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CONTEMPORARY AGRICULTURE / SAVREMENA POLJOPRIVREDA



University of Novi Sad - Univerzitet u Novom Sadu  
Faculty of Agriculture - Poljoprivredni fakultet



# CONTEMPORARY AGRICULTURE SAVREMENA POLJOPRIVREDA

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*Srpski časopis za poljoprivredne nauke*



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## WEED FLORA OF THE PANČEVAČKI RIT\*

MARKO LJ. NESTOROVIĆ<sup>1</sup>

*SUMMARY: The different types of weeds and ruderal habitats of the Pančevački rit revealed the presence of 160 species of weeds, from 135 genera and 36 families. The paper was presented floristic, ecological and phytogeographical analysis weed and ruderal flora. Most are family Asteraceae, Poaceae, Fabaceae, Lamiaceae, Boraginaceae and Scrophulariaceae. Analysis of the representation of life forms of plants in the examined weed flora was found hemicryptophytic – therophytic character (48.75%: 42.50%). Analysis of ecological indices for moisture, acidity, amount of nitrogen, light and temperature determined the dominance of plants that prefer submesophyte and subxerophyte habitats, mainly neutral to weak alkaline reaction, secondary to the rich minerals, mainly semi-open to open in character, as well as mesothermic to thermophilic regarding temperature regime. Phytogeographic analysis of the weed flora found the presence of 160 different floristic elements, grouped in 8 basic types of area. The largest is the Eurasian (35.63%), Pontic-Centralasian (19.38%), Middle-European (15.63%) and Circumholartic-cosmopolitan group (15.63%).*

**Key words:** weed flora, ecological analysis, phytogeographical analysis, Pančevački rit, Belgrade.

### INTRODUCTION

Weed-ruderal flora and vegetation is undoubtedly one of the youngest and most dynamic floristic-vegetation complexes. As a result, a phenomenal object, not only for

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Original scientific paper / *Originalni naučni rad*

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\* This paper presents the results of investigation in research projects Ministry of Science and Technological Development, Republic of Serbia:

1. State and changes in biological and geological diversity of modified regions on the example of the central parts of Serbia (No 1864) financed by 01.01.2002. to 31.12.2005.
2. Diversity fossil and recent flora and fauna of Serbia - evaluation of the degree of diversity and vulnerability assessment as indicators of the protection of natural values (No 146023) funded by 01.01.2006.



basic research geobotanical, but for different applied research that can provide answers to numerous questions about the ways and mechanisms of adaptation of plant species in highly specific ecological conditions of urban biotope.

As a secondary, “less attractive and economically less significant”, weed-ruderal vegetation for a long time attention of modern herbologists in the area of Belgrade. In contrast, modern European (especially Middle-European) botanist this issue dedicated to the much greater attention to testify about what a whole series of monographs, studies and individual papers published over the past forty years (Jovanović, 1994; Nestorović, 2002, 2005, 2008).

Delay in the research weed-ruderal of flora and vegetation in the area of Belgrade is only a partial publication of detailed ecological analysis of weed-ruderal flora and vegetation in the territory of 10 urban (predominantly urban) municipalities of Belgrade (Jovanović, 1994; Jovanović and Bartula, 1996; Nestorović, 2002, 2005, 2008; Nestorović and Jovanović, 2002, 2003). This statement is usually refers to the total flora and vegetation not only the area Pančevački rit, but also for territory municipalities Obrenovac, Lazarevac, Mladenovac, Barajevo and Sopot. Because of their predominantly agricultural character, can be expected to flora and vegetation has the greatest percentage of ruderal, or ruderal-agricultural character.

## **MATERIALS AND METHODS**

Collection of plant material was research in the field in the action period from April 2004 to October 2006 year in the area of Pančevački rit (Krnjača, Ovča, Kovilovo, Glogonjski Rit, Jabučki Rit and Dunavac).

The identification of the plants was made according to: Josifović ed. (1970-1977), Čanak et al. (1978), Javorka-Csapody (1975), Pignatti (1982), and Kojić and Janjić, (1994).

Life forms of plants have been determined according to Ellenberg et Muller-Dambois (1967), which is elaborated and updated to Stevanović (1992).

Phytogeographic affiliation of floristic elements taken according to Gajic (1980).

Ecological (biotic) indices for each type of the the basic ecological factors to the division you give Kojić et al. (1994, 1997), Kojić and Janjić (1994).

## **RESULTS AND DISCUSSION**

On the different types of weeds and ruderal habitats Pačevački rit found the presence of 160 species of vascular plants from 135 genera and 36 families (Table 1).

Table 1. Overview of weed flora of Pančevački rit.

Tabela 1. Pregled korovske flore Pančevačkog rita.

Family / Species <i>Familija / Vrsta</i>	Family / Species <i>Familija / Vrsta</i>
Fam. <i>AMARANTHACEAE</i> <i>Amaranthus retroflexus</i> L.	Fam. <i>FUMARIACEAE</i> <i>Fumaria officinalis</i> L.
Fam. <i>APIACEAE</i> <i>Conium maculatum</i> L. <i>Daucus carota</i> L. <i>Eryngium campestre</i> L. <i>Falcaria vulgaris</i> L.	Fam. <i>HYPERICACEAE</i> <i>Hypericum perforatum</i> L.
Fam. <i>ARISTOLOCHIACEAE</i> <i>Aristolochia clematitis</i> L.	Fam. <i>LAMIACEAE</i> <i>Ballota nigra</i> L. <i>Glechoma hederacea</i> L. <i>Lamium amplexicaule</i> L. <i>Lamium purpureum</i> L. <i>Mentha arvensis</i> L. <i>Mentha piperita</i> L. <i>Salvia vericillata</i> L. <i>Stachys annua</i> L. <i>Stachys germanica</i> L.
Fam. <i>ASTERACEAE</i> <i>Achillea millefolium</i> L. <i>Achillea asplenifolia</i> Vent. <i>Ambrosia artemisiifolia</i> L. <i>Anthemis arvensis</i> L. <i>Arctium lappa</i> L. <i>Artemisia vulgaris</i> L. <i>Aster lanceolatus</i> Willd. <i>Aster salignus</i> Willd. <i>Bellis perennis</i> L. <i>Carduus acanthoides</i> L. <i>Centaurea pannonica</i> (Heuff.) Sim. <i>Centaurea scabiosa</i> L. <i>Centaurea stoebe</i> subsp. <i>micranthos</i> (Gmel.) Hayek <i>Cichorium intybus</i> L. <i>Cirsium arvense</i> (L.) Scop. <i>Cirsium lanceolatum</i> (L.) Scop. <i>Crepis rhoendifolia</i> L. <i>Erigeron canadensis</i> L. <i>Eupatorium cannabinum</i> L. <i>Galinsoga parviflora</i> Cav. <i>Helminthia echioides</i> L. <i>Helianthus tuberosus</i> L. <i>Inula britannica</i> L. <i>Iva xanthifolia</i> Nutt. <i>Lactuca serriola</i> L. <i>Matricaria chamomilla</i> L. <i>Matricaria inodora</i> L. <i>Picris hieracioides</i> L. <i>Senecio erucifolius</i> L. <i>Senecio vernalis</i> W. et K. <i>Senecio vulgaris</i> L. <i>Sonchus arvensis</i> L. <i>Tanacetum vulgare</i> L. <i>Taraxacum officinale</i> Webb.	Fam. <i>LILIACEAE</i> <i>Alium angulosum</i> L. <i>Ornithogalum umbellatum</i> L.
	Fam. <i>LYTHRACEAE</i> <i>Lythrum salicaria</i> L. <i>Lythrum virgatum</i> L.
	Fam. <i>MALVACEAE</i> <i>Abutilon theophrastii</i> Med. <i>Hibiscus trionum</i> L. <i>Malva silvestris</i> L.
	Fam. <i>OXALIDACEAE</i> <i>Oxalis stricta</i> L.
	Fam. <i>PAPAVERACEAE</i> <i>Chelidonium majus</i> L. <i>Papaver rhoeas</i> L.
	Fam. <i>PLANTAGINACEAE</i> <i>Plantago lanceolata</i> L. <i>Plantago media</i> L.
	Fam. <i>POACEAE</i> <i>Agropyrum repens</i> (L.) P. B. <i>Alopecurus pratensis</i> L. <i>Arrhenatherum elatius</i> (L.) M. K. <i>Avena fatua</i> L. <i>Bromus mollis</i> L. <i>Cynodon dactylon</i> (L.) Pers. <i>Dactylus glomerata</i> L. <i>Digitaria ciliaris</i> (Retz.) Koel. <i>Echinochloa crus-galli</i> (L.) Beauv. <i>Hordeum murinum</i> L. <i>Poa annua</i> L. <i>Poa pratensis</i> L.

<p><i>Tragopogon dubius</i> Scop.  <i>Tussilago farfara</i> L.  <i>Xanthium strumarium</i> L.  <i>Xeranthemum annuum</i> L.  Fam. <b>BORAGINACEAE</b>  <i>Anchusa arvensis</i> (L.) M. B.  <i>Anchusa officinalis</i> L.  <i>Cerinth minor</i> L.  <i>Echium vulgare</i> L.  <i>Heliotropium europaeum</i> L.  <i>Lithospermum arvense</i> L.  <i>Myosotis arvensis</i> (L.) Hill.  <i>Nonneta pulla</i> (L.) Lam. et D.C.  <i>Symphytum officinale</i> L.  Fam. <b>BRASSICACEAE</b>  <i>Alyssum alyssoides</i> L.  <i>Brassica napus</i> L.  <i>Capsella bursa-pastoris</i> (L.) Med.  <i>Lepidium draba</i> L.  <i>Rorippa silvestris</i> (L.) Bess.  <i>Sinapis arvensis</i> L.  <i>Thlaspi arvense</i> L.  Fam. <b>CARYOPHYLLACEAE</b>  <i>Agrostemma githago</i> L.  <i>Saponaria officinalis</i> L.  <i>Silene alba</i> (Mill.) Krause  <i>Stellaria media</i> (L.) Vill.  Fam. <b>CHENOPODIACEAE</b>  <i>Chenopodium album</i> L.  <i>Chenopodium murale</i> L.  <i>Kochia scoparia</i> (L.) Schrad.  Fam. <b>CONVOLVULACEAE</b>  <i>Calystegia sepium</i> L.  <i>Convolvulus arvensis</i> L.  Fam. <b>DIPSACACEAE</b>  <i>Dipsacus laciniatus</i> L.  <i>Knautia arvensis</i> (L.) Coult.  Fam. <b>EQUISETACEAE</b>  <i>Equisetum arvense</i> L.  Fam. <b>EUPHORBIACEAE</b>  <i>Euphorbia cyparissia</i> L.  <i>Euphorbia helioscopia</i> L.  <i>Euphorbia virgata</i> W. et K.  Fam. <b>FABACEAE</b>  <i>Astragalus cicer</i> L.  <i>Lathyrus aphaca</i> L.  <i>Lathyrus tuberosus</i> L.  <i>Lotus corniculatus</i> L.  <i>Medicago falcata</i> L.  <i>Medicago lupulina</i> L.</p>	<p><i>Setaria glauca</i> (L.) P. B.  <i>Setaria viridis</i> (L.) P. B.  <i>Sorghum halepense</i> (L.) Pers.  Fam. <b>POLYGONACEAE</b>  <i>Bilderdykia convolvulus</i> L.  <i>Polygonum aviculare</i> L.  <i>Polygonum lapathifolium</i> L.  <i>Rumex crispus</i> L.  Fam. <b>PRIMULACEAE</b>  <i>Anagalis arvensis</i> L.  <i>Lysimachia vulgaris</i> L.  Fam. <b>RANUNCULACEAE</b>  <i>Adonis aestivalis</i> L.  <i>Clematis integrifolia</i> L.  <i>Consolida regalis</i> Gray.  <i>Nigella arvensis</i> L.  <i>Ranunculus acer</i> L.  <i>Ranunculus acris</i> L.  Fam. <b>RESEDACEAE</b>  <i>Reseda lutea</i> L.  Fam. <b>ROSACEAE</b>  <i>Potentilla anserina</i> L.  <i>Potentilla arenaria</i> Borkh.  <i>Potentilla reptans</i> L.  <i>Rosa canina</i> L.  <i>Rubus caesius</i> L.  Fam. <b>RUBIACEAE</b>  <i>Galium aparine</i> L.  <i>Galium mollugo</i> L.  <i>Galium verum</i> L.  Fam. <b>SAMBUCACEAE</b>  <i>Sambucus ebulus</i> L.  Fam. <b>SIMARUBIACE</b>  <i>Ailathus altissima</i> (Mill.) Swingle  Fam. <b>SCROPHULARIACEAE</b>  <i>Antirrhinum maius</i> L.  <i>Linaria genistifolia</i> (L.) Mill.  <i>Linaria vulgaris</i> Mill.  <i>Verbascum blattaria</i> L.  <i>Verbascum phlomoides</i> L.  <i>Veronica byzantina</i> L.  <i>Veronica chamaedrys</i> L.  <i>Veronica jacquinii</i> Baumg.  Fam. <b>SOLANACEAE</b>  <i>Datura stramonium</i> L.  <i>Solanum dulcamara</i> L.  <i>Solanum nigrum</i> L.  Fam. <b>URTICACEAE</b>  <i>Urtica dioica</i> L.  Fam. <b>VERBENACEAE</b></p>
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<i>Ononis spinosa</i> L. <i>Robinia pseudo-acacia</i> L. <i>Trifolium pratense</i> L. <i>Vicia cracca</i> L. <i>Vicia sativa</i> L. <i>Vicia villosa</i> Roth.	<i>Verbena officinalis</i> L. Fam. VIOLACEAE <i>Viola arvensis</i> Murr <i>Viola kitaibeliana</i> R. et Schult. <i>Viola odorata</i> L.
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Of the total number of species, class *Liliopsida* (*Monocotyledones*) belongs to 17 species (10.63%), while the class *Magnoliopsida* (*Dicotyledones*) belongs to 143 species (89.38%). The *Equisetophyta* is represented with 1 type (0.63%).

Among most families that include a total of 109 species, especially by the number of families are the *Asteraceae* (23.75%), *Poaceae* (9.38%), *Fabaceae* (7.50%), *Lamiaceae* (5.63%), *Boraginaceae* (5.63%) and *Scrophulariaceae* (5.00%), which are by the number of species and genera, or most of the flora of Serbia. Relatively large number of species are represented and the family *Brassicaceae* (4.38%), *Ranunculaceae* (3.75%), *Rosaceae* (3.13%). The remaining families are represented with less than 5 species: *Caryophyllaceae* (2.5%), *Chenopodiaceae* (1.88%), *Malvaceae* (1.88%), *Polygonaceae* (2.5%), *Solanaceae* (1.88%), *Apiaceae* (2.5%), *Euphorbiaceae* (1.88%), *Rubiaceae* (1.88%) and *Violaceae* (1.88%), which is based on the synanthropic character of a large number of representatives from these families, can be expected. Otherwise, these families are among the most in weed-ruderal flora of Belgrade (Jovanović, 1994) and Serbia (Nestorović, 2008) pointing to the anthropogenic character of different habitats, their nitrification or the presence of intensive mowing and other anthropogenic influences that weed habitats are very dynamic and unstable biotope.

On the basis of the results of other researchers (Jovanović, 1994; Bartula and Jovanović, 1996; Nestorović, 2002, 2005; Nestorović and Jovanović, 2002) of the investigated habitats was determined the presence of 10 plant species (*Achillea asplenifolia*, *Alium angulosum*, *Centaurea stoebe* subsp. *micranthos*, *Helminthia echioides*, *Matricaria inodora*, *Nigella arvensis*, *Nonnela pulla*, *Ranunculus acer*, *Veronica byzantina*, *Veronica jacquini*) that is not in the list of total weed - ruderal flora urban area of Belgrade. This fact, in the best way points to the need and importance of future research floristic ruderal and agricultural habitats suburban area of Belgrade.

In the present crop and planted 101 species (63.13%), and the ruderal habitats 125 species (78.13%). From a total of 160 species of weeds, which are found in the explored localities, in almost all crops and plantation and ruderal habitats are 32 kinds of luck (20.00%), while 55 species are present only in ruderal habitats.

Analysis of life forms (Table 2) weed - ruderal flora Pančevački rit points to the domination hemicryptophytes (48.75%), which is in accordance with the representation of the life forms in the entire flora of Serbia. Besides the long scapose hemicryptophytes most with a total of 61 type (38.13%). In terms of phenological dynamics of these life forms of domination finds summer - blooming species (77), while in respect of different categories size emphasize the high plants. All these characteristics are consistent with the character of many life forms hemicryptophytes.

Table 2. Overview and presence of plant life forms of weed flora.

Tabela 2. Pregled zastupljenosti životnih formi korovske flore.

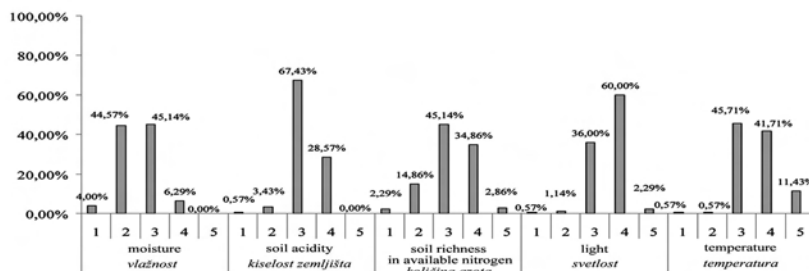
Life forms <i>Životna forma</i>	n	%	Life forms <i>Životna forma</i>	n	%
Hemicryptophytes (H) <i>Hemikriptofite</i>			Chamaephytes (Ch) <i>Hamefite</i>		
H scap	61	38.13%	Ch suff caesp	2	1.25%
H caesp	5	3.13%	Ch herb rept	2	1.25%
H ros	5	3.13%	Ch herb succ	1	0.63%
H rept	5	3.13%	total <i>ukupno</i>	5	3.13%
H semiros	2	1.25%			
total <i>ukupno</i>	78	48.75%			
Therophytes (T) <i>Terofite</i>			Phanerophytes (P) <i>Faneroofite</i>		
T scap	57	35.63%	P scap	2	1.25%
T caesp	7	4.38%	P caesp	1	0.63%
T rept	3	1.88%	P rept	1	0.63%
T ros	1	0.63%	total <i>ukupno</i>	4	2.50%
total <i>ukupno</i>	68	42.50%			
Geophytes (G) <i>Geofite</i>			Scandentophytes (S) <i>Skandentofite</i>		
G rhiz	6	3.75%	S herb	3	1.88%
G rad	3	1.88%	S lig	1	0.63%
G tub	2	1.25%	total <i>ukupno</i>	4	2.50%
G bulb	2	1.25%			
total <i>ukupno</i>	13	8.13%			

In the spectrum of basic life forms of weed flora in second place by number are therophytes with 62 species (42.50%). Most are scapose terofite with 57 species (Table 2). In terms of seasonal dynamics of primate species certainly have a spring, as a lower category of increase, which explains their one character or the need to make your life cycle (from seed to seed) completed during vegetacione one season.

Life form geophytes (G) are represented with 13 species in total weed flora, of which 6 belong to the group rhizomic geophytes. Three species belong to the group root-budding geophytes, two types belong to the group tuberous geophytes, and one species belongs to the group bulbous geophytes (Table 2).

Analysis of the ecological index (Graph. 1) for the 5 main environmental factors (humidity, acidity, amount of nitrogen, light, temperature) was determined dominance

plants prefer subxerophyte and submesophyte habitats, mainly neutral to weak alkaline reaction, secondary to the rich minerals, semiopen to predominantly open character, as well as meothermal to thermophylic in respect temperature regime.



Graph. 1. The analysis's of ecological indices.

*Graf. 1. Analiza ekoloških indeksa.*

Phytogeographic analysis of the weed–ruderal flora of Pančevački rit shows the great variety of floristic elements, identified the presence of 160 different floristic elements (Table 3). The spectrum is dominated by elements floristic elements distribution wide, which is in conformity with the allegations of the majority of authors who have discussed this issue in a variety of crops and plantations (Kojić and Pejčinović, in 1982; Kojić et al., 1997; Stanković, 1987; Stefanović, 1984).

Table 3. Spectrum of arealtype.

*Tabela 3. Spektar arealtipova.*

Group <i>Grupa</i>	n	%	Floristic element <i>Florni element</i>	Abbreviation <i>Skraćenica</i>	n	%
Euroasian <i>Evroazijska</i>	57	35.63%	Euroasian <i>Evroazijski</i>	Evr	29	18.13%
			Subeuroasian <i>Subevroazijski</i>	Subevr	23	14.38%
			Subsouthholartic <i>Subjužnosibirski</i>	Subj.sib	5	3.13%
Middle-European <i>Srednje-evropska</i>	25	15.63%	Submiddleeuropean <i>Subsrednjeevropski</i>	Subse	21	13.13%
Circumholartic-cosmopolitan <i>Cirkumpolarno-kosmopolitska</i>	25	15.63%	Circumholartic <i>Cirkumpolarni</i>	Cirk	4	2.50%
			Subcircumholartic <i>Subcirkumpolarni</i>	Subcirk	3	1.88%
			Cosmopolitan <i>Kosmopolitski</i>	Kosm	13	8.13%

Pontic-Central-Asian <i>Pontsko-centralnoazijska</i>	31	19.38%	Pontic-Panonian <i>Pontsko-panonski</i>	Pont-pan	1	0.63%
			Subpontic <i>Subpontski</i>	Subpont	3	1.88%
			Subponticcentralasian <i>Subpontskocentralno-azijski</i>	Subpont-ca	6	3.75%
			<i>Subponticsubmediterranean</i> <i>Subpontsko-submediteranski</i>	Subpont-subm	12	7.50%
			Pontic-Centralasian <i>Pontsko-centralnoazijski</i>	Pont-ca	2	1.25%
			Pontic-Centralasian-Submediterranean <i>Pontsko-centralnoazijski-submediteranski</i>	Pont-ca-subm	3	1.88%
			Subpontic-Subcentralasian-Submediterranean <i>Subpontsko-subcentralnoazijski-submediteranski</i>	Subpont-subca-subm	1	0.63%
Submediterranean <i>Submediteranska</i>	13	8.13%	Submediterranean <i>Submediteranski</i>	Subm	5	3.13%
			Pontic-Submediterranean <i>Pontsko-submediteranski</i>	Pont-subm	7	4.38%
Adventive <i>Adventivni</i>	17	10.63%	Adventive <i>Adventivni</i>	Adv	16	10.00%
Atlantic <i>Atlanska</i>	1	0.63%	Subatlantic-Submediterranean <i>Subatlansko-submediteranski</i>	Subatl-subm	1	0.63%
Endemic and relict species <i>Endemične i reliktno vrste</i>	1	0.63%	Subpanonian <i>Subpanonski</i>	Subpan	1	0.63%
total <i>ukupno</i>					160	100%

Range of area types (Table 3) indicates that the largest is the Eurasian group with 57 species (35.36%), then the Pontic-Central-Asian with 31 species (19.38%), Middle-European and Circumholartic-cosmopolitan, with 25 species. With far lower percentage of plant species are present in the Submediterranean group (8.13%), adventive (10.63%), Atlantic (0.63%) and the endemic and relict species (0.63%). Total number of established weeds species of 160 representatives and dominant participation is a kind of wide area in accordance with the ecological characteristics of weeds growing in the immediate vicinity of settlements and the strong influence of anthropogenic.

What particularly characterized weed-ruderal flora as a whole and ruderal flora in the area of Belgrade (Jovanović, 1994), significant participation adventive (10.63%) and cosmopolitan species (8.13%). Increased number of adventive and cosmopolitan kind of points to the instability weeds habitats. Characteristic representatives adventive plant

species were *Abutilon theophrastii*, *Agrostemma githago*, *Amaranthus retroflexus*, *Ambrosia artemisiifolia*, *Erigeron canadensis*, *Galinsoga parviflora*, *Iva xanthifolia*, while the typical representatives cosmopolitan species *Capsella bursa-pastoris*, *Chenopodium album*, *Chenopodium murale*, *Convolvulus arvensis*, *Cynodon dactylon*, *Echinochloa crus-galli*, *Stellaria media*.

## CONCLUSION

Different habitats in the urban environment Pančevački rit revealed the presence of 160 species of vascular plants from 135 genera and 36 families. Of the class *Magnoliopsida* (*Dicotyledones*) belongs to the 143 type, class *Liliopsida* (*Monocotyledones*) belongs to 17 species, while *Equisetophyta* presented only 1 kind.

Most are family *Asteraceae* (23.75%), *Poaceae* (9.38%), *Fabaceae* (7.50%), *Lamiaceae* (5.63%), *Boraginaceae* (5.63%) and *Scrophulariaceae* (5.00%), that is, otherwise, characterized by the largest variety of flora in the entire area of Belgrade and Serbia. High participation in these types of family points to a large extent to the anthropogenic character and specificity analysis of flora.

Analysis of the representation of life forms of plants in the examined weed-ruderal flora was found hemicryptophytic – therophytic character (48.75%: 42.50%). High participation hemicryptophytes are in line with the dominant representation of the life forms in the whole flora of Serbia, which causes climate of this region. Increased the number of types of life forms therophytes are directly related to the instability of most ruderal and agricultural habitats in which the man of his frequent interventions interfere with the development of many years of plants. The analysis ecological (biotic) index for 5 main ecological factors (humidity, acidity, amount of nitrogen, light and temperature) was determined dominance plants that prefer submesophyte and subxerophyte habitats, mainly neutral to weak alkaline reaction, secondary to the rich rich minerals, mainly semi-open to open type, as well as mesothermal to thermophylic in respect temperature regime.

Phytogeographic analysis of the weed flora found the presence of 160 different floristic elements, grouped in 8 basic types of area. Analysis floristic elements and their representation are about the participation of the dominant type of large area. The largest is the Eurasian group with 57 species (35.63%), Pontic-Centralasian with 31 species (19.38%), Middle-European and Circumholartic-cosmopolitan, with 25 species. Significantly less represented plant species from the Submediterranean, adventivne, Atlantic, and the endemic and relict species. This phytogeographical structure of weeds in accordance with the ecological characteristics of weeds growing in the immediate vicinity of settlements and the strong influence of anthropogenic.

