate. For more agricultural oriented drought monitoring more indices should be included into the consideration.

Key words: drought monitoring, agriculture, IRRFIB, SPI, numerical modelling, crop water balance

IZVLEČEK

VZPOSTAVLJANJE MONITORINGA KMETIJSKE SUŠE V JUGOVZHODNI EVROPI NA RAZLIČNIH PROSTORSKIH SKALAH

Eden izmed večjih izzivov na področju monitoringa suše v določeni državi ali regiji je določanje časovne in prostorske variabilnosti suše, saj ne obstaja splošna definicija, ki bi določala intenzivnost in trajanje različnih tipov suše. V študiji predlagamo primanjkljaj vode pri rastlinah (CWD), simuliran z vodnobilančnim modelom IRRFIB in podprt z *in-situ* meritvami vode v tleh s TDR tehnologijo, kot primerno orodje za lokalno določanje kmetijske suše. Na širšem, regionalnem nivoju pa se pojavi ovira pri dostopnosti podatkov, zato si pri pripravi regionalnih produktov lahko pomagamo z globalnimi nizi. Opisujemo dve možnosti, primerni za regionalno skalo: preliminarne karte standardiziranega padavinskega indeksa (SPI) in produkte, ki jih generiramo z implementacijo numeričnega modela za napovedovanje vremena. Pri obeh se kaže velik potencial za prvi, splošni pregled nad stanjem glavnih meteoroloških parametrov v regiji. Za primer smo vzeli razvoj suše leta 2009 ter letne rezultate za različna obdobja po letu 1971. Leta 2009 so sušna obdobja hudo prizadela poljščine v Sloveniji. Pridelek koruze kaže najboljšo povezanost s primanjkljajem vode CWD (r = 0,65) in z indeksom SPI na šestmesečni časovni skali za september (r = 0,61). Indeks SPI se ni izkazal za primernega pri obravnavi obdobij z višjo stopnjo potencialne evapotranspiracije. Opozarjamo še na dejstvo, da bi bilo potrebno za bolj kmetijsko usmerjen monitoring suše vključiti več različnih indeksov.

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Ključne besede: monitoring suše, kmetijstvo, IRRFIB, SPI, numerično modeliranje, vodna bilanca rastlin

1 INTRODUCTION

All types of drought originate from a deficiency of precipitation (Wilhite and Glantz, 1985). Meteorological drought is defined as extended period of time with significant precipitation deficit. Agricultural drought is defined more commonly by the availability of soil water to support crop and forage growth than by departure of normal precipitation over some specific period of time (Wilhite, 2007). It can also be determined by a period of reduced plant growth with a prolonged and abnormal soil water deficiency. Many attempts were made to create agricultural drought index, some of the 'rainfall indices' can be related, for example, to soil and crop type, crop status and climatological parameters such as air temperatures, air humidity and wind (Maracchi, 2002). A soil water deficit within the rooting zone can result in crop water stress, depending on the crop status and climatological factors affecting evapotranspiration.

Drought indicators and triggers are important for several reasons: to detect and monitor drought conditions; to determine the timing and level of drought responses; and to characterize and compare drought events.

However, agricultural drought depends on soil moisture and evapotranspiration deficits. For this reason, water balance model IRRFIB was developed, which computes the main components of water balance aiming to quantify drought stress of crop canopy. On a daily basis it evaluates soil moisture content. It also computes seasonal and annual integrated drought stress by the ratio of actual to potential transpiration.

A simulation study of the soil moisture content under a maize field was carried out. The approach of analysing the effect of drought on crop using dynamic crop models has the advantage to include all relevant drought impact factors of the soil-crop-atmosphere system over short time periods. This is of special interest when answering the questions whether agrometeorological model IRRFIB is sufficient to simulate the water balance and the occurrence of drought on local scale.

Beside assessment of drought conditions on local scale (which can be extremely variable due to local conditions) there is a need to estimate situation on larger scale. One of possible (and frequently applied) procedures is application of point measurements and geostatistical techniques for spatial interpolation (such as kriging; see for example Pardo-Iguzquiza, 1998). There are other possibilities; numerical weather prediction (NWP) models (that are routinely used for weather forecast) are potentially useful tool for drought monitoring. Under term NWP model we usually understand mathematical set of equations describing motion of air and other events that take place in the atmosphere. Modern NWP models are constructed around the full set of primitive equations which govern atmospheric motions and are formulated in discrete numerical form; some processes are not fully resolved and are rather presented by parameterization, such as turbulent diffusion, radiation, moist processes, heat exchange, soil, vegetation, surface water, convection etc. NWP models simulate values in regular grid mesh; error is expected to be spread over whole computing domain and doesn't strongly depend on distance from nearest observation as in the case of statistical interpolation. For larger areas with various density of observation NWP models seem to be useful tool for drought detection despite their known deficiencies (see for example Ebert and McBride, 2000).

2 MATERIALS AND METHODS

2.1 Site descriptions

The experimental fields were located in the southeastern Slovenia. Murska Sobota is located on flat area, at 46° 39' latitude, 16° 11' longitude, and at an elevation 188 m a.s.l. Platform for meteorological measurements is located within agricultural research area. Meteorological observations were recorded in the frame of national meteorological network. Climate is characterized by cool, wet winter and warm, dry summers, with an average (1971-2000) annual precipitation of 805 mm (Figure 1).

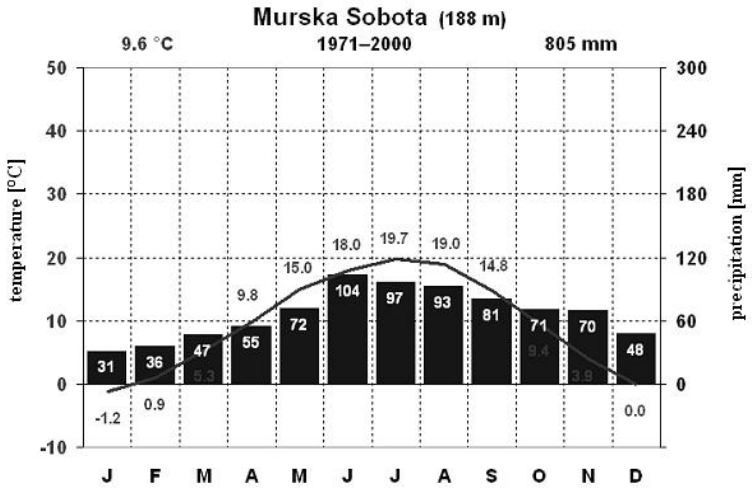

Figure 1: Climate diagram for Murska Sobota (source: EARS, 2009)

Slika 1: Klimagram za Mursko Soboto (vir: ARSO, 2009)

Around 60 % of the precipitation occurs between April and September. Mean annual air temperature is 10.2 °C, with the mean monthly maximum of 37.8 °C occurring in August. Precipitation during the recent vegetation periods was less than 60 % of the long-term average, primarily due to seasonal shift to more dry vegetation periods. Average annual potential evapotranspiration is around 700 mm, around 80 % occurring during the vegetation period.

2.2 Climate data

The following meteorological parameters were used in the study: minimum air temperature, maximum air temperature, relative air humidity, cloudiness or duration of irradiation, wind speed and precipitation. Daily meteorological data for the period 1971-2009 were obtained from the database of the Slovenian Meteorological Office (EARS, 2009).

2.3 Crop data

Phenological data for grass (*Dactylis glomerata)* and maize (*Zea mays*) have been obtained from the database of the Slovenian Meteorological Office (EARS, 2009). The phenological stages used in the study included sowing, emergence, 3rd leaf, beginning of male flowering, beginning of female flowering, milky ripe, vax ripe, full ripe and harvest of maize (middle ripening class) for the period 1971-2009 with some missing years in the dataset. For model IRRFIB verification with regard to soil moisture measurements phenological data of grass heading and flowering for the period 2006-2008 were used. For the period 1993-2008 maize yield data were obtained from Agriculture Institute of Slovenia. Over time some cultivars were changed but still remain in the same FAO ripening class.

2.4 Drought impact reports

The drought impacts on crops were obtained from Agrometeorological reports of Meteorological Office of the Republic of Slovenia as timely information on the severity and spatial extent of drought and its associated impacts (EARS, 2009a). Improved information on drought impacts helped to identify the type of impacts and where they were occurring.

2.5 Soil data

Soil water characteristics and hydraulic conductivity functions have been described through field capacity (Fc) and wilting point (Wp) through experimental data. Soil water holding capacity (SWC) is around 100 mm. For soil water measurement Time-Domain Reflectometry (TDR) technology was used; probes are mounted in 10, 20 and 30 cm depths at both meteorological stations. TDR device (*Trime*) for continuous and non-destructive determination of volumetric soil moisture consists of electronic sensor which measures dielectric constant of the material and recalculates it to the soil moisture content. Data are available in 10 minute intervals. For the model verification measurements for the period 2006-2008 were obtained. The experimental plots with yield data are near the meteorological station in Murska Sobota, where the soils have the same characteristics.

2.6 Model IRRFIB description

IRRFIB simulates the water balance in the crop-soil-system on the daily basis. The model calculates evapotranspiration (ET) using the Penman-Monteith equation (FAO, 1998) for different crop covers considering the relevant processes of heat, water and vapour transport in the soil-crop-atmosphere interface (Table 1). Crop coefficients and rooting depths are linearly interpolated during each phenological phase and are used for calculating actual evapotranspiration and soil water reservoir, respectively.

Table 1: Input and output parameters of IRRFIB model (Sušnik, 2006).

Tabela 1: Vhodni in izhodni parametri modela IRRFIB (Sušnik, 2006).

	INPUT	Value	OUTPUT
Weather	Minimal air temperature	Daily values	Potential evapotranspiration
	Maximal air temperature	Daily values	Actual evapotranspiration
	Relative air humidity	Daily values	
	Cloudiness / Duration of irradiation	Daily values	
	Wind speed	Daily values	
	Precipitation	Daily values	
Crop	Phenological phase	Dates for maize, grass	Crop coefficient (daily)
	Crop coefficient (for phase)	0-1 (grass); 0-1.1(maize)	Crop water demand
	Roots depth	20 cm (grass); 0-50 cm (maize)	Irrigation demand
Soil	Field capacity	Different values for locations	Precipitation infiltration
	Wilting point	Different values for locations	Soil water content
			Soil water deficit

Crop water simulation model IRRFIB was tested for a variety of crops and applications (Sušnik et al, 2006). Model results were validated against water content measurements using a TDR sensor in 2004 at the measurement site of meteorological station in Ljubljana. Strong correlations were obtained during the testing period (r^2 = 0.94) (Sušnik, 2006). Model performance was also tested for a test site in Braunschweig Germany (Sušnik, 2005). Recent study with model SIMPLE showed good degree of concomitance with IRRFIB model (r^2 =0.69).

Model runs were performed for the period 1971-2008 due to availability of phenological data.

Water balance (B) and crop water deficit (CWD)

Water balance of the first day assumes that water reservoir is full as follows:

$$B_1 = PK \cdot Z$$

PK vol. % of water at PK

Z rooting depth [mm]

For the crop coefficient K_c and rooting depth Z linear approximations in the vegetation period were performed. The volume of plant available water (PAW) is defined as $(1 - pp)$. In this study pp equals 0.5. The lower threshold of available water is defined as $B_{threshold}$:

$$B_{threshold} = \left(TV + (PK - TV)\, pp\right) \cdot Z \quad \ldots (2)$$

Following data are needed for the water balance calculation for i-th day: reference evapotranspiration ET_{oi}, daily precipitation P_i, crop coefficient K_{ci}, rooting depth Z_i and water balance on previous day B_{i-1}.

Daily water deficit on day i CWD_i is a difference between daily precipitation and crop evapotranspiration (ET_{ri}), which can be expressed as:

$$ET_{ri} = K_{ci} \cdot ET_{oi} \quad \ldots (3)$$

$$CWD_i = P_i - ET_{ri}, \text{ if } B_{i-1} > B_{threshold} \quad \ldots (4)$$

$$CWD_i = P_i - ET_{ri}/2, \text{ if } B_{i-1} \le B_{threshold} \quad \ldots (5)$$

In our study only daily water deficits with values less than $B_{threshold}$ were used.

The water balance on day i, is defined as

$$B_i = B_{i-1} + CWD_i$$

if $B_i < TV_i \cdot Z_i$ is equal to $TV_i \cdot Z_i$ … (6)

if $B_i > PK_i \cdot Z_i$ is equal to $PK_i \cdot Z_i$ … (7)

Number of days with CWD was summarized over vegetation period.

2.7 Drought stress days (DS)

Drought stress occurs in situations where crop evapotranspiration (ET_r) is less than potential evapotranspiration (ET_o). Inside IRRFIB model drought stress is simulated as impact of soil water availability on ET_r, assuming that soil moisture limited ET_r beyond a threshold suction value (50 % of Fc) and than decreased linearly to zero at permanent wilting point. The limit of crop available soil water is a threshold, under which a half of actual evapotranspiration is subtracted from precipitation amount, resulting in daily water deficit. During vegetation period drought stress intervals were analysed. Days with the soil water content under this limit are considered as days with drought stress.

2.8 Standardized precipitation index (SPI)

Standardized Precipitation Index represents the transformation of the precipitation time series into standardised normal distribution. Detailed description of transformation procedure can be found in Guttman (1999). Due to simplicity (it requires only precipitation data) it became one of most frequently applied tools for drought monitoring. Variable time scale of SPI calculation enables description of drought conditions in meteorological, agricultural and hydrological applications. Drought dynamics is another important feature that is addressed with variable time scale; it is capable of determining the onset, duration and intensity of drought. We have implemented a modified version of SPI software from Colorado Climate Center, which is capable of calculating SPI on specified time scale and also accounts for zero precipitation. Time scale was specified as the number of days or months provided daily or monthly precipitation sums at meteorological stations as input data.

2.9 Statistical methods

Statistical measures like average error (AE), root mean square error (RMSE), modelling efficiency (EF), coefficient of residual mass (CRM) and Pearson's correlation coefficient (r) are used in the study. For the classification of vegetation periods regarding drought severity, Conrad-Chapman percentile classification (Sušnik, 2005) is used.

3 RESULTS

3.1 Model IRRFIB verification

Comparison of modelled grass water balance with measurements was made for three years (2006-2008) in Murska Sobota. Values of AE, RMSE and CRM are indicating little deviation between measured and simulated values when they are near zero. On the other hand, the optimum value for EF is 1, representing a good modelling efficiency (Elmaloglou and Malamos, 2000). CRM is negative, where IRRFIB obviously overestimates soil water content. Correlation r with measurements is significant (Table 2).

Relatively small overall differences imply that IRRFIB can be a useful tool in simulating soil water balance (Figure 2).

Table 2: Five statistical criteria for comparison of measured (Trime) and simulated (IRRFIB) values of soil water content in Murska Sobota

Tabela 2: Pet statističnih kriterijev za primerjavo izmerjenih (Trime) in simuliranih (IRRFIB) vrednosti količine vode v tleh v Murski Soboti

location	AE [vol.%]	RMSE [%]	EF	CRM	r
Murska Sobota	2,11	20,40	0,55	-0,10	0,84**

** Correlation is significant at 0.01 level.

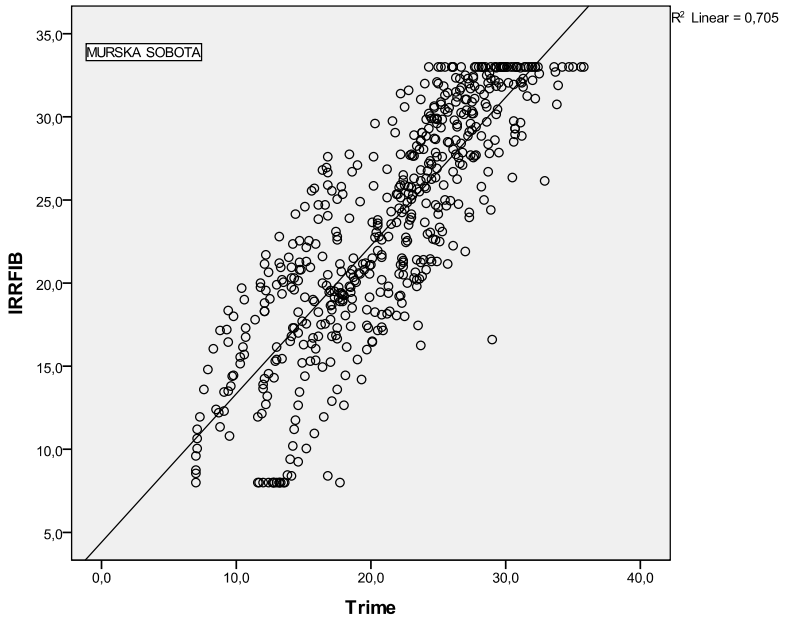

Figure 2: Comparison of measured (Trime) and simulated (IRRFIB) values of soil water content in Murska Sobota in the period 2006-2008

Slika 2: Primerjava izmerjenih (Trime) in simuliranih (IRRFIB) vrednosti količine vode v tleh v Murski Soboti v obdobju 2006-2008

3.2 Comparison of SPI with water balance

The case study for year 2009 revealed the importance of relationship between drought duration and water balance during the growing season, when monitoring agricultural drought. In order to estimate the degree of agreement between index values and water balance dynamics, the graphical comparison between SPI and soil water balance was made for growing season in 2009 (Figure 3).

Results revealed best agreement between cumulative water deficit and SPI on the time scale of two months (SPI2). SPI2 was calculated for every day of vegetation season and compared with soil water balance for the reference crop. Daily values of soil water balance were calculated as a difference between precipitation and evapotranspiration cumulative for a period of two months. When the soil moisture deficit increased as a consequence of higher evapotranspiration rates, SPI2 wasn't capable to identify drought situations.

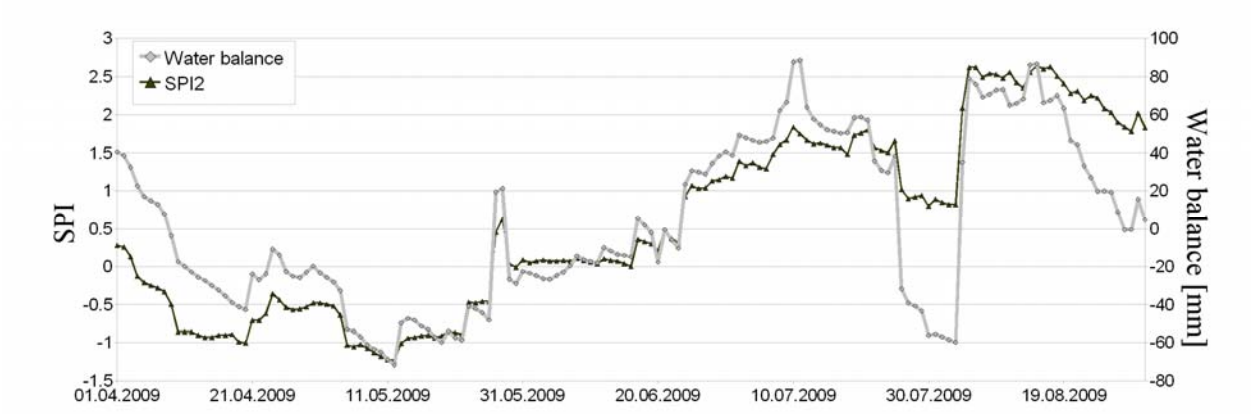

Figure 3: SPI values on the time period of two months (left y axis) and cumulative water deficit (right y axis) during vegetation period 2009 in Murska Sobota

Slika 3: Vrednosti indeksa SPI na dvomesečni skali (leva y os) in kumulativne vodne balance (desna y os) v vegetacijskem obdobju 2009 v Murski Soboti

This can be seen at the end of July, with a period of high water deficit, whereas SPI2 remained positive. Same situation occurred after an extreme precipitation event at the 4th of August, which was followed by the period of very hot weather with an occurrence of a heat wave. Thus, SPI solely couldn't explain the water balance dynamics in the root zone during periods, when soil moisture couldn't meet the plant needs.

3.3 Relationship between yield and different drought indicators

Crop yield at the harvest is a good indicator of climate, soil and management practices during the vegetation season.

Table 3: Correlation coefficients (r) among yield and drought indicators in the period 1983-2008 in Murska Sobota

Tabela 3: Koeficienti korelacije (r) med pridelkom in različnimi kazalniki suše za obdobje 1983-2008 v Murski Soboti

		P	ET_o	CWD	DS	SPI_6
Yield MS	Pearson Correlation	,462*	-,397	,652**	-,510*	,614**
	Sig. (2-tailed)	,027	,061	,001	,013	,001
	N	23	23	23	23	26

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

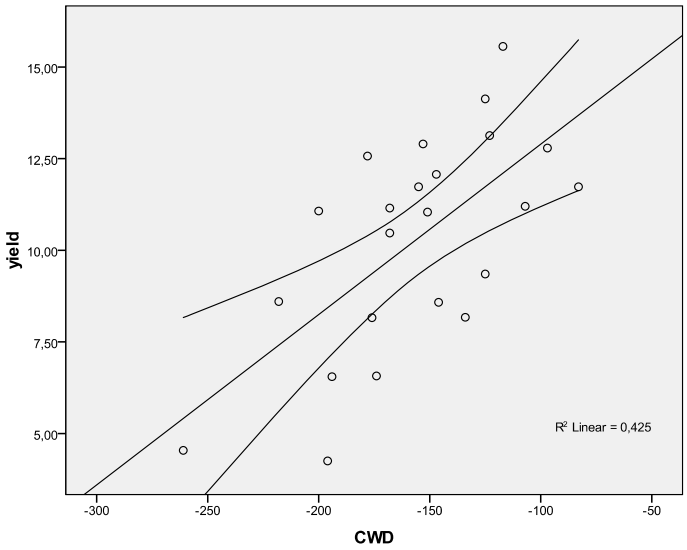

Figure 4: Yield vs. crop water deficit (CWD) for maize on soil with medium water holding capacity in Murska Sobota in the period 1983-2008

Slika 4: Pridelek v odvisnosti od primankljaja vode (CWD) za koruzo na tleh s srednjo zadrževalno sposobnostjo za obdobje 1983-2008 v Murski Soboti

Under standardized management practice routines and potential nutrition applications, climate determines the variability of crop yield for a certain soil type. SPI and model IRRFIB were used in order to investigate the effects of different indicators like precipitation (P), evapotranspiration (ET_o), crop water deficit (CWD) and drought stress (DS) on the maize yield over long-term period. Strong correlation is observed between yield and crop water deficit, whereas it was weaker with only one meteorological parameter like ET_o or P (Table 3). The correlation coefficients (r) between the crop water deficit and yield are significant indicating that higher crop water deficit lead to yield decrease (Figure 4).

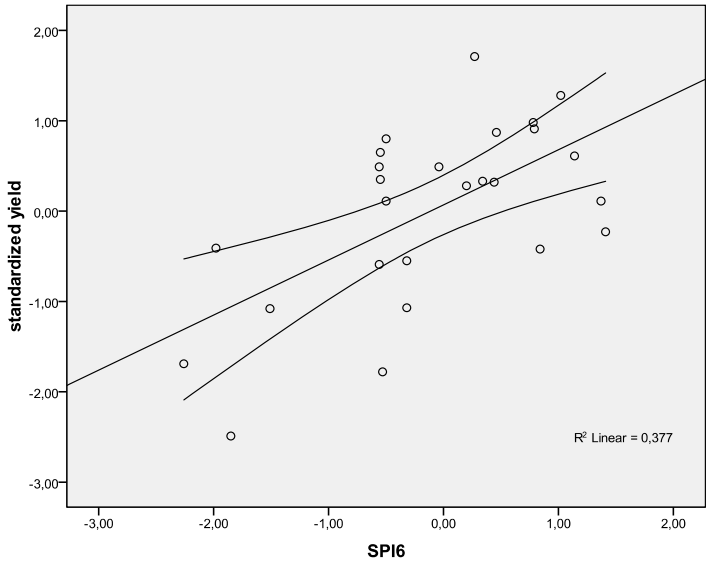

Figure 5: Standardized yield vs. standardized precipitation index on the time scale of 6 months (SPI6) in Murska Sobota in the period 1983-2008

Slika 5: Standardiziran pridelek v odvisnosti od indeksa SPI na šestmesečni skali za obdobje 1983-2008 v Murski soboti

Proxy data (drought impact reports) were also used for comparison due to the fact that long-term data on yield are unfortunately not available for Slovenia. The results showed that crop water deficit represents a good indicator when linking it with drought reports. Based on our understanding soil moisture can significantly affect the yield, but other factors like diseases and pests can trigger the decrease of yield as well (for example year 2005).

A comparison was also made between maize yield and SPI on different time scales.

In order to make a direct comparison with SPI, yield data were standardized for a period between 1983 and 2008. Best agreement was found between maize yield and SPI on the time scale of six months for September (Figure 5), which is in the time frame of maize growing season. There were significant differences in years with high temperature variability during growing season (Figure 6). Year 2006 shows highest disagreement; in that case the vegetation period was characterized by above normal precipitation (SPI value of 1.5), but the yield was below average. Lower yield was the consequence of high temperatures and low precipitation amounts during June and July. This is the period when maize is approaching tasseling and shows high degree of vulnerability to high temperatures and water deficiencies (Čergan et al., 2008). Large evapotranspiration rates during this period have limited potential development rate, which affected grain filling later in the season and consequently lowered the final yield.

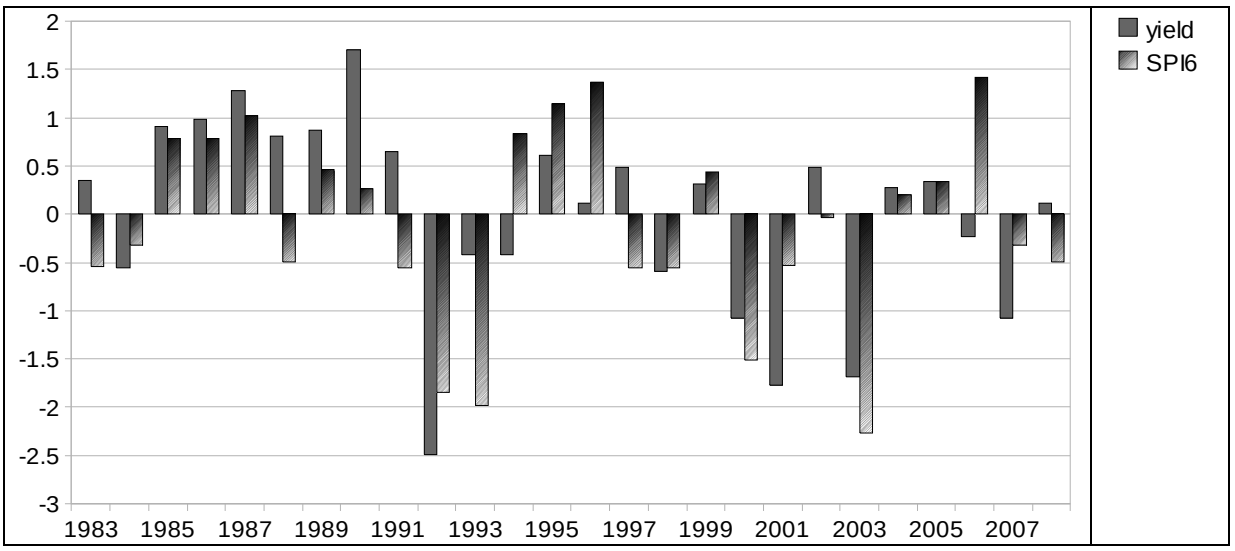

Figure 6: SPI on the time scale of 6 months and standardized maize yield in Murska Sobota in the period 1983-2008

Slika 6: Indeks SPI na šestmesečni skali in standardiziran pridelek koruze v Murski Soboti v obdobju 1983-2009

3.4 Crop water deficit as a measure of drought severity

In the end of this section we focused on the crop water deficit as a measure of drought severity. In order to investigate whether CWD is reliable in time before records of yield are available, we used CWD for the period of available phenological data for maize and meteorological data since 1971. The results show that the driest vegetation period in Murska Sobota occurred in 2003 (Figure 7). Very dry years were 1983 and 1993 and dry years 1984, 1988, 2000 and 2001 (Table 4).

Table 4: Percentile classes of crop water deficit (CWD) for maize on soil with medium water holding capacity in Murska Sobota in the period 1972-2008

Tabela 4: Percentilni razredi primanjkljaja vode (CWD) za koruzo na tleh s srednjo zadrževalno sposobnostjo za obdobje 1972-2008 v Murski Soboti

extremely dry	very dry	dry	normal	wet	very wet	extremely wet
< -237	-237 to -198	-198 to -174	-174 to -107	-107 to -82	-82 to -70	> -70
2003	1983	1984	1981	1973	1972	1975
	1993	1988	1985	1982	1980	
		2000	1986	1989		
		2001	1987	1997		
			1990	2005		
			1991			
			1994			
			1998			
			1999			
			2002			
			2004			
			2006			
			2007			
			2008			

The data have been checked with the reported drought impacts over a specified period of time. Drought impacts on cereals were confirmed in all extremely dry, very dry and dry vegetation seasons (HMZ / EARS, 1983-2003). The seasonal water deficit up to 240 mm was recorded in dry seasons (Table 4) in Murska Sobota.

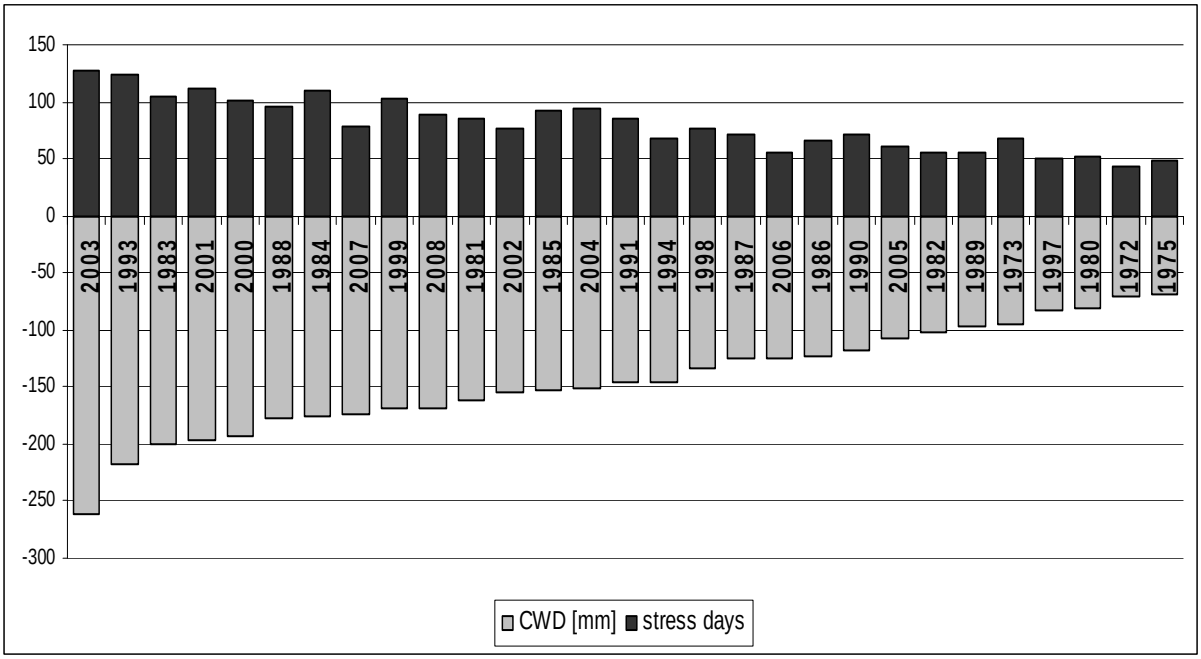

Figure 7: Crop water deficit (CWD) for maize on soil with medium water holding capacity in Murska Sobota in the period 1972-2008 in descending order

Slika 7: Primanjkljaj vode (CWD) za koruzo na tleh s srednjo zadrževalno sposobnostjo za obdobje 1972-2008 v Murski Soboti v padajočem vrstnem redu

3.5 NWP simulations as a tool for drought monitoring

Potential evapotranspiration and precipitation are among NWP simulated variables that are relevant for assessing drought conditions. It is known that numerical simulation of precipitation amount is among least reliable NWP output. This was confirmed by application of NMM numerical meteorological model on domain situated over SE Europe with approximately 8 km horizontal resolution; R^2 for 60-day precipitation accumulation of simulations, nested into ERA-Interim reanalyses (Simmons et. al., 2007) for stations in Slovenia haven't exceeded value 0.8 (in some cases it remained below 0.5), while in case of accumulation of evapotranspiration R^2 exceeded value 0.9 for all stations that were taken into account (Roškar and Gregorič, 2010). Overall performance of NWP model for drought monitoring is therefore promising; the question remains whether it is appropriate for drought impact assessment in local scale.