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# KOROVSKA FLORA PANČEVAČKOG RITA

MARKO LJ. NESTOROVIĆ

## Izvod

Ovim radom predstavljeni su rezultati trogodišnjeg istraživanja (2004-2006) korovsko - ruderalne flore na području Pančevačkog rita (Krnjača, Ovča, Kovilovo, Glogonjski Rit, Jabučki Rit, Dunavac). Na različitim tipovima korovskih i ruderalnih staništa utvrđeno je prisustvo 160 vrsta korovskih biljaka iz 135 rodova i 36 familija. Najbrojnije familije u korovsko-ruderalnoj flori Pančevačkog rita su: *Asteraceae* (23,75%), *Poaceae* (9,38%), *Fabaceae* (7,50%), *Lamiaceae* (5,63%), *Boraginaceae* (5,63%), *Scrophulariaceae* (5,00 %), koje su po broju vrsta i rodova inače najzastupljenije u flori Srbije. Međutim, relativno velikim brojem vrsta su zastupljene i familije *Brassicaceae* (4,38%), *Ranunculaceae* (3,75%), *Rosaceae* (3,13%) ukazujući na antropogeni karakter korovskih staništa, na njihovu nitrifikovanost ili kserotermnost, ili pak na prisustvo intenzivnog košenja i ostale antropogene uticaje koji korovska staništa čine vrlo dinamičnim i nestabilnim biotopima. Analizom zastupljenosti životnih formi biljaka u ispitivanoj korovskoj flori ustanovljen je hemikriptofitsko-terofitski karakter (48,75%:42,50%). Analizom ekoloških indeksa za 5 osnovnih ekoloških faktora (vlažnost, kiselost, količina azota, svetlost, temperatura) utvrđena je dominacija biljaka koje preferiraju subkserofitna i submezofitna staništa, pretežno neutralne do slabo alkalne reakcije, srednje bogata do bogata mineralnim materijama, pretežno poluotvorenog do otvorenog karaktera, kao i mezotermna do termofilna u pogledu temperaturnog režima. Fitogeografskom analizom utvrđeno je prisustvo 160 različitih flornih elemenata, grupisanih u 8 osnovnih areal tipova. Najbrojnija je grupa koja pripada evroazijskom areal tipu (33,14%).

**Ključne reči:** korovska flora, ekološka analiza, fitogeografska analiza, Pančevački rit, Beograd.

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## TESTING PEPPER VARIETIES INTENDED FOR PRODUCTION OF VEGETABLE CAVIAR

ĐURO GVOZDENOVIĆ<sup>1</sup>

*SUMMARY: Pepper (*Capsicum annum L*) is definitely a major vegetable crop, both in terms of its acreage and the scope of its possible uses. Whether consumed fresh or processed, the pepper is a rich source of vitamins, minerals and other organic compounds necessary for human nutrition. The main focus of pepper breeding in our country is the development of cultivars for different uses. When developing a pepper cultivar, a large number of requirements must be considered such as high yield, early maturity, vitamin content, and levels of mineral substances and other compounds. In addition to this, matters related to the color, taste, aroma and appearance of the pepper fruit must also be taken into account. The Institute of Field and Vegetable Crops in Novi Sad has developed a number of pepper varieties of different types, such as bell (Novosadska bela babura, Matica, Buketna I, Atina, Anita, and Vranjska), elongated (Una and Amfora), tomato (Novosađanka), and longum peppers (Plamena and Krušnica). These varieties, which are yellow or green in color at technological maturity and differ in taste and pericarp thickness, were studied for yield, morphological characteristics of the fruit, and chemical composition in order to identify the best ones for the production of vegetable caviar ajvar, the traditional Balkan vegetable caviar. Thanks to their characteristics, these cultivars can be sold fresh on the green market or served in restaurants, used for roasting, freezing, breading, or pickling, or processed industrially by slicing, dicing, etc. Our study has shown Amfora, Una and Atina and the standard Kurtovska kapija to be the best varieties for the preparation of ajvar.*

**Key words:** *pepper, selection, yield, morphological characteristics, chemical composition, quality, vegetable caviar.*

### INTRODUCTION

Pepper is a profitable crop, bringing high profit per unit area when grown both

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commercially or for seed. In view of demands for production characteristics and prevailing consumption and processing methods, pepper breeding is aimed at the development of high-yielding cultivars, having specified fruit type, shape, color and quality, adapted to specific growing methods and used for specific purposes (Gvozdenović et al., 1996).

A pepper cultivar should meet the following criteria: it should be acclimated to certain agro-ecological conditions and it should have certain fruit weight and pericarp (wall) thickness. Further, it should have a well-developed root system, it should tolerate a certain crop stand per unit area and it should produce a satisfactory number of marketable fruits per plant, having good quality and balanced amounts of vitamins, sugars and amino acids (good chemical composition) (Gvozdenović et al., 2004).

## **MATERIAL AND METHOD**

In addition to domestic and domesticated cultivars, new pepper cultivars and hybrids, both domestic and foreign, are grown in our country. Pepper breeding is determined by specific properties of the crops, market demand and requirements and climatic conditions in the production region. In view of production, utilization and processing requirements, pepper breeding is targeted on the development of highly productive cultivars, having defined fruit type, shape, color and quality, and traditional methods of production and utilization. The Vegetable Department of Institute of Field and Vegetable Crops in Novi Sad has developed a large number of pepper cultivars varying in type: bell peppers (Novosadska bela babura, Matica, Buketna 1, Atina, Anita and Vranjska); the elongated fruit type: (Una and Amfora); the tomato-pepper type (Novosađanka); and the longum type: (Plamena and Krušnica). These cultivars are yellow or green at technological maturity, and they have specified taste and the desired pericarp (wall) thickness (Gvozdenović, 2001). All these cultivars were included in this study, whose objective was to assess these cultivars for yield performance, morphological fruit properties, fruit chemical composition and suitability for vegetable caviar making. Experiments were conducted during 2006-2008 following the conventional methodology. All results were statistically processed by the analysis of variance. Treatments (genotypes) were compared by the Duncan test. The LSD test included two significance levels, 1% and 5%.

## **RESULTS AND DISCUSSION**

Yield is the ultimate result of vegetative and generative plant development (Borojević, 1981). It is a complex characteristic that comprises a large number of quantitative components, whose genetic bases are polygenic. In the case of peppers, the yield as a complex characteristic is determined by the number of plants per unit area and the number and weight of fruits per plant (Betlach, 1969).

In addition to yield and yield components (number of plants per unit area, number of fruits and fruit weight) which are main targets in pepper breeding (Betlach, 1969, Milkova, 1986), morphological characteristics of the fruit (length, width and pericarp (wall) thickness) are also important (Hristov, 1966).

Tab. 1. Yield of pepper cultivars (t/ha) during 2006-2008

Tab. 1. Prinos sorti paprike (t/ha) tokom 2006-2008.godina

Cultivar/Sorta	Year/Godina			Average Prosek
	2006	2007	2008	
1. Anita	34,83	41.15	42.08	39.35
2. Una	36.33	47.71	33.89	39.31
3. Vranjska	35.37	43.54	34.49	37.80
4. Amfora	35,50	41.97	34.49	37.18
5. Atina	32,37	42.51	34.02	36.30
6. Šorokšari	32.10	36.81	34.03	34.31
7. Plamena	29.33	36.99	29.88	32.07
8. Kurt. kapija	28.30	39.01	26.05	31.12
9. Krušnica	26.23	36.36	23.40	28.66
10.Matica	27.53	30.77	25.61	27.97
11.Novosađanka	26.67	26.91	29.71	27.76
12.Buketna 1	23.63	32.56	27.03	27.74
13.Kaliforn. čudo	26.47	29.26	24.71	26.81
14.Novos.b.babua	25.30	26.18	26.18	25.89
Average / Prosek	30.00	36.55	30.39	32.31
<b>LSD</b>	0.05	1.34	4.14	6.39
	0.01	2.05	5.58	8.46

In the course of the three-year study (Table 1), the highest average yield was obtained with the bell type cultivar Anita (39.35 t/ha), the lowest the bell type cultivar Novosadska bela babura (25.89 t/ha). In the case of the cultivars with elongated fruits, the highest yield was obtained with Una (39.31 t/ha), the lowest with Krušnica (28.66 t/ha). Amfora and Kurtovska kapija, the two cultivars most suited for processing, yielded 37.18 t/ha and 31.12 t/ha, respectively (Table 1). These results were in agreement with previously obtained results (Gvozdenović et al., 2006).

Morphological characteristics of pepper fruits (length, width and pericarp (wall) thickness) are important characteristics too. Number of fruits per plant is considered one of most important yield components. Fruit weight differs in dependence of fruit type, ranging from 1 to 500 g. Fruit weight is a relatively stable indicator, which is greatly affected by the environment and which is positively correlated with leaf size and fruit yield (Popova, 1966).

Tab. 2. Morphological characteristics of pepper cultivars tested during 2006-2008

Tab. 2. Morfološke karakteristike ispitivanih sorti paprike tokom 2006-2008.godine

<b>CULTIVAR SORTA</b>	Fruit length <i>Dužina ploda (cm)</i>	Fruit width <i>Širina ploda (cm)</i>	Pericarp thickness <i>Debljina perikarpa (mm)</i>	Fruit weight <i>Masa ploda (g)</i>	Fruit utilization % <i>% korisnog dela ploda</i>	
Anita	9.90	7.80	7.20	140.7	83.40	
Una	14.84	3.79	3.95	80.2	83.23	
Vranjska	9.55	5.68	4.53	90.4	81.50	
Amfora	12.50	5.68	4.86	135.2	82.70	
Atina	10.70	8.20	6.50	134.7	81.50	
Šorokšari	9.50	7.50	5.80	125.7	82.10	
Plamena	15.50	2.60	2.60	38.4	75.65	
Kurtov. kapi.	13.68	4.20	3.88	67.0	82.60	
Krušnica	15.40	2.30	2.34	32.5	76.49	
Matica	9.90	5.40	5.54	89.2	84.00	
Buketna 1	8.50	5.80	4.56	83.6	82.60	
Kaliforn.čudo	9.24	6.60	4.43	130.3	82.35	
Novo. b. bab.	8.90	4.56	3.55	79.9	80.70	
Novosađanka	5.20	5.80	8.50	80.5	84.60	
LSD	0.05	0.14	0.09	0.14	0.17	0.12
	0.01	0.20	0.14	0.20	0.24	0.18

The results of the three-year study (Table 2) indicated that longest fruits were found for the cultivar Atina (10.70 cm), which also had widest fruits (8.20 cm). Buketna 1 had shortest fruits (8.50 cm) and Matica had smallest width (5.40 cm). Among the cultivars with elongated fruits, Plamena had longest fruits (15,4 cm) while Krušnica had narrowest fruits (2.30 cm). The largest pericarp thickness was founding the cultivar Novosađanka, (8.50 mm), while Krušnica had the thinnest pericarp (2.34 mm). Anita had the highest fruit weight (140.7 g), Krušnica the lowest (32.5 g). Novosađanka achieved the best fruit utilization rate (84.60%), Plamena the lowest (75.65%) (Table 2).

Pepper fruit has a high nutritive value; it is rich in carbohydrates, sugars, malic and citric acids, B-carotene, capsaicin and vitamins, especially vitamin C (Marković, Vračar, 1998).

In this study, highest dry matter contents were found in the cultivars Una (10.53%) Kurtovska kapija (10.07%) and Amfora (10.3%), the lowest in Anita (8.89) (Table 3). Regarding total sugars, the highest content was found in Vranjska (7.60%), the lowest in Amfora (5.18). The highest total acidity was found in Atina (0.30%), the lowest in Kurtovska kapija (0.21%). The highest cellulose content was found in Kurtovska kapija (0.95), the lowest in Anita (0.56). The highest vitamin C content was found in Anita (193.7 mg/100 g), the lowest in Kurtovska kapija (72.9 mg/100 g). The highest content of pectins was found in Amfora (0.78%, the lowest in Kurtovska kapija (0.51%) (Table 3).

Tab. 3. Chemical analysis of the fruit of the tested pepper cultivars  
 Tab. 3. Rezultati hemijskih analiza ploda ispitivanih sorti paprike

Sorta Cultivar	Characteristic / Osobine								
	Dry matter content(R) SMR,%	Dry matter content(D) SMS%	Ukupni šećer % Total sugars	Ukupna kiselost % Total acidity	Celuloza % Cellulose	Vitamin C/mg/100 g Vitamin C	B-karotin mg/g/SM Beta carotene	Pepeco% Ashes	Ca-pektat % Ca-pectate
Kurt.kap	8.20	10.07	5.64	0.21	0.95	72.9	2420.2	0.40	0.51
Amfora	8.05	10.03	5.18	0.26	0.83	164.5	2228.4	0.40	0.78
Una	8.00	10.53	5.24	0.23	0.94	124.7	1081.7	0.47	0.52
Atina	8.40	9.54	7.02	0.30	0.91	128.5	2032.3	0.40	0.59
Anita	6.50	8.89	6.50	0.23	0.59	193.7	2040.1	0.34	0.63
Vranjska	7.50	9.46	7.60	0.25	0.71	115.6	1131.2	0.41	0.54

As Amfora has the highest Ca-pectate content, which prevents color caramelization during boiling of vegetable caviar, the caviar made of Amfore retains an attractive red color. The cultivars Amfora, Una, Kurtovska kapija and Atina are exceptionally suitable for preparation of high-quality baked vegetable caviar.

These cultivars achieve exceptionally high yields and they have a high fruit utilization rate, high dry matter content and high pectins content, which is important for vegetable caviar preparation. Most producers use their own formula in preparing pasteurized baked vegetable caviar from the cultivar Amfora, which has an intensively red color, thick but spreadable consistency, mild taste and the aroma characteristic for peppers.

The technological process of vegetable caviar preparation starts with manual or machine cleaning and washing of peppers and eggplants. The fruits are then parboiled, ground, mixed according to the formula and boiled in a vacuum boiler to 11% dry matter. Baking on oil to 14% dry matter. Taste enhancement by adding salt, oil, vinegar, herbs (garlic powder) and tomato concentrate. Bottling in 720-ml glass containers with twist-off caps. Net weight of a bottle is 650 g. A dozen bottles are thermoplastic wrapped on a cardboard tray. Bottle capping is followed by pasteurization. After a seven-day rest period, bottles are labeled and packaged. The shelf life of the produce is 24 months. Bottles should be kept at room temperature, from 2 to 30°C, protected from direct sunlight. The produce is used as salad, side dish to roast or grilled meat, or as a spread.

In addition to Kurtovska kapija as the standard cultivar, Amfora, Una and Atina are most suitable for preparation of vegetable caviar. These cultivars, as well as the others, may be used for preparation of chopped peppers, roasted peppers, pepper filets, frozen peppers, pickled peppers and as components of various mixed dishes such as vegetable stew, Mexican salad, mixed salad, etc.

## CONCLUSION

The pepper breeding program conducted in previous years has produced cultivars adapted to the local agro-ecological conditions and attractive to consumers, suitable for outdoor and indoor production and planting from transplants or directly from seed. Because of its characteristics and fruit types, they may be consumed fresh or can be roasted, frozen or breaded. They are used by the catering industry, for homemade preserves, or may be processed into filets, shredded salad, etc. Amfora, Una, Atina and the standard cultivar Kurtovska kapija showed to be most suitable for preparation of vegetable caviar.

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## TESTIRANJE PAPIRIKE U CILJU STVARANJA SORTI ZA SPRAVLJANJE AJVARA

ĐURO GVOZDENOVIĆ

### Izvod

Paprika (*Capsicum annuum* L.) je nesumnjivo jedna od najvažnijih povrtarskih kultura i to kako po površinama koje zauzima, tako i po mnogostрукim oblicima njenog korišćenja. Bilo da se koristi u svežem ili prerađenom stanju ona predstavlja bogat izvor vitamina, mineralnih materija i drugih organskih jedinjenja potrebnih u savremenoj



ishrani. Osnovni pravci u selekciji paprike, kod nas, su stvaranje sorti za različite vidove korišćenja. Kod stvaranja sorti paprike mora se uzimati u obzir veliki broj zahteva koji se odnose na visok prinos, ranostasnost, sadržaj vitaminima, mineralnih materija i drugih organskih jedinjenja. Pored biološke vrednosti moramo voditi računa, o boji, mirisu, izgledu i ukusu. Oplemenjivanje paprike je permanentan proces koji zavisi od niza faktora, a pre svega od ljudstva koje radi na toj problematici, raspoloživih zemljišnih površina, od intenziteta proizvodnje i nivoa tehnologije gajenja, zahteva tržišta, a posebno od genetske divergentnosti polaznog materijala za ukrštanja. Kao rezultat oplemenjivačkog rada u Institutu za ratarstvo i povrtarstvo, u Novom Sadu, stvoren je veći broj sorti paprike različitog tipa: babure: (Novosadska bela babura, Matica, Buketna 1, Atina, Anita, i Vranjska); kapije: (Una i Amfora); paradajz paprika (Novosađanka); Šipke: (Plamena i Krušnica), žute ili zelene boje u tehnološkoj zrelosti, odgovarajućeg ukusa, određene debljine mesa, koje su korišćene za ova istraživanja, u cilju ispitivanja prinosa, morfoloških osobina ploda i hemijskog sastava i odabiranja najboljih za spravljanja ajvara. Zbog svojih navedenih karakteristika i izgleda ploda mogu da se koriste u svežem stanju za zelenu pijacu, za pečenje, smrzavanje, pohovanje, punjenje, restoransku potrošnju, kišljenje, turšija, a u industrijskoj preradi za spravljanje fileta, kocki i sl. Za spravljanje ajvara najbolje su se pokazale sorte Amfora, Una i Atina, kao i standardna sorta Kurtovska kapija.

**Ključne reči:** paprika, selektija, prinos, morfološke osobine, hemijski sastav, kvalitet, biljni kavijar.

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## INTENSITY OF BOAR SPERM UTILIZATION IN VOJVODINA AND POSSIBILITY OF ITS INCREASE\*

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*SUMMARY: The intensive pig production requires a significant increase in the reproductive exploitation of boars. It is more and more achieved by the intra-uterine insemination with the doses of significantly reduced volume and number of spermatozoa. Our results show that the volume of an average ejaculate of the studied boars in Vojvodina is 278 ml, with  $44 \times 10^9$  on average of progressively motile spermatozoa. Out of this ejaculate 14.6 of the insemination doses, of 100 ml volume with  $3 \times 10^9$  spermatozoa on average, can be obtained. In that way, about 300 sows per year can be inseminated with the doses obtained from one boar. By the application of the intra-uterine insemination, with the doses of the reduced volume to 50 ml, with  $1.5 \times 10^9$  spermatozoa, the number of doses per ejaculate (almost 30) can be doubled. Thus, the number of the inseminated sows, per boar a year, would be increased from 300 to 600, which would significantly increase the boars reproductive exploitation rate, without a significant decrease in the fertility of sows inseminated in that way.*

**Key words:** sperm, quality, intra-uterine insemination, reproductive efficiency, boar

### INTRODUCTION

The technology of artificial insemination is widely used in the modern intensive pig production. In a great number of the developed countries in Europe (Holland, France, Germany, Spain, Norway, Finland, the Great Britain) over 80% of sows and gilts

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are artificially inseminated (Gadea, 2003), with the doses of fresh diluted sperm, which contain 3 to  $6 \times 10^9$  of progressively motile spermatozoa (Alm et al., 2006). The doses of the liquid diluted sperm are kept at 15 to 20°C and are most frequently used within 1 to 2 days, after being taken from a boar (Johnson et al., 2000). On average, about 1300 insemination doses per year (21 doses per ejaculate) are obtained from one boar, which is enough for a successful insemination of only about 300 sows per year (Singleton, 2001). That is why the necessity for the increase in the reproductive exploitation of genetically superior boars is, more and more, emphasized. In view of that fact the studies concerning the possibilities of obtaining a significantly greater number of the insemination doses per boar a year are more and more frequent (Glossop, 2000; Stančić, 2000; Stančić et al., 2008). This increase is possible to achieve by a significant reduction in the spermatozoa number in one insemination dose, from the present 3 to 6 billion to 1 to 2 billion (Belstra, 2002). The use of the insemination doses with the significantly reduced number of spermatozoa, without a significant decrease in the fertility of the inseminated sows is possible due to the new technology of intra-uterine insemination (Roseboom et al., 2004; Mezalira et al., 2005; Stančić et al., 2006; Stančić et al., 2007; Radović et al., 2007). In our country the number (%) of the artificially inseminated breeding females is significantly lower than the one in the developed European countries but, with us, the necessity for the increase in the number of the obtained insemination doses, particularly of the genetically superior boars is more and more emphasized.

For that reason, the aim of this paper was to ascertain the basic parameters of the fertilization capacity of native ejaculates of the basic boar breeds, which are used for the artificial insemination on farm units in Vojvodina, as well as to assess, based on the obtained values, the possibility of the increase in the number of the obtained insemination doses per boar a year by the reduction in spermatozoa number per a dose.

## MATERIAL AND METHODS

The studies were carried out on a number of large pig-breeding farms in Vojvodina during one year (from February 2008 to February 2009). The total of 122 boars, of basic breeds, such as: Duroc – D (n = 27), Hampshire – H (n = 21), Lagre White – LW (n = 42) and Swedish Landrace – SL (n = 32) were used. From each boar the total of 24 native ejaculates were examined, two ejaculates per each month in the year of study. The ejaculates were taken approximately in the first and the last third of the month. Immediately after being taken, on the farm, the volume of each ejaculate was determined without the gel fraction.

Within two or three hours after being taken from the boars the ejaculates were delivered to the laboratory for reproduction and AI (Faculty of Agriculture in Novi Sad). The samples of about 50 ml of native ejaculate were transported in the sterile plastic bottles, stored in a thermo-box for sperm transport and preservation (Minitüb, Germany), at + 17 °C. On being brought to the laboratory, the sperm samples were heated at + 37.5 °C in the water bath for 30 to 40 minutes. After heating, the basic parameters of the fertilization capacity of native ejaculates were determined as follows: (1) progressive motility, (2) total number and concentration of spermatozoa and (3) number of dead and morphologically changed spermatozoa. The progressive motility was determined under

the light microscope (medium magnification) on the scale from 1 to 5, in percentage. The total number and the concentration of the spermatozoa in the ejaculate were determined by the photometric method (Photometer SDM 5, Minitüb, Germany).

## RESULTS AND DISCUSSION

The average ejaculate volume of the studied boars was 278 ml while the average ejaculate volume of the Duroc boars was 212 ml and it was statistically significantly lower ( $P < 0.01$ ) than the average ejaculate volume of the Hampshire breed (308 ml), the Large White (289 ml) and the Swedish Landrace (291 ml) which did not significantly differ from each other ( $P < 0.05$ ) ( Table 1).

Table 1. Native ejaculate parameters

	Breeds of Boars				Average for all breeds (n=122)
	D (n=27)	H (n=21)	VJ (n=42)	ŠL (n=32)	
Volume (ml)	212 <sup>AB</sup> (75-350)	308 (200-450)	289 <sup>A</sup> (120-500)	291 <sup>B</sup> (110-650)	278 (75-650)
Total spzt. number ( $\times 10^9$ )	45 <sup>a</sup> (21-87)	52 (38-76)	54 <sup>a</sup> (12-125)	59 (23-135)	53 (12-135)
Sptz. concentration ( $\times 10^6$ /ml)	224 <sup>A</sup> (109-483)	174 <sup>A</sup> (123-243)	190 (67-361)	211 (105-460)	200 (67-483)
Prog. motility (%)	82 (65-95)	85 (70-90)	84 (65-95)	85 (75-95)	84 (65-95)
Total prog. motile spzt. ( $\times 10^9$ )	37 (17-71)	44 (32-65)	46 (10-105)	50 (19-115)	44 (10-113)

D-Duroc; H-Hampshire; LW-Large White; SL-Swedish Landrace. Min. and max. values in parenthesis.

<sup>AB</sup> Values with the same superscript are significantly different ( $P < 0.01$ ).

<sup>a</sup> Values with the same superscript are significantly different ( $P < 0.05$ ).

The concentration of spermatozoa in 1 ml of native sperm varied between 174 (Hampshire) and  $224 \times 10^9$  (Duroc), on average. The total number of spermatozoa per ejaculate was  $53 \times 10^9$  for all the breeds on average and ranged between  $45 \times 10^6$  (Duroc) and  $59 \times 10^9$  (Swedish Landrace). The progressive motility of native sperm was satisfactory in all the boars and ranged between 82% and 85%, so that the total number of the progressively motile spermatozoa in an ejaculate was between 37 and  $50 \times 10^9$  (Table 1). Some other authors, as well, have found the differences in the parameters of native ejaculates between particular boar breeds (Laouda, 1988; Kuo et al., 1997; Stančić, 2002.; Stančić et al., 2003 a; Sutkeviciene and Zilinskas, 2004). Based on the found average ejaculate volume and the average number of the progressively motile spermatozoa in an ejaculate, the possible average number of the insemination doses per ejaculate as well as the necessary rate of native ejaculate dilution depending on the number of the progres-

sively motile spermatozoa per insemination dose were calculated (Table 2).

Table 2. Possible number of insemination doses per ejaculate

	Breeds of Boars				Average for all breeds (n=122)	
	D (n=27)	H (n=21)	VJ (n=42)	ŠL (n=32)		
Av. ejaculate volume (ml)	212	308	289	291	278	
Av. no. prog. motile spztz. per ejaculate ( $10^9$ )	37	44	46	50	44	
Sptz. no. per dose = $5 \times 10^9$	A	7.4	8.8	9.1	10.0	8.9
	B	1 : 3.5	1 : 3	1 : 3	1 : 3	1 : 3
Sptz. no. per dose = $3 \times 10^9$	A	12.0	14.6	15.0	16.6	14.6
	B	1 : 5	1 : 5	1 : 5	1 : 6	1 : 5
Sptz. no. per dose = $2 \times 10^9$	A	18.5	22.0	23.0	25.0	22.0
	B	1 : 9	1 : 7	1 : 8	1 : 8	1 : 7

A – Possible number of insemination doses per ejaculate. B – Necessary dilution rate of ejaculate.

By the use of the insemination doses with  $5 \times 10^9$  of progressively motile spermatozoa, as practised in our country (Stančić et al., 2003), from an average ejaculate between 7 and 10 doses can be formed, depending on the boar breed. By the reduction in spermatozoa number in a dose to  $3 \times 10^9$ , between 12 and 16 doses can be formed whereas by the further reduction in the spermatozoa number to  $2 \times 10^9$ , between 18 and 25 insemination doses can be formed. However, by increasing the number of doses per ejaculate, at the standard dose volume of 100 ml of diluted sperm, the proportional increase in dilution rate of the native ejaculate must be carried out (Table 2). To a great extent, this fact can reduce the possibility of practical utilization of the insemination doses with the considerably reduced number of spermatozoa, particularly in case the doses are kept longer than 24 hours. Namely, it has been observed that the sperm of only 20% to 30% of boars has sufficient tolerance to a high dilution rate and a longer in vitro storing (Weitze, 1990; Baltés, 1993). Our previous studies as well, carried out on large pig breeding farms in Vojvodina, show that about 60% of the studied boars, of all important breeds, are tolerant to the dilution rate of 1:4, during 24 hours of storing at +17 °C while that number decreases to only about 20% when stored for 72 hours at the same temperature and with the same dilution rate (Stančić et al., 2002; Stančić et al., 2003 b).

It is possible to overcome this problem by the application of the insemination doses of half the volume. For instance, a standard dose with  $4 \times 10^9$  spermatozoa of 100 ml volume can be divided into two doses of 50 ml containing  $2 \times 10^9$ . In the process, the new intra-uterine dose application instead of the standard intra-cervical dose application should be used. Namely, it has been found that the application of the intra-uterine insemination with the doses of 20 to 50 ml (in relation to the standard dose volume of 80 to 100 ml) and the reduced spermatozoa number from 0.5 to  $2.5 \times 10^9$  of spermatozoa has similar or better results of the inseminated sows fertility in comparison to the sows inseminated by the standard intra-cervical method (Vansickle, 2002; Watson & Behan, 2002; Rozeboom et al., 2004; Mezalira et al., 2005; Grafenau, Sr. & Grafenau, Jr., 2004; Grafenau et al., 2005; Stančić et al., 2006; Radović et al., 2007; Stančić et al., 2008). It has been based on the long ago established fact that the number of spermatozoa necessary for the successful fertilization rapidly decreases if their application is performed

more cranially (deeper) in the uterus, i.e. closer to the fertilization spot (Hancock & Hovell, 1961). By the application of the intra-uterine insemination with the doses of half the volume (50 ml), compared to the standard (100ml) which contain  $1.5 \times 10^9$  of spermatozoa, according to our results, the number of the insemination doses per ejaculate would be doubled (from 14.6 to 29.2) whereas the dilution rate would not be changed.

Based on the calculated number of the insemination doses which contain  $3 \times 10^9$  of progressively motile spermatozoa obtained from one boar, it is possible to inseminate 304 sows on average between 250 and 345, depending on the boar breed). The assumption is that in a certain breeding stock, without returns, 80% of sows are successfully inseminated with one return 10%, while with two returns 10% of sows. The conclusion is that 4 insemination doses per year are necessary for 80% of sows, for 10% of sows it is 6 insemination doses whereas for 10% of sows 8 insemination doses per year are necessary. It means that, for 100 sows, it is necessary to provide 500 insemination doses per year or 5 doses per sow a year. It is also assumed that each boar has two ejaculates a week (Table 3).

Table 3. Possible number of inseminated sows per year

	Breeds of Boars				Average for all breeds (n=122)
	D (n=27)	H (n=21)	VJ (n=42)	SL (n=32)	
Ejaculate no. Boar/week	2	2	2	2	2
Ejaculate no. Boar/year	104	104	104	104	104
Average dose no.per ejaculate	12.0	14.6	15.0	16.6	14.6
Average. dose no.boar/year	1.248	1.518	1.560	1.726	1.518
Av. insem.dose no. sow/year	5	5	5	5	5
Possible number of inseminated sows/year*	250	304	312	345	304

\* Insemination dose contains  $3 \times 10^9$  spermatozoa.  
80% sows farrow after first AI, 10% after second, and 10% sows farrow after third AI.

Although the increase in the insemination dose number per ejaculate in the standard AI technology (intra-cervical insemination) is limited, the number of spermatozoa per dose has constantly decreased for the past 50 to 60 years. Some recent data, from the more developed European countries, show that the current average insemination dose is 80 ml of the diluted sperm with  $3.25 \times 10^9$  spermatozoa. On average, about 1,300 insemination doses (21 doses per ejaculate) are obtained from one boar per year which is enough for the successful insemination of about 300 sows per year (Singleton, 2001). The significantly larger average number of the insemination doses per ejaculate (21) in the European countries, in comparison to our results (14.6) with the similar spermatozoa number per dose ( $3.25$  to  $3 \times 10^9$ ) is the result of the fact that the average spermatozoa number per ejaculate in the European countries is significantly higher ( $70 \times 10^9$ ) than the number of spermatozoa which we have found in our boars ( $53 \times 10^9$ ). In the current, more intensive production, this production of the insemination doses per boar a year is regarded as insufficiently efficient, from both the zoo-technical and economic aspect. The application of the new technology of intra-uterine (trans-cervical) insemination makes the use of the insemination doses of the reduced volume and number of spermatozoa as

well as the increase in the reproductive exploitation of boars possible.

In order to advance the practical efficiency of the technology of the intra-uterine pig insemination, it is necessary to carry out further experimental research in regard to: **(a)** the physiology of transmission and survival of spermatozoa in the female sexual tract (Gomeida et al., 1998; Radović et al., 2006), **(b)** the determination of the minimum spermatozoa number in an insemination dose (Vazquez et al., 2005) **(c)** the determination of the optimum design of the intra-uterine catheters (Stančić et al., 1998; Belstra, 2004; Grafenau et al., 2005; Stančić et al., 2005; Stančić et al., 2006) and **(d)** the optimum depths of sperm deposition in uterus horns for achieving the maximum fertility of the inseminated sows (Martin Rilo et al., 2000).

## CONCLUSION

On the basis of the results obtained in this research as well as the results obtained by other authors the following conclusions can be drawn:

1. The average ejaculate of the studied boars has the volume of 278 ml with the average  $44 \times 10^9$  of progressively motile spermatozoa.
2. An average of 14.6 insemination doses of the 100 ml volume of diluted sperm with  $3 \times 10^9$  of progressively motile spermatozoa can be formed from one ejaculate.
3. In the standard technology of intra-cervical insemination 1,518 such doses can be obtained from one boar per year which is enough for the insemination of 304 sows.
4. Twice as many inseminated sows could be achieved by using the doses of half the volume (50 ml) and half the number of spermatozoa ( $1.5 \times 10^9$ ).
5. The research results by other authors show that by the intra-uterine insemination with such reduced doses the fertility rate of the inseminated sows is not reduced.

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## **INTENZITET ISKORIŠTAVANJE SPERME NERASTOVA U VOJVODINI I MOGUĆNOST NJEGOVOG POVEĆANJA**

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### **Izvod**

Intenzivna proizvodnja svinja zahteva značajno povećanje reproduktivne eksploatacije nerastova. Ovo se, sve češće, postiže intrauterinom inseminacijom dozama znatno redukovanog volumena i broja spermatozoida. Naši rezultati pokazuju da volumen prosečnog ejakulata ispitivanih nerastova u Vojvodini iznosi 278ml, sa prosečno  $44 \times 10^9$  progresivno pokretnih spermatozoida. Od ovog ejakulata se može napraviti prosečno 14,6 inseminacionih doza, volumena 100ml, sa po  $3 \times 10^9$  spermatozoida. Na taj način se dozama dobijenim od jednog nerasta, može osemeniti oko 300 krmača godišnje. Primenom intrauterinog osemenjavanja, dozama redukovanog volumena na 50ml, sa  $1,5 \times 10^9$  spermatozoida, moglo bi se dobiti duplo više doza (blizu 30) po ejakulatu. Na taj način bi se i broj osemenjenih krmača, po nerstu godišnje, povećao sa 300 na 600, što bi značajno povećalo stepen reproduktivne eksploatacije nerastova, bez značajnijeg smanjenja fertiliteta tako osemenjenih krmača.

**Ključne reči:** sperma, kvalitet, intrauterina inseminacija, reproduktivna efikasnost, nerast.

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## EFFECTS OF SOW NUTRITION DURING THE FIRST STAGE OF GESTATION ON THE LITTER SIZE\*

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*SUMMARY: The experiment dealt with the effect of 2 and 3.2 kg of feed a day, in the first month of gestation, on the results of sow farrowing. The experiment comprised 300 inseminated gilts and sows divided into three groups. The greater amount of food in the first month of gilt gestation resulted in the significant increase in the litter size of 8.17 piglets in control group I which consumed 2 kg of feed to 9.24 and 9.48 in groups II and III which were fed with 3.2 kg of feed a day. In sows a greater amount of feed at early gestation significantly affected the decrease in litter size of 10.82 in group I to 10.35 in group II and 10.31 piglets in group III.*

**Key words:** amount of feed, gestating sow, gilt, litter size

### INTRODUCTION

The restricted nutrition of sows in the first month of gestation has been a generally accepted solution for a long time. In numerous studies it has been concluded that the increase in feed intake i.e. energy during the first stage of gestation, before the nidation of zygotes, results in the increase of embryo mortality which can affect the decrease in litter size. A higher embryo survival as the result of the restricted feed intake of 1.8-2 kg a day was found by Den Hartog and Van Kempen (1980), Ashworth (1990), Jindal et al. (1996) and Carlson (2002). In contrast to this finding in the investigation of Dritz et al. (1997), Huegton (2001), Scharlach (2001), Kongsted (2004), Thacher (2006), Goodbund et al. (2007), a negative effect of greater feed intake was established only during the first three days of the migration of zygotes towards uterus, and afterwards a higher feeding

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level was of no negative effect.

Contrary to the previous results Kirkwood et al.(1990) established a positive effect of the greater amount of feed on embryo survival by feeding the gestating gilts with 1.8 and 3.6 kg of feed in the first third of gestation. A statistically high significant positive effect of ad libidum feeding in the first four weeks of gestation was also found by Love et al. (1993), who interpreted the obtained results with the fact that sows in the experiment were of poor condition as they lost considerable body weight during the previous lactation due to the high environmental temperature. The similar results and opinions were presented by Tokach et al. (1999), Hughes (1993) and Aherne (2007) who suggest that the amount of feed during the first three weeks of gestation should be increased to 3-3.5 kg for sows of poorer condition.

In accordance with the above mentioned the objective of this investigation was to establish the effect of the increased feed intake during the first three days in the first month of gestation on the farrowing results of sows and at the outset of oestrus after weaning.

### MATERIAL AND METHOD

The investigation comprised 300 inseminated gilts and sows which were divided into three groups immediately after the insemination according to the farrowing parity. The first group were fed with 2 kg of feed a day and in the second group the amount of feed was increased to 3.2 kg. In group III sows were fed with 2 kg of feed during the first three days and afterwards the feed intake was increased to 3.2 kg. After the first month of gestation all the sows in the experiment were fed with 2 kg of feed a day till the end of gestation i.e. till the transfer to the farrowing shed.

As criteria for the assessment of the effect of feed intake at the early stage of gestation the results of the sow farrowing were used: the weight of litter and piglets at farrowing and piglets in litter. These results were registered separately for the first litter sows as well as for older sows. The obtained results were dealt with by the variance analysis method and the differences tested by t-test. Besides, after the weaning of piglets, the length of the weaning-oestrus interval in certain groups of sows as well as for the first litter and older sows was registered and statistically presented.

Table 1. Composition of the experimental diets and daily feed consumption

Groups		I	II	III
Feed,kg/day	first 3 days	2	3,2	2
	first month	2	3,2	3,2
Corn		77,40		
Soybean meal		19,00		
Salt		0,50		
Dicalcium phosphate		1,40		
Limestone		0,70		
Premix		1,00		
Total, %		100,00		

Crude protein, %	13,91
Calcium,%	0,78
Phosphorus,%	0,52

## RESULTS

The amount of feed during the first stage of gestation had an effect on the litter size (Table 2). In the nutrition of first litter sows the increase in the amount of feed during the first month of gestation resulted in a statistically significant increase in litter size. In the control group, which were fed with 2 kg of feed a day the litter size was 8.17 and in the groups in which the amount of feed was increased to 3.2 kg the litter was statistically significantly bigger and it was 9.24 in group II and 9.48 piglets in group III.

With the increase in litter size in groups II and III the average body weight of piglets was decreased from 1.64 kg in control group I to 1.44 and 1.48 kg in groups II and III respectively.

In the nutrition of older sows the increase in the amount of feed in early gestation brought about a statistically accounted for decrease in litter size (Table 2). In group I which were fed with 2 kg of feed the litter size was 10.82 piglets, whereas in groups II and III in which the amount of feed was increased to 3.2 kg the number of piglets per litter was 10.35 and 10.31 respectively. The established differences were statistically highly significant.

The amount of feed in the first three days directly after the fertilization did not affect the litter size as the difference in the number of piglets per litter between groups II and III was not statistically accounted for.

Table 2. Effect of feeding level in the early gestation on piglets per litters

Groups		I	II	III
Feed,kg/day	first 3 days	2	3.2	2
	first month	2	3.2	3.2
<b>First litter sows</b>				
Average litter weight, kg		13.19	13.06	13.97
Index,%		100.00	99.01	105.91
Piglets per litter		8.17 <sup>a</sup>	9.24 <sup>ab</sup>	9.48 <sup>b</sup>
Index,%		100.00	113.10	116.03
Average piglets weight,kg		1,64	1,44	1,48
Index,%		100,00	87,55	91,33
<b>Adult sows</b>				
Average litter weight, kg		16.43	15.97	15.41
Index,%		100.00	97.20	93.79
Piglets per litter		10.82 <sup>A</sup>	10.35 <sup>B</sup>	10.31 <sup>B</sup>
Index,%		100.00	95.66	95.29
Average piglets weight,kg		1,52	1,54	1,49
Index,%		100,00	101,58	98,48

*A-B visoko signifikantno (P<0.01); a-b signifikantno (P<0.05)*

A-B highly significant (P<0.01) ; a-significant (P<0.05)

Table 3. Effect of litter size on the length of weaning-oestrus period

Groups		I	II	III
Feed,kg/day	first 3 days	2	3.2	2
	first month	2	3.2	3.2
<b>First litter sows</b>				
piglets per litter		8.17 <sup>a</sup>	9.24 <sup>ab</sup>	9.48 <sup>b</sup>
weaning-oestrus interval,days		8.31	11.19	14.44
differences between groups, days		-	2,88	6,13
<b>Adult sows</b>				
piglets per litter		10.82	10.35	10.31
weaning-oestrus interval,days		8.16	7.27	7.42
differences between groups,days		-	-0,89	-0,74

The amount of feed in the first month of gestation did not affect the length of the weaning–oestrus interval in older sows. However, in first litter sows a statistically accounted for prolongation of this interval in groups II and III, which were fed with a greater amount of feed during the early gestation, was found. The reason for a delayed oestrus in first litter sows in groups II and III was probably the consequence of a significantly greater number of piglets per litter which resulted in heavy burden on sows in lactation for milk secretion in these groups.

## DISCUSSION

The increase in the amount of feed to 3.2 kg a day in the early gestation in this study resulted in a statistically significant increase in the litter size in first litter sows. The positive effect of higher feeding level in gestating gilts at the first stage is probably the result of the still intensive development i.e. protein synthesis so that there is no surplus energy in metabolism which can negatively affect the embryo survival. This is supported by the studies of Jakovljević (2008) and Radović et al (2008) who stated that with aging in gilt fertilization i.e. with body weight increase at the end of the performance test the litter size was increased as well. However in older sows the effect of a greater amount of feed at the early stage of gestation is smaller but in spite of it, a greater amount of feed affected a statistically accounted for decrease in litter size. In literature there are also various results concerning the greater amount of food in early lactation. In the studies of Kirkwood et al.(1990) and Love et al. (1993) in which the increase in the amount of feed to 3.6 kg i.e. ad libitum feeding in the first month of gestation resulted in the increase of litter size, whereas in the studies of Den Hartog & Van Kempen (1980), Ashworth (1990), Jindal et al. (1996) and Carlson (2002) a smaller amount of feed in the first month resulted in the decrease in embryo mortality. Due to the differences established in certain studies Tokach et al. (1999), Hughes (1993) and Aherne (2007) suggest that the amount of feed in the first month of gestation should be determined based on the sow condition.

## CONCLUSION

With the aim of establishing the effect of the amount of feed at the early stage of gestation an experiment was carried out comprising 300 first litter and older sows divided into three groups. The first group were fed with 2 kg of feed throughout the whole experiment while the second group consumed 3.2 kg of feed during the first month. In group III the amount of feed in the first three days was 2 kg and then it was 3.2 kg till the end of the first month. At the later stage of gestation all the sows were fed with 2 kg of feed a day. Based on such an experiment the following conclusions can be drawn:

- In first litter sows the increase in the amount of feed at the early stage of gestation resulted in a statistically significant increase in litter size. In the first control group the litter size was 8.17 piglets and in groups II and III which were fed the increased amount of feed in the early gestation the litter was 9.24 and 9.48 piglets respectively.
- A greater amount of feed in the early gestation resulted in the decrease of litter in older sows from 10.82 piglets in the control group I to 10.35 in group II and 10.31 in group III.
- The weaning-oestrus interval did not differ in older sows whereas in first litter sows this interval was longer in the groups which were fed with the increased amount of feed at the early stage of gestation and which reared a significantly greater number of piglets per litter.

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## UTICAJ ISHRANE KRMAČA U PRVOJ FAZI SUPRASNOSTI NA VELIČINU LEGLA

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### Izvod

U ogledu je ispitivan uticaj 2 i 3,2 kg hrane dnevno u prvom mesecu suprasnosti na rezultate prašenja krmača. U ogled je uključeno 300 osemenjenih nazimica i krmača podeljenih u 3 grupe. Veća količina hrane u prvom mesecu suprasnosti nazimica dovela je do signifikantnog povećanja veličine legla od 8,17 prasadi u I kontrolnoj grupi, koja je konzumirala 2 kg hrane na 9,24 i 9,48 u II i III grupi, koje su hranjene sa 3,2 kg hrane dnevno. Kod krmača veća količina hrane u ranoj suprasnosti je uticala na signifikantno smanjenje legla od 10,82 u I grupi na 10,35 u II i 10,31 prase u III grupi.

**Ključne reči:** Količina hrane, suprasna krmača, nazimica, veličina legla.

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## ANATOMICAL AND HISTOLOGICAL CHARACTERISTICS IN EARLY PUERPERIUM AND ESTRUS OF SWEDISH LANDRACE AND GREAT WHITE (YORKSHIRE) CROSS-BREDS UTERUS

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*SUMMARY: Anatomical and histological researches of uteruses were conducted on 35 female pigs in early puerperium and estrus. The female pigs were hybrids between Swedish Landrace and Yorkshire Swine (Large White). In order to obtain real view on the process of involution in early puerperium and estrous animals were sacrificed between first and twenty eighth day post partum. In the early puerperium and estrous it is established that anatomical and histological characteristics of swine's uteruses are variable. Width changes on the uterus horns were determined in the estrous and puerperium. Macroscopic and microscopic changes of female pig's genital organs were just like those we can find in female pigs during lactation period. Possibilities of early weaning were confirmed by examination of histological changes on the female pig's uterus during involution at the estrus and puerperium.*

**Key words:** *uterus, female pigs, puerperium, estrus.*

### INTRODUCTION

Mammalians need to have involuted reproductive system completely especially ovaries and uterus in order to establish a novel gestation. Histological and anatomical alterations of uterus after partus are considered as involution. Examination of involution process in uterus and changes in ovaries are mostly investigated on cows (2, 4, 8, 9, 19, 20, and 25). For better understanding of involution process, ultrasound is also used (21). Lots of useful data concerning better conception and shortened calving period is obtained by ultrasound. On the other hand, involution process in the pig's uterus is less

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investigated. Some authors (22, 23) claim that pigs have uterus of normal dimensions 3-4 weeks after partus, while uterus has pregestation weight and length after 3 weeks. Development of uterus epithelium is not recorded until an ablactating is carried out. Experiment of hastened involution and consequently early estrous introduction in pigs is partially done by ablactating (15, 16, 17) and changing antibiotics. Using ultrasound useful data are obtained considering the estrous and ovaries status (12). Localization of laminin and collagen IV as a factor of rat's (26) and mouse's (1) uterus involution after partus are investigated by some other authors. Similar examination with pigs (18) referring to laminin and collagen provide conclusion that the involution of uterus is prolonged during the lactation. Swine's uterus 31 days after partus is the same as 20 days after partus.

The goal of this paper is to consider histological alteration in the swine's uterus during the puerperal period and estrous in order to improve conception and shortening the lactation period.

## **MATERIALS AND METHODS**

Genital organs are taken after the pigs were sacrificed. Pigs were cross-breds (Swedish Landrace and Yorkshire Large White). They were sacrificed during the lactation period and estrous. Samples of uterus tissue were sorted in groups according to day of sacrificing. Five groups were made: 1-3, 5-7, 10-13, 16-19 and 21-28 day post partum. All animals were also in estrous. Histological appearance of uterus was described and uterine horns were measured by micrometer. After measurement was done samples of uterus wall were taken and fixed in the Buen solution. Samples were held in fixative for 15 days and after fixation they were kept in 5% formalin until molding with paraffine. Molded samples were sliced in several cuts. Cut's thickness was approximately 5 – 6  $\mu\text{m}$ . There were made 36 histological slides and one half was stained with eosin and another half was stained using the Heidenheim method. Tissue samples stained using these two techniques are good for examination of histological structure. In the end of the process the slides were covered with cover slips. Cover slips were glued to the slides using the Canada balsam. Examination of histological slides is conducted using the light microscope. The following magnifications were used: 100x, 200x, and under the magnification of 400x only interested area were examined. During the histological examination under magnification of 400x some measurements were also done, therefore microscopic factor is calculated and its value was 2,32. In order to obtain histological view of slides respectively as well as descriptive appearance, slides were examined in general. Condition of endometrial epithelia and epithelia of uterine gland were examined as well as myometrium status in order to observe process of involution. The following measurements were done: endometrial epithelia height, uterine gland cells height. During the histological examination interesting details were photographed.

## RESULTS

Minimal thickness is recorded in the period from 16th to 19th day post partum and results are showed in the Table 1. Maximal thickness is recorded in the period from 1st to 3rd day post partum. Histological examination and measurements show minimal height of endometrial epithelia in the period from 1st to 3rd day post partum, and results are presented in the Table 2. Maximal height of endometrial epithelia is recorded in the period of estrous as we can see on Picture 1 and Picture 2.

Table 1. Thickness of uterine horn / mm

*Tabela 1. Debljina roga uterususa / mm*

Debljina uterusnog roga <i>Thickness of uterine horn mm</i>								
<i>Days p.p</i>	<i>Measure</i>	n	x	S $\xi$	S	S%	<i>Minimum</i>	<i>Maximum</i>
1. - 3.	<i>Thickness</i>	6	40.333	4.944	12.110	30.025	20	50
5. - 7.	<i>Thickness</i>	6	34.333	1.453	3.559	10.366	30	40
10. - 13.	<i>Thickness</i>	6	22.333	1.453	3.559	15.936	17	26
16. - 19.	<i>Thickness</i>	6	20.500	2.125	5.205	25.390	14	26
21. - 28.	<i>Thickness</i>	8	18.750	0.674	1.908	10.176	16	21
Estrous	<i>Thickness</i>	4	19.250	1.796	3.593	18.644	16	24

Table 2 Height of endometrial epithelium

*Tabela 2. Visina epitela endometriuma*

<i>Height of endometrial epithelium/<math>\mu</math>, days p.p.</i>						
<i>Dan Days</i>	1 – 3	5 – 7	10 – 13	16 – 19	21 – 28	<i>Estrous</i>
x	9.50	20.88	23.93	23.77	26.89	30.17
Sx	0.12	0.17	0.22	0.07	0.15	0.19
S	2.69	3.71	5.51	1.59	4.16	3.82
S%	9.26	13.92	20.88	4.64	13.92	16.24
<i>Minimum</i>	4.64	13.92	13.92	20.88	18.56	20.88
<i>Maximum</i>	13.90	27.84	34.80	25.52	32.48	37.12
n	500	500	600	500	800	400

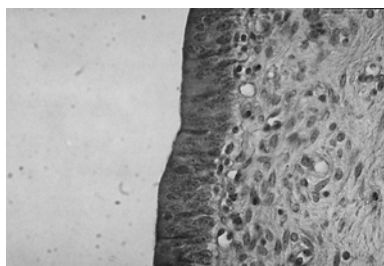
Minimal height of uterine glands epithelium is recorded in the period from 21st to 28th day post partum and estrous, Table 3, while maximal was recorded from 5th to 7th day post partum, Picture 3 and Picture 4.

Table 3 High of epithelium of uterine glands

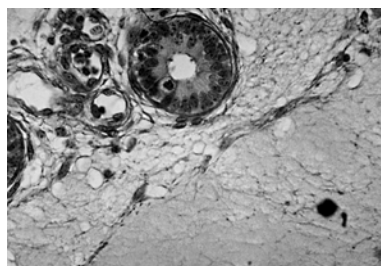
*Tabela 3. Visina epitela uterusnih žlezda*

<i>High of epithelium of uterine glands/days post partum</i>						
<i>Days</i>	1–3	5–7	10-13	16–19	21–28	<i>Estrus / Estrous</i>
X	14.82	18.88	17.59	13.34	14.14	13.67
Sx	0.08	0.15	0.14	0.07	0.09	0.12

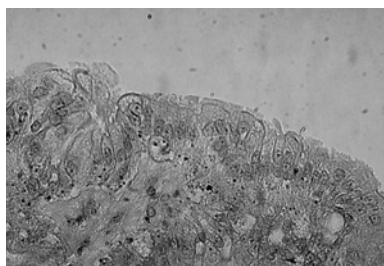
S	1.94	3.69	3.43	1.67	2.68	2.48
S%	6.96	13.92	16.24	4.64	9.28	9.28
<i>Minimum</i>	11.60	13.92	11.60	11.60	9.28	9.28
<i>Maximum</i>	18.56	27.84	27.84	16.24	18.56	18.56
n	600	600	600	500	800	400



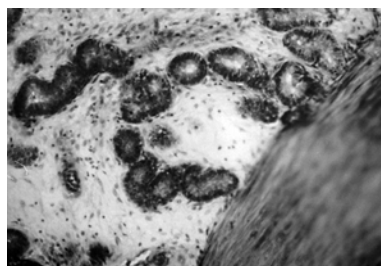
Picture 1. Epithelium of uterus, 1.day post partum  
*Slika 1. Epitel uterusa, 1. dan post partum*



Picture 3. Uterine glands, 24.days post partum  
*Slika 3. Uterusne žlezde, 24. dana post partum*



Picture 2. Epithelium of uterus-period of estrus  
*Slika 2. Epitel uterusa-estrus*



Picture 4. Uterine glands, 7.days post partum  
*Slika 4. Uterusne žlezde, 7. dan post partum*

## DISCUSION

During the puerperium and ovary cycle all processes are very important for normal swine reproduction. Physiological involution of uterus after farrowing ensures optimal efficiency of reproduction potential. According to this, it is very important to establish the end of uterus involution. Uterine horns thickness is measured in the period from 1st to 28th day of lactation and estrous. Thickness of uterine horns was reduced until 7th day post partum. Horn's reducing after 10th day were insignificantly, while during the estrous slightly increasing of thickness was recorded. The other authors' findings correspond with ours Palmera (22) i Heraka (7). Histological examination of swine uterus indicates that the endometrium is highly edematous. Epithelium is proportionally lower with significant degenerative alterations, Kudlača (10.). Epithelium height of uterine glands was significant. Epithelia have pseudo stratified structure from 7th to 9th day post partum. Cells become larger; numerous sub epithelial neutrophil granulocytes

penetrate to lumen of uterus. Uterine glands are not significantly changed. In the period from 16th to 19th day normal appearance of uterus corresponds to uterus in late puerperal period (7, 3, 13, and 22)

## CONCLUSIONS

Analyzing obtained data follow conclusions were made:

1. Minimal uterine horns thickness was recorded in the period from 16 to 19 day post partum, and maximal uterine horn thickness was recorded from 1 to 3 day post partum.
2. Minimal height of endometrial epithelia was recorded in the period from 1 to 3 day post partum, while maximal height in the period of estrous.
3. Minimal height of uterine gland epithelia was recorded in the period from 21 to 28 day post partum and in the estrous, and maximal in the period from 5 to 7 day post partum.