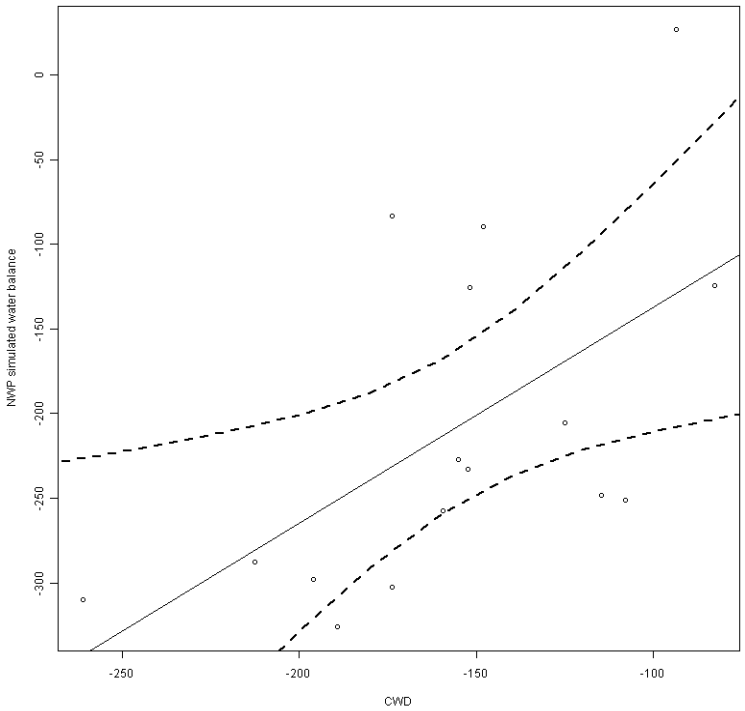

Figure 8: Comparison of maize crop water deficit in Murska Sobota with NWP simulations of surface water balance in the period 1989-2007

Slika 8: NWP simulacije površinske vodne balance v odvisnosti od primankljaja vode (CWD) za koruzo za obdobje 1989-2007 v Murski Soboti

Table 5: Percentile classes of maize crop water deficit (CWD - see Table 4) and NWP simulated surface water balance in 5 percentile classes for years 1989-2008

Tabela 5: Razdelitev primankljaja vode za koruzo (CWD) in simulirane površinske vodne balance (NWP) v pet percentilnih razredov za obdobje 1989-2008

Year	CWD	NWP simulation
1989	extremely/very wet	extremely/very wet
1990	wet	normal
1991	normal	wet
1993	extremely/very dry	dry
1994	normal	normal
1997	extremely/very wet	wet
1998	normal	normal
1999	normal	wet
2000	dry	extremely/very dry
2001	dry	dry
2002	normal	normal
2003	extremely/very dry	extremely/very dry
2004	normal	normal
2005	wet	normal
2006	wet	normal
2007	normal	dry

Since CWD appears to be parameter that adequately represents local drought conditions, it can be used as measure of success of NWP simulation. Figure 8 shows comparison of modelled surface water balance (cumulative evapotranspiration subtracted from cumulative precipitation between May and September) to measurement-based calculation of CWD in period 1989-2007. Cumulative water balance between May and September was found to be closest parameter derived from NWP simulations using normal post-processing techniques to measurement-based CWD for maize. However, adjusted value of R^2 was only 0.29. Similar as in the case of SPI index, basic post-processing of NWP simulations could not explain significant part of interannual variability of drought stress estimated through CWD. This fact is presented also in Table 5 which contains measurement based CWD and NWP in percentile classes as in Table 4.

Only 5 percentile classes were used in this case (two most extreme classes on both sides were joined into single extreme wet or extreme dry class). In 7 years (out of total 16) the percentile classes don't match. In 5 out of 7 cases there is "dry bias" of NWP derived water balance (in 1990, 2005 and 2006 "normal" opposed to "wet"; in 2007 "dry" opposed to "normal" and in 2000 "extremely dry" opposed to "dry"). In two cases (1991, 1999) "wet bias" was observed ("normal" opposed to "wet").

4 DISCUSSION AND CONCLUSIONS

The following conclusions can be reached on the basis of above comparison and analysis:

(1) Water balance model IRRFIB simulations are of good quality. The relative difference of calibration results between IRRFIB and measurements is small (r = 0.8). In addition, model detection of crop water deficit, its drought stress and impact on yield is less consistent. In other words, CWD possess very micro-location capability.

(2) The yield decreases with the increase of CWD and DS. The fitting R-squares is 0.652 and 0.510, respectively. This indicates that CWD could represent drought conditions, while the fitting R-squares of P and ET_o are only 0.462 and 0.397, respectively. From the scatter points distribution of CWD dry years are confirmed with reported drought impacts. This is a clear demonstration of drought information for local scale and specific crop.

(3) Best agreement was found between maize yield and SPI on the time scale of six months for September, which is in the time frame of maize growing season. There were significant differences in years with high temperature variability during growing season. The SPI can be used to monitor conditions on a variety of time scales and is to be useful in both short-term agricultural and long-term applications.

(4) Comparison of NWP derived accumulated water balance to measurement based CWD indicates correlation to be rather poor (R-squared reaches values around 0.3 for various periods of accumulation). Although it is statistically significant at 0.01 level it is not possible to use NWP output directly to estimate drought impacts on crops. However, due to capability of NWP models to simulate temperature and evapotranspiration anomalies (and less successfully precipitation), there is potential to develop drought monitoring tools for regional scale.

(5) The integration of existing drought monitoring tools is essential for improving local and regional drought monitoring. A proactive approach emphasizing integration requires the collective use of multiple tools, which can be used to detect trends in crop water availability and provide early indicators at local, national, and regional scales on the likely occurrence of drought.

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Agrovoc descriptors: rotational cropping,plant protection,conventional tillage,traditional uses,integrated plant production, animal production,plant production,mixed farming,farming systems,monoculture,cropping systems, legislation,sustainability

Agris category code: F07, H01, L01

Crop rotation on arable and livestock farms in Slovenia

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ABSTRACT

Despite the fact that successive sowing of maize was legally limited due to the occurrence of the corn rootworm beetle in 2003 and the integrated crop production was introduced in 2004, maize is still the most common and desired crop on arable and livestock farms in Slovenia. With a focus on the economic motives for the production farmers are gradually beginning to consider also the phytosanitary viewpoint, but the planning of a crop rotation is a demanding task, especially for younger farmers with no previous experience. The results of the analysis of crop rotations on conventional and integrated arable and livestock farms in north-east and western Slovenia in the period from 2000 to 2009 show that the maize monoculture has been supplemented by other grains, mostly wheat and barley, but legumes and supplementary crops are still missing from the rotation. With newly introduced crops to Slovene fields the need for new and modern agro-technical measures is increasing and also the need for improved knowledge of biological characteristics of individual varieties and species with their suitable order and share in the crop rotation. To help the farmers find the best solution for their production we have prepared some recommendations for the crop rotations with the main and supplementary crops, following good and proven examples of crop rotations used in the past. Whether farmers will use them on their farms depends not only on their technical equipment and knowledge, flexibility and receptiveness, but also on the legislative measures and sustainable nature of EU agricultural policy where farmers got used to be paid for every function and production that is environmentally and food friendly.

Key words: crop rotation, phytosanitary importance of rotation, conventional crop production, integrated crop production, arable and livestock farms, Slovenia

IZVLEČEK

KOLOBAR NA POLJEDELSKO-ŽIVINOREJSKIH KMETIJAH V SLOVENIJI

V Sloveniji je koruza, kljub zakonski omejitvi zaporedne setve zaradi pojava koruznega hrošča leta 2003 in vključevanja kmetij v integrirano pridelavo poljščin leta 2004, še vedno najbolj razširjena in zaželena poljščina na poljedelsko-živinorejskih kmetijah. Ekonomski vidik pridelave postopoma upošteva fitosanitarnega. Načrtovanje kolobarja je zahtevno, zlasti za mlajše kmete, ki nimajo izkušenj iz preteklosti. Rezultati analize kolobarjev na konvencionalnih in integriranih poljedelsko-živinorejskih kmetijah v severovzhodni in v zahodni Sloveniji v obdobju od leta 2000 do 2009 kažejo, da so monokulturo koruze razbremenila druga žita, zlasti pšenica in ječmen, manjkajo pa stročnice in dosevki. Z novo vključenimi poljščinami se povečujejo potrebe ne le po novi in sodobni agrotehniki, ampak tudi po poznavanju bioloških zakonitosti posameznih vrst in sort ob hkratni primerni razporeditvi in deležu v kolobarju. V oporo kmetom smo sestavili nekaj biološko uravnoteženih kolobarjev iz glavnih posevkov in dosevkov, ki se zgledujejo po preizkušenih vrstilnih kolobarjih iz preteklosti. Njihova uporaba na kmetijah bo odvisna ne le od tehnične opremljenosti kmetije, znanja, dojemljivosti in prožnosti gospodarjev ampak v glavnem od zakonskih predpisov in sonaravnih usmeritev kmetijske politike v EU, kjer so se kmetje navadili na plačilo za vsako okolju in hrani prijaznejše opravilo in postopek pridelave.

Ključne besede: kolobar, koruza, fitosanitarni pomen kolobarja, konvencionalna pridelava poljščin, integrirana pridelava poljščin, poljedelsko-živinorejske kmetije, Slovenija

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1 INTRODUCTION

Balanced crop rotation with alternations between grains and non-grain cultures was designed in the middle of the 18th century in Great Britain (Spanring 1959, Sadar 1961, Geisler 1980, Butorac 1999, Kocjan Ačko et al. 2005, Diepenbrock et al. 2005, Martin et al. 2006). Results of the scientific research and farmers experiences show that biologically balanced crop rotation can be achieved when 40 to 50-percent of the fields are covered with grains, while root crops and legumes cover from 20 to 30% of land each. Especially legumes are very useful to maintain soil fertility (symbiosis with *Rhizobium* bacteria), and their phytosanitary importance within the crop rotation is reflected in reduced weediness, less infections and less damage on grains and root crops.

Approximately 40-percent share of maize in the sowing structure of crops in the last two decades puts Slovenia to the first place among all European countries (Tajnšek and Šantavec 1998; Statistical yearbook and Statistical information 2009). This wide use of maize in the rotation prevents the composition of a biologically balanced crop rotation. When maize is sown as a monoculture or in a narrow crop rotation (maize – wheat/barley) we can find a higher occurrence of specific pathogens (fusariozis, corn smut – *Ustilago maydis*), pests (Elateridae, corn borer) and more weeds (Zscheischler et al. 1990, Čergan et al. 2008, Vogelsang et al, 2009).

We have studied the changes in the sowing structure of crops on arable and livestock farms. We analysed the composition of the crop rotation in first two regions that recorded the occurrence of maize beetle in Slovenia, where they had to – due to the legal provisions – introduce maize into the crop rotation. We were also interested in differences in the composition of the rotation between conventional and integrated farms. The goal of the research was to prepare recommendations of biologically balanced crop rotations that could be used on arable and livestock farms in the future.

2 MATERIALS AND METHODS

The sequence of crops was studied on ten conventional and ten integrated farms in Pomurje (north-eastern Slovenia) and in Goriška region (western part of Slovenia) in the period from 2000-2009. We have recorded the crops in the rotation on individual farms where we also discussed with the householders the characteristics of the crop rotation and the sequence of the crops in the rotation.

Crop rotations were evaluated with the methods of analysis, synthesis, generalization and specialization referring also to domestic and foreign realizations, principles of the crop order in the rotation, duration of the rotation and results of the research. For each individual farm we determined the most frequent rotation of five crop rotations. We have analysed its composition before and after the appearance of the corn beetle in 2003.

We have reviewed the prohibitions, required measures and recommendations regarding the inclusion of the maize in the crop rotation. All producers have the obligation to respect the provisions of the Rules of the phytosanitary measures to prevent the spreading of the corn rootworm beetle (O.J. RS, no. 21/2004 and 106/2006) and Instructions of the Monitoring and Forecast Service on movement and occurrence of beetles that are posted on the internet (http://www.furs.si/Diabrotica/Index.asp) and are simultaneously amended. Producers who decided on integrated production have to respect all prohibitions, demands and recommendations that are written in Technological guidelines for integrated crop production in the current year considering every change in situations. One of important required measures is five-year crop rotation where maize can be sown on the same land twice in three years, but never twice successively.

Following the example of the Norfolk crop rotation from the 18th century (Geisler 1980, Butorac 1999, Diepenbrock et al. 2005, Martin et al. 2006) and by composing four-year crop rotations and other modifications of the sequential crop rotation including the old Slovene five-year crop rotation (Sadar 1961) and the five-year Rhine crop rotation, used in Germany (Diepenbrock et al. 2005) we have prepared recommendations for new crop rotations considering also biological characteristics of individual species with the indication of their suitable share in the rotation.

3 RESULTS AND DISCUSSION

3.1 Crop rotation on conventional arable and livestock farms in north-east Slovenia

In the period from 2000 to 2009 crop rotation was re-introduced to conventional arable and livestock farms in north-east part of Slovenia. Before 2003 the maize monoculture was reorganised into two crop production – maize/wheat or maize/barley. A permanent two-crop production – maize/wheat or maize/barley was found in four crop rotations where barley gradually prevailed. The reason for increased production of barley in recent years compared to the past is the stable yield of new

varieties therefore the production of barley is more economic compared to maize and it has a high fodder quality for domestic animals, mostly pigs. The extreme summer drought in 2003 (Monthly weather report, 2003) was also the reason for sowing the winter barley that ripens before wheat and uses winter moist for growth and development. The crop rotation that included maize and sugar beet was composed entirely of root plants but was too short for sugar beet and therefore inappropriate. By including barley between maize and sugar beet they prolonged the rotation to three years. In that rotation winter rapeseed replaced sugar beet when its production has been abolished in 2008 by the state (the reason was the close-down of the sugar factory in Ormož). On the other side after 2003 the three year root crop rotation (maize – wheat – sugar beet) was shortened to the repeating two-crop production wheat/barley. In nine out of ten crop rotations there are no legumes the only exemption being the rotation on one farm where in 2004 they have decided to sow grass-clover mixture (GCM). It remained on the field for two years and afterwards they used the maize-wheat crop rotation. No farm used the supplementary crops that is why the stubbly fields got weedy and became the fertile ground for pests and the need for pesticides increased.

3.2 Crop rotation on integrated arable and livestock farms in north-east Slovenia

On integrated arable and livestock farms even before the year 2004 and before farms entered into the supervised production in 2005 they introduced grains into the maize rotation every second and third year and crop rotations with sugar beet lasted three years. With the introduction of the integrated production six farms decided to produce sorghum as the third crop and biotic diversity of otherwise grain crop rotations increased with fodder supplementary crops (Italian rye-grass, Crimson clover, fodder rapeseed) or with supplementary crops for green manure (winter rye); for bee pasture and green manure the farmers sowed California bluebell. After they stopped producing sugar beet four crop rotations used the alternation between maize and wheat or barley and every second or third year they introduced supplementary crops from other botanic families (crucifers, legumes, and water-leaf plants). Annual sowing of Crimson clover as a supplementary crop which is unacceptable due to the auto-toxicity of the Crimson clover has been found in six crop rotations. From the phytosanitary view it would be more appropriate to introduce the alternation between the Crimson clover and fodder rape or other crucifers or to replace the Crimson clover with the Landsberger mixture which beside the Crimson clover also includes vetch and Italian rye-grass. A suitable choice would also be the mixtures of vetch and grains that were often sown on Slovene arable and livestock farms until mid 20th century.

3.3 Crop rotation on conventional arable and livestock farms in western Slovenia

Also in the Goriško region (west part of Slovenia) they had to give up successive sowing of maize in 2004. The maize monoculture was supplemented by the grain crops (wheat and barley) in 2004 and 2005.

In phytosanitary terms the rotation of maize and wheat is not suitable since an increased occurrence of fusariosis on wheat can be expected and consequential contamination of food and animal feed with mycotoxins (Bottalico 1998, Bartles in Rodermann 2003, Vanova et. al. 2008, Zemljič et al. 2008,). In phytosanitary terms more suitable rotation would be the oats – wheat rotation that was quite common in the past (Sadar, 1961; Martin et al. 2006).

After 2003 two farms decided to grow lucerne that was left on the field for two or three years which is too short compared to its usual use of four to five years.

From the same reasons as in the Pomurje region, farmers in Goriško region also preferred to grow barley to the wheat.

Six crop rotations used no legumes, and all ten rotations were missing supplementary crops, at least after the harvest of the winter grains. Due to the summer heat and drought in this area there is almost no possibility of supplementary crops on the farms without the irrigation system.

3.4 Crop rotation on integrated arable and livestock farms in western Slovenia

On integrated arable and livestock farms in Goriško region (2005-2009) the rotation originates from the maize monoculture or the maize-wheat rotation. Worst phitosanitary effects were detected after two cases of barley crop before the wheat (increased occurence of stub and root rot caused by *Gaeumannomyces graminis* for wheat) (Cook 2003). After the introduction of integrated production the third crop was introduced into the rotation on all ten farms (spring oats, red clover, fodder sorghum, silage legumes) and the biotic diversity of the rotation was improved by the inclusion of supplementary crops (fodder rape, crimson clover, rapeseed). In six crop rotations we detected successive sowing of Crimson clover.

In phytosanitary sense the break between the crops is also too short in majority of crop rotations that is the

reason that the pesticides are still used as the basic protection against weeds, pests and diseases.

3.5 Recommendations of biologically balanced crop rotations

Alternation between maize and winter grains was the main characteristics of all crop rotations on arable and livestock farms in north-east and in the western region of the country. On integrated farms there is a higher number of crops included in the rotation, but farmers do not always use the correct order and suitable share of individual crops within the rotation.

Compared to presently used rotations on arable and livestock farms with conventional production and with the same number of animals and same type of the livestock production four year rotations are biologically more suitable (Table 1, 2, 3) and producers have a number of options to choose from.