According to the results of examination the weaning was recommended 17 days post partum. This will not have any harmful consequences on the swine reproductive ability.

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# ANATOMSKE I HISTOLOŠKE KARAKTERISTIKE MATERNICE SVINJA KRIŽANACA ŠVEDSKOG LANDRASA I VELIKOG JORKŠIRA U RANOM PUERPERIJU I ESTRUSU

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## Izvod

Istraživanja anatomskih i histoloških karakteristika maternice svinja u ranom puerperiju i u estrusu vršena su kod 35 nazimica (prvopraskinja) križanaca švedskog landrasa i velikog jorkšira (ŠLxVJ). Da bi se što vjerodostojnije sagledao tok promjena na maternici kod krmača u ranom puerperiju i u estrusu, životinje su žrtvovane u dojnem periodu (puerperij) od prvog do dvadeset osmog dana post partuma i u estrusu. Konstatovano je da anatomske i histološke karakteristike maternice svinja variraju u periodu ranog puerperija i estrusa. Na uterusu su konstatovane promjene koje su se iskazale u promjeni širine uterušnog roga u ispitivanim periodima. Makroskopske i mikroskopske promjene spolnih organa krmača za vrijeme puerperija su bile tipične za plotkinje koje doje prasadi. Proučavanjem histoloških promjena na maternici svinja tokom involucije u dojnom i estrusnom periodu potvrđene su mogućnosti ranijeg zalučenja prasadi, a time i povećanja obrta stada.

**Ključne reči:** maternica, krmača, puerperij, estrus.

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## VEGETATION OF THE CLASSES *HYDROCHARI-LEMNETEA* OBERD. 1967 AND *POTAMETEA* TX. ET PRSG. 1942 IN THE CANAL BAČKI PETROVAC-KARAVUKOVO\*

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*SUMMARY: The canal "Bački Petrovac-Karavukovo" is a part of the main canal network of the Hydrosystem Danube-Tisza-Danube (MCN Hs DTD) in the Bačka. The vegetation comprises aquatic associations of the classes Hydrochari-Lemnetea Oberd. 1967 and Potametea Tx. et Prsg. 1942. The class Hydrochari-Lemnetea Oberd. 1967 includes the following phytocoenoses: Lemno-Spirodeletum W. Koch 1954, Müller et Görs 1960, Salvinio-Spirodeletum polyrrhizae Slavnić 1956, Ceratophylletum demersi (Soó 27) Hild. 1956 i Hydrocharidetum morsus-ranae Van Langendonck 1935. The class Potametea Tx. et Prsg. 1942 includes the associations Ceratophyllo demersi-Vallisnerietum spiralis Lazić 2006, Nymphaetum albo-luteae Nowinski 1928 subass. nupharetosum (Timár 54) Karpati 61 i Trapetum natantis Müller et Görs 1960. Vegetation diversity of this antropogenic ecosystem is conditioned with slow flow, controlled water regime and diferent depth of some sections.*

**Key words:** *Hydrosystem Danube-Tisza-Danube (Hs DTD), canal "Bački Petrovac-Karavukovo", aquatic vegetation, Hydrochari-Lemnetea class, Potametea class.*

### INTRODUCTION

The canal Bački Petrovac-Karavukovo is a part of the main canal network of the Danube-Tisza-Danube Hydrosystem (MCN Hs DTD) and it is located in the region of Bačka. It starts from the weir near Bački Petrovac (end of the canal Novi Sad-Savino

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Selo - km 21+210) and, after a 52-km run, it ends with the weir Karavukovo (start of the canal Bečej-Bogojevo - km 84+050). The studied ecosystem receives water indirectly from the canal Bečej-Bogojevo, via the weir at Karavukovo. In the stretch from Karavukovo to Bač, the canal is less than 2.5 m deep, and the depth increases somewhat downstream from Bač. The width of the vegetation-free surface along the entire course of the canal is about 35 m. The canal is navigable for small crafts (up to 500 t) and it has a slower water flow than the other canals of the MCN Hs DTD. Major users of canal water are “Mostonga” fishpond in Bač and several irrigation systems.

Based on the concept of sustainable development and ecosystem protection and cost-efficient utilization, detailed studies of aquatic vegetation contribute, in the first place, to the maintenance of species and ecosystem biodiversity in swamp, marsh and bog biotopes. With these concepts in mind, we have defined as the objective of this study to analyze aquatic phytocoenoses of the classes *Hydrochari-Lemnetea* and *Potametea* that had been identified in the canal Bački Petrovac-Karavukovo.

## MATERIAL AND METHODS

The phytocoenological studies were conducted according to the principles of the Zurich-Montpellier School (Braun-Blanquet, 1964). The syntaxonomic review of the studied vegetation was done according to Soó (1964-1980). Plant determination was done according to the publications »Flora of SR Serbia, I-IX« (Josifović, ed. 1970-1977) and »Flora Europeae, I-V» (Tutin et al., 1964-1980 I-V).

## RESULTS AND DISCUSSION

Syntaxonomic review of the associations of classis *Hydrochari-Lemnetea* and *Potametea* in canal “Bački Petrovac-Karavukovo” is (Lazić, 2006; Stojanović i sar., 2007):

### **Klasa HYDROCHARI-LEMNETEA Oberd. 1967**

Red *Hydrocharietalia* Rübél 1933

Sveza *Lemnion minoris* W. Koch et Tx. ex Oberd 1957

Ass. *Lemno-Spirodeletum* W. Koch 1954, Müller et Görs 1960

Ass. *Salvinio-Spirodeletum polyrrhizae* Slavnić 1956

Sveza *Ceratophyllion* Den Hartog et Segal 1964

Ass. *Ceratophylletum demersi* (Soó 27) Hild. 1956

Sveza *Hydrocharition* Rübél 1933

Ass. *Hydrocharidetum morsus-ranae* Van Langendonck 1935

### **Klasa POTAMETEA Tx. et Prsg. 1942**

Red *Potametalia* W. Koch 1926

Sveza *Potamion* W. Koch 1926 emend. Oberd. 1957

Ass. *Ceratophyllo demersi-Vallisnerietum spiralis* Lazić 2006

Sveza *Nymphaeion* Oberd. 1956

Ass. *Nymphaeetum albo-luteae* Nowinski 1928 subass.

*nupharetosum* (Timár 54) Karpati 61

Ass. *Trapetum natantis* Müller et Görs 1960



### 1. Association *Lemno-Spirodeletum*

Floating stands of the association *Lemno-Spirodeletum* grow in the middle and lower sections of the canal Bački Petrovac-Karavukovo, near the villages of Bač, Tovariševo, Obrovac, Nova Gajdobra and Bački Petrovac. In all of these locations these stands form narrow belts along the stands of emergent associations *Scirpo-Phragmitetum*, *Glycerietum maximae*, *Typhetum angustifoliae* and *Typhetum latifoliae* or they spread into empty spots inside the stands of the latter associations. The thick floating layer in the observed stands has been formed, in addition to the dominant species *Spirodela polyrrhiza* and *Lemna minor*, by *Salvinia natans*, *Hydrocharis morsus-ranae* and *Trapa natans*, the characteristic species of the class *Hydrocharietalia*. The sparse submerged layer consists entirely of the species *Ceratophyllum demersum* and *Vallisneria spiralis*.

### 2. Association *Salvinio-Spirodeletum polyrrhizae*

Floating stands of the association *Salvinio-Spirodeletum polyrrhizae* were observed in the canal Bački Petrovac-Karavukovo in the vicinity of the villages Deronja and Obrovac, in the section from Gajdobra to Čelarevo and in the vicinity of Bač. The stands form small floating islands in the middle of the vegetation-free surface, next to floating stands of the associations *Hydrocharidetum morsus-ranae* and *Trapetum natantis* or next to emergent stands of the phytocoenoses *Scirpo-Phragmitetum*, *Glycerietum maximae* and *Typhetum angustifoliae*. Because of controlled water regime in the studied water body, the observed phytocoenoses have a limited distribution. Otherwise, they are fairly frequent in the aquatic ecosystems in the Vojvodina Province (Stojanović et al., 1994).

The floating layer of the observed stands included *Salvinia natans* and *Spirodela polyrrhiza*, the characteristic species of this association, as well as the species *Hydrocharis morsus-ranae* and *Lemna minor*. The stands' dense submerged layer is formed by the species *Najas marina*, *Elodea canadensis*, *Ceratophyllum demersum* and *Myriophyllum spicatum*.

### 3. Association *Ceratophylletum demersi*

Submerged stands of the phytocoenosis *Ceratophylletum demersi* were seen in the central section of the canal Bački Petrovac-Karavukovo, i.e., near Bač, Obrovac, in the section Gajdobra – Čelarevo, and near Deronje and Tovariševo. The stands form islands or belts 2-3m wide, making the last vegetated part towards the median, deepest parts of the canal. These stands are frequently conterminous with submerged stands of the association *Ceratophyllo demersi-Vallisnerietum spiralis* and floating stands of the association *Trapetum natantis*, and they seldom grow adjacent to the emergent stands of the associations *Glycerietum maximae* and *Scirpo-Phragmitetum*.

In deep waters, stands of this association typically form only the submerged layer predominated by the species *Ceratophyllum demersum* (Džigurski et al., 2009). In shallow waters, the submerged and the floating layers are clearly differentiated. The submerged layer is formed by the species *Ceratophyllum demersum* and *Najas marina*, the floating by *Hydrocharis morsus-ranae*, *Spirodela polyrrhiza*, *Lemna minor*, *L. gibba* and *Trapa natans*.

### 4. Association *Hydrocharidetum morsus-ranae*

Floating stands of the association *Hydrocharidetum morsus-ranae* were observed in slow-moving, shallow and warm waters of the canal Bački Petrovac-Karavukovo in the

vicinity of Karavukovo, Deronje, Bač, in the section Bač – Tovariševo, near Tovariševo, Obrovac, Nova Gajdobra, in the section Gajdobra – Čelarevo, near Bački Petrovac and in the section Bački Petrovac – Kisač. Typically they form islands 2-5 m in diameter. Towards the middle of the water body, the stands of the analyzed phytocoenosis grow adjacent to submerged stands of the associations *Ceratophyllo demersi-Vallisnerietum spiralis* and *Ceratophylletum demersi* and floating stands of the association *Trapetum natantis*. Towards the bank, the stands are conterminous with emergent stands of the associations *Scirpo-Phragmitetum*, *Typhetum angustifoliae* and *Typhetum latifoliae*.

The floating layer of the observed stands comprises, in addition to *Hydrocharis morsus-ranae* which is the dominant species, the species *Spirodela polyrrhiza*, *Salvinia natans*, *Lemna minor* and *Trapa natans*. The well-developed submerged layer is constituted of the species *Ceratophyllum demersum* and *Vallisneria spiralis*.

### **5. Association *Ceratophyllo demersi-Vallisnerietum spiralis***

Submerged stands of the association *Ceratophyllo demersi-Vallisnerietum spiralis* were registered in the upper section of the canal Bački Petrovac-Karavukovo, near Karavukovo and Deronje. They are most frequent in the sections with slanting and well-kept banks free of the emergent vegetation and without submerged or floating layers in the water near the banks. In rare cases, stands of this association form between submerged stands of the association *Ceratophylletum demersi*, which occupy median parts of the canal, and floating stands of the associations *Nymphaeetum albo-luteae* subass. *nupharetosum*, *Hydrocharidetum morsus-ranae* and *Trapetum natantis*, which grow towards the banks. The width of the observed stands of the association *Ceratophyllo demersi-Vallisnerietum spiralis* is 5-6 m, and their length is several dozens of meters.

The stands of this phytocoenosis are quite poor from the floristic standpoint. The profuse submerged layer is formed by the dominant species *Vallisneria spiralis* and *Ceratophyllum demersum*, while the floating layer, featuring minimum species number and coverage, is formed by the species *Hydrocharis morsus-ranae* and *Salvinia natans*.

### **6. Association *Nymphaeetum albo-luteae* subass. *nupharetosum***

Floating stands of the association *Nymphaeetum albo-luteae* subass. *nupharetosum* were found on a limited area in the canal Bački Petrovac-Karavukovo, in the vicinity of Karavukovo. Towards the median part of the canal, they grow adjacent to submerged stands of the association *Ceratophyllo demersi-Vallisnerietum spiralis*, and towards the banks they border with emergent stands of the association *Typhetum angustifoliae*.

The stands of this association typically have a two-layer structure. The layer of floating plants is formed by the dominant species *Nuphar luteum* and *Trapa natans*, the characteristic species of the alliance *Nymphaeion*. In situations when *Nuphar luteum* and *Trapa natans* compete for light, the spatterdock has a biological advantage in the early phases of their development, limiting the growth of the water chestnut, and even causing its extinction (Blaženčić, 2005). This is why *Trapa natans* exhibited minimum numbers and coverage in the observed stands. It also explains why stands of the association *Trapetum natantis*, which are well-represented along the whole length of the canal Bački Petrovac-Karavukovo, are absent in the location of Karavukovo. The submerged layer is formed by the species *Ceratophyllum demersum* and *Vallisneria spiralis*. These species are adapted to the conditions of limited light caused by large floating leaves of the dominant species *Nuphar luteum* (Lazić et al., 2005).

## 7. Association *Trapa natantis*

Floating stands of the association *Trapa natantis* are the dominant vegetation element in the plant cover of the canal Bački Petrovac-Karavukovo. They overgrow the canal in the vicinity of Bač, Tovariševo, Nova Gajdobra, in the section Bački Petrovac – Kisač and near Bački Petrovac. In deep waters, where they do not compete with other floating species, these stands form luxuriant belts which are several meters wide and several hundreds of meters long. In shallow waters, they form belts of floating vegetation together with stands of the associations *Hydrocharidetum morsus-ranae* and *Salvinio-Spirodeletum polyrrhizae*. In addition to the stands of the previously mentioned floating associations, stands of the association *Trapa natantis* also grow adjacent to submerged stands of the associations *Ceratophylletum demersi* and *Ceratophyllo demersi-Vallisnerietum spiralis* and emergent stands of the ass. *Scirpo-Phragmitetum*, *Typhetum angustifoliae* and *Typhetum latifoliae*.

The stands of this association have a two-layer structure. The floating layer is formed by the dominant species *Trapa natans*, whose large leaves permit the development of the species *Hydrocharis morsus-ranae* and sporadically the species *Spirodela polyrrhiza*, *Lemna minor* and *Salvinia natans*. Because of the dense floating layer, the submerged layer is considerably less developed and it is formed by the species *Ceratophyllum demersum*, *Myriophyllum spicatum*, *Vallisneria spiralis* and *Elodea canadensis*.

## CONCLUSION

The canal Bački Petrovac-Karavukovo is a section of the MCN Hs DTD and it runs through the region of Bačka. It starts from the weir near Bački Petrovac (end of the canal Novi Sad-Savino Selo) and it ends at the weir near Karavukovo (the start of the canal Bečej-Bogojevo). Its length is 52 km.

The vegetation comprises aquatic associations of the classes *Hydrochari-Lemnetea* and *Potametea*. The class *Hydrochari-Lemnetea* includes the following phytocoenoses: *Lemno-Spirodeletum*, *Salvinio-Spirodeletum polyrrhizae*, *Ceratophylletum demersi* and *Hydrocharidetum morsus-ranae*. The class *Potametea* includes the associations *Ceratophyllo demersi-Vallisnerietum spiralis*, *Nymphaeetum albo-luteae* subass. *nupharetosum* and *Trapa natantis*. Vegetation diversity of this antropogenic ecosystem is conditioned with slow flow, controlled water regime and diferent depth of some sections.

Monitoring of natural components growing in antropogenic aquatic ecosystems is not only an obligation ensuing from conventions on biological biodiversity preservation and evaluation of environmental resources, but also an effective tool for selecting methods and measures of control of excessive growth of vegetation, which may threaten to overgrow and impede the use of man-made waterways.

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## **VEGETACIJA KLASA *HYDROCHARI-LEMNETEA* OBERD. 1967 I *POTAMETEA* TX. ET PRSG. 1942 U KANALU “BAČKI PETROVAC-KARAVUKOVO”**

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### **Izvod**

Kanal “Bački Petrovac-Karavukovo” je kanal OKM Hs DTD u Bačkoj. Duž njegovog toka konstatovane su akvatične zajednice klasa *Hydrochari-Lemnetea* i *Potametea*. Iz klase *Hydrochari-Lemnetea* razvijene su sastojine fitocenoza: *Lemno-Spirodeletum*, *Salvinio-Spirodeletum polyrrhizae*, *Ceratophylletum demersi* i *Hydrocharidetum morsus-ranae*. Iz klase *Potametea* razvijene su sastojine asocijacija: *Ceratophyllo demersi-Vallisnerietum spiralis*, *Nymphaeetum albo-luteae* subass. *nupharetosum* i *Trapetum natantis*. Vegetacijsku raznolikost ovog antropogenog ekosistema uslovljava: slaba protočnost, dirigovani vodni režim i različita dubina pojedinih deonica.

**Ključne reči:** Hidrosistem Dunav-Tisa-Dunav (Hs DTD), kanal “Bački Petrovac-Karavukovo”, akvatična vegetacija, klasa *Hydrochari-Lemnetea*, klasa *Potametea*.

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## MOLECULAR EVOLUTION OF NEWCASTLE DISEASE VIRUS IN UKRAINE

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*SUMMARY: Represented study is devoted to analysis of variability of F gene of Newcastle disease virus. 15 Newcastle disease virus (NDV) isolates were compared by F0-protein gene structure. There were recognized 3 sequences variants of viruses in accordance with study of 345 bp amplicones of F-gene variable loci. Strong level of relations of domestic poultry and wild birds' isolates were shown. The intraspecies migration of virus was founded from poultry to wild birds and back to poultry in the period of 12 years.*

**Key words:** *isolates, molecular evolution, Newcastle disease, phylogenetics, sequencing*

### INTRODUCTION

Newcastle disease is wide distributed disease of wild and domestic birds, caused by avian paramyxovirus type 1. O.I.E. data promote information, that during last 20 years this disease was registered in different countries of all continents of Earth (Leslie 2000; O.I.E. 2008).

First communication about this disease was done in 1926, and since that time disease became pandemic in poultry. Causative agent of disease represents 1strained RNA-contained virus, which that belongs to genus *Avulavirus* from subfamily Paramyxovirinae, family Paramyxoviridae (Saif, 2002, Roussa, 2008; Bagalli-Pordany, 2008).

ND diagnostics measures contain couple of serological, virological and molecular-genetics tests. Classical indication scheme consists in following embryonic isolation of virus the identification of agent by serological and molecular techniques (Bagalli-Pordany, 2008).

Very important step in identification procedure is collection of data about molecu-

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lar characterization of isolate. As a first step it is necessary to determine viral authentic origin. It is possible to do with classical or real-time PCR protocols described in specific literature (Kim, 2007; Qin, 2008; Tsai, 2004).

The next step of viral typing consists in pathotype determination. This procedure can be applied by different techniques. Most wide used of them are RFLP-typing and partial sequences of NP and F gene (Mohan, 2006, Yang, 1997).

But the most informative method of viral genomes study is comparison of viral RNA sequences in different kinds of phylogeny study. It gives possibility to understand mechanisms of viral variability and evolution in nature. From the practical point of view it gives information about circulating geno- and pathotype in wild nature and domestic poultry. It is useful for creation of effective protection schemes and elaboration of disease eradication system after determination of source of infection.

There were described a lot of different algorithms for viral genetic typing. Classical one is Aldous E. system; in accordance with it NDVs subdivide to 6 genotypes, and several subtypes. This classification is based on phylogenic comparison of sequences from the region of cleavage site of fusion protein – hemagglutinine gene (Aldous, 2003).

This kind of virus typing is not unique. A lot of authors had described different results about virus variability study by F-gene. Non-stable partitions of this gene have high level of polymorphism and provide a lot of possibilities for molecular study of viral changes and evolution (Mohan, 2007; Weingartl, 2003; Deng, 1999; Douglas, 2007).

## MATERIAL AND METHOD OF THE STUDY

*Viruses.* The molecular relations study was provided among 15 viral isolates of NDV, allocated from domestic poultry and wild birds in a period since 1993 to 2007. The list of isolates is described below (Table 1).

*RNA-extraction and PCR-assay.* RNA was extracted from extraembryonal liquid of directly from clinical material (in case of wild birds' study, when viruses were non-cultivated). Nucleic acids were extracted by commercial kit that based on the method of affine sorption on silicate gel granules. We obtained cDNA directly from extracted RNA-samples by commercial reverse transcription kit. Amplification of specific fragments of viral cDNA was provided with primer system NDV fusion FF (5' AGG CCT CAT GCA GCT GCA GAG C 3') and RR (3' GTT GCA ACC CTA AGA GCT ACA C 5') (10 pmol), 2.5 U of Taq polymerase, 2.5 mmol of MgCl<sub>2</sub>, 2.5 mmol each dNTP, 5 µl of 5x Taq Buffer (AmplySens) in final volume of 25 µl. cDNA template were added in volume of 5 µl after 1 per 4 TE-buffer dilution. Amplification was performed under following conditions: 1 step for preliminary denaturation (5 min), 40 cycles: 30 sec of denaturation in 94 C, 40 sec of primer annealing in 62 C, and elongation in 72 C during 40 sec. The 345 bp fragment was obtained.

*Sequencing.* Samples, determined as positive in PCR were studied with sequencing. Amplicones were purified with Rapid DNA purification kit and quantified with spectrophotometry. For sequencing they were diluted to concentration of 25-50 ng/µl. Automatic sequences was done from NDV fusion primers and Big Dye terminator kit after cloning of fragments in M13 phage DNA. After sequencing chromatograms were analyzed with MEGA 3.1.

*Phylogenetic study.* Sequences of F0 gene of NDV were used for multiple alignment and phylogenetic tree construction. Phylogenetic trees were constructed by Neighbor Joining and Minimum Evolution algorithms. Pair distance was determined by Kimura algorithm. All phylogeny trees buildings and analyses were done with modules of MEGA 3.1. software.

## RESULTS AND DISCUSSION

As the first step of our study viral authentic origin was determined by PCR assay of analyzed samples. Both of them were determined as NDVs: 7 – from chicken origin and 8 – from wild birds' origin (Table 1).

Table 1. NDV strains, used in this study

*Tabela 1. Sojevi NDV korišćene u ovom istraživanju*

	Isolate name	Source of isolation	Amplicone concentration
1.	Ch/Lubotyn/2003	Chicken	48,6
2.	Muscovy duck/Ukraine/2005	Muscovy duck	72,2
3.	Ch/Borky/2003	Chicken	44,5
4.	Ch/Lypova dolyna/2003	Chicken	43,2
5.	NDV/Dnipro/2007	Pigeon	44,8
6.	Ch/Kharkiv/2007	Chicken	52,1
7.	Ch/Taranivka/93	Chicken	66,5
8.	Ch/Korobovka/93	Chicken	72,3
9.	Ch/PMV/93	Chicken	70,8
10.	WB/Ukraine/9/2006	Wild waterfowl	71,1
11.	WB/Ukraine/11/2006	Wild waterfowl	35,6
12.	WB/Ukraine/23/2006	Wild waterfowl	49,2
13.	WB/Ukraine/20/2006	Wild waterfowl	45,5
14.	WB/Ukraine/22/2006	Wild waterfowl	46,7
15.	WB/Ukraine/19/2006	Wild waterfowl	72,3

DNA-analysis of obtained sequences was shown, that both sequences contain 280-290 bp fragments of NDV, which are specific in comparison with LaSota and Belgium strains, already published in GeneBank. Specific mismatches were observed in analyzed fragments of nucleic acids (Figure 1).

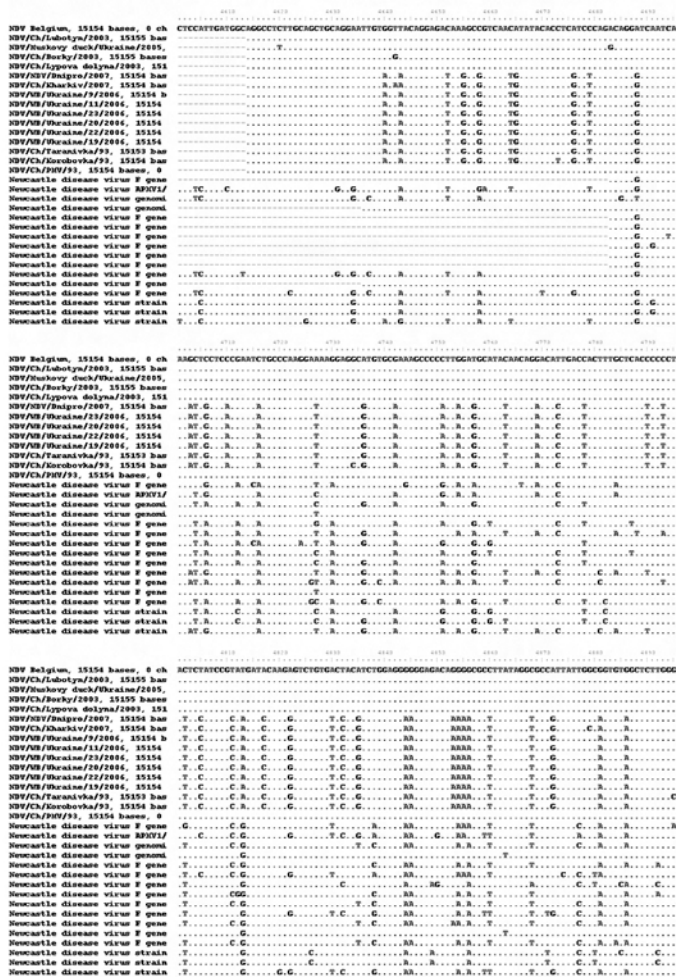


Figure 1. Comparative multiple alignment of the sequenced F-gene fragments of Ukrainian NDV isolates

Figura 1. Komparativna višestruka poravnanja sekvenciranih delova gena F ukrajinskih NDV izolata

Multiple alignments of cDNA samples gave a possibility to recognize two different types of sequence. First group, included five isolates have shown strong homology with Belgian strain, allocated in 2004. We observed different levels of homology with this matrix strain in sequences from analyzed group. From 0 to 2 mismatches were registered in examined F-gene partition in compare with plot matrix (full-length genome of Belgian strain). We had observed, that NDV isolates Ch/Lubotyń/2003, Muscovy duck/Ukraine/2005, Ch/Borky/2003, Ch/Lypova dolyna/2003 and Ch/PMV/93 belonged to this first group.

All others isolates belong to else big group of viruses. Their F-gene partial se-



quences have shown large volume of nucleotide mismatches – up to 46 changes, including 4 tandem transitions and traisvertions (2-4 bp) in compare to matrix genome.

We identified three main genetic variants inside this massive of sequences. First (basic) subgroup represents by strains NDV/Dnipro/2007 (pegion), WB/Ukraine/9/2006 (wild birds), WB/Ukraine/11/2006, WB/Ukraine/23/2006, WB/Ukraine/20/2006, WB/Ukraine/22/2006 and WB/Ukraine/19/2006. Second variant contains only chicken isolate NDV/Kharkov/2007, and the last variant represents by isolates NDV/Korobovka/93 and NDV/Taranivka/93.