Table 1: Recommended Norfolk four-year crop rotation for arable and livestock farms in north-east and western Slovenia

	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
1. year					MAIZE (for grains or silage)							
2. year			SPRING BARLEY (under crop red clover)					RED CLOVER				
3. year	RED CLOVER									WINTER WHEAT		
4. year	WINTER WHEAT							Oil radish				

Table 2: Recommendations (a, b, c, d) for a four-year crop rotation in the sequence of leafy plants (L) with cereals (C) (L-C-L-C) for arable and livestock farms in north-east and western Slovenia

a

	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
1. year	Italian rye-grass				MAIZE (for grains or silage)							
2. year			OATS					Oil radish				
3. year			FODDER FIELD BEAN							WINTER BARLEY		
4. year	WINTER BARLEY						Italian rye-grass					

b

	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
1. year					PUMPKIN					WINTER WHEAT		
2. year	WINTER WHEAT							Fodder rapeseed				
3. year			PEAS							TRITICALE		
4. year	TRITICALE							California bluebell				

c

	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
1. year					MAIZE (for grains or silage)							
2. year			OATS					Italian rye-grass				
3. year	Italian rye-grass				SOYA (for silage)					WINTER WHEAT		
4. year	WINTER WHEAT							Oil radish				

d

	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
1. year					MAIZE FOR GRAINS							
2. year			OATS					Landsberg mixture				
3. year	Landsberg mixture				SILAGE MAIZE					WINTER WHEAT		
4. year	WINTER WHEAT							Fodder rapeseed				

Table 3: Recommendation for a four-year crop rotation in the sequence of leafy plants with cereals (L- L -C -C) for arable and livestock farms in north-east and western Slovenia

	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
1. year				POTATOES						Winter rye + winter vetch		
2. year	Winter rye + winter vetch					MAIZE (for grains or silage)						
3. year			OATS							WINTER WHEAT		
4. year	WINTER WHEAT								Turnip rape			

Based on previous practice at home and abroad we have prepared five-year rotations (Table 4 to 6) also for the farms in integrated production. In biotic sense the recommended rotations have much higher biotic diversity than the ones presently used.

Table 4: Recommendation of an old Slovene five-year crop rotation with specific order of leafy plants with cereals: oats-clover-L-C-C for arable and livestock farms in north-east and western Slovenia

	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
1. year			OATS (undercrop CGM)						CGM			
2. year	CLOVER-GRASS MIXTURE (CGM)											
3. year	CGM				MAIZE (for silage)					WINTER WHEAT		
4. year	WINTER WHEAT									WINTER BARLEY		
5. year	WINTER BARLEY						Maize (for silage)					

Table 5: Recommendation of an old Slovene five-year crop rotation with specific order of leafy plants with cereals: oats-clover-L-C-L for arable and livestock farms in north-east Slovenia

	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
1. year			OATS (undercrop CGM)						CGM			
2. year	CLOVER-GRASS MIXTURE (CGM)											
3. year					PUMPKINS					WINTER WHEAT		
4. year	WINTER WHEAT							Fodder rapeseed				
5. year				MAIZE (for grains or silage)								

We are aware that in phytosanitary sense the more suitable crop rotations can in short term threaten the intensive livestock production on the farm, but they are acceptable for a long term planned supply of animal feed from natural meadows and pastures from the early spring to late autumn. Higher biotic diversity on arable and livestock farms is therefore limited by the intensity of the livestock production and some breeders and experts strongly oppose such changes.

Table 6: Recommendations (a, b, c, d) of the Rhyne five-year crop rotation with specific order of leafy plants with cereals: (L-C-C-L-C) for arable and livestock farms in north-east and west Slovenia

a

	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
1. year	MAIZE (for grains or silage)											
2. year	OATS									WINTER WHEAT		
3. year	WINTER WHEAT									Landsberger mixture		
4. year	Landsberger mixture					MAIZE (for silage)				WINTER BARLEY		
5. year	WINTER BARLEY						Sudan grass					

b

	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
1. year	PEAS									WINTER WHEAT		
2. year	WINTER WHEAT									WINTER BARLEY		
3. year	WINTER BARLEY								White mustard			
4. year	MAIZE (for grains or silage)											
5. year	OATS							California bluebell				

c

	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
1. year	FIELD BEAN									WINTER WHEAT		
2. year	WINTER WHEAT									TRITICALE		
3. year	TRITICALE								White mustard			
4. year	MAIZE (for grains or silage)											
5. year	OATS							California bluebell				

d

	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
1. year	RAPESEED						Silage maize					
2. year	OATS									WINTER WHEAT		
3. year	WINTER WHEAT							Landsberger mixture				
4. year	Landsberger mixture					MAIZE (for silage)				WINTER BARLEY		
5. year	WINTER BARLEY							RAPESEED				

4 CONCLUSIONS

These are the findings and conclusions of our analysis of crop rotation on intensive arable and livestock farms:

- The occurrence of the maize beetle in 2003, introduction of the integrated production in 2005 and certain measures of Slovene environmental programme are the main reasons for the reintroduction of crop rotation on Slovene farms.
- Maize is no longer a monoculture, but is still the most frequently produced crop in rotation with wheat or barley.
- In integrated production the third crop in the five-year rotation is most frequently a grain. Biotic diversity, which is essential for healthy crops on integrated farm, is for now depending on supplementary crops, their selection and correct introduction into the rotation.
- While on conventional arable and livestock farms that we have studied in north-east Slovenia there were no legumes in the rotation, on some analyzed farms in Goriška region (west of Slovenia) they have introduced the lucerne into the rotation, which is biologically beneficial only with longer crop rotations, when the break before sowing lucerne for the second time is the same as the number of years that it has been used.

- The sequence of legumes with shorter growing periods is also problematic. The main reason for that is their auto-toxicity when sown on the same field, therefore we should have a look at mixtures of legumes with grains and grasses that were in a past an important part of crop rotations on arable and livestock farms.
- Introduction of legumes (for fodder and for grains) is also an important possibility to produce proteins on Slovene fields, which also means less expense for protein feed.
- After the production of sugar beet has been abolished on the Slovene farms, there are no real root crops in the rotation. Despite the fact that potatoes and sugar beet are both large users of humus from the soil, as root crops they have a favourable effect and serve as a tampon preventing high weediness.
- We also discovered that farmers only fulfil the minimum legal requirements, included in the Regulation on required procedures and good agricultural practice, Rules on integrated crop production and Rules on the phytosanitary measures to prevent the spreading of the corn beetle.

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Povezave med zavarovanimi območji, turizmom in razvojem podeželja

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IZVLEČEK

Povezave med zavarovanimi območji, turizmom in razvojem podeželja smo preučevali na primerih Triglavskega narodnega parka in Kozjanskega parka. Na vsakem območju je bilo anketiranih 200 lokalnih prebivalcev. Glede na dobljene rezultate lahko zaključimo, da preučevani zavarovani območji omogočata razvoj podeželskega turizma. Da je razvoj turizma v zavarovanih območjih uspešnejši od razvoja turizma izven zavarovanih območij, ne moremo trditi. Anketirani prebivalci Triglavskega narodnega parka med vsemi gospodarskimi panogami najbolj podpirajo razvoj turizma na območju (86,5 %), kar pa ne velja za anketirane prebivalce Kozjanskega parka, ki se najbolj strinjajo z usmeritvijo območja v kmetijstvo ter razvoj malega podjetništva in obrti. Vseeno ni zanemarljivo dejstvo, da se kljub temu visok delež anketiranih prebivalcev Kozjanskega parka strinja, da bi se moralo območje osredotočiti na razvoj turizma (74,5 %). Da je priložnost zavarovanega območja v boljših možnostih za poslovanje v turizmu, se strinja skoraj polovica anketiranih prebivalcev Triglavskega narodnega parka (47 %) in le 15 % anketiranih prebivalcev Kozjanskega parka. Iz tega lahko sklepamo, da Triglavski narodni park nudi več priložnosti oziroma dodatnih možnosti za poslovanje v turizmu kot pa Kozjanski park. Na zavarovanem območju, kjer je turizem bolj razvit (Triglavski narodni park), anketirani prebivalci menijo, da so strategije varstva narave manj uspešne, in občutijo več negativnih obremenitev turizma (promet in gneča, višje cene). Nasprotno pa v primeru, kjer je turizem na zavarovanem območju manj razvit (Kozjanski park), anketirani prebivalci opažajo, da so strategije ohranjanja narave uspešnejše in da jih turizem manj obremenjuje.

Ključne besede: zavarovana območja, narodni park, regionalni park, razvoj, turizem, podeželje, Slovenija

ABSTRACT

CONNECTIONS BETWEEN PROTECTED AREAS, TOURISM AND DEVELOPMENT OF THE COUNTRYSIDE

Connections between protected areas, tourism and development of the countryside were studied in the examples of the Triglav National Park and the Kozjanski Park. 200 local inhabitants were interviewed in each area. According to the results, it can be concluded that the studied protected areas give an opportunity to develop rural tourism. It cannot be claimed that the development of tourism in protected areas is more successful than the development of tourism outside the protected areas. The interviewed inhabitants of the Triglav National Park support the development of tourism in the area (86.5 %) more than all other industries, whereas this is not true for the interviewed inhabitants of the Kozjanski Park. The latter agree the area should be oriented in agriculture and the development of small business and craft. Nevertheless it is not insignificant that a high share of the interviewed inhabitants of the Kozjanski Park agrees on focusing this area on tourism development (74.5 %). Almost half of the interviewed inhabitants of the Triglav National Park (47 %) and only 15 % of the interviewed inhabitants of the Kozjanski Park agree that the opportunity of the protected area is a better possibility in tourism business. Thus we can conclude that the Triglav National Park offers more opportunities or additional possibilities for business in tourism than the Kozjanski Park. In the protected area, where tourism is more developed (the Triglav National Park), the interviewed inhabitants believe that the nature conservation strategies are less successful and perceive more negative burdens of tourism (traffic and crowds, higher prices). On the contrary, in the protected area, where tourism is less developed (the Kozjanski Park), the interviewed inhabitants observe that nature conservation strategies are more successful and they are less influenced by tourism.

Key-words: protected areas, national park, regional park, development, tourism, rural areas, Slovenia

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1 UVOD

Zavarovana območja ustanavljamo z namenom obvarovanja narave pred človeškim uničenjem. Prebivalci zavarovanega območja zahtevajo razvoj, ki omogoča sodoben način življenja. Pogosto prav zaradi navzkrižja med interesi uprave parka in lokalnih prebivalcev prihaja do konfliktnih situacij in nezadovoljstva na obeh straneh, zato je treba poiskati možnosti, ki bi zagotovile razvoj območja in hkrati ohranjanje okolja. Turizem se v tem konceptu predstavlja kot povezovalni element med zavarovanim območjem (upravo parka) in lokalnimi prebivalci.

Raziskave potrjujejo, da turizem lahko pozitivno vpliva na ohranjanje narave (Murphree, 1993; Baez, 1996; Goodwin in Roe, 2001; Hochtl in sod., 2005; Nyaupane in Thapa, 2006) in razvoj območja s tem, da lahko omogoči izboljšanje ekonomskih možnosti lokalnih prebivalcev (Child in Heath, 1990; Durbin in Ratrimoarisaona, 1996; Lindberg in sod., 1996; McCool, 1996; Lorah in Southwich, 2003; Poissonnet in sod., 2006) ter izboljšanje kvalitete življenja v domači lokalni skupnosti (Martin, 2004). Raziskave potrjujejo tudi negativne vplive turizma oziroma določenih oblik turizma na naravo in življenje ljudi v zavarovanem območju. Ti se kažejo v obremenitvi okolja (Jeršič, 1989; Rejec Brancelj, 2000; Cigale, 2004; Martin, 2004), finančni obremenitvi (UNEP, 2008) in družbeni obremenitvi (King in Stewaet, 1996; Goodwin in sod., 1998; Uddhammar, 2006).

Ko analiziramo povezavo med zavarovanimi območji, lokalnimi prebivalci in turizmom, ugotovimo, da obstajajo različni medsebojni vplivi, ki se odražajo v različnih rezultatih. Najbolj zaželeno je, da imajo vsi trije udeleženci (zavarovano območje, lokalni prebivalci in turizem) vzajemne koristi. Druga možnost je, da imata eden ali dva od udeležencev korist, tretji udeleženec pa ne. Tretja možnost je, da vsi trije udeleženci drug na drugega vplivajo negativno (Nepal, 2000).

Z raziskovanjem mnenj lokalnih prebivalcev Triglavskega narodnega parka in Kozjanskega parka ter pregledom objektivnih podatkov o razvojnih potencialih preučevanih zavarovanih območij smo želeli preveriti zastavljeni hipotezi, in sicer da zavarovana območja v regiji omogočajo razvoj podeželskega turizma ter da ima podeželski turizem pomembno vlogo pri razvoju podeželja v regijah z zavarovanimi območji (naravni parki, druga zavarovana območja).

1.1 Razvojni potenciali zavarovanih območij

Območja varovanja v Sloveniji združujejo okoljske, kulturne, socialne in človeške vrednote in kot taka nudijo ugodne razmere za nadzorovan regionalni razvoj na osnovi dejavnosti, ki so v skladu predvsem s cilji ohranjanja naravne in kulturne dediščine in hkrati nudijo priložnosti za razvoj sonaravnih dejavnosti (Lampič in Mrak, 2008; Plut, 2008).

Podatki o razvojnih potencialih preučevanih zavarovanih območjih potrjujejo, da imata tako Triglavski narodni park kot Kozjanski park brez dvoma okoljski in kulturni potencial, ki sta ključna za razvoj turizma. Triglavski narodni park je ustanovljen prav zaradi ohranitve posebne vrednosti narave na območju. V primeru Kozjanskega parka je bila ustanovitev zavarovanega območja posledica namena ohranitve kulturnega potenciala območja, naravnih vrednot in značilnosti območja. Ugotovili smo tudi, da imata tako Triglavski narodni park kot Kozjanski park, socialni potencial med drugim v obliki različnih društev, ki so povezana z ohranjanjem narave in kulturne dediščine in ki spodbujajo sodelovanje ter krepijo regionalni razvoj.

Za uspešen razvoj območja je nadvse pomemben dejavnik človeški potencial. Podatki kažejo, da so za Triglavski narodni park in Kozjanski park značilne razmeroma neugodna starostna in izobrazbena sestava, dnevne migracije na delo ter precejšna brezposelnost, ki so rezultat dosedanjih neugodnih socio-ekonomskih procesov ter predstavljajo precejšno razvojno oviro. Pri razvoju območij je namreč treba upoštevati tako lokalne želje in zmožnosti kot tudi kakovost delovne sile, ki je potrebna za različne dejavnosti (Plut, 2008). Ugotavljamo, da je situacija v primeru Kozjanskega parka slabša:

- Kozjanski park izstopa po nizki izobrazbeni strukturi prebivalstva. 50 % prebivalstva, starega 15 let ali več, ima le osnovno ali nedokončano osnovno šolo. Delež visoko izobraženega prebivalstva je le 5 % (Popis 2002, 2002; Predlog osnutka …, 2008).
- Za Kozjanski park je poleg tega v večji meri kot za Triglavski narodni park značilno, da se število prebivalcev zmanjšuje zaradi pomanjkanja delovnih mest na območju (Popis 2002, 2002; SURS, 2002, cit. po Zidar, 2005; Plut, 2008).
- 67,9 % delovno aktivnih prebivalcev, ki živijo v naseljih, ki so vsaj z delom svoje površine znotraj meja Triglavskega narodnega parka, dnevno migrira na delo iz domačega kraja, od tega 38,2 % v drugo

občino ali celo drugo regijo (Popis 2002, 2002; Plut, 2008).
- Za Triglavski narodni park je značilen nizek delež kmetijske dejavnosti (3,7 %) (Popis 2002, 2002; Plut, 2008). V Kozjanskem parku je opazen velik upad kmetijstva, saj se je s to dejavnostjo ob zadnjem popisu ukvarjalo le 8 % prebivalcev, kar je zelo malo v primerjavi s podatkom iz leta 1971, ko je bilo prebivalcev, ki so se ukvarjali s kmetijstvom, kar 69 % (SURS, 2002, cit. po Zidar, 2005).
- Za Triglavski narodni park velja poudariti, da ima turizem v njem že sedaj velik pomen (Popis 2002, 2002; Plut, 2008).

2 MATERIAL IN METODA

Raziskava temelji na dveh študijah primera. Izbrani sta bili dve območji (regiji) v Sloveniji, kjer se nahajata zavarovani območji, in sicer Triglavski narodni park in Kozjanski park.

Zbiranje podatkov v Triglavskem narodnem parku je bilo izvedeno v sklopu projekta *Triglavski narodni park – Analiza izkušenj lokalnega prebivalstva*, naročenega s strani parka, med 200 naključno izbranimi lokalnimi prebivalci v parku in izven njega z uporabo anketnega vprašalnika (Rodela, 2007). V anketiranje so bili vključeni prebivalci vasi, ki ležijo v zavarovanem območju, in prebivalci vasi, ki ležijo izven zavarovanega območja, to je na obrobju zavarovanega območja. Zbiranje podatkov je potekalo od 5. do 21. septembra 2006. V Triglavskem narodnem parku je bilo anketiranih 46 prebivalcev iz 19 vasi, kar predstavlja 23 % celotnega vzorca. Izven Triglavskega narodnega parka je bilo anketiranih 154 prebivalcev iz 36 vasi, kar je 77 % od celotnega vzorca.

Zbiranje podatkov v Kozjanskem parku je bilo izvedeno med 200 naključno izbranimi lokalnimi prebivalci v Kozjanskem parku in izven njega z uporabo anketnega vprašalnika (Rodela, 2007). V anketiranje so bili vključeni prebivalci vasi, ki ležijo v zavarovanem območju, in prebivalci vasi, ki ležijo izven zavarovanega območja, to je na obrobju zavarovanega območja. Zbiranje podatkov je potekalo od 1. aprila do 30. junija 2007. V Kozjanskem parku je bilo anketiranih 172 prebivalcev iz 24 vasi, kar predstavlja 86 % celotnega vzorca. Izven Kozjanskega parka je bilo anketiranih 28 prebivalcev iz 9 vasi, kar je 14 % od celotnega vzorca.

Anketirance smo povprašali po sledečih socialno-demografskih karakteristikah: kraju stalnega bivališča, spolu, letu rojstva, številu članov v gospodinjstvu in številu otrok, zakonskem stanu, zaposlitvenem statusu, kraju dela in pridobljeni izobrazbi.

Vzorec merjencev v Triglavskem narodnem parku je bil enakovredno porazdeljen med ženskim (54,5 %) in moškim (45,5 %) spolom. Večina anketirancev je bila stara med 26 in 55 leti (74,5 %) in pripadajo najbolj aktivnemu delu populacije. Izobrazbena raven kaže, da je imela večina anketiranih prebivalcev srednješolsko izobrazbo (64,5 %). Glede na zaposlitveni status je bilo v anketiranje vključenih 14 % kmetov, 32,5 % turističnih delavcev in 53,5 % zaposlenih v drugih gospodarskih panogah. 38,5 % anketiranih prebivalcev je živelo v družinah z dvema članoma, 25,5 % jih je živelo v družinah s tremi člani in 25,5 % jih je živelo v družinah s štirimi člani. Več kot polovica anketiranih prebivalcev (53 %) je živela brez otrok. 21 % anketiranih prebivalcev je živelo z enim otrokom in 18,5 % jih je živelo z dvema otrokoma. 61 % anketiranih prebivalcev je bilo poročenih, 18,5 % jih je bilo samskih in 16,5 % jih je živelo v izvenzakonski zvezi. 88,5 % anketiranih prebivalcev je bilo zaposlenih v občini, kjer so imeli stalno bivališče, 7 % se jih je vozilo na delo v sosednjo občino.

V Kozjanskem parku je bilo anketiranih 79 % žensk in 21 % moških. Večina anketirancev je bila stara med 36 in 65 leti (71 %). Izobrazbena raven kaže, da je imela večina anketiranih prebivalcev srednješolsko izobrazbo (50,5 %). Glede na zaposlitveni status je bilo v anketiranje vključenih 35,5 % kmetov, 3,5 % turističnih delavcev in 61 % zaposlenih v drugih gospodarskih panogah. 42,5 % anketiranih prebivalcev je živelo v družinah z dvema članoma, 25,5 % jih je živelo v družinah s tremi člani in 11 % jih je živelo v družinah z enim članom. Več kot polovica anketiranih prebivalcev (64,5 %) je živela brez otrok. 17,5 % anketiranih prebivalcev je živelo z enim otrokom in 10,5 % jih je živelo z dvema otrokoma. 63,5 % anketiranih prebivalcev je bilo poročenih, 7,5 % jih je bilo samskih in 3,5 % jih je živelo v izvenzakonski zvezi. 72 % anketiranih prebivalcev je bilo zaposlenih v občini, kjer so imeli stalno bivališče, 21 % se jih je vozilo na delo v sosednjo občino.

S spremenljivkami, ki jih je vseboval anketni vprašalnik smo ugotavljali značilnosti mnenj anketiranih prebivalcev o: potrebah območja na katerem anketirani prebivalci živijo, uspešnosti sedanjih strategij razvoja območja, razvojni usmeritvi območja, priložnostih zavarovanega območja za njih osebno, bremenih zavarovanega območja za njih osebno, priložnostih zavarovanega območja za celotno območje in bremenih zavarovanega območja za celotno območje.

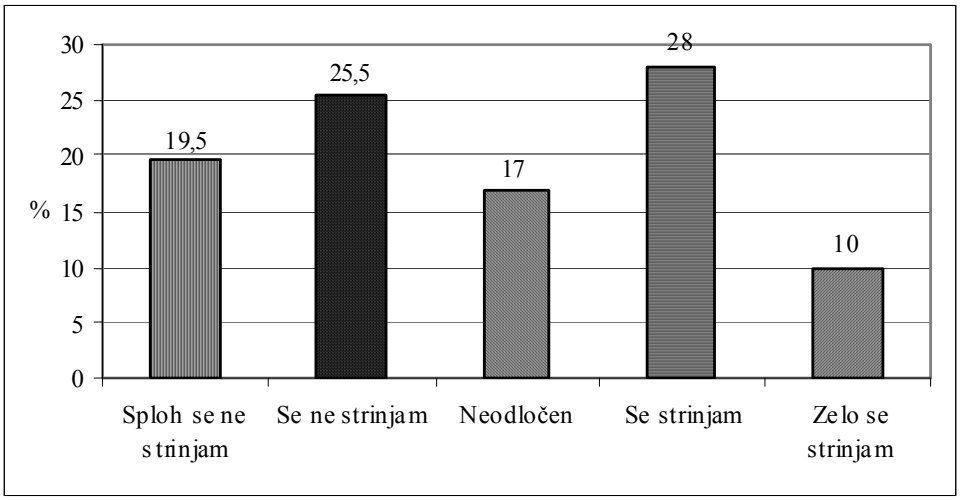
Anketiranci so ovrednotili trditve s pomočjo sedemtočkovne ocenjevane lestvice, pri čemer je številka 1 pomenila, da se s trditvijo sploh ne strinjajo, in številka 7, da se s trditvijo zelo strinjajo. Pri obdelavi podatkov smo zaradi majhnega števila posameznih odgovorov nekatere kategorije na vrednostni lestvici od 1 do 7 združili, in sicer kategoriji 2 in 3 ter kategoriji 5 in 6. Za ugotavljanje razlik med posameznimi spremenljivkami glede na mesto bivanja (v zavarovanem območju, izven njega) smo uporabili kontingenčne preglednice in Hi-kvadrat test. Kot statistično pomembne smo upoštevali razlike z vrednostjo 0,05 in manj. Vse analize podatkov so bile narejene z računalniškim statističnim paketom SPSS 15.0.

3 REZULTATI IN RAZPRAVA

3.1 Zavarovana območja v regiji omogočajo razvoj podeželskega turizma

Če s predstavljenimi ugotovitvami o razvojnih potencialih na preučevanih območjih v uvodu poskušamo najprej odgovoriti na vprašanje, ali zavarovani območji omogočata razvoj podeželskega turizma v smislu, da imata razvojni potencial, ki je za to potreben oziroma bi to omogočal, ugotavljamo, da so nekateri razvojni potenciali pomanjkljivi. Pri tem gre zlasti za pomanjkljivost sestavin človeškega razvojnega potenciala tako v primeru Triglavskega narodnega parka kot Kozjanskega parka, čeprav ugotavljamo, da je situacija v primeru Kozjanskega parka slabša.

Anketirani prebivalci Triglavskega narodnega parka menijo, da sedanje strategije razvoja podeželja na tem območju niso zelo uspešne (55 %) in da to območje potrebuje boljšo politiko razvoja podeželja (88 %) ter boljšo koordinacijo/vodenje območja (81 %). Kljub temu lahko trdimo, da je razvoj turizma uspešnejši od sedanjih strategij razvoja drugih gospodarskih panog – malega podjetništva in obrti, kmetijstva ter industrije – na območju. Rezultati namreč kažejo, da se 38 % anketiranih prebivalcev Triglavskega narodnega parka strinja, da so sedanje strategije razvoja turizma na območju zelo uspešne (Slika 1).

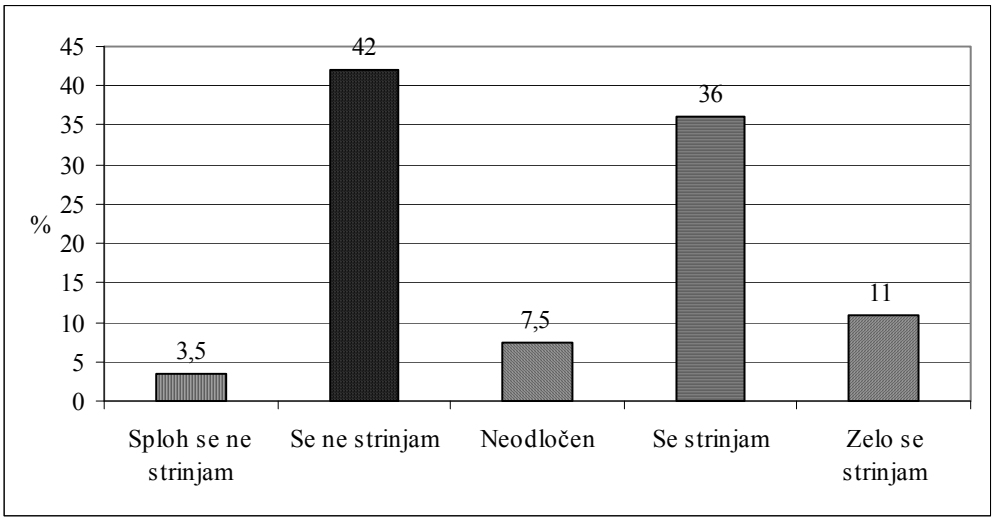


Slika 1: Sedanje strategije razvoja turizma na območju Triglavskega narodnega parka so zelo uspešne, 2006

Figure 1: Present tourism development strategies in the area of the Triglav National Park are very successful, 2006

Nadalje se 21 % anketiranih prebivalcev Triglavskega narodnega parka strinja, da so sedanje strategije razvoja kmetijstva zelo uspešne, 20,5 % anketiranih prebivalcev se strinja, da so sedanje strategije razvoja malega podjetništva in obrti zelo uspešne, ter 10,5 % anketiranih prebivalcev se strinja, da so sedanje strategije razvoja industrije zelo uspešne.

Približno enak delež anketiranih prebivalcev Kozjanskega parka kot anketiranih prebivalcev Triglavskega narodnega parka se ne strinja s trditvijo, da so sedanje strategije razvoja podeželja na tem območju zelo uspešne (56,5 %). Da območje potrebuje boljšo politiko razvoja podeželja, meni 93 % anketiranih prebivalcev Kozjanskega parka, ter da območje potrebuje boljšo kordinacijo/vodenje, meni 71,5 % anketiranih prebivalcev. Tudi v primeru Kozjanskega parka so anketirani prebivalci opredelili sedanje strategije razvoja turizma na območju kot najuspešnejše izmed gospodarskih panog. In sicer 47 % anketiranih prebivalcev Kozjanskega parka meni, da so sedanje strategije razvoja turizma na območju zelo uspešne (Slika 2).



Slika 2: Sedanje strategije razvoja turizma na območju Kozjanskega parka so zelo uspešne, 2007

Figure 2: Present tourism development strategies in the area of the Kozjanski park are very successful, 2007

Primerjava z uspešnostjo razvoja ostalih gospodarskih panog na območju je pokazala, da se 35,5 % anketiranih prebivalcev Kozjanskega parka strinja, da so sedanje strategije razvoja kmetijstva na tem območju zelo uspešne, 32 % anketiranih prebivalcev meni, da so sedanje strategije razvoja malega podjetništva in obrti na območju zelo uspešne, in 7 % anketiranih prebivalcev meni, da so sedanje strategije razvoja industrije na tem območju zelo uspešne.

Glede na dobljene rezultate lahko sklepamo, da zavarovano območje v regiji omogoča razvoj podeželskega turizma. Vendar pa se ob tem poraja vprašanje, ali je razvoj turizma v zavarovanem območju uspešnejši od razvoja turizma izven zavarovanega območja. Čeprav ni statistično pomembne razlike med mnenjem anketiranih prebivalcev Triglavskega narodnega parka, da so sedanje strategije razvoja na tem območju zelo uspešne, in mestom bivanja (v zavarovanem območju oziroma izven njega) ($p = 0,076$), je iz rezultatov razvidno, da so s sedanjimi strategijami razvoja turizma bolj nezadovoljni anketirani prebivalci v zavarovanem območju, saj 56,5 % anketiranih prebivalcev v Triglavskem narodnem parku in 41,5 % anketiranih prebivalcev izven parka meni, da sedanje strategije razvoja turizma niso uspešne. V primeru Kozjanskega parka ugotavljamo, da se anketirani prebivalci v parku v večjem deležu ne strinjajo s tem, da so strategije razvoja turizma zelo uspešne. Rezultati namreč kažejo, da 47,7 % anketiranih prebivalcev v zavarovanem območju in 32,1 % anketiranih prebivalcev izven zavarovanega območju meni, da so sedanje strategije razvoja turizma na območju neuspešne ($p = 0,002$).

Izhajajoč iz teh rezultatov lahko torej povzamemo, da so sedanje strategije razvoja turizma v zavarovanih območjih približno enako uspešne oziroma manj uspešne od strategij razvoja turizma izven zavarovanega območja. Vseeno velja poudariti, da se sedanje strategije razvoja turizma v preučevanih zavarovanih območjih in izven njih povezujejo, saj se izven zavarovanega območja razvija predvsem turistična infrastruktura, ki temelji na naravnih značilnostih okolja v zavarovanem območju (Triglavski narodni park) oziroma se z njimi dopolnjuje (Kozjanski park).

3.2 Vloga podeželskega turizma pri razvoju podeželja v regijah z zavarovanimi območji (naravni parki, druga zavarovana območja)

Anketirani prebivalci Triglavskega narodnega parka podpirajo razvoj turizma na območju. Rezultati kažejo, da se kar 86,5 % anketiranih prebivalcev Triglavskega narodnega parka strinja, da bi se območje moralo osredotočiti na razvoj turizma, kar postane pomemben podatek, če ga primerjamo z mnenjem anketiranih prebivalcev glede osredotočenja območja na druge gospodarske panoge. Rezultati namreč kažejo, da 80,5 % anketiranih prebivalcev Triglavskega narodnega parka meni, da bi se območje moralo osredotočiti na razvoj malih podjetnikov in obrtnikov, 80 % anketiranih prebivalcev meni, da bi se območje moralo osredotočiti na razvoj ekološkega kmetijstva, 23 % anketiranih prebivalcev meni, da bi se območje moralo osredotočiti na razvoj večjih podjetij, 21,5 % anketiranih prebivalcev meni, da bi se območje moralo osredotočiti na razvoj konvencionalnega kmetijstva, in 18,5 % anketiranih prebivalcev meni, da bi se območje moralo osredotočiti na razvoj industrije.

V primeru Kozjanskega parka pa je moč opaziti, da se anketirani prebivalci najbolj strinjajo z usmeritvijo območja v kmetijstvo ter razvoj malega podjetništva in obrti. Vseeno ni zanemarljivo dejstvo, da se kljub temu visok delež anketiranih prebivalcev strinja, da bi se območje moralo osredotočiti na razvoj turizma. Rezultati namreč kažejo, da 93 % anketiranih prebivalcev Kozjanskega parka meni, da bi se območje moralo osredotočiti na razvoj konvencionalnega kmetijstva, 82 % anketiranih prebivalcev meni, da bi se območje moralo osredotočiti na razvoj malih podjetnikov in obrtnikov, 78,5 % anketiranih prebivalcev meni, da bi se območje moralo osredotočiti na razvoj ekološkega kmetijstva, 74,5 % anketiranih prebivalcev meni, da bi se območje moralo osredotočiti na razvoj turizma, 69,5 % anketiranih prebivalcev meni, da bi se območje moralo osredotočiti na razvoj večjih podjetij, in 56,5 % anketiranih prebivalcev meni, da bi se območje moralo osredotočiti na razvoj industrije.

Dejstvo je, da zaradi omejitev, ki jih postavlja zavarovano območje, razvoj katerekoli gospodarske panoge na podeželju ni neodvisen in da to pomeni, da pravzaprav zavarovano območje usmerja razvoj na območju. Glede na našo raziskavo lahko povzamemo, da se tega bolj zavedajo anketirani prebivalci Triglavskega narodnega parka (58 %), kot pa anketirani prebivalci Kozjanskega parka (32 %).

3.2.1 Turizem kot spodbujevalec razvoja in ustvarjalec novih delovnih mest

Večina anketiranih prebivalcev, tako Triglavskega narodnega parka kot Kozjanskega parka, se strinja s trditvama, da območje potrebuje boljše možnosti zaposlovanja in boljše možnosti zaposlovanja za višje in visoko izobražene, ter ti dve potrebi območja postavlja tudi na prvi dve mesti po pomembnosti.

Dodatne možnosti zaposlovanja vidi v zavarovanem območju 38,5 % anketiranih prebivalcev Triglavskega narodnega parka in 17,5 % anketiranih prebivalcev Kozjanskega parka. Vseeno pa, tako prvi kot drugi, kot dodatne priložnosti oziroma možnosti zavarovanega območja za njih osebno na prva tri mesta po pomembnosti postavljajo zdravo okolje, možnost rekreacije, oddiha v območju naravnih lepot in ohranitev estetskih atributov pokrajine. Prav ti trije atributi veljajo za ključne elemente uspešnega razvoja turizma v zavarovanih območjih.

3.2.2 Turizem kot alternativni vir dohodka

Anketirani prebivalci Triglavskega narodnega parka vidijo alternativne vire dohodka, ki jih nudi zavarovano območje, v pridobitvi dodatnih finančnih sredstev (36,5 %), odškodninah, nadomestilih za rabo kmetijskih zemljišč znotraj parka (17 %), prodaji kmetijskih proizvodov pod znamko parka (16,5 %) in prodaji rokodelskih proizvodov pod znamko parka (11,5 %). Nadalje anketirani prebivalci Kozjanskega parka naštevajo kot vire alternativnega dohodka, ki jih nudi zavarovano območje, pridobitev dodatnih finančnih sredstev (11 %), prodajo kmetijskih proizvodov pod znamko parka (11 %), odškodnine, nadomestila za rabo kmetijskih zemljišč znotraj parka (7,5 %) in prodajo rokodelskih proizvodov pod znamko parka (7,5 %). Da je priložnost zavarovanega območja boljša možnost za poslovanje v turizmu za njih osebno, se strinja skoraj polovica anketiranih prebivalcev Triglavskega narodnega parka (47 %) in le 15 % anketiranih prebivalcev Kozjanskega parka.