It was possible to show some differences between sequences variants of each subgroup. Two mismatches were detected in variant 2 in comparison with variant 1 (localizations were founded in positions of 4642, 4878 bp by plot matrix). Also two additional mismatches between variant 3 and 1 in positions ## 4672, 4734 bp were observed.

Neighbor Joining tree was built by using of 15 sequences. Russian NDV isolates were used for phylogeny study. Topography of this tree has given possibility to recognize high level of homology of Russian and Ukrainian NDV isolates. Three independent clusters (two groups with three subgroups) were determined. First group represents by poultry isolates from chicken and isolates from wild waterfowl and group of Russian isolates. Second group represents by chicken and Muscovy duck isolates from 1993, 2003 and 2005. Pairwise distances between Ukrainin 1<sup>st</sup> group isolates and Russian isolates were 0.1, and between Ukrainian 1<sup>st</sup> and 2<sup>nd</sup> groups – 0.18 (Figure 2) Intragroup levels of nucleotide polymorphism were observed in range 0.01-0.03 for group 1 and 0.005-0.015 for group 2.

This dendrogramm represented massive of Ukrainian strains as two independent parts, including chicken isolates, pigeon and wild waterfowl isolates (group 1) related to Russian NDVs and chicken viruses related to European NDVs.

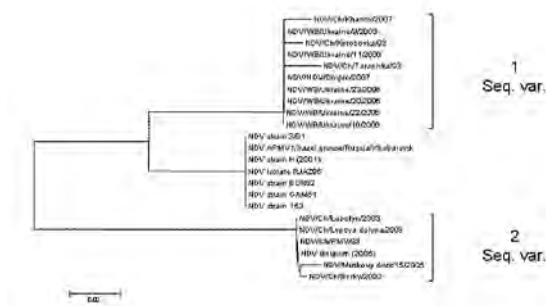


Figure 2. Phylogenic relations of Ukrainian and Russian strains NDV by F-gene partial sequences (Neighbor Joining)

Figura 2. Filogenetske relacije ukrajinskih i ruskih sojeva NDV po parcijalnim sekvencama gena F (povezivanje suseda)

The tree with same topography was designed after processing with Minimum Evolution algorithm with Boot-Strap value 1000. We observed only some intraclade changes. Validity of space branch orientation changes was determined, but true intraclad localizations of isolates were not characterized.

Topographic positions of each of isolates were shown by intrabranched comparison test. In accordance with these data only NDV/Taranivka/93 NDV isolate's position was not validated (38 %) (Figure 3).

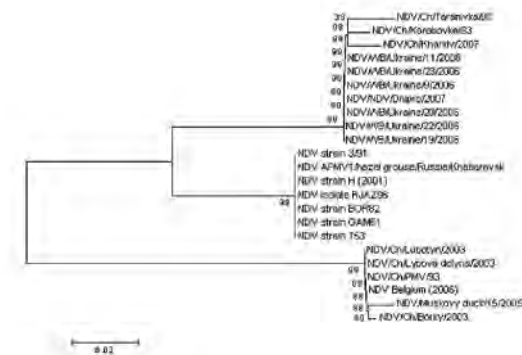


Figure 3. Intrabranched comparison test of isolates (Minimum Evolution, BS value 10,000, valid index >70)

*Figura 3. Test upoređivanja izolata unutar ogranaka (minimalna evolucija, BS vrednost 10 000, važeći indeks >70)*

The next step of our study we carried in-depth analysis by adding to data massive sequences of different strains allocated in Europe in the period of 2000-2007. Phylogenetic study was not successful with NJ and ME algorithms, because partial sequences of Ukrainian NDVs were not alignment with partial sequences of strains that allocated in EU territory. Our material was analyzed without end-cut procedure.

Maximum Parsimony tree was constructed for obtaining of valid results. Out-group virus genomic RNA sequence (avian paramyxovirus type 6) was used for polarization of dendrogramm.

Tree topography analysis shows presence of 4 clads (Figure 4). The first one consisted from 14 viruses and subdivided to 2 independent subclads. The first from them includes 5 Ukrainian and two Russian isolates, and also strain NDV Belgium (plot matrix for sequencing products identification). The per cent of assumption changes was 0.2 % in subclade. Second subclade contains only Russian strains with polymorphism value about 0.3-0.5 %.

Second clad contains one goose isolate, allocated in Khabarovsk (Russia) and wild and domestic birds' viruses (n = 10). Its interior variability was not more than 0.5-1.0 %. Phylogenetic kinship it was shown with clad 1 (nucleotide changes rate was 2.2 %).

The third clad consisted from isolates that was allocated from wild birds in Far East (n = 5) and in Europe (n = 9, including one isolate from Russia). Phylogenetic nearness of clad 3 to clades 1 and 2 was attended by 3.2 % nucleotide differences.

The last clad was represented by isolates from wild and domestic birds from Middle East and Western European countries (n = 11).

So, in accordance with F-gene sequences polymorphism of Ukrainian isolates' and provided phylogeny study, it was shown, that isolates can be subdivided into two

groups. The 1<sup>st</sup> one belongs to clad 1 of NDVs. The typical origin for them is domestic poultry. Also these strains are closely related to range of Russian strains. In addition, we didn't observe serious genetic changes between strains that were allocated in 1993, 2003, and 2005. Probably, these strains are stationary circulating, they can affect only non-vaccinated birds, and their natural reservoir is wild birds of synantropic species. This phenomenon need very carefully study in future, because collected data can be used for creation of wide conception of molecular epidemiology of ND in studied area.

Viruses from clad 2 were isolated principally from wild birds, especially – waterfowl. These agents were demonstrated high level of relations to strains of previously described group, but enough strong changes gave a possibility to group it in separated clad. This subtaxon contains new strains (2006-2007), and old isolates (1993). It gives possibility to suggest possible viral affection of wild birds from poultry, and back viral spread to poultry from wild birds. At the last time viral circulation increased its volume and affected wild birds – waterfowl, pigeons (isolates NDV/WB/2006, NDV/Dnipro/2007), and started spread in poultry (NDV/Kharkiv/2007).

This data is not unique all over the World. Aldous E. (Aldous, 2003 and 2004), Alexander D. (Alexander, 2006) and other authors have been reported similar viral migration from waterfowl to chicken (Japan, China – history of 4d genotype origin), from chicken to pigeons and back in Italy and Great Britain. This situation must carefully study to recognize transmission mechanisms in molecular level and to create its eradication measures.

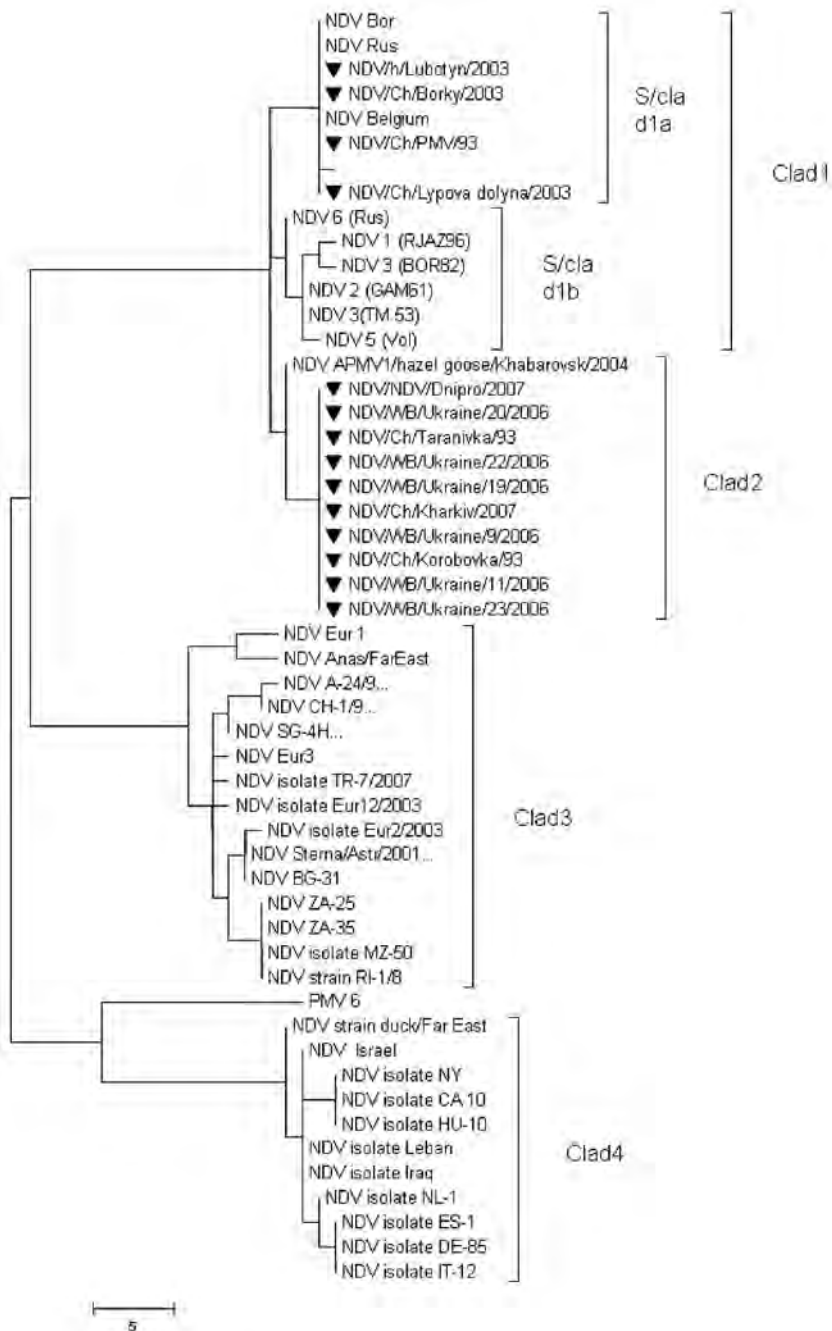


Figure 4. Phylogenetic relations between Ukrainian and European, and Asian isolates of NDV (Maximum parsimony, BS value 1000, Ukrainian isolates marked with '▼')

*Figura 4. Filogenetske relacije između ukrajinskih, evropskih i azijskih NDV izolata (maksimalna parsimonija, BS vrednost 1000, ukrajinski izolati obeleženi sa "▼")*

## CONCLUSION

NDV F gene partial sequences study shows two natural lineages of strains. First group has high percentage of similarity to Russian and European strains, and the second one to Far East strain. Both groups contain isolates for wild and domestic birds of different species. Nucleotide sequences study shows intraspecies migration of strains from poultry to wild birds and back to poultry during 5-10 years period.

Sequences partitions of F gene were published in GeneBank with accession numbers EU780898-EU780912.

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## MOLEKULARNA EVOLUCIJA VIRUSA NEWCASTLE BOLESTI U UKRAJINI

ANTON GERILOVYCH, ALEKSANDAR POTKONJAK

### Izvod

Istraživanje se odnosi na analizu varijabilnosti F gena virusa Newcastle bolesti. Petnaest izolata virusa Newcastle bolesti (NDV) upoređeno je po genetskoj strukturi proteina F0. Prepoznata su 3 varijeteta sekvence virusa na osnovu proučavanja amplikona od 345 bp gena F promenljivog položaja. Ustanovljen je visok nivo povezanosti između izolata domaće živine i divljih ptica. Migracija virusa unutar vrsta se vršila sa živine na divlje ptice i nazad na živinu tokom perioda od 12 godina.

**Ključne reči:** izolati, molekularna evolucija, Newcastle bolest, filogenetika, sekvencioniranje

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## THE DEVELOPMENT OF FERTILE BRANCHES OF PEACH CULTIVARS DEPENDING ON THE POSITION IN THE TREE CONOPY

NADA ZAVIŠIĆ, LJUBOMIR RADOŠ<sup>1</sup>

*SUMMARY: This paper deals with the morphological characteristics of peach mixed fertile branches (cultivars; Redhaven, Suncrest and Vesna) of the lower and upper crown half, in the spindel bush breeding system. The cultivars Redhaven and Suncrest had longer productive branches in the lower crown half. Stronger pruning is recommended because of the higher number of flower buds per branch in the lower crown half. The yield potential is higher in the shoots that are developed on the biennial tree. There are differences in the flower/vegetative buds ratio between the two crown halves in the cultivars. The cultivars with higher flower/vegetative buds ratio have higher yield potential. The percentage share of nodes with the individual bud category varies between the crown halves within each variety.*

**Key words:** peach, fertile branch, position in the tree conopy, spindel bush.

### INTRODUCTION

The peach is a fruit species that is significantly present in many countries around the world. The peach tree brings a main part of the yield from the mixed fertile branches. The mixed fertile branches are annual ones (40-50 cm) with differently distributed buds on the nodes. They are located at the biennial tree. The twined flower buds with one vegetative bud in the middle are prevailing on the moderately abundant mixed fertile branches. At the top of the branch there are the lateral flower buds and the apical vegetative bud as well as in the basal part of the branch. Higher density planting systems are prevailing in the modern plantations. The most common breeding system is the Veronese spill or so called spindle-shaped bush that is a combination of palmettes and spindle. During the introduction, it is necessary to examine the basic biological properties of the

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Original scientific paper / *Originalni naučni rad*

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new peach cultivars in the dense planting system (Preškić et al., 2007). The advantages of the dense peach breeding systems are based on the cheap and high quality operations such as pruning, thinning and harvesting (Zec, 2007).

The aim of this paper is to indicate the differences in the development of fertile branches in the lower and higher crown halves of the peach tree, as well as the differences between the branches of different origin (from the annual and biennial tree) within a single floor.

## MATERIAL AND METHOD

The trials were carried out in the spring 2008 in peach plantation that is in property of "Agros-Milka" Laktaši on the plot in the business unit Rječani. The orchard is in the fifth year and all cultivars were grafted on the vineyard peach. Planting distance was 3.5 X 2.0 m. The applied breeding system is the spindle bush. The three peach cultivars (Redhaven, Suncrest and Vesna) were examined in the trial. In the winter rest period, sixty mixed branches of various lengths were taken from the lower and upper crown halves (thirty annual branches from the biennial tree and thirty branches from the perennial tree). The length of the branches was measured with tape measure (cm) and the number of the nodes and the vegetative and flower buds were counted in the Laboratory for the Pomology. The determination of the nodes was carried out with the magnifying glass (according to the allocation of the buds) in five categories: the nodes with a single vegetative or flower bud, nodes with two lateral flower buds and one central vegetative bud, nodes with one vegetative and one flower bud and nodes without buds. In addition, the number of nodes and the number of flower and vegetative buds, per meter and per branch, was counted, as well as their ratio. The trial results were investigated with the statistical T test for paired samples. Statistically significant differences are marked with a ( $p>0.05$ ), and ones in which differences are highly significant with ( $p>0.01$ ).

## RESULTS

The results of fertile branches measuring and their structure on the biennial tree are shown in the Table no 1.

Table 1. The properties of fertile branches on biennial peach tree in both crown halves of peach cultivars  
*Tabela 1. Osobine rodnih grančica na dvogodišnjem drvetu obe etaže stabla breskve*

Cultivar		Shoots						Flower / vegetative buds ratio	Number of nodes
		Length (cm)	N° of flower buds		N° of vegetative buds				
			Per m	Per shoot	Per m	Per shoot			
Redhaven	I	60,60	42,74	25,90	33,44	20,27	1,28	25,93	
	II	63,17	36,94	23,33	32,77	20,70	1,13	25,27	
Vesna	I	55,23	36,45	20,13*	36,21	20,00	1,01	24,13	
	II	51,70	22,76	23,23*	34,89	20,37	0,65	24,43	
Suncrest	I	54,17	41,54	22,50	42,22	22,87**	0,98	28,93**	
	II	50,40	48,74	24,57	38,10	19,20**	1,28	25,53**	

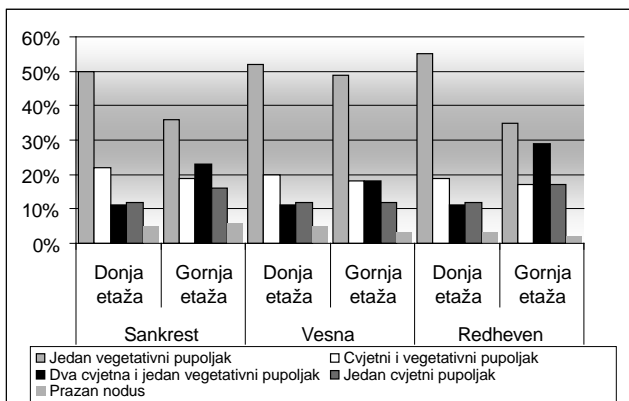


The results of measuring the length of fertile branches and their structure on perennial tree are represented in the table 2.

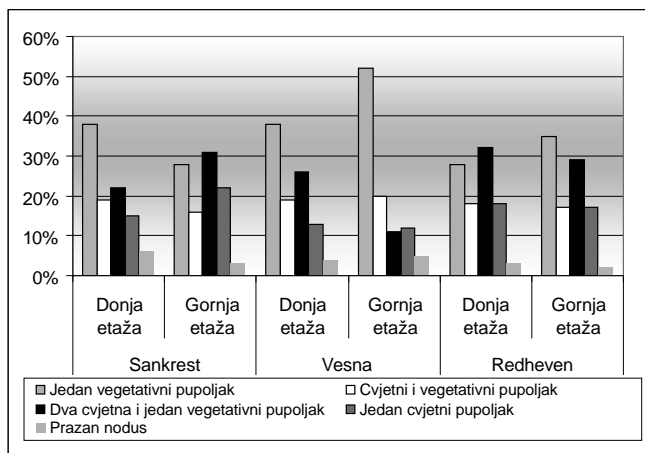
Table 2. The properties of fertile branches on old tree in higher and lower crown half of peach cultivar  
*Tabela 2. Osobine rodnih grančica na starom drvetu u gornjoj i donjoj etaži stabla breskve*

Cultivar		Premature shoots						
		Length (cm)	N° of flower buds		N° of vegetative buds		Flower / vegetative buds ratio	Number of nodes /shoot
			Per m	Per shoot	Per m	Per shoot		
Redhaven	I	55,40**	18,83	10,43*	29,84	16,53**	0,63	19,27
	II	47,03**	28,14	13,23*	29,98	14,10**	0,94	18,50
Vesna	I	45,10	44,94	10,27	39,39	15,73	1,14	18,80
	II	45,63	27,39	12,50	35,87	16,37	0,76	19,23
Suncrest	I	54,03**	23,57	12,73*	34,24	18,50	0,69	22,00
	II	47,97**	35,44	17,00*	34,61	16,60	1,02	21,30

In the graphs (number 1 and 2) the percentages show the participation of different bud categories on the nodes on mixed fertile branches. In mixed branches on the perennial tree the nodes with two lateral flower buds and one central vegetative bud are more present in relation to the other bud categories (Graph 2).



Graph. 1 Participation of the nodes with different bud categories on the perennial tree  
*Graf. 1 Procentualno učesće nodusa sa pojedinim kategorijama pupoljaka na dvogodišnjem drvetu*



Graph. 2 Participation of the nodes with different bud categories on the biennial three  
 Graf. 2 Procentualno učestće nodusa sa pojedinim kategorijama pupoljaka na višegodišnjem drvetu

## DISCUSSION

The peach has five types of fertile branches: mixed, May bouquets (1 – 5 cm), straw branches (20 - 30 cm), short branches (7 - 10 cm) and early branches (Gvozdrenović, 1997). In the research of Rahović and Rajković (1976) the average length of the fertile branches for nineteen peach cultivars was 53,8 cm, which is in accordance with the results of our research (55,8 cm). With peach varieties Redhaven and Suncrest there is a statistically significant difference in the length of the branches between the lower and the upper crown half (Table 2). The length of the branches in both crown halves of Redhaven peach variety in our research is in accordance with the research in the Belgrade (Mratinić et al., 2008), while the results Radivojević et al. (2005) showed lower values in relation to our results. The results show that the fertile branches on the biennial tree (Table 1) are longer in relation to the branches on the perennial tree (Table 2).

In our trial, examined cultivars did not show significant differences in the number of branches per node between the floors. The Suncrest variety had a statistically significant higher number of nodes in the lower in relation to the upper crown half, which is a consequence of the greater exuberance of this variety (Table 1). The average number of flower buds per meter on the biennial tree in the Redhaven peach variety is lower in relation to the research done by (Mratinić et al., 2008). Their results reached up to 52,0 flower buds per meter.

The classification of the peach varieties in three categories based on the number of buds per mixed fertile branch was carried out (Hugard i Saunier, 1978): varieties with a good density (more than 15 flower buds), varieties with a middle density (10 – 15 flower buds) and varieties with a low density (less than 10 flower buds). On the bases of this categorisation, the variety Suncrest in the upper crown half belongs to the group of varieties with the good density (17 flower buds per branch), and the other two varieties with the medium density (Table 2).

Our results indicate that there is no significant difference in the number of flower

buds per fertile branch between the lower and the upper crown half within the variety. The exception is the variety Vesna in which case there is a significant difference between the lower and the upper crown half in the number of flower bud per fertile branch (Table 1). There is a significant difference in the number of flower buds per meter and per branch depending on whether the branch is located on the biennial or the perennial tree. There can be concluded that the main yielding potential of examined cultivars is located on the mixed fertile branches that originate from the biennial tree (Table 1). The number of vegetative buds per branch is an important property for ensuring the conditions for efficient photosynthetic activity of the fruit tree. About thirty normally developed leaves are required for the achievement of a satisfactory fruit quality (Tošić, 1982). The number of leaves per one fruit can be lower depending on the location of the branch in the three canopy. The average number of vegetative buds between the lower and upper crown half on the biennial tree is significantly different in the peach variety Suncrest (Table 1).

The relation between the number of flower and vegetative buds in our research (Table 1) is between 0,65 (Vesna) and 1,28 (Redhaven), that is in accordance to the research done by (Mratinić, 2008). The differences are evident among the varieties as well as both crown halves within variety. There are differences between the lower and upper crown half within the variety, depending if the fertile branch is located on the biennial or the perennial tree.

## CONCLUSION

Based on the fertility elements examination of three peach varieties, by observing both crown halves as well as the distribution of mixed fertile branches in the tree canopies, the following conclusions can be made:

- The average length of the mixed fertile branches in examined peach varieties is between 45 cm and 63 cm. Fertile branches that originate from the biennial tree were longer compared to the fertile branches from the perennial tree.
- The variety Suncrest has a higher number of nodes per branch on the lower crown half in relation to the upper crown half because of more favorable conditions for growing.
- The density of the flower buds is different between the two crown halves. A stronger pruning in the lower crown half is recommended in the varieties with a higher number of flower buds.
- The highest yielding potential of examined varieties is on the fertile branches that originate from the biennial tree.
- The flower and vegetative buds ratio is between 0,65 and 1,28. There are differences among the varieties and the crown halves within the variety.
- The varieties with a bigger flower/vegetative buds ratio have higher yielding potential that will enable better fruit quality with the appropriate number of leaves.
- The percentage of participation of the nodes with different bud categories is different between the crown halves within the variety.
- The mixed fertile branches that originate from the perennial tree have evenly located nodes with every bud category.

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## RAZVIJENOST RODNIH GRANČICA BRESKVE U ZAVISNOSTI OD POLOŽAJA NA STABLU

NADA ZAVIŠIĆ, LJUBOMIR RADOŠ

### Izvod

U radu su ispitivane morfološke osobine rodni grančica breskve (Redhaven, Suncrest i Vesna) donje i gornje etaže stabla, u sistemu uzgoja vretenasti žbun. Rodne grančice donje etaže su duže kod sorti Redhaven i Suncrest. Broj cvjetnih pupoljaka je veći na donjoj etaži. Rodni potencijal je veći na mješovitim grančicama koje su na dvogodišnjem drvetu. Postoje razlike u odnosu cvjetnih i vegetativnih pupoljaka između sorti i etaža u okviru jedne sorte. Procentualno učešće nodusa sa pojedinim kategorijama pupoljaka je različito između etaža u okviru jedne sorte.

**Ključne riječi:** breskva, mješovita rodna grančica, položaj na stablu, vretenasti žbun.

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## **SOW FERTILITY AFTER CONVENTIONAL AI WITH INSEMINATION DOSES OF VARIOUS VOLUMES AND SPERMATOZOA NUMBER\***

BLAGOJE STANČIĆ, IVAN RADOVIĆ, ALEKSANDAR BOŽIĆ,  
MLADEN GAGRČIN, ROBIN ANDERSON<sup>1</sup>

*SUMMARY: Artificial insemination (AI) of sows has increased in recent years. In order to more fully realize the economic advantages of using genetically superior boars; however, recent research work is focused on reducing the number of spermatozoa necessary for the insemination in one oestrus, without affecting the farrowing rate and litter size. This paper deals with the results of the sow fertility of 2<sup>nd</sup> to 5<sup>th</sup> parity (30 sows per group 30), intracervically inseminated 12h and 24h after the onset of the standing oestrus which occurred 5-6 days after weaning, with dose volumes of 100 or 50 ml with  $4 \times 10^9$  or  $2 \times 10^9$  motile spermatozoa. The obtained results show that the 2-fold reduction of the spermatozoa number in the 100 ml dose volume, did not significantly affect the farrowing rate and resultant litter sizes in inseminated sows. Conversely, a 2-fold reduction of the dose volume to 50 ml greatly decreased the farrowing rate but did not affect litter size. Accordingly, by reducing the number of spermatozoa in the dose of conventional volume from  $4 \times 10^9$  to  $2 \times 10^9$  of the motile spermatozoa it is possible to obtain twice as many insemination doses from one ejaculate and thus double the number of inseminated sows per boar per year.*

**Key words:** AI, intracervically, dose volume, spermatozoa number, sow.

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Original scientific paper / *Originalni naučni rad*

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## INTRODUCTION

Due to increasing artificial insemination (AI) in swine production, there is a need for a greater reproductive exploitation of the genetically superior boars at lower total cost. Currently, the price of one insemination dose accounts for more than 50% the cost of insemination (Glossop, 2000; Stančić, 2000). In practice this can be achieved by increasing the number of insemination doses per ejaculate.

According to the data from the EU countries, the average volume of an insemination dose is about 100 ml with about  $4 \times 10^9$  of progressively motile spermatozoa. On average, about 5 ejaculates are obtained from one boar a month, i.e. about 1200 insemination doses per year (Singleton, 2001; Flowers, 2003; Rozeboom et al, 2004). In today's more intensive production systems, the annual production of insemination doses per boar is regarded as -inefficient both from a zootechnical and an economic aspect. Consequently, insemination protocols using doses with highly reduced volume and spermatozoa number are increasingly being studied in order to increase the number of the insemination doses per ejaculate (Belstra, 2002). To be successful, however, insemination with such doses should not reduce the currently achieved level of sow fertility (Rath, 2002; Stančić, 2002; Stančić et al., 2003).