Boljše možnosti za poslovanje v turizmu so torej anketirani prebivalci Triglavskega narodnega parka in Kozjanskega parka v najvišjem deležu opredelili kot priložnost zavarovanega območja. Vendar pa anketirani prebivalci Triglavskega narodnega parka v veliko večjem deležu kot anketirani prebivalci Kozjanskega parka menijo, da je priložnost zavarovanega območja v boljših možnostih za poslovanje v turizmu. Iz tega lahko sklepamo, da Triglavski narodni park nudi več priložnosti oziroma dodatnih možnosti za poslovanje v turizmu kot Kozjanski park.

3.2.3 Turizem pomembno prispeva k trajnostnemu razvoju regije

Rezultati kažejo, da se več kot polovica anketiranih prebivalcev Triglavskega narodnega parka strinja, da so sedanje strategije varovanja narave uspešne (54 %). V Kozjanskem parku se je s to trditvijo strinja še več anketiranih prebivalcev, in sicer 63,5 %.

Kar 58,5 % anketiranih prebivalcev Triglavskega narodnega parka meni, da promet in gneča zaradi povečanega pretoka turistov bremenita območje. Nadalje ugotavljamo, da se s to trditvijo strinja le 10,5 % anketiranih prebivalcev Kozjanskega parka. Da je breme turizma splošno povišanje cen v zavarovanem območju, se strinja kar 49,5 % anketiranih prebivalcev Triglavskega narodnega parka in le 3,5 % anketiranih prebivalcev Kozjanskega parka.

Če povežemo ti dve dognanji (o sedanjih strategijah varstva narave na območju in bremenu turizma na območju), lahko sklepamo, da so na zavarovanem območju, kjer je turizem bolj razvit (Triglavski narodni park), strategije varstva narave manj uspešne ter da lokalni prebivalci občutijo več negativnih obremenitev turizma (promet in gneča, višje cene). Nasprotno pa v primeru, kjer je turizem na zavarovanem območju manj razvit (Kozjanski park), anketirani prebivalci opažajo,

da so strategije ohranjanja narave uspešnejše ter da jih turizem manj obremenjuje.

3.2.4 Turizem pomembno prispeva k večji konkurenčnosti regije

Da se je zaradi zavarovanega območja povečal turistični ugled kraja, meni kar 81 % anketiranih prebivalcev Triglavskega narodnega parka in 57 % anketiranih prebivalcev Kozjanskega parka. S trditvijo se torej bolj strinjajo anketirani prebivalci Triglavskega narodnega parka kot pa anketirani prebivalci Kozjanskega parka. V primeru Triglavskega narodnega parka je jasno, da zavarovano območje oziroma lepote narave turizem omogočajo. V primeru Kozjanskega parka pa ugotavljamo, da zavarovano območje turizem podpira. V tem primeru so se namreč v preteklih letih izven zavarovanega območja usmerili na razvoj termalnih kopališč (danes Terme Olimia v občini Podčetrtek in Terme Čatež v občini Brežice). V zadnjih letih se zavarovano območje vedno bolj ceni kot sestavni člen razvoja turizma na območju, predvsem zaradi vlaganj v obnovo kulturne dediščine (stare stavbe, gradovi, trgi ...), urejanja okolice ter mnogih prireditev.

Glede na rezultate lahko povzamemo, da turizem in z njim povezane dejavnosti na zavarovanih območjih pomembno prispevajo h konkurenčnosti regije, kar še posebej velja za Triglavski narodni park.

4 SKLEPI

Povezave med zavarovanimi območji, turizmom in razvojem podeželja smo raziskovali na primeru mnenj lokalnih prebivalcev dveh zavarovanih območij v Sloveniji, Triglavskega narodnega parka in Kozjanskega parka.

Med razvojnimi potenciali preučevanih zavarovanih območjih je pomanjkljiv človeški potencial, kar se kaže predvsem v primeru Kozjanskega parka.

Več kot polovica anketiranih prebivalcev preučevanih zavarovanih območjih (tj. Triglavskega narodnega parka in Kozjanskega parka) meni, da sedanje strategije razvoja podeželja niso zelo uspešne, vendar nadalje tudi menijo, da je razvoj turizma na območju, kjer prebivajo, uspešnejši od strategij razvoja drugih gospodarskih dejavnosti – malega podjetništva in obrti, kmetijstva ter industrije.

Glede na dobljene rezultate lahko potrdimo hipotezo, da zavarovano območje v regiji omogoča razvoj podeželskega turizma, vendar pa, izhajajoč iz rezultatov, ugotavljamo, da so sedanje strategije razvoja turizma v zavarovanih območjih približno enako uspešne oziroma manj uspešne od strategij razvoja turizma izven zavarovanega območja.

Sedanje strategije razvoja turizma v preučevanih zavarovanih območjih in izven njih se povezujejo, saj se izven zavarovanega območja razvija predvsem turistična infrastruktura, ki temelji na naravnih značilnostih okolja v zavarovanem območju (Triglavski narodni park) oziroma se z njimi dopolnjuje (Kozjanski park).

Anketirani prebivalci Triglavskega narodnega parka podpirajo razvoj turizma na območju. V primeru Kozjanskega parka pa je moč opaziti, da se anketirani prebivalci najbolj strinjajo z usmeritvijo območja v kmetijstvo ter razvoj malega podjetništva in obrti. Vseeno ni zanemarljivo dejstvo, da se kljub temu visok delež anketiranih prebivalcev strinja, da bi se območje osredotočilo na razvoj turizma.

Dejstvo je, da zaradi omejitev, ki jih postavlja zavarovano območje, razvoj vsake gospodarske panoge na podeželju ni neodvisen in da to pomeni, da pravzaprav zavarovano območje usmerja razvoj na območju. Glede na rezultate raziskave lahko povzamemo, da se tega bolj zavedajo anketirani prebivalci Triglavskega narodnega parka kot pa anketirani prebivalci Kozjanskega parka.

Kot priložnost zavarovanega območja, v smislu pridobivanja alternativnih virov dohodka, so anketirani prebivalci Triglavskega narodnega parka in Kozjanskega parka v najvišjem deležu opredelili boljše možnosti za poslovanje v turizmu. Anketirani prebivalci Triglavskega narodnega parka v veliko večjem deležu kot anketirani prebivalci Kozjanskega parka menijo, da je priložnost zavarovanega območja v boljših možnostih za poslovanje v turizmu (47 % proti 15 %). Iz tega lahko sklepamo, da Triglavski narodni park nudi več priložnosti oziroma dodatnih možnosti za poslovanje v turizmu kot pa Kozjanski park.

Če povežemo dognanji o sedanjih strategijah varstva narave na območju in bremenu turizma na območju, lahko sklepamo, da so na zavarovanem območju, kjer je turizem bolj razvit (Triglavski narodni park), strategije varstva narave manj uspešne ter da lokalni prebivalci občutijo več negativnih obremenitev turizma (promet in gneča, višje cene). Nasprotno pa v primeru, kjer je turizem na zavarovanem območju manj razvit (Kozjanski park), anketirani prebivalci opažajo, da so strategije ohranjanja narave uspešnejše in da jih turizem manj obremenjuje.

Anketirani prebivalci Triglavskega narodnega parka v zavarovanem območju vidijo več dodatnih možnosti za ukvarjanje s turizmom kot pa anketirani prebivalci Kozjanskega parka. Torej turizem v zavarovanem območju predstavlja določene koristi za lokalno prebivalstvo. Glede na dosedanje ugotovitve lahko sklepamo, da zavarovano območje podpira turizem.

Da se je zaradi zavarovanega območja povečal turistični ugled kraja, se torej bolj strinjajo anketirani prebivalci Triglavskega narodnega parka kot pa anketirani prebivalci Kozjanskega parka. V primeru Triglavskega narodnega parka je jasno, da

zavarovano območje oziroma lepote narave turizem omogočajo. V primeru Kozjanskega parka pa ugotavljamo, da zavarovano območje turizem podpira.

Glede na rezultate lahko potrdimo hipotezo, da ima turizem pomembno vlogo pri razvoju podeželja v regijah z zavarovanimi območji. Menimo, da za Triglavski narodni park v večji meri kot za Kozjanski park velja, da turizem v zavarovanem območju ne prinaša lokalnim prebivalcem le koristi, temveč so prisotne tudi večje izgube, kar se kaže v negativnem vplivu turizma na lokalne prebivalce (moteč promet in gneča zaradi turistov, povišane cene ...) ter po mnenju anketiranih prebivalcev v slabših strategijah varovanja narave.

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Oblikovanje baze podatkov o slovenskem medu

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IZVLEČEK

V prispevku je opisano oblikovanje baze podatkov o značilnostih slovenskega medu. Prikazana je strategija oblikovanja baze, sistem vzorčenja, predstavljeni so vsi analizirani parametri in način hranjenja vzorcev medu. Poudarjena sta pomen in vloga podatkovne baze pri karakterizaciji posameznih, za Slovenijo značilnih vrst medu, pri ugotavljanju in potrjevanju botaničnega in geografskega porekla, spremljanju kakovosti medu in zaščiti potrošnika ter posredno pri sledenju obremenjenosti okolja.

Ključne besede: slovenski med, baza podatkov, senzorična analiza, fizikalnokemijske analize, mikroskopska analiza

ABSTRACT

CREATION OF DATABASE OF SLOVENIAN HONEY

Development and compilation of database on characteristics of Slovenian honey is presented. In the paper are described strategic approach to database formation, the sampling system, the parameters analysed and the method of samples storage. Database on composition and sensory and pollen characteristics of different honey types, distinctive of Slovenia, participates greatly in characterisation of different Slovenian types of honey, in determination and verification of botanical and geographical origin of honey, in monitoring the quality of honey and protection of consumer market, and indirectly in monitoring the environmental burden.

Keywords: Slovenian honey, database, sensory analysis, physico-chemical analyses, microscopic analysis

1 UVOD

V zadnjem času postajajo baze podatkov o posameznem živilu ali skupini določenih živil vedno bolj pomembne. Glede na podatke, ki jih baze vključujejo, nam nudijo pomembne informacije o izvoru živila, prehranski vrednosti, senzoričnih lastnostih, varnosti, pa tudi o onesnaženosti okolja.

Eno izmed od nekdaj zelo cenjenih naravnih živil je med. Glede na to, da zaradi večje osveščenosti ljudi njegova potrošnja v zadnjih letih tako v svetu kot tudi v Sloveniji narašča, se je pokazala potreba po oblikovanju baze podatkov za slovenski med.

V Sloveniji je proizvodnja medu na prebivalca ena izmed najvišjih v Evropi. Okrog 7.000 čebelarjev čebelari s skupno približno 150.000 čebeljimi družinami. V zadnjih desetih letih so pridelali med 1.480 in 2.550 tonami medu letno (Statistični urad RS, 2010). Podobna proizvodnji je tudi poraba medu, Slovenci pojemo letno med 1.900 in 2.780 tonami medu (Statistični urad RS, 2010). Večinoma je to slovenski med, saj med iz uvoza predstavlja povprečno le 14 % delež ponudbe. Slovenski potrošnik je, kot porabnik medu, dokaj zahteven in razmeroma dobro pozna tako različne vrste medu (akacijev, lipov, kostanjev,

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smrekov, hojev) kot mešane tipe medu (cvetlični, gozdni, škržatov). Pri nakupu medu običajno vpraša po točno določeni vrsti, ker pričakuje neke specifične lastnosti. Nekateri potrošniki imajo radi redko tekoč med, blagega, nežnega okusa, svetle barve, drugi uživajo le goste, temne vrste medu, in tretji, ki iščejo izključno npr. kostanjev med, za katerega je značilen izrazito grenek okus. Zahtevam tržišča sledjo tudi čebelarji. Da zagotovijo čim bolj čiste vrste medu, ga iztočijo skrbno in pravočasno po vsaki končani paši. Seveda je »botanična čistost« posameznih vrst medu odvisna tudi od številnih drugih dejavnikov, na katere pa čebelarji nimajo neposrednega vpliva. Predvsem je pomembna intenzivnost posamezne paše, ki pa je neposredno odvisna od vremenskih pogojev. Zato je proizvodnja posameznih vrst medu med posameznimi letniki zelo različna. Npr. izrazito neugodne vremenske razmere v spomladanskem in zgodnjem poletnem času leta 2009 so imele za posledico, da kostanjevega in lipovega medu praktično ni bilo, zelo slaba pa je bila tudi bera medu iz mane.

2 SESTAVA MEDU

Čeprav je med v glavnem koncentrirana vodna raztopina dveh monosaharidov: glukoze in fruktoze, so v njem tudi številne druge sestavine, kot so mnogi drugi ogljikovi hidrati (di- in tri-saharidi), različne organske kisline, beljakovine, aminokisline, encimi, vitamini, mineralne in aromatične snovi ter različne fenolne spojine. Intenzivnost sladkosti, najznačilnejše lastnosti medu, je odvisna od količine in razmerja med prisotnimi mono-, di- in trisaharidi, medtem ko so individualne razlike med različnimi vrstami, pa tudi med posameznimi vzorci medu, posledica vseh ostalih sestavin, pa čeprav so le-te zastopane velikokrat le v sledovih.

Slovenija je relativno majhna država, vendar imamo zaradi specifičnosti in pestrosti rastlinja v posameznih naravnogeografskih pokrajinah dokaj široko paleto različnih vrst medu. Med najbolj pogoste vrste medu spadajo kostanjev, cvetlični, akacijev, lipov, hojev, smrekov in gozdni med. Zaradi vse večje pridelave oljne ogrščice, se v zadnjih letih na tržišču pogosteje pojavlja tudi med oljne ogrščice, čebelarji pogosto omenjajo še javorjev, regratov, češnjev med, med sadnih dreves. Pred približno 10 leti je bil v Primorju prisoten med škržata *Metcalfa pruinosa.* Nekateri mu pravijo primorska mana, ker ga proizvaja škržat, žuželka, ki se hrani s sokom zelenih delov kulturnih rastlin, cvetov, in tudi plevela. Za ta med so značilna odstopanja v fizikalnokemijskih in senzoričnih lastnostih od drugih medov. V strokovnih krogih ga imenujemo škržatov med.

3 PODATKOVNA BAZA

Vsaka vrsta medu ima specifične in značilne tako senzorične in fizikalnokemijske lastnosti kot tudi pelodno sestavo. Za definiranje območij vrednosti vseh omenjenih parametrov je bilo potrebno zbrati in analizirati veliko število vrstno značilnih vzorcev medu, različnih letnikov in iz vseh slovenskih geografskih regij. Z vsakoletnim namenskim vzorčenjem medu in analizami se je oblikovala baza vzorcev medu in podatkov o njihovi sestavi in senzoričnih lastnostih.

Zbiranje vzorcev

Zaradi številnih komponent, ki so v medu le v sledovih, smo morali poskrbeti za pravilno vzorčenje, to je ustrezen način jemanja vzorcev, ki je zagotavljal pridobitev pristnih vzorcev slovenskega medu in obenem preprečeval, da bi prišlo do kontaminacije medu. Pri tem smo poskrbeli za ustrezno embalažo. Izbrali smo bele, 1100 ml polipropilenske posode s pokrovi, ki jih je mogoče nepredušno zapreti. Embalaža je primerna za stik z živili.

Za zagotovitev reprezentativnih vzorcev različnih vrst medu, znanega botaničnega in geografskega izvora, smo se poslužili jemanja vzorcev neposredno pri čebelarjih. Na Geografskem inštitutu smo dobili zemljevid naravnogeografskih pokrajin Slovenije (Perko, 1998), na ČZS pa pridobili podatke o predsednikih čebelarskih društev iz posameznih področij. V Sloveniji je skupno 216 čebelarskih društev in zvez, zato smo prošnjo po zbiranju vzorcev naslovili le na nekatera, običajno večja čebelarska društva.

Pri zasnovi projekta smo pazili, da bomo pridobili vzorce različnih vrst medu (botanična različnost), da bodo vzorci medu iz čim bolj različnih področij (geografska različnost), obenem pa tudi, da bomo pridobili zadostno število vzorcev posamezne vrste. Vzorce medu smo organizirano zbirali v letih 2004-2009.

V teku večletne raziskave smo tako čebelarjem širom Slovenije razposlali preko 1500 plastičnih posod s pokrovi in priloženimi natančnimi navodili o postopku

vzorčenja. Čebelarji so bili naprošeni, da navedejo lokacijo paše, točen datum točenja, količino iztočenega medu, označijo ali imajo stacionarni čebelnjak oziroma so prevozniki ter iz kakšnega materiala so oprema in posode, v katerih shranjujejo med.

Vzorci so bili dostavljeni v laboratorij s hitro pošto, in nato tam popisani ter označeni z naključnimi števili. Opravljena je bila kratka – hitra senzorična analiza, katere namen je bil le potrditev vrste (v primeru, ko je čebelar navedel vrsto medu) oziroma določitev vrste medu (v primeru, ko čebelar vrste medu ni navedel). Za vse nadaljnje analize smo, zato da bi preprečili kontaminacijo s kovinami, jemali vzorce s plastičnimi žličkami.

Vzorci so se za nadaljnje analize hranili v tesno zaprtih posodah v temi in pri sobni temperaturi. Po končanih analizah smo za namene banke vzorcev medu alikvoten del (370 ml) posameznega vzorca shranili v nove steklene kozarčke. Hranijo se v temnem prostoru pri sobni temperaturi.

Izdelali smo elektronsko podatkovno bazo vzorcev, ki obsega vse podatke navedene s strani čebelarjev ter obsežno preglednico z analiziranimi parametri. Bazo nenehno dopolnjujemo z novimi vzorci, pa tudi z novimi analiziranimi parametri.

Analize medu

V okviru raziskav na področju medu smo naredili izbor ter razvijali in preverjali metodologijo za postavitev kriterijev vrednotenja kakovosti medu. V okviru sprejetja prvega slovenskega pravilnika o medu leta 1999 smo testirali vse, v njem predpisane, metode ter preverjali minimalne oziroma maksimalne dovoljene vrednosti posameznih analiziranih parametrov za posamezno vrsto slovenskega medu (Pravilnik o medu, 1999; Pravilnik o medu, 2004; Pravilnik o spremembi pravilnika o medu, 2004).

S pravilno izbranimi kriteriji smo želeli opredeliti kakovostne parametre posameznih vrst slovenskega medu ter z dobljenimi rezultati prispevati k dvigu kakovosti in prepoznavnosti slovenskega medu na našem tržišču. Rezultati raziskave pa naj bi omogočili tudi varovanje potrošnika in zaščito slovenskega čebelarstva.

Nadaljnje raziskave so obsegale senzorične, fizikalnokemijske in mikroskopske analize velikega števila vzorcev različnih vrst slovenskega medu z namenom oblikovanja baze podatkov, ki bo omogočala identifikacijo botaničnega in geografskega izvora medu. V sklopu teh analiz je bilo analiziranih preko 20 parametrov, med njimi tudi posamezni minerali, izotopska sestava, antioksidativna učinkovitost in vsebnost posameznih fenolnih spojin (Golob in sod., 2005; Bertoncelj in sod., 2007; Kropf in sod., 2008; Bertoncelj, 2008; Kropf, 2009; Korošec in sod., 2009; Nečemer in sod., 2009; Kropf in sod., 2010). Z začetkom projekta SiMOČ (Sistem za monitoring okolja s čebelami, V4-0479) se je začel tudi namenski izbor in ustrezno hranjenje reprezentativnih vzorcev medu posamezne vrste in letnika, na katerih so bile že opravljene analize, mogoče pa bi bile tudi še druge. Obenem je potekalo tudi vzorčenje in analiza vzorcev tekočega letnika.

Določevanje botaničnega porekla medu je že od nekdaj predmet številnih raziskav. Večina strokovnjakov meni, da je najzanesljivejša metoda določevanja vrste medu senzorična analiza izkušene senzorične komisije, ki jo le potrdimo z za vrsto medu značilnimi fizikalno-kemijskimi parametri in mikroskopsko analizo sedimenta medu (Persano Oddo in sod., 1995). Popek (2001) pa je ugotovil, da lahko določimo vrsto medu z merjenjem električne prevodnosti, vsebnosti kislin, pepela, saharoze in reducirajočih sladkorjev. Meni, da je mikroskopska analiza cvetnega prahu le začetna analiza za določanje vrste medu, ki pa jo moramo dopolniti z merjenjem ustreznih fizikalnokemijskih parametrov, posebno, če je delež cvetnega prahu blizu meje, ki določa vrsto medu.

Senzorična analiza

Senzorična analiza medu temelji na prepoznavanju senzoričnih značilnosti videza, vonja, okusa in arome posameznih vrst medu. Pri senzoričnem ocenjevanju medu moramo poznati tako optimalne značilnosti teh lastnosti kot tudi vsa možna odstopanja navzgor ali navzdol po lestvici, s katero ocenjujemo. Zato zahteva senzorična analiza izšolano in preverjeno senzorično komisijo, ki dela po natančno določenih kriterijih in je v svojih ocenah dosledna in ponovljiva. Glavni pripomoček pri tem so za posamezno vrsto medu natančno definirane značilnosti: videz (barva, kristaliziranost, bistrost, čistost), vonj (značilnost in intenzivnost), okus (intenzivnost sladkosti, kislosti, grenkosti) ter aroma (značilnost, intenzivnost in obstojnost arome).

Kot pomoč pri senzoričnem ocenjevanju medu smo za devet vrst slovenskega medu (akacijev, lipov, kostanjev, cvetlični, smrekov, hojev, gozdni, regratov med in med oljne ogrščice) oblikovali tabele, v katerih so podane značilnosti senzoričnih lastnosti posameznih vrst medu; teh kriterijev še nimamo izdelanih za vrste medu, ki se pridelajo v manjših količinah oziroma so pogostejši šele v zadnjih letih, npr. za med rešeljike, javorjev med.

Barva, vonj, okus in aroma medu so kriteriji, ki imajo velik pomen pri ugotavljanju vrste in kakovosti medu (Piana in sod., 2004). Omenjene senzorične lastnosti so

tipične za določeno vrsto medu, odvisne so od botaničnega in geografskega porekla, od količine in razmerja posameznih komponent v medu (barvil, sladkorjev, organskih kislin, mineralnih snovi, beljakovin, aminokislin), od vremenskih pogojev, časa medenja, individualne čebelarske prakse ter od ravnanja z medom med skladiščenjem. Senzorične lastnosti zelo vplivajo na sprejemljivost medu pri potrošnikih, saj so za njih prvo merilo o kakovosti medu.

Zato je senzorična analiza medu zelo pomembna kot vzporedna metoda pelodni analizi pri določanju botaničnega porekla (Bogdanov in sod., 2004).

Barva medu je zelo različna in značilna za posamezne vrste. Območje barve medu sega od skoraj brezbarvne, preko svetlo rumene, jantarne, rjave, rdečkaste do skoraj črne. Komponente, ki vplivajo na barvo medu, so različni rastlinski pigmenti: karoteni, ksantofili, klorofili, antocianini in drugi (González-Miret in sod., 2005). Barva je odvisna tudi od količine beljakovin, aminokislin in drugih dušikovih snovi. Potemnitev medu med toplotno obdelavo in skladiščenjem je posledica Maillardove reakcije in karamelizacije sladkorjev (Turkmen in sod., 2006). Pri vrednotenju barve medu je potrebno upoštevati, da je barva kristaliziranega medu svetlejša od barve tekočega medu. Merjenje in senzorično ocenjevanje barve se običajno izvaja na tekočem medu.

Vonj je posledica aromatičnih komponent, ki jih vsebuje nektar oz. mana. Med posameznih rastlin ima specifičen vonj, ki je lahko bolj ali manj izrazit. Vonj medu oblikujejo karbonilne spojine, alkoholi, estri alifatskih in aromatskih kislin ter eterična olja (Persano Oddo in sod., 2000). Odvisno od vrste medu so te snovi prisotne v različnih količinah in razmerjih.

Okus je odvisen od razmerja med različnimi sladkorji in mineralnimi snovmi in se pri različnih vrstah medu lahko precej razlikuje. Različne vrste medu niso enako sladke, ker je razmerje med glukozo, fruktozo in saharozo različno. Različni ogljikovi hidrati so namreč različno sladki, najslajša je fruktoza. K sladkosti lahko prispevajo tudi mineralne in aromatične snovi, proste kisline in beljakovine. Kisel okus povzročajo kemijsko kisle snovi, vendar le teh v medu ne občutimo kot prave kisline in tudi ni pravega razmerja med zaznano kislostjo in vrednostjo pH. Ugotovili smo, da vsebnost kislin ni v povezavi z vrednostjo pH, kar je na prvi pogled nerazumljivo, obstaja pa premo sorazmerna povezava med vsebnostjo mineralov in vrednostjo pH. Razlog je v močno povečani puferni kapaciteti medu z večjo vsebnostjo elementov (Kropf, 2009). Grenak okus je značilnost kostanjevega medu, prisotnost grenkega okusa v drugih vrstah medu je običajno pokazatelj prisotnosti kostanjevega medu ali nekaterih vrst mane. Slanega okusa v medu običajno ne zaznamo, saj je v medu zanemarljivo malo mineralnih snovi, ki so nosilke slanega okusa.

Snovi, ki medu dajejo specifično aromo, so lahko skupne vsem vrstam medu, nekatere pa so značilne za posamezne rastline in jih najdemo le v nekaterih vrstah medu, npr. metilantranilat, ki daje značilno aromo medu citrusov (Alissandrakis in sod., 2005). Aromatične snovi so dokaj hlapne in pri višjih temperaturah hitro hlapijo. K aromi medu prispevajo različne organske spojine; alkoholi (alifatski in aromatski), aldehidi, ketoni, kisline in njihovi estri (Persano Oddo in sod., 2000). Identifikacija aromatičnih komponent v medu se izvaja z uporabo plinske kromatografije, s pomočjo katere lahko danes v medu ločijo že preko dvesto aromatičnih spojin. Vrsta in količina teh spojin se med skladiščenjem medu spreminjata.

Analiza cvetnega prahu

Analiza cvetnega prahu z mikroskopsko metodo ima poleg senzorične analize pomembno vlogo pri določanju vrste medu. Velja za precej zamudno in zahtevno, predvsem kar se tiče izkušenosti in širokega znanja analitika. V zadnjem času pripisujejo mikroskopski analizi pomen tudi pri določanju potvorb in geografskega izvora medu (Ruoff in Bogdanov, 2004; Kerkvliet in Meijer, 2000). Predvsem s potrebami po zaščiti lastnih živilskih izdelkov in željami po geografskih zaščitah tipičnih proizvodov se je pokazala nuja po kompleksnejši obravnavi identifikacije peloda. To je obsežna raziskava, ki zahteva poleg oblikovanja zbirke (atlasa) pelodnih zrn vseh medovitih rastlin na področju Slovenije tudi tako imenovani »prstni odtis« ali kompleksno poznavanje kombinacije pelodnih zrn z določenega geografskega področja. Zbirka, podobna tem, ki v svetu obstajajo in so plod dolgoletnih raziskav, se oblikuje tudi pri nas na Čebelarski zvezi Slovenije.

Fizikalnokemijska analiza

Kakovost medu je odvisna od različnih fizikalnokemijskih parametrov: vsebnosti vode, sladkorjev, invertnega sladkorja, HMF, mineralnih snovi, v vodi netopnih snovi, kislin, električne prevodnosti, aktivnosti encima diastaze (Golob in Plestenjak, 1999).

Glavne zahteve glede kakovosti medu, namenjenega prodaji, so jasno definirane in predpisane s Pravilnikom o medu (2004).

Slovenska baza podatkov o sestavi medu vsebuje analitske podatke za vse s pravilnikom predpisane parametre. Poleg teh je bila v okviru projekta in doktorske disertacije (Golob in sod., 2005; Kropf, 2009; Nečemer in sod., 2009) opravljena tudi analiza mineralne sestave skoraj 300 vzorcev sedmih vrst medu

različnih letnikov. Ob začetku raziskave smo domnevali, da se vsebnost mineralov razlikuje glede na botanični in geografski izvor medu. Predvidevali smo, da bi poznavanje vsebnosti posameznih mineralov služilo pri določanju geografskega porekla medu, kot so to tudi potrdili nekateri tuji avtorji objavljenih rezultatov raziskav (Bogdanov in sod., 2007). Minerali pridejo v med s pelodom, kislinami, encimi, ki jih medičini dodajo čebele, iz posode, opreme, lahko tudi iz zraka, itd.. Vsebnost mineralov v medu določene vrste je pogojena s pelodom rastlin, na katerih čebele nabirajo medičino.

Poleg tega se poznavanje vsebnosti nekaterih mineralov – težkih kovin (Pb, Cd, in Hg) – v medu lahko uporablja tudi kot indikator obremenjenosti okolja (Garcia in sod., 2006).

Znano je, da so minerali pomembni tako s prehranskega in fiziološkega vidika kot tudi s senzoričnega, saj pomembno prispevajo k aromi in teksturi hrane. Obenem so minerali aktivatorji ali inhibitorji encimsko kataliziranih in drugih reakcij. Med elementi, ki jih med vsebuje, izstopata, glede na količino v nekaterih vrstah medu in prehranska priporočila, predvsem kalij in mangan (Kropf in sod., 2009). Količinsko daleč največ je kalija, zlasti veliko ga je v kostanjevem medu in medovih iz mane.

Druga skupina posebnih fizikalnokemijskih parametrov, t. i. bioaktivnih spojin, ki so zajeti v podatkovni bazi, so vsebnosti fenolnih spojin, to je fenolnih kislin in flavonoidov, v vzorcih različnih vrst slovenskega medu: *p*-kumarne, kavne, elaginske in klorogenske kisline ter flavonoidov miricetina, luteolina, kvercetina, naringenina, apigenina, pinobanksina, kamferola, pinocembrina, krizina in galangina. Kot je pokazala raziskava, imajo analizirani vzorci različnih vrst slovenskega medu podoben, toda kvantitativno različen fenolni profil. Obenem smo ugotovili, da različne vrste slovenskega medu nimajo specifičnih markerjev za morebitno določanje botaničnega porekla medu, čeprav bi bilo to ugotovitev potrebno preveriti z nadaljnjimi analizami, v katerih bi uporabili dodatne standardne spojine. Pri določanju botaničnega porekla medu na osnovi vsebnosti fenolnih spojin je, bolj kot prisotnost in vsebnost ene same spojine, pomembna sestava celotnega fenolnega profila medu (Bertoncelj, 2008).

Pristnost medu

Proizvodnja medu je dolgotrajna in relativno draga, zato pogosto prihaja do potvorb medu. Najstarejši način potvarjanja je dodajanje kuhinjskega sladkorja, v zadnjem času pa med potvarjajo z dodajanjem industrijsko pridobljenih sirupov: najpogosteje fruktozno-glukoznega ali koruznega sirupa z visokim deležem fruktoze. Dokazovanje dodajanja sladkorja, če izvira iz sladkornega trsa, je zanesljivo in z izotopsko analizo dokaj enostavno izvedljivo (White, 1992; White in sod., 1998); popolnoma drugače pa je, če se medu dodaja sirup, ki izvira iz pese ali drugih rastlin C3, ki se proizvaja v večini evropskih držav (White in sod., 1998). Dodajanje sladkornega sirupa vpliva tudi na vsebnost v medu prisotnih encimov, ki se med drugim odraža v nižji vrednosti diastaznega števila. Takšno potvorbo zato ponarejevalci pogosto skušajo prikriti z dodatkom tujih amilaz (Voldřich in sod., 2009). Da bi preprečili potvarjanje medu, je s Pravilnikom o medu (2004) predpisano, da je med živilo, ki se mu ne sme nič dodati in nič odvzeti, analize pa gredo na tem področju v smeri določanja razmerja izotopov ogljika v medu in frakcijah sladkorjev (mono-, di- in trisaharidov) ter razmerja izotopov ogljika in dušika v proteinih izoliranih iz medu. Podatki o razmerju izotopov ogljika v medu in proteinskem izolatu ter razmerja izotopov dušika v slednjem so shranjeni tudi v predstavljeni bazi podatkov za okrog 300 vzorcev medu (Kropf, 2009; in neobjavljeni podatki).

4 ZAKLJUČEK

V prispevku je bilo predstavljeno oblikovanje podatkovne baze o izvoru in sestavi vzorcev različnih vrst slovenskega medu. Taka banka podatkov lahko služi kot izhodišče za oblikovanje podatkovnih baz o drugih slovenskih čebeljih pridelkih, kot sta propolis in matični mleček. Analiziranje senzoričnih in fizikalnokemijskih parametrov ter pelodnih zrn različnih vzorcev medu ter oblikovanje banke podatkov je pomembno zaradi:

- oblikovanja banke podatkov o cvetnem prahu vzorcev medu iz različnih področij Slovenije,
- poznavanja kriterijev kakovosti različnih vrst medu,
- spremljanja in zagotavljanja kontrolirane kakovosti in varnosti medu ter zaščite potrošnikov,
- pomena za čebelarje, saj dobijo tako pomembno informacijo o kakovosti medu, ki jim je v pomoč pri sodelovanju na različnih tekmovanjih,
- možnosti potrditve ali celo določitve botaničnega porekla,
- možnosti potrditve ali ugotavljanja geografskega porekla,
- monitoringa okolja,
- zagotavljanja dodatnih informacij za oceno prehranskega stanja slovenskega prebivalstva,
- nadaljnjih znanstvenih raziskav medu, npr. s področja proučevanja funkcionalnih, antioksidativnih lastnosti medu.

Baza, ki se je oblikovala v okviru projekta SiMOČ, namreč ne vsebuje le podatkov o analiziranih parametrih v vzorcih medu, marveč tudi ekvivalenten del vzorca medu. Vzorci se hranijo v steklenih kozarcih v temi, na sobni temperaturi. Pogosto slišimo, da je med »živo« živilo, saj se njegova sestava zaradi delovanja encimov v medu pri sobni temperaturi in zunanjih vplivov sčasoma nekoliko spreminja. Da bi se prvotna sestava in kakovost medu kar najbolj ohranili, s čimer bi zagotovili tudi kakovostne rezultate kasnejših analiz, bi bilo v prihodnosti potrebno, ob ustreznih prostorskih možnostih in finančni podpori, bazo vzorcev medu preseliti v zamrzovalnik.