The objective of this paper is to present our results in sow fertility (% of farrowing and litter size), after the conventional intracervical insemination, performed with the insemination doses of the reduced volume and number of spermatozoa.

## MATERIAL AND METHODS

The total of 120 sows, between 2<sup>nd</sup> and 5<sup>th</sup> parity of farrowing were divided into 4 groups (30 each) according to the volume of the insemination dose and spermatozoa number in a dose. The insemination was performed with the doses of conventional volume (100 ml) or doubly reduced volume (50 ml) which contained  $4 \times 10^9$  or  $2 \times 10^9$  of progressively motile spermatozoa.

The conventional intracervical insemination was performed with the throwaway Foamtip safe blue catheters (Minitüb, Germany). The BTS 1 dilution agent was used for the sperm dilution and for the short-term preservation of the liquid diluted sperm, a product from the same company was applied.

The insemination was performed in the oestrus occurring on 5<sup>th</sup> to 6<sup>th</sup> day after lactation which lasted about 28 days on average. The first insemination was carried out about 12 hours after the oestrus detection and the second about 24 hours later. The oestrus detection was performed twice within 24 hours with a boar teaser in the interval of about 12 hours.

The data on the sow fertility (%), farrowing rate and litter size at farrowing from the first post-lactation insemination were recorded.

## RESULTS AND DISCUSSION

The obtained values of the farrowing rate and litter size, after the intracervical insemination with the conventional doses and those of the reduced volume and sperma-

tozoa number are shown in Table 1.

Table 1. Sow fertility

		Dose parameters			
		V = 100ml		V = 50ml	
		4x10 <sup>9</sup>	2x10 <sup>9</sup>	4x10 <sup>9</sup>	2x10 <sup>9</sup>
Inseminated sows (n)		30	30	30	30
Farrowing rate (%)		83.3 <sup>a</sup>	80.0 <sup>a</sup>	73.3 <sup>b</sup>	70.0 <sup>b</sup>
Average litter size at farrowing (n)	live	10.16	10.21	10.27	9.85
	dead	0.48	0.50	0.50	0.48
	total	10.64	10.71	10.77	10.33

<sup>a,b</sup> – Values with different superscripts are significantly different ( $P < 0,01$ ).

The insemination, performed with the doubly reduced volume of the insemination dose resulted in a significant decrease in the farrowing rate ( $P < 0.01$ ), regardless of the spermatozoa number in a dose. However, with the application of the conventional dose volume (100 ml) containing double reduction of spermatozoa number did not significantly decrease the farrowing rate (83.3% vs. 80.0%). Litter size were not significantly ( $P > 0,05$ ) affected by dose volume or spermatozoa number per dose (Table1). These results are in agreement with earlier reports of decreased farrowing rates following conventional intracervical insemination with reduced dose volume but not with reduced spermatozoa number (Watson and Behan, 2002; Stančić et al., 2006). The reduction of the spermatozoa number in an insemination dose below  $2 \times 10^9$  does not have good results in the conventional technology of intracervical insemination. The more significant reduction of the volume and the spermatozoa number per dose has good results of the sow fertility only with the application of a new technology of shallow and deep intrauterine insemination (Mezalira et al., 2005; Stančić et al., 2007; Sumransap et al., 2007; Dimitrov et al., 2007; Radović i sar., 2007; Pelland et al., 2008). The relation of the fertility level of sows and dose volumes and the spermatozoa number in it is primarily determined by the physiology of spermatozoa progression and survival in the sow reproductive tract during the periovular period (Rath, 2002; Mezalira et al., 2005; Stančić et al., 2006). Namely, it was found that the dose volume and the spermatozoa number in it can significantly be decreased when the dose is deposited nearer to the fertilization seat, i.e. oviduct ampulla (Hunter, 1995). However, the insemination with the doses of the reduced volume and the spermatozoa number must be carried out as precise as possible in relation to the first signs of the standing oestrus, i.e. 10 to 12 hours before the ovulation (Kaeoket et al., 2005). That is why the application of the new technology of shallow or deep intrauterine insemination requires a very precise detection of the exact moment of the standing oestrus occurrence as it is highly correlated to the moment of ovulation (Weitze et al., 1994; Borchardt Neto, 1998; Stančić and Šahinović, 1998).

The results obtained in this paper clearly indicate that it is possible to produce twice as many insemination doses per boar per year, in the conventional intracervical insemination with doubly reduced spermatozoa number (from  $4 \times 10^9$  to  $2 \times 10^9$ ) per dose. This does not result in a significant decrease of fertility parameters (farrowing rate and litter size) in the inseminated sows.

## CONCLUSION

Based on the obtained results, the following conclusions can be drawn:

1. By the application of the conventional intracervical insemination with the doses of doubly reduced spermatozoa number it is possible to significantly increase the reproductive exploitation of boars of high genetic potential.
2. This does not result in a significant decrease of the fertility parameters in the inseminated sows.

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## FERTILITET KRMAČA POSLE KLASIČNOG VO INSEMINACIONIM DOZAMA RAZLIČITOG VOLUMENA I BROJA SPERMATOZOIDA

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### Izvod

Poslednjih godina se značajno povećava upotreba veštačkog osemenjavanja svinja. Zbog toga se veliki broj istraživanja fokusira na mogućnost redukcije broja spermatozoida, potrebnog za osemenjavanje u jednom estrusu, a da se, pri tome, ne kompromituju vrednosti prašenja i veličine legla. U ovom radu su prikazani rezultati fertiliteta krmača 2. do 5. pariteta (po 30 u grupi), intracerviklano osemenjenih 12h i 24h posle početka estrusa, koji se pojavio 5-6 dana posle zalučenja, dozama volumena 100 ili 50ml, sa  $4 \times 10^9$  ili  $2 \times 10^9$  pokretnih spermatozoida. Dobijeni rezultati pokazuju da dupla redukcija broja spermatozoida, u dozi volumena 100ml, ne utiče na značajno smanjenje vrednosti prašenja i veličine legla. Međutim, dupla redukcija volumena doze na 50ml, značajno smanjuje vrednost prašenja, bez značajnog uticaja na veličinu legla. S tim u vezi, redukcijom broja spermatozoida u dozi klasičnog volumena, sa  $4 \times 10^9$  na  $2 \times 10^9$  pokretnih spermatozoida, moguće je dobiti duplo veći broj inseminacionih doza od jednog ejakulata i, time, duplo povećati broj osemenjenih krmača po nerastu godišnje.

**Ključne reči:** VO, intracervikalno, volumen doze, broj spermatozoida, krmača.

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## ECONOMIC RESULTS OF TABLE EGG PRODUCTION ON SMALL FAMILY FARMS IN SERBIA: AN ESTIMATE OF THE EFFECTS OF IMPLEMENTING THE EU REGULATIONS\*

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*SUMMARY: Due to public pressure, EU countries have been putting more and more effort in environmental, welfare and food safety issues. This has resulted in more strict legislation to become obligatory for producers and as such requiring specific changes in egg production. The effects are already reflected in egg production costs, i.e. in production competitiveness. The fact is that the level of EU regulations covering egg production differs significantly from those in other parts of the world. Estimates of the expected impact of EU regulations on egg production in Serbia are important: on the one hand in view of future accession (which would make EU legislation obligatory for Serbian producers). On the other hand, such estimates are important for egg exports. In the paper an assessment is given from the economic standpoint, of the effects of implementation of poultry welfare EU regulations in egg production on small family farms in Serbia.*

**Key words:** egg production, EU legislation, welfare, economic results

### INTRODUCTION

In agriculture of the developed countries, increased attention has been given to environmental issues, animal welfare and food safety, being defined as policy goals of ever-growing importance, directly related to global sustainable development goals. The European Union is the leader in that respect regarding its policy measures aimed at realizing these goals, which require institutional adjustments and new regulations as well as considerable financial means. Compliance with EU regulations (requirements in force) as a rule imposes higher production costs and product price, which can have direct im-

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pact on producers' profit and hence on the very production in the long run.

In poultry production, the best economic results are obtained in highly intensive production. However, in such production the principles of poultry welfare and environment protection are the least recognized ones, so it is already unacceptable, with the prospects of being not allowed at all in the EU countries in the close future (1999/74/EC EU Directive, Appleby, 2003) and similar trends can be expected in other developed countries in the world (Bell, 2000, Blokhuis, 2004, Sumner et al., 2008).

This paper is aimed at estimating the possible effects, economic consequences in the first place, of the implementation of EU regulations covering poultry welfare in table egg production on small family farms in Serbia.

## **EU REGULATIONS ON POULTRY WELFARE**

Poultry welfare became an issue of serious concern in the European Union some 20 years ago, when the minimum standards were defined for laying hens protection in battery system of housing, as stated in the 88/166/EEC Directive (4). Advancement in the minimum standards/norms was due to publicly promoted interests in improving the inappropriate housing systems, systems of insufficient quality. In 1998 by the 98/58/EC Directive further requirements were defined for animal husbandry; the stress was on the housing system, feed and care that should meet the farm animals' physiological and etological needs. Consequently the new systems have been developed of laying hens housing, like enriched cages, houses with a range, aviary system, free range housing, organic production, and the like (Perić et al. 2007a, Perić et al., 2008).

Finally the 1999/74/EC Directive set the standards that imposed very serious task for producers: gradual abandoning of dominant, battery cage housing system. Installing and use of such conventional cages was only allowed until 2002 (450cm<sup>2</sup> per hen) and after that only the installation of the so called enriched cages (600- 750 cm<sup>2</sup> per hen) was permitted, with the equipment providing conditions that allow hens to behave naturally (perches, nests, sand bathing...). The ban on the use of conventional cages was planned to be enforced by 2012, and the minimum space of 750 cm<sup>2</sup> per laying hen was defined.

The Directive also implies some other changes in treating poultry. For instance, forced molting is completely banned, and trimming is only permitted if performed by trained persons, and only up to chicken's 10th day. Poultry condition must be checked at least once a day, noise in buildings for poultry must be reduced to a certain minimum, etc. All that requires so many changes in the very production system that a number of producers will be forced out of egg production after 2012. Such expectations are based on some studies assessing socio-economic implications of introduction of additional legislation as proposed by the Directive (AGRA CEAS, 2004).

In Serbia, changes in housing systems are still not required by present legislation. However, regarding the Government's explicit aim of joining the EU, the expectations are that in the close future housing systems will be regulated in compliance with the EU regulations. Poultry production, especially small producers would in that case be exposed to major changes of the present practice, so for them it is of utmost importance to get prepared for the changes to come, in terms of both production technology and economic consequences.

## ECONOMIC IMPLICATIONS OF IMPLEMENTING EU DIRECTIVE REQUIREMENTS ON SMALL FAMILY FARMS

According to some studies, competitiveness of European table egg producers has been significantly undermined due to great differences in legislation on poultry welfare within the EU on the one hand and other countries, on the other (Vocke 1991, Van Horne and Bondt 2003, Van Horne and Achterbosch, 2008). Introduction of alternative housing systems has brought about several disadvantages in comparison to battery cage systems: worse working conditions for farm workers (Van den Top et al., 1995), increased ammonia emission (Groot Koerkamp, 1998) and the most important one for producers themselves - higher production costs (Agra CEAS, 2004, Polet, 2005, Van Horne & Bondt, 2006, Van Horn, 2007).

As calculated, by 2012 the production costs of table eggs will be higher in the EU by 13-21 percent on the average, depending on the housing system, due to full implementation of poultry welfare rules. It is estimated that on the EU level the prohibition of cage housing for laying hens could increase production costs by over €350 million.

Although in Serbia there is still no commercial production of table eggs in alternative housing systems, the experiments conducted on the Experimental farm of the Department for Animal Husbandry (Perić et al., 2007b, Rodić et al., 2008) have shown that both production and economic results with the enriched cages and houses with a range lag behind those obtained with battery cages. On the one hand these result from higher hen mortality, reduced number of eggs, higher share of second grade eggs and higher daily average feed consumption. On the other hand, there is still no chance in Serbia to count on higher prices for eggs produced in alternative housing systems, in spite of the fact that our consumers are to some extent willing to pay the so called premium price for products from alternative systems (Rodić et al., 2003).

There are no reliable data on the scope of egg production on family farms in Serbia, but it is presumably not small at all (Rodić et al., 2002). Since the big producers have for many years been deep in crisis, relatively small family farms with 1,000-5,000 laying hens have a significant share in meeting demands, partly due to the fact that a good deal of egg trade in Serbia is still done through farm's direct sale. For majority of family farms egg production is just an additional source of income. However, they manage to survive regardless of their production capacity, due to their production results that are significantly higher (in conditions of cage housing, quality commercial laying hens and adequate concentrate feed mixture) than the average ones for family farms. Ban on cage housing would certainly have adverse consequences for such producers in the first place.

Since there are no commercial farms with alternative housing systems in Serbia, the starting point of the analysis presented in this paper are the data obtained in the experiment (Table 1). The starting assumption was that problems identical or similar to those detected in the experiment would also appear on small family farms, at least over the course of the first few years of production in alternative systems, which would result in significantly lower production results – as was the case in the experimental conditions.

Table 1. Production results of egg production in different housing systems

Tabela 1. Proizvodni rezultati proizvodnje jaja u različitim sistemima držanja

Group <i>Grupa</i>	No. of eggs per hen housed <i>Broj jaja po useljenoj nosilji</i>	2nd grade eggs, % <i>Jaja II klase, %</i>	Mortality rate, % <i>Mortalitet</i>	Aver. daily feed consumption <i>Pros. dnevni utrošak hrane</i>	Average egg weight <i>Pros. masa jaja</i>	Feed conversion ratio <i>Konverzija hrane</i>
BC	275.4	0.70	10.41	121	65.25	2.51
EU	269.4	1.40	14.44	125	64.33	2.70
HR	236.0	26.9	20.00	134	65.28	2.94
BC – battery cage; EU - enriched cage HR – house with a range <i>BC – konvencionalni kavezi; EU – obogaćeni kavezi, HR – podni sistem sa ispustom</i>						

Basing on these production parameters the economic ones were defined: overall income, variable costs and gross margin representing the difference between overall income and variable costs. The results are given in Table 2.

Table 2. Economic parameters of table egg production in different housing systems

Tabela 2. Ekonomski pokazatelji proizvodnje konzumnih jaja u različitim sistemima držanja

Housing system <i>Sistem držanja</i>	Total revenue (RSD) <i>Ukupan prihod</i>	Variable costs (RSD) <i>Varijabilni troškovi</i>	Gross margin	
			Per hen housed <i>Po useljenoj nosilji</i>	Per egg <i>Po jajetu</i>
BC	1,445.50	991.35	454.15	1.65
EU	1,405.67	997.78	407.89	1.51
HR	1,024.31	1,016.38	7.93	0.03
BC – battery cage; EU - enriched cage; R – house with a range <i>BC – konvencionalni kavezi; EU – obogaćeni kavezi, HR – podni sistem sa ispustom</i>				

The comparison of economic effects of production in battery cages (BC), enriched ones (EU) and in houses with a range (HR) has shown that in the conditions of the identical selling price and production scope of eggs produced in each of the three housing systems, the houses with a range system is absolutely non-competitive. Its economic results proved to be far too low, with less than 8 RSD (€0.09) per housed hen left for covering the fixed costs, hence with no profit at all.

It should be pointed out that in the repeated experiment significantly better production results were obtained with the houses with a range – reduced hen mortality, increased number of grade A eggs. This leads to the conclusion that with the alternative systems certain mistakes will be corrected as the actual experience suggests. Nevertheless, even with such expected improvements in production results the significantly increased production costs will hardly be manageable without price differences for eggs produced in different housing systems.

## CONCLUSION

Although the newly recommended poultry housing systems have much in com-

mon with the extensive systems we had less than half a century ago (and are still used in village households for natural consumption) the alternative systems, however, are not „the return to an old practice“. These are new systems of poultry housing, recommended to commodity producers, and the producers have to overcome difficulties arising from legislative pressures if they want to remain in the market and keep their production economically justifiable. If given the opportunity to chose, the majority of egg producers would chose conventional cages. However, in case of Serbia becoming the EU member, certain housing systems will not be an issue to discuss any more but an obligation to fulfill. That is why it is so important for producers to know exactly what to expect in that case, so as to begin preparing themselves in time. Therefore investing in conventional cages at this moment should not be recommended, regardless of the fact that they are still allowed by regulations in force. It could easily happen that the duration of their use gets shortened due to adoption of new legislative, and consequently such investment doesn't pay off, affecting seriously overall economical efficiency of egg production. Perhaps the example of producer's good practice in some of the EU countries should be followed: the obsolete traditional cages were replaced with the enriched ones even before the latter became obligatory, but without introducing the accompanying equipment and with higher stocking density. As such the cages will be used for as long as possible, and the investments into equipment and changes in stocking density will only be done when the Directive requirements are in force and the producers conform to new standards.

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## **PROCENA UTICAJA PRIMENE EU REGULATIVE NA EKONOMSKE REZULTATE PROIZVODNJE KONZUMNIH JAJA NA MALIM PO- RODICNIM FARMAMA**

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### **Izvod**

Usled pritiska potrošača, u zemljama EU se sve više pažnje posvećuje brizi o životnoj sredini, dobrobiti životinja i zdravstvenoj bezbednosti hrane. Sve to rezultira regulativom koja za proizvođače postaje obavezujuća i kao takva zahteva određene izmene u proizvodnji, što se odražava i na troškove proizvodnje, odnosno njenu konkurentnost. Činjenica je da u proizvodnji konzumnih jaja postoje velike razlike u nivou regulative u pogledu dobrobiti životinja između zemalja EU i ostatka sveta, što vodi narušavanju konkurentnosti ove proizvodnje. Za našu zemlju je procena očekivanog uticaja primene ove regulative bitna kako zbog eventualnog priključenja (jer bi u tom slučaju ona postala obavezujuća i za naše proizvođače), tako i zbog mogućnost izvoza jaja. U radu je urađena procena uticaja primene EU regulative vezane za dobrobit životinja na proizvodnju konzumnih jaja na malim porodičnim farmama kod nas, pre svega u domenu ekonomskih posledica.

**Ključne reči:** proizvodnja jaja, EU regulativa, dobrobit, ekonomski rezultati.

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## EFFECTS OF INCORPORATING AMELIORATIVE SUBSTANCES ON CATION EXCHANGE CAPACITY IN SOLONETZ SOIL\*

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*SUMMARY: This paper reviews the results of a study of an incorporation of ameliorative substances effects on cation exchange capacity (CEC) of solonetz soil in the Vojvodina Province. CEC was determined by cation extraction with ammonium acetate at pH 7. Based on the results of field visits and laboratory analyses, ameliorating fertilization of solonetz by phosphogypsum at Kuman site did not affect CEC, while the application of organic waste material (by-products of sugar beet preprocessing) at Žabalj locality had resulted in a statistically significant decrease of CEC for 5,81 cmol/kg.*

**Key words:** solonetz, amelioration, phosphogypsum, organic matter, cation exchange capacity

### INTRODUCTION

Cation exchange capacity (CEC) is the amount of negative charge in soil that is available to bind positively charged ions (cations) in a form that makes them available to plants and makes possible their replacement by equivalent amounts of cations from the soil solution. Only a small percentage of the essential plant nutrient cations ( $K^+$ ,  $Ca^{2+}$ ,  $Mg^{2+}$ , and  $NH_4^+$ ) will be 'loose' in the soil water, hence available for plant uptake. Thus the CEC is important because it provides a reservoir of nutrients to replenish those removed from the soil water by plant uptake. Also, CEC buffers fluctuations in nutrient availability and soil pH. The CEC of a soil depends on the presence of organic colloids (organic matter - humus) and mineral ones (clay minerals), whose quality and quantity determine how large CEC is going to be (Syers et al., 1970; Parfitt et al., 1995).

In order to improve physical and chemical properties of the solonetz soils (~ 80,000

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ha) in Vojvodina Province (main agricultural area in Serbia), a number of authors (Hadžić et al., 1995; Belić, 1999, 2005) have argued for the necessity of use of the basic ameliorative measures (application of gypsum, incorporation of mineral and organic fertilizers, set-up of drains, and ameliorative tillage). The incorporation of phosphogypsum as one of the less expensive raw materials for the improvement of alkaline soils has as its goal the neutralization of alkalinity by substituting calcium ions for sodium ones in the adsorption complex. Organic matter decomposition and plant root action also help dissolve the calcium compounds found in most soils, thus, promoting reclamation and increasing the fertility of solonetz. Organic manures have long been known to facilitate the amelioration of sodic soils (Kanwar, et al., 1965). Ameliorative tillage measures include loosening of the soil, disking and shallow plowing in the later stages of amelioration in order to homogenize the topsoil layers of solonetz.

The objective of this study was to determine the effects of incorporation of relatively inexpensive waste materials, such as phosphogypsum and waste organic matter from sugar beet industry on cation exchange capacity of solonetz soil.

## MATERIALS AND METHODS

At the Kumane site, in 1981, a trial was set up at the location on a total area of two hectares. In 1984-1985, the trial was reconstructed for the purpose of setting up pipe drainage and an open canal network. In order to determine the influence of incorporation of phosphogypsum on cation exchange capacity of solonetz, samples were collected from trial treatments in 2006: the ameliorated treatment (drain spacing of 10 m + 50 t ha<sup>-1</sup> of phosphogypsum + soil loosening down to 50 cm) and a control treatment (a natural pasture). Mineralogical analysis of the phosphogypsum applied showed its composition to be as follows: gypsum (CaSO<sub>4</sub>\*2H<sub>2</sub>O) 80-95%; calcium hydro phosphate (CaHPO<sub>4</sub>\*2H<sub>2</sub>O) 10-15%; apatites, illites, smectites, quartz, feldspars; and trace minerals 1%. At the Žabalj site, organic waste material (OWM) consisting of beet leaves, pulp, and taproots that are by-products of sugar beet preprocessing was deposited on a natural pasture six hectares in area during 2004-2006. To determine the effects of organic matter incorporation on cation exchange capacity, soil samples were taken from a control plot and a plot on which OWM was deposited. The chemical composition of the OWM was as follows: moisture 8.23%, protein 12.23%, cellulose 10.22%, fat 1.68%, ash 20.06%, and nitrogen-free extracts 62.61%.

The disturbed soil samples from both sites and all treatments (60) were taken in three replicates at 0-10, 10-20, 20-30, 30-40 and 40-50 cm depth. Once collected, the samples (<2 mm) were analyzed using recognized contemporary methods commonly utilized in this type of research:

- mechanical soil composition was determined by the pipette method, the samples were prepared for analysis using sodium pyrophosphate (Thun, 1955), while textural class was determined based on the classification by Tommerup (Tommerup, 1934);
- organic matter content was determined by the Tjurin method, as modified by Simakov (Simakov et al., 1960);
- pH value in a soil suspension with potassium chloride and water was determined potentiometrically by an InoLab pH meter ;

- cation exchange capacity was determined by cation extraction with ammonium and sodium acetate (Richards, 1954).

For statistical analysis of laboratory data, the arithmetic mean was calculated ( $\bar{x}$ ) as a measure of central tendency. Significance of differences among the arithmetic means was determined by the least significant differences test (LSD) at 5% level, via the analysis of variance, after the system of random blocks (Statistica for Windows, 2007).

## RESULTS AND DISCUSSION

At the Kumane site, the effects of ameliorative measures (drain spacing of 10 m + 50 t ha<sup>-1</sup> phosphogypsum + soil loosening down to 50 cm depth) on CEC were studied. The physiological acidity means in the control treatment ranged between 5.64 and 7.68 pH depending on soil depth (Table 1.), while those in the ameliorated treatment varied from 5.51 to 8.16 pH. Humus levels increased considerably, so the average humus content of the topsoil (0-10 cm) in the check treatment was found to be 2.69%. After amelioration, the humus level increased to 3.36%, however, the average humus content of all the soil depths studied did not increase significantly. According to Bresler et al. (1982), the organic matter content of the topsoil in arid areas usually ranges between 0.5 and 2.0%, while organic matter contribution to soil CEC value varies from 1 till 4 cmol kg<sup>-1</sup>. The same author, along with Belić (1999), concluded that CEC values increase with increasing pH values.

Table 1. Mean values of basic chemical properties of solonetz at Kumane site

*Tabela 1. Srednje vrednosti osnovnih hemijskih svojstava solonjeca na lokalitetu Kumane*

Treatments <i>Varijante</i>	Depth (cm) <i>Dubina (cm)</i>	pH in H <sub>2</sub> O <i>pH u H<sub>2</sub>O</i>	pH in KCl <i>pH u KCl</i>	Humus (%) <i>Humus (%)</i>	CaCO <sub>3</sub> (%)	CEC (cmol kg <sup>-1</sup> )
Control <i>Kontrola</i>	0-10	6.99	5.64	2.69	0.28	31.47
	10-20	8.35	6.44	2.42	0.49	37.60
	20-30	9.05	7.06	2.23	0.42	41.20
	30-40	9.35	7.49	2.28	0.49	44.93
	40-50	9.56	7.68	1.99	0.84	46.80
Phosphogypsum <i>Fosfogips</i>	0-10	7.10	5.51	3.36	0.42	34.67
	10-20	7.46	5.91	3.30	0.49	36.93
	20-30	9.02	7.08	1.91	1.06	41.73
	30-40	9.59	7.85	1.66	3.03	42.27
	40-50	9.85	8.16	1.49	4.57	43.73

No statistically significant differences in CEC values were observed between the treatments (Table 2.). Among individual depths within the same treatment, however, there were highly significant differences. CEC values increased with increasing depth in both treatments. Multiple authors (Kurjački, 1993; Hadžić, 1995) reported that the CEC of solonetz changed under the influence of complex ameliorative measures such as

incorporation of phosphogypsum, manure and mineral fertilizer. However, amelioration of solonetz is primarily aimed at bringing about a qualitative change of the adsorption complex, i.e. at changing the qualitative and quantitative composition of the cations adsorbed (Belić, 1999).

Table 2. Cation exchange capacity (cmol kg<sup>-1</sup>) of solonetz at Kumane site

*Tabela 2. Kapacitet izmenljivih katjona (cmol kg<sup>-1</sup>) solonjeca na lokalitetu Kumane*

Factor A (Treatment) <i>Faktor A (Varijanta)</i>	Factor B (depth in cm) <i>Faktor B (dubina u cm)</i>					Average A <i>Prosek A</i>
	0-10	10-20	20-30	30-40	40-50	
Control <i>Kontrola</i>	31.47	37.60	41.20	44.93	46.80	40.40
Phosphogypsum <i>Fosfogips</i>	34.67	36.93	41.73	42.27	43.73	39.87
Average B <i>Prosek B</i>	33.07	37.27	41.47	43.60	45.27	/
LSD <i>NZR</i>	%	A		B		AB
	5	2.28		3.61		5.11
	1	3.13		4.95		7.00

At the Žabalj site, one of the objectives of the study was to determine organic matter effects on CEC of solonetz. Soil samples were taken from a plot to which organic waste material (OWM) had been added (sugar beet leaves, tops and taproots) as well as from a control plot where no OWM incorporation had been performed. The addition of OWM decreased soil pH and increased the organic matter (humus) content (Table 3).