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CONTENT ANALYSIS OF THE PAPERS IN THE ACTA AGRICULTURAE SLOVENICA

VSEBINSKA OBDELAVA PRISPEVKOV V ACTA AGRICULTURAE SLOVENICA let. 95 št. 3

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VSEBINSKO KAZALO PO SKUPINAH ZNANJA (PREDMETNIH KATEGORIJAH)

In memoriam

PROF. DR. JOŽE SPANRING
(1923 - 2010)

Sredi letošnjega poletja je v Ljubljani, v 88 letu starosti, umrl dr. Jože Spanring, zaslužni profesor Biotehniške fakultete Univerze v Ljubljani (BF), za področja poljedelstvo, zdravilne rastline in informatika.

Prof. dr. Jože Spanring je bil v mnogih pogledih izredna osebnost. Vsestransko intelektualno nadarjenost in pokončnost je izkazoval že v osnovni šoli v Laporju pri Poljčanah (1929-34), v mladeniških letih, ko je po končani gimnaziji v Ljubljani (1942), še ne dvajsetleten, v internaciji v italijanskih taboriščih (1942-43) zasnoval tajno pisavo za sporazumevanje s sojetniki – in kasneje kot študent, ko je kot najboljši v letniku z odličnimi ocenami diplomiral na Kmetijsko gozdarski fakulteti v Zagrebu (1949). Ohranjeni zapiski s predavanj kažejo na pregledno, disciplinirano zabeleženo in z lepimi risbami opremljeno študijsko gradivo, in v tej njegovi odliki bi že takrat lahko zaznali zametke Spanringovega kasnejšega razvoja do mednarodno priznanega profesorja dokumentalistike in informatike. Toda profesor Spanring je bil najprej in predvsem poljedelec, pomen poljedelstva je, med drugim, poudarjal z dejstvom, da, v globalnem pogledu, ta veja kmetijstva prispeva več kot 80 % energije za prehrano človeštva.

Prof. dr. Jožeta Spanringa so hranile in mu osmišljale življenje štiri velike ljubezni: ljubezen do znanosti in odkrivanja vsega novega, ljubezen do domovine, ljubezen do domačih krajev okrog Poljčan in ljubezen do družine. Ljubezen do znanosti in inovacij je bila morda najsilovitejša, saj se ji je večino dni predajal od jutra do poznih večernih ur.

Po kratkem službovanju na dveh državnih posestvih, v Žovneku pri Braslovčah in Grosuplju ter na Državni planski komisiji je postal asistent za poljedelstvo (1951) na novoustanovljeni Fakulteti za agronomijo, gozdarstvo in veterino v Ljubljani.

Slovenska kmetijska stroka je imela srečo, da je oblast dovolj zgodaj zaznala Spanringovo nadarjenost za znanost in pedagoško delo, tako da mu je dodelila več štipendij za študijsko izpopolnjevanje v tujini: v Nemčiji (1953-54), ZDA (1957, 1979) in na Nizozemskem (1960, 1961). Tuje znanje je zajemal z veliko žlico in se z zajetnimi kupi literature vračal v domovino, čeprav so ga v tujini snubili in mu tam obetali lepšo znanstveno prihodnost. Samo detajl k njegovi domoljubnosti in moralni pokončnosti: Ko je bil v ZDA nekoč na neki okrogli mizi z zahodnimi znanstveniki, mu je moderator na začetku razprave dejal, da lahko sodeluje, če obljubi, da znanstvene informacije, o kateri bodo razpravljali, ne bo izdal Sovjetom, ko pride domov. Odvrnil je: »Ne morem vam obljubiti, da znanstvenih novosti ne bom posredoval naprej. Če postavljate tak pogoj, mi informacije raje ne zaupajte!«

Čeprav je profesor Spanring od leta 1954 dalje pomembno prispeval k sorazmerno uspešnemu napredku slovenskega kmetijstva, predvsem poljedelstva, se je v obdobju do 1966 največ posvečal razvoju kmetijske stroke in znanosti, to je vzgoji agronomov na

BF, kasneje tudi na Višji agronomski šoli v Mariboru. Imel je pregled nad vsemi diplomanti in je veljal za neformalnega kadrovika. Kot napreden rodoljub se je profesor Spanring obenem zavzemal tudi za napredek kmetijskega podeželja, zato je kot dolgoletni urednik Kmetijskih nasvetov na Radiu Ljubljana pridobival strokovne sodelavce za podajanje aktualnih kmetijskih nasvetov; sam je imel več kot 250 radijskih predavanj, objavil pa je tudi številne strokovne prispevke v Kmečkem glasu, Soc. kmetijstvu in Sodobnem kmetijstvu. Zdi se, da je mnogo bolj cenil tehtne inovativne strokovne objave v domačem strokovnem časopisju kot pa znanstvene objave v tujih znanstvenih časopisih. Ocenil je, da ga je v tistem trenutku najbolj potrebovala predvsem slovenska kmetijska stroka. V tem smislu je imel odločilne zasluge za ustanovitev KPC Jable (1954), sodeloval je v pripravi semenskega zakona in pri oblikovanju komisije za potrjevanje sort in semenskih posevkov, za katero je pripravil ustrezne strokovne okvire. Njegovo veljavnost je z lastnim potrjevanjem semenskih posevkov tudi neposredno ovrednotil. Izdelal je načrt za introdukcijo novih sort poljščin (1954), od katerih je štiri vzgojil sam. Pripravil je strokovne podlage za uvajanje poljedelske knjige na sodobne obrate (1962).

Podpisani je profesorja Spanringa prvič srečal jeseni 1960 na poljedelskih vajah na gradu Jable. Profesor Spanring, takrat še mlad asistent, je novopečene bruce očaral s prijetnim, rahlo igrivim podajanjem vsebine o bodočih študijskih objektih, ki so se v obliki številnih papirnatih krožnikov s semeni sort poljščin, trav in zelišč, kolekcij njivnih in travniških rastlin, plevelov in zdravilnih zelišč razprostirale po vsem prvem nadstropju gradu. Iz raznovrstnosti kolekcij so študentje sklepali o vsej obsežnosti Spanringovega strokovnega in znanstvenega dela.

Čeprav so študentje v tistih časih spoštovali vse profesorje, so bile učne ure pri profesorju Spanringu nekaj posebnega! Njegovo, v tujini pridobljeno znanje, mu je omogočalo, da je slušateljem podajal za takratne čase najsodobnejše vsebine predmeta Pridelovanje poljščin: Ne receptur za pridelovanje, ampak biološke osnove pridelovanja, v povezavi z obratoslovjem in ekonomiko! Podajal je torej metode, s sintezo katerih si strokovno usposobljen poljedelec za konkretne pridelovalne razmere lahko sam izdela najgospodarnejše postopke pridelovanja. Danes bi temu rekli, da ni prodajal rib, ampak je podajal metode, s katerimi se ribe lovi. Že takrat je poudarjal pomembnost pridobivanja znanstvenih in strokovnih informacij iz primarnih in sekundarnih znanstvenih virov. Pridobil je finančna sredstva, s katerimi je naročil večje število tujih znanstvenih in strokovnih časopisov s področja kmetijskih ved. To je bila osnova za nastanek Indok centra za biotehniko (1967-1994).

Zaradi svojih mednarodnih zvez je bil Spanring pravzaprav edini profesor, ki je lahko študentom odpiral pogled tudi na zahod, zato jim je bil upanje in vzpodbuda za nadaljevanje izobraževanja po diplomi. V zgodnjih šestdesetih letih, ko so bile poti mladih slovenskih agronomov na zahod težko prehodne, so imela zanje Spanringova predavanja pomemben motivacijski vzgib.

Študentje so bili nanj zelo ponosni, ko jih je vodil na absolventske izlete v tujino, kjer so ga na vseh inštitucijah pozdravljali kot svojega dobrega prijatelja in priznanega strokovnjaka. Zaradi teh Spanringovih znanstev so bili poljedelci med privilegiranimi študenti današnje BF, saj so z njegovo pomočjo lahko brez večjih težav odhajali na izpopolnjevanje na strokovne in znanstvene ustanove v tujini.

Spanringova ljubezen do rojstnega kraja in tankočutnost do moralnih vrednot se je izražala tudi v načinu njegovega pripovedovanja o kmečkem življenju v domači vasi. V spominu ostaja njegov hudomušni nasmešek in iskrive oči, ko je včasih pri kakem predavanju s spoštovanjem poudarjal enako družbeno veljavo dela univerzitetnega profesorja, kmečkega fizičnega delavca ali šoferja tovornjaka. V tem pogledu študentov ni le učil, ampak tudi vzgajal k plemenitemu ravnanju v kasnejšem življenju.

Večji udarec je prof. Spanring doživel leta 1962, ko je v Wageningenu, v zaključni fazi doktorskega dela o rastlinski alelopatiji, umrl njegov mentor. Novega mentorja za to zelo specifično delo ni uspel najti. Doktoriral je iz metodike za ocenjevanje sort poljščin v introdukciji (1977). Odslej je, poleg ključnih zaslug za izgradnjo Tovarne sladkorja Ormož, širil nova znanstvena obzorja predvsem v dokumentalistiki oziroma informatiki ter na področju zdravilnih rastlin. Na omenjenih področjih je opravil pionirsko delo in postal cenjen profesor.

Ob vsem pedagoškem, znanstvenem in strokovnem delu je profesor Spanring uspešno opravljal tudi vodstvena dela, vodil je Agronomski oddelek (1969-1971), Katedro za poljedelstvo in pridelovanje krme (1966-1977), bil je predsednik ali član uredniških odborov več znanstvenih in strokovnih časopisov, ves čas pa se je nesebično razdajal tudi pri svetovalnem delu za predstavnike oblasti, zlasti sekretariata za kmetijstvo in Gospodarske zbornice Slovenije.

Zaslužni profesor dr. Jože Spanring je trajnostno zarezal rodovitne brazde v povojno slovensko kmetijstvo in v vse, ki so bili njegovi učenci.

Anton Tajnšek

NAVODILA AVTORJEM

Prispevki

Sprejemamo izvirne znanstvene članke, predhodne objave in raziskovalne notice s področja agronomije, hortikulture, rastlinske biotehnologije, raziskave živil rastlinskega izvora, agrarne ekonomike in informatike ter s sorodnih področij v slovenskem, angleškem in nemškem jeziku, znanstveno pregledne članke samo po poprejšnjem dogovoru. Objavljamo prispevke, podane na simpozijih, ki niso bili v celoti objavljeni v zborniku simpozija. Če je prispevek del diplomske naloge, magistrskega ali doktorskega dela, navedemo to in tudi mentorja na dnu prve strani. Navedbe morajo biti v slovenskem in angleškem jeziku.

Pri prispevkih v slovenskem jeziku morajo biti preglednice, grafikoni, slike in priloge dvojezični, povsod je slovenščina na prvem mestu. Naslovi grafikonov in slik so pod njimi. Slike in grafikoni so v besedilu. Priloženi morajo biti tudi jasno označeni izvirniki slik. Na avtorjevo željo jih vračamo, s tem da je želja pisno sporočena ob oddaji gradiva in ponovno v teku 30 dni po izidu. Latinske izraze pišemo ležeče. V slovenščini uporabljamo decimalno vejico, v angleščini decimalno piko. Prispevki v angleščini morajo imeti povzetek v slovenščini in obratno. Prispevki v nemščini morajo imeti tudi povzetka v slovenščini in angleščini.

Prispevki naj bodo strnjeni, kratki, praviloma največ 12 strani. Uporabljamo Microsoft Word 97 (Windows); pisava Times New Roman, velikost strani 16,2 x 23,5 cm, velikost črk besedila 10, v obsežnih preglednicah je lahko 8; izvlečki in metode dela Arial velikost 8, levi in desni rob 2,1 cm, zgornji rob 1,3 cm, spodnji rob 1,6 cm,

Prva stran

Na prvi strani prispevka na desni strani označimo vrsto prispevka v slovenščini in angleščini, sledi naslov prispevka, pod njim avtorji. Ime avtorjev navedemo v polni obliki (ime in priimek). Vsak avtor naj bo označen z indeksom, ki ga navedemo takoj pod avtorji, in vsebuje polni naslov ustanove ter znanstveni in akademski naslov; vse v jeziku prispevka. Navedemo sedež ustanove, kjer avtor dela. Če je raziskava opravljena drugje, avtor navede tudi sedež te inštitucije. Na željo avtorjev bomo navedli naslov elektronske pošte.

Pod naslovi avtorjev je datum prispetja in datum sprejetja prispevka, ki ostaneta odprta. Sledi razumljiv in poveden izvleček z do 250 besedami. Vsebuje namen in metode dela, rezultate, razpravo in sklepe. Sledijo ključne besede.

Izvlečku v jeziku objave sledi naslov in izvleček s ključnimi besedami v drugem jeziku.

Viri

V besedilu navajamo v oklepaju avtorja in leto objave: (priimek, leto). Če sta avtorja dva, pišemo: (priimek in priimek, leto), če je avtorjev več, pišemo: (priimek in sod., leto). Sekundarni vir označimo z "navedeno v" ali "cv.". Seznam virov je na koncu prispevka, neoštevilčen in v abecednem redu. Vire istega avtorja, objavljene v istem letu, razvrstimo kronološko z a, b, c. Primer: 1997a. Navajanje literature naj bo popolno: pri revijah letnik, leto, številka, strani; pri knjigah kraj, založba, leto, strani. Za naslove revij je dovoljena uradna okrajšava, za okrajšanimi besedami naj bodo vedno pike. Navedbo zaključimo s piko. Za primere upoštevajte objave v Zborniku BFUL.

Oddaja

Avtorji prispevke oddajo v dveh izvodih, enega z dvojnim razmakom med vrsticami in največ 35 vrst na strani, in na disketi. Priložijo tudi izjavo s podpisi vseh avtorjev, da avtorske pravice v celoti odstopajo reviji.

Prispevke recenziramo in lektoriramo. Praviloma pošljemo mnenje prvemu avtorju, po želji lahko tudi drugače. Če uredniki ali recenzenti predlagajo spremembe oz. izboljšave, vrne avtor popravljeno besedilo v 10 dneh v dveh izvodih, enega z dvojnim razmakom. Ko prvi avtor vnese še uredniške pripombe, odda popravljeno besedilo v enem izvodu in na disketi ter vrne izvod z uredniškimi popravki.

Prispevke sprejemamo vse leto.

NOTES FOR AUTHORS

Papers

We publish original scientific papers, preliminary communications and research statements on the subject of agronomy, horticulture, plant biotechnology, food technology of foods of plant origin, agricultural economics and informatics; in Slovenian, English and German languages while scientific reviews are published only upon agreement. Reports presented on conferences that were not published entirely in the conference reports can be published. If the paper is a part of diploma thesis, master of science thesis or dissertation, it should be indicated at the bottom of the front page as well as the name of the supervisor. All notes should be written in Slovenian and English language.

Papers in Slovenian language should have tables, graphs, figures and appendices in both languages, Slovenian language being the first. Titles of graphs and figures are below them. Figures and graphs are part of the text. Clearly marked origins of figures should be added; they can be returned if author desires. Latin expressions are written in italics. Decimal coma is used in Slovenian and decimal point in English. Papers in English should contain abstract in Slovenian and *vice versa*. Papers in German should contain abstracts in German, Slovenian and English.

The papers should be condensed, short and usually should not exceed 12 pages. Microsoft Word 97 (Windows) should be used, fonts Times New Roman, paper size 16.2 x 23.5 cm, font size in main text 10; in large tables size 8 could be used, abstracts and material and methods Arial size 8, right and left margin 2.1 cm, upper margin 1.3 cm and lower margin 1.6 cm.

First page

The type of the paper should be indicated on the first page on the right side in Slovenian and English language following by title of the paper and authors. Full names of authors are used (first name and surname). Each name of the author should have been added an index, which is put immediately after the author(s), and contains address of the institution and academic degree of the author, in the language of the paper. The address of the institution in which the author works is indicated. If the research was realised elsewhere, the author should name the headquarters of the institution. E-mail is optional.

Under the address of the authors some space for dates of arrival and acceptance for publishing should be left. A comprehensive and explicit abstract up to 250 words follows indicating the objective and methods of work, results, discussion and conclusions. Key words follow the abstract.

The abstract in the language of the paper is followed by the title, abstract and key words in another language.

References

References should be indicated in the text by giving author's name, with the year of publication in parentheses, e.g. (surname, year). If authors are two, the following form is used: (surname and surname, year). If authors are several, we use (surname *et al.*, year). Secondary literary sources should be quoted in the form "cited in". The references should be listed at the end of the paper in the alphabetical order and not numbered. If several papers by the same author and from the year are cited, a, b, c, etc. should be put after the year of the publication: e.g. 1997a. The following form of citation is used: for journals volume, year, number, page; for books place of publication, publisher, year, pages. For journals official abbreviated forms can be used. A full stop should be put after the abbreviated words. Each reference is also closed by a full stop. Examples are in previous issues.

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