Table 3. Mean values of basic chemical properties of solonetz at Žabalj site

*Tabela 3. Srednje vrednosti osnovnih hemijskih svojstava solonjeca na lokalitetu Žabalj*

Treatments <i>Varijante</i>	Depth (cm) <i>Dubina (cm)</i>	pH in H <sub>2</sub> O <i>pH u H<sub>2</sub>O</i>	pH in KCl <i>pH u KCl</i>	Humus (%) <i>Humus (%)</i>	CaCO <sub>3</sub> (%)	CEC (cmol kg <sup>-1</sup> )
Control <i>Kontrola</i>	0-10	8.79	7.44	2.95	1.78	20.93
	10-20	9.77	8.16	2.28	12.34	26.27
	20-30	10.42	8.87	1.30	10.98	29.47
	30-40	10.55	9.05	2.93	15.44	29.20
	40-50	10.55	9.18	0.92	1.36	25.33
OWM* <i>OOM*</i>	0-10	6.53	5.53	7.19	0.56	18.53
	10-20	7.75	6.02	3.67	0.23	18.40
	20-30	8.66	6.81	2.32	1.08	20.13
	30-40	9.48	7.53	1.81	1.17	21.73
	40-50	9.68	7.85	1.11	1.92	23.33

\*OWM stands for organic waste material / OOM - otpadna organska materija

In the control treatment, the mean values of physiological acidity varied between 7.44 and 9.18 pH depending on soil depth, whereas in the treatment with OWM they were in the 5.53-7.85 pH range. The average humus content of the topsoil increased significantly from 2.95% in the control treatment to 7.19% in the treatment with OWM. According to Tate & Theng (cit. Caravaca et al., 1999), more humic substances are adsorbed by soils in which clay with a large specific surface area is the dominant component than by those in which clay with a small specific area predominates. Belic (1999), observed that the clay fraction of the solonetz in Vojvodina is composed mainly of illite and kaolinite clay minerals. Theng (cit. Lax, 1991) points to the fixation of organic fractions in smectites leading to the blocking of some exchangeable positions and reduced CEC values. In the present study, we found a highly significant difference in CEC between the treatments (Table 4.), as the mean value of CEC was 26.24 cmol kg<sup>-1</sup> before incorporation of organic waste materials and 20.43 cmol kg<sup>-1</sup> afterwards. The reduction in CEC may have been caused by organic matter fixation by clay minerals, but it may have also been a result of a reduced active acidity value.

Table 4. Cation exchange capacity (cmol kg<sup>-1</sup>) of solonetz at Zabalj site  
*Tabela 4. Kapacitet izmenljivih katjona (cmol kg<sup>-1</sup>) solonjeca na lokalitetu Žabalj*

Factor A (Treatment) <i>Faktor A (Varijanta)</i>	Factor B (depth in cm) <i>Faktor B (dubina u cm)</i>					Average A <i>Prosek A</i>
	0-10	10-20	20-30	30-40	40-50	
Control <i>Kontrola</i>	20.93	26.27	29.47	29.20	25.33	26.24
OWM* <i>OOM*</i>	18.53	18.40	20.13	21.73	23.33	20.43
Average B <i>Prosek B</i>	19.73	22.33	24.80	25.47	24.33	
LSD <i>NZR</i>	%	A	B		AB	
	5	3.68	5.82		8.23	
	1	5.04	7.97		11.28	

*\*OWM stands for organic waste material / OOM – otpadna organska materija*

Several authors (Bresler et al., 1982; Belić, 1999), reported that CEC values significantly increase with increasing pH values of the soil and also decrease significantly with decreasing soil pH. According to Jakovljević and Pantović (1991), changes in the pH value of a soil solution lead to changes in the adsorption capacity of the soil solid phase. In previous research of solonetz on both localities (Laslo, 2007), a positive and highly significant correlation was found between soil pH and CEC values.

## CONCLUSION

At the Kumane site, the incorporation of phosphogypsum into solonetz increased the humus content of the topsoil and decreased soil pH but had no significant effect on cation exchange capacity. The addition of organic waste materials from the sugar beet

industry to solonetz at Žabalj locality increased the organic matter content and reduced soil pH values, which led to a significant decrease of cation exchange capacity.

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## UTICAJ UNOŠENJA AMELIORATIVNIH SREDSTAVA NA KAPACITET IZMENLJIVIH KATJONA SOLONJECA

ANA GAJIĆ, MILIVOJ BELIĆ, MAJA MANOJLOVIĆ, LJILJANA NEŠIĆ

### Izvod

U radu su prikazani rezultati istraživanja uticaja različitih ameliorativnih sredstava na kapacitet izmenljivih katjona (CEC) solonjeca u AP Vojvodini. CEC je određen ek-

strakcijom katjona uz pomoć amonijum acetata pri pH 7. Na osnovu analize rezultata terenskog i laboratorijskog rada, inkorporacija fosfogipsa u solonjec na lokalitetu Kumane nije imala uticaja na CEC, dok je aplikacija otpadne organske materije (nusprodukti prerade šećerne repe) uzrokovala statistički značajno smanjenje CEC-a za 5,81 cmol/kg.

**Ključne reči:** solonjec, amelioracija, fosfogips, organska materija, kapacitet izmenljivih katjona.

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## CALCIUM, PHOSPHORUS AND MAGNESIUM CONTENT IN THE BLOOD SERUM OF COWS WITH DIFFERENT MILKING ABILITY\*

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*SUMMARY: The amount of calcium, phosphorus and magnesium in milking cows' blood was tested and it is one of indicators cows were fed with these substances. The average amount of calcium in tested cows' blood was 12.35 mg/100 ml serum, the average amount of phosphorus was 5.45 mg/100 ml and the average amount of magnesium was 3.25 mg/100 ml.*

*Key words: cow, calcium, phosphorus, magnesium, blod serum, milking ability.*

### INTRODUCTION

The amount of these mineral substance in latge content of fodder all over our is not tested enough. Last research results of mineral substance in the fodder show the low level of phosphorus that appears more often than calcium does. The manifestation appears more often during the drought and during some periods that occurs very often at Kosovo and Metohija and where the tests were performed. It should be mentioned the fact that the soil Kosovo and Metohija contains a low level of physiologically active phosphorus ( $P_2O_5$ ), as Miric (1989) established and the low level of this element in soil has an adverse affect on the level of this element in plants. It should be mentioned Stojkovic's (2006) observation that lots of plants from this area contain the low level of phosphorus. Examinations of the level of calcium, phosphorus and magnesium in cow's blood serum which are fed by different fodder as a source of these elements and standard fodder with mineral would certainly contribute to better knowingeness of general status and dynamics circulation of these elements and their relations in cows' blood serum. They assumed that their level in blood serum is one of the indicators that cows fed with these elements. Contribution is certainly greater since the cows with different lactation period were examined.

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Original scientific paper / *Originalni naučni rad*

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## MATERIAL AND METHODS

The experiments were carried out on Simmental cows at the farm. It lasted 45 days during which the blood samples were taken for the mineral analyses. There were 20 cows and five of them were at the beginning of the lactation period with average 25 kg of milk per day (first group). In the second group there were five cows in the middle of lactation period with average 22.5 kg of milk per day. In the third group there were five cows at the end of lactation period with average 12.6 kg of milk per day and in fifth group were pregnant cows.

They were fed with 4.0 kg of alfalfa hay, 25.0 kg of maize silage, while the fodder for the milking cows was distributed by groups : cows at the beginning of lactation 5 kg, cows in the middle of lactation 4 kg, and those at the end of lactation and pregnant cows 3 kg. Structure and nutrition value of cow' servings are showed in the table 1 and chemical composition, nutritious value and mineral composition in table 2.

Table 1. Composition and nutritive value of diet

*Tabela 1. Sastav i hranljiva vrednost obroka*

Group Grupa	Food Hranivo	kg	S.M. (kg)	H.J.	S.P. (g)	Ca (g)	P (g)	Mg (g)
I	<i>Alfala hay</i> Seno lucerke	4,0	3,64	1,82	337	41,0	13,8	2,90
	<i>Maize silage</i> Kukuruzna silaža	25,0	7,50	7,20	520	127,0	45,3	11,8
	<i>Forage mixture</i> Krmna smeša	5,0	4,55	5,60	587	75,0	51,9	4,60
	<i>Total</i> Ukupno		15,69	14,62	1444	243,0	111	19,0
II	<i>Alfala hay</i> Seno lucerke	4,0	3,64	1,82	335	41,0	13,8	2,95
	<i>Maize silage</i> Kukuruzna silaža	25,0	7,50	7,0	495	130,0	45,3	11,89
	<i>Forage mixture</i> Krmna smeša	4,0	3,50	4,85	470	61,2	37,6	3,80
	<i>Total</i> Ukupno		14,64	13,66	1300	232,2	96,7	18,64
III i IV	<i>Alfala hay</i> Seno lucerke	4,0	3,64	1,82	337	41,0	13,8	2,90
	<i>Maize silage</i> Kukuruzna silaža	25,0	7,50	7,0	495	130,0	45,3	11,70
	<i>Forage mixture</i> Krmna smeša	3,0	2,66	4,10	380	52,2	28,9	3,15
	<i>Total</i> Ukupno		13,90	12,68	1223	226,4	89,15	17,87

The level of calcium, phosphorus and magnesium in cows' blood and food they were fed with was tested. Cows' blood was taken by puncture of v. jugularis and the serum was isolated and tested to these metals. Calcium in the samples of fodder was tested by



permanganate method. Serum samples were tested by atomic – absorbing methods, the hollow cathode HCL at 442,7 nanometre wave length. Phosphorus in the fodder samples was tested by classical gravimetical methods, measured as  $M_{g_2}P_2O_7$  and serum samples by colourmethyl methods on photocolourmetre. Magnesium in the fodder samples was tested by gravimetical method as  $M_gO$ , and serum on atomic absorber.

Table 2. Chemical composition and nutritious value of used feeds

Tabela 2. Hemijski sastav i hranljiva vrednost korišćenih hraniva

Feed <i>Hranivo</i>	Alfala hay <i>Seno lucerke</i>	Maize silage <i>Kukuruzna silaža</i>	Forage mixture <i>Krmna smeša</i>
Moisture/ <i>Vlaga</i> , %	9,60	69,45	11,28
Ashes / <i>Pepeo</i> , %	6,25	3,61	6,45
Proteins/ <i>Proteini</i> %	16,00	4,29	12,60
Cellulose/ <i>Celuloza</i> ,%	31,25	7,79	5,87
Fat / <i>Masti</i> ,%	3,75	0,34	3,50
NFE, <i>BEM</i> , %	33,94	16,87	60,70
Ca (g)	13,70	5,20	13,90
P (g)	4,50	1,80	6,83
Mg (g)	0,95	2,0	1,10
S.P. (g)	1,10	1,98	11, 50
H.J	0,45	0,28	1,10

Statistical analysis of data is done by Statistica programme version 6, StatSoft. Inc. (2003).

## RESULTS AND DISCUSSION

The amounts of calcium, phosphorus and magnesium, measured in the experiments, are in table 3 and 4.

The average amount of calcium in cows' blood serum in the experiment is 12.35 mg/100 ml serum (table 4). That amounte was within the normal limits. The amount of calcium in fodder was sufficient to provide enough calcium in the blood serum (224-242).

The average amount of phosphorus for all groups in the experiment is 5.45 mg/ 100 ml. serum. This resulte is on the lower level within the normal scale amount on literature data (4.5-6.5 mg/100 ml). Observing apart the amounts of the content it can be seen that 9 out of 20 cows had amount of phosphorus under the lower limit of normal content. So it can be concluded that there was not enough phosphorus in the foodstuff. Since it was established that there was enough amount of phosphoruse in the fodder, it is possible that other factors influenced to the low amount in the blood serum among which it should be mentioned first of all the level of usage out of some kind of fodder.

Based on the mineral elements' analysis, it is concluded that amount of calcium and phosphoruse are directly connected to cows' lactation. The group of cows with aver-

age daily lactation of 25.0kg had the lowest amount of calcium and the pregnant cows had the highest amount. The proportion was 10.52 : 12.40 mg/100 ml serum (table 3).

The amount of magnesium was within the normal limits (3.25 mg/100 ml) and there were slight changes among groups and among cows. There were no individual changes in the amount of magnesium nor there were changes within the group of cows with different lactation. But groups' average amounts indicated that magnesium is not in the same relations to lactation as calcium and phosphorus are. It means that the cows with highest lactation had the highest amount of magnesium and vice versa. The difference between the lowest and the highest amount was 9%, in the favor of the highest amount.

Table 3. Content of Ca, P and Mg in blood serum of investigated cows (mg/100 ml)

*Tabela 3. Sadržaj Ca, P i Mg u krvnom serumu ispitivanih krava (mg/100 ml)*

Group <i>Grupa</i>	Mineral substances <i>Mineralne materije</i>	X
I	Ca	10,52
	P	4,08
	Mg	3,20
II	Ca	11,65
	P	4,81
	Mg	3,18
III	Ca	10,85
	P	5,60
	Mg	3,12
IV	Ca	12,40
	P	6,10
	Mg	3,10

Judging by data from the book (Underwood, 1972 and 1976), (Miric, 1990), this amount was 8.66% lower from the average amount of calcium in the previous experiments (Stojkovic, 2001 and 2006). Based on same data the amount of calcium in the blood serum milking cows can be considerably higher, (Vijchulata et al., 1983) which was the case when high amounts of calcium were added to their servings. There are also cases with extremely low amounts of calcium. As (Lalov et al., 1989) mentioned in his experiments the amount of calcium was just 4.47 mg in 100 ml with the very high amount of phosphorus (15.67 mg/100) at the same time.

Table 4. The content of calcium, phosphours and magnesium in the cows' blood serum

*Tabela 4. Sadržaj kalcijuma, fosfora i magnezijuma u krvnom serumu krava*

Element	X	S	CV	IV
Ca	12,35	2,71	11,30	8,97 – 13,17
P	5,45	2,50	18,90	3,68 – 7,12
Mg	3,25	2,10	8,90	2,10-3,62

The amount of phosphorus changed in the relation to cows' lactation. The group

of cows with average daily lactation of 25.00 kg had the lowest amount of phosphorus in the blood serum which was 4.08 mg/100 ml serum (table 3). These amounts were under the lower limits of normal amounts and also insufficient amount for the organism. The amount of phosphorus was increasing in the group of cows with lower lactation. In the group of cows with average daily lactation of 22.50 kg the amount of phosphorus was 4.81 mg/100 ml and that was above lower level of the normal amounts. This amount was even more increased (5.60 mg in 100 ml) with the group of cows with average daily lactation of 12.60 kg and even more (6.10 mg/100 ml, table 3) with the group of pregnate cows.

In the experiment with milking cows (Miric et al., 1990) established that the of phosphorus in the blood serum is in correlation with lactation which (Stojković, 2001 and 2006) results confirmed. The amount of phosphorus in Stojkovic's previous testing was 5% lower than in this. The fact that amount of phosphorus in the blood serum can be above the average (4.5 – 6.5 mg/100 ml) confirms the experiments of (Underwoodu, 1972 and 1976) and (Herak, et al., 1986) where the pregnant heifers had from 6.92 to 7.8 mg/100 ml phosphorus. The amount of phosphorus was even greater (9.94 – 10.40 mg/100 ml) in the experiments of (Seidela et al. 1970).

Undrwoodu (1976) and Obracevic (1973) estimated that there were slight changes in the amount of magnesium because magnesium doesn't decrease in the soft tissues even when skeleton lost 30% of magnesium. The results of experiments showed certain correlation between the amount of calcium and phosphorus and lactation. The cows with high lactation had lower amounts of these elements and vice versa. This fact was established even when these elements were not examined or showed a deficit. This manifestation was evident in the variations in the amount of phosphorus and little less evident in the amount of calcium while the amount of magnesium behaved differently.

## CONCLUSION

The levels of calcium, magnesium and phosphorus in the blood serum were tested, as one of the indicators that the cows are fed with these elements.

The results of the experiments are:

1. The average amount of calcium in the blood serum is 12.35 mg/100 ml of serum, of phosphorus is 5.45 mg/100 ml and magnesium 3.25 mg/100 ml. The amounts of calcium were on the upper level of normal amounts gotten from books while the amount of phosphorus was almost deficient.

2. The amounts of calcium and phosphours were decreasing during the period of high lactation while the cows with low lactation had these amounts increased. Calcium varies from 10.52 to 12.40 and phosphorus varies from 4.08 to 6.10 mg in 100 ml of serum.

3. The amounts of magnesium didn't change much in relations to cows' lactation but magnesium behaved differently from calcium and phosphorus.

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## SADRŽAJ KALCIJUMA, FOSFORA I MAGNEZIJUMA U KRVNOM SERUMU KRAVA RAZLIČITE MLEČNOSTI

JOVAN STOJKOVIĆ

### Izvod

Ispitivan je sadržaj kalcijuma, fosfora i magnezijuma u krvnom serumu krava, kao jednog od indikatora obezbeđenosti životinja ovim elementima. Prosečan sadržaj kalcijuma u krvnom serumu ispitivanih krava iznosio je 12,35 mg/100 ml seruma, fosfora 5,45 mg/100 ml i magnezijuma 3,25 mg/ u 100 ml krvnog seruma.

**Ključne reči:** krava, kalcijum, fosfor, magnezijum, krvni srum, mlečnost.

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## EFFECT OF PROBIOTIC ON PERFORMANCE OF BROILER CHICKENS\*

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*SUMMARY: Use of probiotics can be alternative to antibiotics which are added to food as growth stimulators. Investigation of the effect of probiotics and antibiotics was done on experimental farm "Pustara", of the Faculty of Agriculture in Novi Sad. Trial consisted of three groups of chickens in five repetitions. First group was control, second group received probiotic in the water and food, and third group received antibiotic in food. Final body weight was (I) 2179 g, (II) 2190 g and in group (III) 2158 g. In first group, feed conversion was 1,93, mortality 4,27% and production index had value of 257, in second group 1,90, 3,47% mortality and PI 260. In third group, conversion was 1,93, mortality 2,40%, and PI value 265. Obtained results indicate positive effect of probiotic on production results, whereas, contrary to expectations the positive effect of antibiotics was not established.*

**Key words:** probiotics, feed conversion, mortality, broiler.

### INTRODUCTION

With banning of the use of antibiotics in nutrition of domestic animals, which includes poultry, the interest for food supplements and additives which cause no resistance to micro organisms and leave no residue in meat or eggs, started to increase. Use of antibiotics as growth stimulators in poultry has been significantly reduced due to the incidence of resistant micro organisms, multiple resistance, antibiotic residues in food stuff of animal origin and genotoxic effect, whereas growth promoters (prebiotics, probiotics and phyto-gen additives) are still in broad use. Use of antibiotics in nutrition

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resulted in considerably better gain, better conversion, lower mortality and better economical results of production (Ferket et al., 2002; Newman, 2002).

In fattening of broilers, Roch (1998) used antibiotic Flavomicin in concentration of 0,5 kg/t of food, and realized higher body weight by 1,6% and lower feed conversion by 5,9%. Since year 1999, when the ban on use of antibiotics for the purposes of stimulation was introduced, many researches are aimed at finding and developing alternative products in order to maintain and preserve the vitality of animals (Monsan and Paul, 1995; Perić et al., 2005; Kanački et al., 2008). Results of trials carried out on animals which received food containing different cultures of lactobacillus (Jin et al., 1996) indicated that by use of these strains as additives considerably higher gain is achieved. Alternative growth promoters represent possibility for stimulation of growth using physiological potential of animals (Ferket et al., 2002; Newman, 2002).

Objective of the paper was to study the effect of antibiotics and probiotics in nutrition on production results of broilers.

## MATERIAL AND METHOD

Trial was carried out on experimental farm "Pustara" of the Faculty of Agriculture in Novi Sad in duration of 42 days. Three groups of chickens with five repetitions were included in the trial. There were 15 boxes in total with 75 chickens per box. Stocking density was 15 chickens/m<sup>2</sup>. Cobb 500 chickens were used and mixed according to the sex. Temperature of the environment was controlled and adjusted according to technology of above hybrid. Food and water were *ad libitum*. All three groups received food of same composition. First group was negative control and chickens in this group were fed standard mixture. Second group received in the food preparation (Biomin IMBO) containing probiotic culture *Enterococcus faecium*, fructooligosacharides, fragments of cell wall and phycophytic substances. Quantity of preparation in starter mixture was 1,0 kg/t, in grower mixture 0,5 kg/t and in finisher 0,25 kg/t. Besides food additives, this group received also in the drinking water on the 1<sup>st</sup>, 2<sup>nd</sup> and 3<sup>rd</sup> day of age the same probiotic. Third group was positive control and chickens in this group received food supplemented with antibiotic (Colistin sulphate COLIVET 4800) in concentration of 50 g/t of food.

Starter, grower and finisher mixtures were of same chemical composition for all three groups and contained: in starter mixture - 22% of proteins, 13 MJ metabolic energy/kg, 0,98% Ca and 0,68% P, in grower mixture - 19,98 % of crude proteins, 13,20 MJ metabolic energy, 0,99 % Ca, and 0,68% P, and in finisher mixture - 18,18 % of crude proteins, 13,27 MJ metabolic energy, 0,99 % Ca, and 0,68% P. Body weight of chickens was measured every week individually, and food consumption recorded when food was taken to the facility. At the age of six weeks the body weight of chickens from all three groups, separately according to sex, was measured. When chickens transited from one phase to the other, food remains were measured from the previous period. Deaths were recorded daily, and mortality at the end of the trial in first group was 4,27%, in second 3,46%, and in third 2,40%.

All obtained results were processed using standard statistical-variation methods (descriptive statistics, variance analysis, t-test) in the program STATISTIKA 7.

## RESULTS

Results of the research show that growth, feed conversion, body weight and mortality depended on the effect of treatment. Also, it was established that group using probiotic additives in food (treatment II) had lower conversion, lower mortality and higher final body weight compared to control, and slightly higher mortality compared to positive control group. Results of measuring of body weight of chickens in the first, third and sixth week show that the highest average body weight was realized by chickens fed diets containing probiotic, difference was statistically significant in the second, third and sixth week in relation to chickens receiving antibiotic in nutrition (tab. 1). The lowest feed conversion during entire trial period was realized by group receiving probiotic cultures in food and water.

Table 1. Average body weight, g

Tabela 1. Prosečna telesna masa, g

Age, weeks <i>Uzrast, nedelja</i>	Group / <i>Tretman</i>		
	Control/ <i>Kontrola</i>	Probiotic / <i>Probiotik</i>	Antibiotic / <i>Antibiotik</i>
Day old/ <i>Prvi dan</i>	41,63	41,46	41,37
1	154,10	155,60	153,90
2	397,00 <sup>A</sup>	396,00 <sup>A</sup>	380,00 <sup>B</sup>
3	770,00 <sup>A</sup>	773,00 <sup>A</sup>	754,00 <sup>B</sup>
4	1212,00	1217,00	1200,00
5	1700,00	1703,00	1707,00
6	2179,00 <sup>AB</sup>	2190,00 <sup>A</sup>	2158,00 <sup>B</sup>

<sup>A-B</sup> Values with no common superscript are significantly different ( $P < 0,05$ )

<sup>A-B</sup> Vrednosti koje nemaju isto slovo u superskriptu značajno su različite ( $P < 0,05$ )

Feed conversion, as well as mortality, varied within the limits determined by the technology norms (tab. 2). Mortality per weeks and total mortality are presented in table 3. It is apparent from this table that the lowest mortality was recorded in chickens receiving antibiotic in their food.

Table 2. Feed conversion at 3 and 6 week, and European Production Efficiency Factor

Tabela 2. Konverzija hrane sa 3. i 6. nedelja i vrednost proizvodnog indeksa (PI)

Group/ <i>Tretman</i>	3 weeks/3 <i>nedelje</i>	6 weeks/6 <i>nedelja</i>	EPEF/ <i>PI</i>
Control/ <i>Kontrola</i>	1,44	1,93	257
Probiotic/ <i>Probiotik</i>	1,40	1,90	265
Antibiotic/ <i>Antibiotik</i>	1,44	1,93	260

Table 3. Mortality rate per week and total

Tabela 3. Mortalitet po nedeljama i ukupni mortalitet

Week / <i>Nedelja</i>	Control / <i>Kontrola</i>		Probiotic / <i>Probiotik</i>		Antibiotic / <i>Antibiotik</i>	
	Chicken / <i>Pilića</i>	%	Chicken / <i>Pilića</i>	%	Chicken / <i>Pilića</i>	%
1	5	1,33	5	0,48	2	0,53
2	1	0,27	0	0,00	1	0,27

3	3	0,80	2	0,53	2	0,53
4	2	0,53	2	0,53	1	0,27
5	1	0,27	1	0,27	2	0,53
6	4	14,06	3	0,80	1	0,27
Total / <i>Ukupno</i>	16	4,27	13	3,46	9	2,40

## DISCUSSION

Data on positive effects of probiotics on gain are recent, and improvement of gain varies at the level from 1 – 9% (Jin et al., 1998; Owings et al., 1990). Positive effects are more distinct in younger animals, while in older animals the positive effects may not occur completely (Watkins and Kratzer, 1984; Maolino et al., 1992). With the use of probiotics similar or better results are realized compared to use of standard food (Owings et al., 1990). In our results, like in results obtained by Newman, (1999), Denev, (2004), Jin et al., (1998), Owings et al., (1990), Petersen, (1998), with the use of probiotics better feed conversion is realized. Awad et al. (2009) point out that inclusion of synbiotics into food caused statistically significant increase of body weight, average daily gain and dressing percentage of broiler carcass compared to control group. Use of probiotics and prebiotics results in almost identical effects like when antibiotics are used (Veled, 1997; Hooge, 2003), but without potential undesired effects (residues, withdrawal period, resistance, allergies, genotoxicity, etc.). obtained results of trial indicated that application of different growth promoters in nutrition has effect on reduction of mortality (Gadd, 1997; Pupovac et al., 1998), but there are also data which determine lack/absence of stated effects (Forest, 1978) or just in cases of poor housing conditions or disease incidence (Baba et al., 1991; Qin et al., 1995).

## CONCLUSION

If obtained results are considered, it is obvious that positive effect is certainly present. It should be pointed out that the effect of probiotic on final body weight was considerable, however, contrary to expectations, positive effect of antibiotic was not recorded. Obtained results indicate that in future, application of alternative growth promoters (probiotics and prebiotics) will gain on importance. Introduction of these additives into weight production will be justified only if the price of these preparations follows the economical effects in production, i.e. if their application will justify their price.

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## **EFEKAT PROBIOTIKA NA PERFORMANSE BROJLERSKIH PILIĆA**

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### **Izvod**

Upotreba probiotika može biti alternativa antibioticima koji se dodaju u hranu kao stimulatori porasta. Ispitivanje efekta probiotika i antibiotika je vršeno na oglednom dobru “Pustara”, Poljoprivrednog fakulteta u Novom Sadu. Ogled se sastojao iz tri grupe pilića sa pet ponavljanja. Prva grupa je predstavljala kontrolu, druga je dobijala probiotik u vodi i hrani, dok je treća grupa dobijala antibiotik u hrani. Završna telesna masa je iznosila (I) 2179 g, (II) 2190 g i kod (III) 2158 g. U prvoj grupi konverzija je iznosila 1,93, mortalitet 4,27% i proizvodni indeks je imao vrednost 257, u drugoj 1,90, 3,47% mortalitet i PI 260. U trećoj gupi konverzija je iznosila 1,93, mortalitet 2,40%, a vrednost PI 265. Dobijeni rezultati ukazuju na pozitivan efekat probiotika na proizvodne rezultate, dok je suprotno očekivanjima, pozitivan efekat antibiotika izostao.

**Ključne reči:** probiotici, konverzija hrane, mortalitet, brojler.

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## THE EFFECT OF GENOTYPE, AGE, SEX AND COMPOSITION OF FEED ON CONTENT OF ABDOMINAL FAT IN CARCASS OF BROILER CHICKENS

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*SUMMARY: In this paper, mass and share of abdominal fat in broiler chickens of Cobb 500 and Hubbard Classic genotype, at the age of 5, 6 and 7 week, fed different feed mixtures were investigated. Also, the effect of interaction genotype x nutrition on mass of abdominal fat was analyzed. Mixture 1 had higher energy value and higher energy : protein ratio, whereas mixture 2 had higher protein value and lower energy : protein ratio. By analysis of results it was concluded that Hubbard chickens had significantly ( $p < 0,05$ ) higher share of abdominal fat in carcass than Cobb chickens. Mass and share of abdominal fat in carcass had significantly ( $p < 0,05$ ) the highest values in chickens at the age of 7 week. Male chickens had statistically significant ( $p < 0,05$ ) lower abdominal fat in carcass in comparison with female chickens. Differences in share of abdominal fat were statistically significant ( $p < 0,05$ ) in chickens fed different mixtures. Namely, chickens fed mixture 2 had less abdominal fat in percentage compared to chickens fed mixture 1. Analysis of interaction genotype x nutrition showed that the mass of abdominal fat in carcass of broiler chickens at the age of 5 and 6 week had significantly ( $p < 0,05$ ) the highest value in chickens of Hubbard genotype which consumed mixture 1 and this occurred also with Cobb chickens, but with smaller differences in obtained values.*

**Key words:** abdominal fat, broiler chickens, genotype, age, sex, feed composition.

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## INTRODUCTION

Intensive broiler production in the Republic of Macedonia in the last ten years has developed increasingly and it represents source of highly valuable animal proteins on Macedonian market. This prosperity is the result of breeding of selected chicken hybrids of high genetic potential for fast growth and development. However, intensive development of broilers for higher economical gain brings also negative consequences, such as increase of total and abdominal fat in chicken carcasses (Havenstein et al, 1994). This author compared typical broiler lines from 1957 to 1991 and concluded that increase of fat layers in carcasses is result of genetic selection on body mass. Abdominal fat includes most of the fat tissue and it is in direct correlation to total quantity of fat in broiler carcass (Becker et al., 1981). The greatest problem of modern hybrids for production of broilers is excessive fat which reflects not only in diminished quality of carcasses and efficiency in utilization of feed, but also in decrease of consumption and greater difficulties in processing industry (Kessler et al., 2000; Stanačev et al., 2008).

Sex and age of chickens affect especially on fat deposit. Pavlovski et al. (1995) were investigated the slaughter traits at male and female chickens on different age. Without consideration of age, the female had bigger share of abdominal fat then male chickens, Age had significantly influence on mass of abdominal fat in the paper of Albuquerque et al. (2003). It is possible to influence the share of fat in broiler carcass through nutrition and quality of feed. Quantity and quality of feed could also influence considerably the composition of body of broilers, but it is difficult to determine the needs in regard to nutrients necessary for fast growth, so that excess energy is not transferred into fat tissue. Also, it is hard to balance precisely the broiler diet according to their needs, so one part of the diet always is transformed into fat tissue (Milošević and Supić, 1995).

Main objective of this paper was to evaluate the mass and share of abdominal fat in carcasses of two broiler genotypes fed mixtures of different energy and protein value and different E : P ratio, at different age and sex, as well as determine interaction genotype x nutrition system and the effect on mass of abdominal fat.

## MATERIAL AND METHOD

Research was carried out on a broiler farm in Macedonia used for intensive breeding of commercial chickens. One day old chickens of genotypes Cobb 500 (1200 males and females) Hubbard Classic (1200 males and females) were used, divided into separate boxes (150 chickens) consisting of four different treatments (two genotypes x two mixtures) and reared to the age of seven weeks. Chickens were fed to the end of fattening using different treatments (mixture 1 with higher energy value and higher energy : protein ratio and mixture 2 with higher protein value and lower energy : protein ratio). At the end of fifth, sixth and seventh week of fattening chickens were selected by method of random sample (10 males and 10 females per treatment), slaughtered manually, carcasses were processed and subsequently abdominal fat was separated and measured. Quantity of abdominal fat was put into relation to body mass prior to slaughtering, and in this way share of abdominal fat was obtained.

Tab. 1 Chemical composition and nutritive value of mixture 1 for broiler nutrition

Tab. 1. *Hemijski sastav i hranljiva vrednost smeše 1 za ishranu brojlera*

Chemical composition <i>Hemijski sastav</i>	Starter <i>Starter</i> (1-2 wks/ <i>ned.</i> )	Grover <i>Grover</i> (3 wks/ <i>ned.</i> )	Finisher 1 <i>Finišer 1</i> (4-5 wks/ <i>ned.</i> )	Finisher 2 <i>Finišer 2</i> (6-7 wks/ <i>ned.</i> )
ME, kcal/kg	3069,08	3197,20	3225,20	3212,30
Crude protein/ <i>Sirovi proteini</i> , %	23,03	22,04	21,06	19,20
Crude fibre/ <i>Sirova vlakna</i> , %	4,34	4,01	4,09	4,31
Crude fat/ <i>Sirova mast</i> , %	8,16	9,88	10,52	9,66
Ca, %	0,91	0,93	0,89	0,88
P (total/ <i>ukupni</i> ), %	0,77	0,76	0,75	0,68
Methionine/ <i>Metionin</i> %	0,61	0,69	0,58	0,64
Cystine/ <i>Cistin</i> , %	0,34	0,32	0,31	0,29
Lysine/ <i>Lizin</i> , %	1,30	1,32	1,10	1,00
Energy : Protein/ <i>Energija : Protein</i>	133,27	145,04	153,14	167,35

Tab. 2 Chemical composition and nutritive value of mixture 2 for broiler nutrition

Tab. 2. *Hemijski sastav i hranljiva vrednost smeše 2 za ishranu brojlera*

Chemical composition <i>Hemijski sastav</i>	Starter <i>Starter</i> (1-2 wks/ <i>ned.</i> )	Grover <i>Grover</i> (3 wks/ <i>ned.</i> )	Finisher 1 <i>Finišer 1</i> (4-5 wks/ <i>ned.</i> )	Finisher 2 <i>Finišer 2</i> (6-7 wks/ <i>ned.</i> )
ME, kcal/kg	3047,38	3107,70	3099,52	3100,58
Crude protein/ <i>Sirovi proteini</i> , %	23,54	22,55	22,02	21,95
Crude fibre/ <i>Sirova vlakna</i> , %	4,16	4,12	4,25	4,58
Crude fat/ <i>Sirova mast</i> , %	7,43	8,39	8,68	9,15
Ca, %	0,93	0,89	0,86	0,87
P (total/ <i>ukupni</i> ), %	0,78	0,76	0,75	0,72
Methionine/ <i>Metionin</i> %	0,74	0,72	0,58	0,68
Cystine/ <i>Cistin</i> , %	0,34	0,33	0,33	0,33
Lysine/ <i>Lizin</i> , %	1,51	1,42	1,27	1,27
Energy : Protein/ <i>Energija : Protein</i>	129,47	137,83	140,76	141,24

Computer program STATISTICA 6, (Stat Soft, 2005) was used to determine mean values and variability measures, and normality of distribution in all investigated traits was checked. Also, analysis of variance was carried out in order to determine traits with statistically significant differences. Considering that the effect of sexes, nutrition and genotype was investigated on two treatments, there was no need to test additionally demonstrated statistically significant differences. The effect of age on three treatments and interaction genotype x nutrition in case of mass of abdominal fat were analyzed, and in post-hoc analysis LSD test were applied at the level of 0,01% of probability.

## RESULTS AND DISCUSSION

In the research on quantity of abdominal fat in broiler carcasses of different geno-

types and different composition of feed, the initial hypothesis was that hybrid type, age and chemical composition of diet have targeted effect on some production parameters and meat quality, especially content of abdominal fat and total fat, so differences between investigated groups of chickens were expected.

Mass of abdominal fat of chickens was under significant influence of factors age and sex (Tab.3). Chickens at age of 49 days had statistically significant ( $p < 0,05$ ) higher quantity of abdominal fat then chickens at age of 35 and 42 days in absolute (25,45 g) and relative (1,06%) values. This results are in accordance with dates of Deaton and Lott (1985) where was determined the increase share of abdominal fat with the increase age of broiler chickens. In the paper of Albuquerque et al. (2003) was established significantly growth of share of abdominal fat at chickens in 49 and 56 days of age in contrast to chickens in 42 days of age.

Females had statistically significant ( $p < 0,05$ ) higher mass of abdominal fat (19,84 g) compared to male chickens (16,79 g), which was expected. This is in concordance with results obtained by Jackson et al. (1982) and Sonaïy and Benyi (1983) who have established considerably higher absolute value of abdominal fat in females compared to male chickens.

The effect of genotype and composition of feed on mass of abdominal fat was not statistically significant although obvious differences between hybrids and nutrition systems were registered. Mass of abdominal fat was not under the influence of genotype in research of Becker et al. (1981) or Smith and Pesti (1998).

In the analysis of results of relative values obtained for abdominal fat due to the effect of investigated factors it was concluded that genotype, age, sex and nutrition system have significantly ( $p < 0,05$ ) influenced the share of abdominal fat in carcasses of broiler chickens. Chickens of Hubbard Classic genotype (0,96%), females (0,96%) and chickens fed mixture 1 (1,02%) had higher percentage of abdominal fat compared to chickens of Cobb 500 genotype (0,83%), males (0,83%) and chickens fed mixture 2 (0,78%).

Tab.3 Mass (g) and portion (%) of abdominal fat of chickens with different genotype, age, sex and system of nutrition

Tab.3 Masa (g) i udeo (%) abdominalne masti pilića različitog genotipa, uzrasta, pola i sistema ishrane

Factor/ Faktor	Abdominal fat/ Abdominalna mast	
	g	%
<i>AGE/ UZRAST</i>		
35 day/ 35. dan	11,43 <sup>c</sup>	0,73 <sup>c</sup>
42 day/ 42. dan	18,08 <sup>b</sup>	0,90 <sup>b</sup>
49 day/ 49. dan	25,45 <sup>a</sup>	1,06 <sup>a</sup>
<i>GENOTYPE/ GENOTIP</i>		
Cobb 500	17,16	0,83
Hubbard	19,47	0,96
<i>SEX/ POL</i>		
Male/ Petlići	16,79	0,83
Female/ Kokice	19,84	0,96
<i>SYSTEM OF NUTRITION/ SISTEM ISHRANE</i>		

Mixture 1/ <i>Smeša 1</i>	19,41	1,02
Mixture 2/ <i>Smeša 2</i>	17,36	0,78
SIGNIFICATION/ ZNAČAJNOST (F TEST)		
Genotype/ <i>Genotip</i>	NS	*
Sex/ <i>Pol</i>	*	*
System of nutrition/ <i>Sistem ishrane</i>	NS	*

\*Statistically significant differences / *Statistički značajne razlike* (P<0,05).

<sup>NS</sup>No statistically significant differences / *Nema statistički značajnih razlika*.

<sup>ac</sup>Average value significantly different on level of 5% / *Prosečne vrednosti značajno različite na nivou od 5%*.

Griffith et al. (1978) and Acar et al. (1991) have recorded differences in deposition of abdominal fat in chickens of different genotypes, which they explained by significant effect of genetic factors. Significant differences in share of abdominal fat in chickens of different genotype are in concordance with results obtained by Bilgili et al. (1992), Ristić (1993) and Hopić et al. (2000).

Higher share of abdominal fat in carcasses of female chickens compared to male chickens was established by Corzo et al. (2005), Milošević et al. (1989), Hopić et al. (1996c), but differences were not statistically significant. Pavlovski et al. (1995) have investigated slaughter characteristics of both sexes at different ages and regardless of the age, and female chickens had higher share of abdominal fat in carcass than males.

Chickens fed mixture higher in proteins and lower energy : protein ratio (mixture 2) in this research had less abdominal fat in carcass in percentages, compared to chickens fed diet higher in energy and with higher energy : protein ratio (mixture 1). This is explained by the effect of lower energy : protein ratio and higher protein values in the mixture. From the food rich in proteins energy is not utilized efficiently enough, contrary to food with less protein. This explains why food with lower energy : protein ratio results in poorer deposition of fat compared to food with higher ration, depending on the quality of protein (Griffith et al., 1977; Smith et al., 1998).

In table 4 results of interaction genotype x nutrition system in regard to trait mass of abdominal fat are presented.

Tab. 4 Interaction genotype x system of nutrition at the mass of abdominal fat

*Tab. 4 Interakcije genotip x sistem ishrane kod mase abdominalne masti*

Influence / <i>Uticaj</i>	x	sd	INTERACTION <i>INTERAKCIJA</i>
<i>35. day/ dan</i>			
Cobb 500 – mixture 1/ <i>smeša 1</i>	9,25	4,29	bc
Cobb 500 - mixture 2/ <i>smeša 2</i>	8,75	4,23	c
Hubbard - mixture 1/ <i>smeša 1</i>	15,45	7,64	a
Hubbard - mixture 2/ <i>smeša a 2</i>	12,25	4,16	ab
Interaction genotype x nutrition <i>Interakcije genotip x smeša</i>		*	
<i>42. day/ dan</i>			

Cobb 500 - mixture 1/ <i>smeša 1</i>	18,95	8,11	ab
Cobb 500 - mixture 2 <i>smeša 2</i>	16,95	7,00	ab
Hubbard - mixture 1/ <i>smeša 1</i>	20,45	6,29	a
Hubbard - mixture 2/ <i>smeša 2</i>	15,95	4,92	b
Interaction genotype x nutrition <i>Interakcije genotip x smeša</i>	*		
49. day/ dan			
Cobb 500 - mixture 1/ <i>smeša 1</i>	25,80	10,38	NS
Cobb 500 - mixture 2 <i>smeša a 2</i>	23,25	7,03	NS
Hubbard - mixture 1/ <i>smeša 1</i>	29,15	11,40	NS
Hubbard - mixture 2/ <i>smeša 2</i>	23,60	9,01	NS
Interaction genotype x nutrition <i>Interakcije genotip x smeša</i>	NS		

<sup>ac</sup> Average value significantly different on level of 5% / *Prosečne vrednosti značajno različite na nivou od 5%*.

<sup>NS</sup>No statistically significant differences / *Nema statistički značajnih razlika*.

\*Statistically significant differences / *Statistički značajne razlike (P<0,05)*.

Statistically significant differences in mass of abdominal fat in carcass of chickens slaughtered at the age of 35 and 42 days were established. Hubbard chickens fed mixture 1 had considerably more abdominal fat in carcass compared to Cobb 500 chickens fed mixtures 1 and 2, whereas Hubbard chickens fed mixture 2 had considerably more abdominal fat in carcass than Cobb 500 chickens fed mixture 2. Statistically significant differences in mass of abdominal fat in carcass of chickens slaughtered at the age of 49 days were not established. Mass of abdominal fat is trait of high variability.

Mass of abdominal fat in presented paper had the highest values in Hubbard genotype consuming food 1, which occurred also in genotype Cobb 500. Mixture 1 containing more energy and higher energy : protein ratio increased the value of abdominal fat. Contrary to these results, in detailed researches of Shanin and Elazeem (2006), interaction genotype x nutrition had no significant effect on value of fat layers which is interpreted as result of independent effect of considered factors on investigated traits. Smith et al. (1998) demonstrated the insignificance of the effect of interaction genotype x nutrition on values of abdominal fat. These results are contrary to results obtained by Leenestra (1984) which indicate that the effect of feed on fat layers varied in different broiler lines. Practically, the effect of energy : protein ratio on deposition of abdominal fat showed considerable differences between lines.

## CONCLUSION

Based on the results of the trial the following can be concluded in this paper:

- Chickens at age of 49 days had statistically significant ( $p<0,05$ ) higher quantity of abdominal fat then chickens at age of 35 and 42 days in absolute and relative values.
- The mass of abdominal fat was under significant ( $p<0,05$ ) effect by sex as factor, so female chickens had considerably more abdominal fat in carcass expressed in absolute and relative values compared to male chickens.



- Chickens of Hubbard Classic genotype had statistically significantly ( $p < 0,05$ ) higher share of abdominal fat in the carcass than chickens of Cobb 500 genotype.
- The effect of the system of nutrition on share of abdominal fat was statistically significant ( $p < 0,05$ ). Chickens which consumed mixture 1 (higher energy and higher energy : protein ratio) had higher share of abdominal fat in carcasses, compared to chickens fed mixture 2 (higher in protein and lower energy : protein ratio).
- Statistically significant ( $p < 0,05$ ) differences in mass of abdominal fat in carcass of chickens slaughtered at the age of 35 and 42 days were established. Hubbard chickens fed mixture 1 had considerably more abdominal fat in carcass compared to Cobb 500 chickens

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## **UTICAJ GENOTIPA, STAROSTI, POLA I SASTAVA HRANE NA SADRŽAJ ABDOMINALNE MASTI U TRUPOVIMA BROJLERSKIH PILIĆA**

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### **Izvod**

U radu su ispitivane masa i udeo abdominalne masti kod brojlerskih pilića genotipa Cobb 500 i Hubbard Classic na uzrastu od 5, 6 i 7 nedelja, hranjenih različitim krmnim smešama. Isto tako analiziran je i uticaj interakcije genotip x sastav obroka kod osobine mase abdominalne masti. Smeša 1 je imala veću energetska vrednost i veći odnos, energija : protein, dok je smeša 2 imala veću proteinsku vrednost hraniva i manji odnos, energija : protein. Analizom rezultata konstatovano je da su pilići Hubbard imali statistički značajno ( $p < 0,05$ ) veći udeo abdominalne masti u trupu od pilića Cobb. Masa i udeo abdominalne masti trupa imale su značajno ( $p < 0,05$ ) najveće vrednosti kod pilića sedme nedelje uzrasta. Petlići oba hibrida imali su značajno ( $p < 0,05$ ) manje abdominalne masti u trupu u odnosu na kokice. Razlike u udelu abdominalne masti bile su statistički značajne ( $p < 0,05$ ) kod pilića hranjenih različitim smešama. Naime, pilići hranjeni smešom 2 imali su procentualno manje abdominalne masti od pilića koji su uzimali smešu 1. Analiza interakcije genotip x sastav obroka pokazala je da je masa abdominalne masti u trupu brojlerskih pilića imala najveću vrednost kod pilića genotipa Hubbard, koji su konzumirali smešu 1 što se dešavalo i kod pilića genotipa Cobb, ali sa

manjim razlikama u dobijenim vrednostima.

**Ključne reči:** abdominalna mast, brojlerski pilići, genotip, uzrast, pol, sastav hrane.

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## EFFECT OF DIFFERENT HOUSING SYSTEMS ON THE PRODUCTIVE PERFORMANCE OF LAYING HENS\*

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*SUMMARY: The aim of this work was to present the effect of housing system on the production results of laying hens. Birds were kept in 5 different housing systems – conventional cages with two stocking densities, enriched cages, house with a limited range and house with an access to a free range. The used hybrid was HyLine brown. The main production parameters were monitored: Number of laid eggs, mortality rate, feed intake, egg weight and number of culled eggs. The best results were realized in cage system with lower housing density, and the worst results in hens housed in floor system on a free range.*

**Key words:** *hen, layers, housing systems, performances.*

### INTRODUCTION

Over the last few decades, production of eggs has become increasingly intensive, and that led to negative critics from the public focused mainly on the welfare of laying hens. Animal welfare has big public and economical significance and this resulted in Directive 1999/74/EC (Council of the European Union, 1999) for the protection of laying hens, which basically intends to replace the conventional battery cages by enriched cages or other non-cage systems. There are a lot of reports analyzing the advantages and disadvantages of battery cages compared to alternative housing systems. General conclusion is that no system is ideal from the aspect of production, welfare and economics (Appleby et al., 1991; Cooper and Albentosa, 2003, Perić et al., 2008). Egg production was lower in furnished cages compared to conventional cages (Heil et al., 2003; Hetland et al., 2004;

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Perić et al., 2007a) or compared to deep litter system (Van-Horne, 1996; Moorthy et al., 2000). Also in case of other alternative systems, adverse effect on economical efficiency of production was registered (Van Horne, 1996).

Therefore, housing system for laying hens must be treated in a way that all production, economical, ecological and social aspects are taken into consideration (De Boer and Cornelissen, 2002).

Objective of this paper is to present the effect of different housing systems on production results of commercial laying hens.

## MATERIAL AND METHODS

Trial was carried out on experimental farm of the Department of Animal Science of the Faculty of Agriculture in Novi Sad and lasted for 346 days. 18 weeks old layers of HyLine brown strain were housed in five different housing systems:

1. Cage system with 5 layers/cage, providing 650 cm<sup>2</sup> of floor space/layer - (BD)
2. Enriched cage of 45.255 cm<sup>2</sup> surface with 60 layers per cage, enriched with perches and nests (Eurovent EU Big Dutchman) – (EU)
3. Standard cage system with 5 layers/cage, providing 500 cm<sup>2</sup> of floor space /hen - (K)
4. Floor system with range providing 1666 cm<sup>2</sup> of floor surface per hen in poultry house and 3333 cm<sup>2</sup> of range per hen (R)
5. Floor system with free range providing 1666 cm<sup>2</sup> of floor surface per hen in poultry house and access to free range covered with pasture (FR)

Total of 564 layers were housed – 120 in group 1 (BD), 180 in group 2 (EU), 360 in group 3 (K), 80 in group 4 (P) and 80 in group 5 (FR). The main production traits were recorded daily: number of eggs, number of second grade eggs (dirty, cracked, soft egg shell of irregular shape, eggs with two yolks) and mortality. Feed intake was calculated on 4- weekly basis and egg mass was controlled weekly. Based on the obtained data statistical analysis was done in program STATISTIKA 8 (StatSoft, Ins., Tusla, USA2008) using ANOVA and LSD-test.

## RESULTS AND DISCUSSION

Based on obtained data registered during production year main production parameters were calculated (tab. 1).

Table 1. Number of eggs, laying percentage and mortality rate

*Tabela 1. Broj snesenih jaja, nosivost i mortalitet kokoši*

Group <i>Grupa</i>	Number of eggs <i>Broj jaja</i>		Laying percentage, % <i>Procenat nosivosti, %</i>		II grade eggs, % <i>Jaja II</i> klase, %	Mortality rate,% <i>Mortalitet, %</i>
	per hen housed <i>po useljenoj</i> <i>nosiji</i>	per average hen <i>po prosečnoj</i> <i>nosilji</i>	per hen housed <i>po useljenoj</i> <i>nosiji</i>	per average hen <i>po prosečnoj</i> <i>nosilji</i>		
1 (BD)	284.5 <sup>a</sup>	285.9 <sup>a</sup>	82.23 <sup>a</sup>	82.64 <sup>a</sup>	1.4	1.67

2 (EU)	273.8 <sup>a</sup>	275.9 <sup>a</sup>	79.14 <sup>a</sup>	79.74 <sup>a</sup>	1.2	1.67
3 (C)	274.3 <sup>a</sup>	280.3 <sup>a</sup>	78.77 <sup>a</sup>	80.40 <sup>a</sup>	1.9	5.14
4 (R)	232.7 <sup>b</sup>	239.5 <sup>b</sup>	67.24 <sup>b</sup>	69.23 <sup>b</sup>	3.3	10.00
5 (FR)	230.4 <sup>b</sup>	238.2 <sup>b</sup>	66.59 <sup>b</sup>	68.85 <sup>b</sup>	2.4	4.82

<sup>a-b</sup> Values without same letter in superscript are significantly different ( $P < 0.01$ )

*Vrednosti koje ne sadrže isto slovo u superskriptu su statistički značajno različite ( $P < 0.01$ )*

Based on the presented data, clear difference between cage and non-cage systems can be seen. There is a significant difference in Number of laid eggs between those systems in favour of either conventional or enriched cages. The highest laying percentage was realized in group 1 (BD), and the worst results in layers on free range (group 4). Climate conditions during the production year had significant adverse effect on the results established in groups 4 (R) and 5 (FR) when considerable drop in laying percentage occurred. On the other hand, mentioned weather conditions didn't have notable influence on mortality rate of hens. Actually, mortality rate was quite low in all 5 groups.

Number of second grade eggs was considerably low in all groups, but again the difference occurred between cage and non-cage systems. Higher percentage of eggs of II class in non-cage systems, especially in system with limited range, is a consequence of laying eggs outside the nest, so high percentage of eggs was dirty. Based on these results it can be concluded that conventional cage system with lower housing density (BD) was the best solution for realization of maximum laying percentage.

Table 2. Feed consumption and feed conversion ratio

*Tabela 2. Utošak hrane i konverzija*

Group <i>Grupa</i>	Average daily feed consumption <i>Prosečan dnevni utošak hrane</i>	Average egg weight <i>Prosečna masa jaja</i>	Feed conversion ratio <i>Konverzija hrane</i>
1 (BD)	123.7 <sup>a</sup>	64.5	2.3
2 (EU)	123.9 <sup>a</sup>	63.7	2.4
3 (C)	124.4 <sup>a</sup>	65.5	2.4
4 (R)	128.4 <sup>b</sup>	64.0	2.9
5 (FR)	139.7 <sup>c</sup>	64.9	3.1

<sup>a-c</sup> Values without same letter in superscript are significantly different ( $P < 0.01$ )

*Vrednosti koje ne sadrže isto slovo u superskriptu su statistički značajno različite ( $P < 0.01$ )*

Average daily feed consumption was the highest in layers on free range and the lowest in layers in conventional cages with lower housing density (BD). Also, feed conversion ratio was the best in group 1 (BD) since this group had the highest laying percentage and lowest feed consumption. These results were expected since the feed consumption in birds kept on a range should be higher because layers spend more energy on motion and maintenance. There were no significant differences between groups in egg mass.

In results published by Heil et al. (2003) average number of eggs laid by hens in cages was 317 compared to floor system where average number of eggs was 283. Conversion was better by 0.28 points in layers housed in cages, whereas no difference in egg mass was established. Van-Horne (1996) and Moorthy et al. (2000) established bet-

ter performances in layers housed in cages compared to layers housed on floor. In results presented by Adams and Craig (1985) and Carey et al. (1995) number of eggs of II class was considerably higher in layers reared in floor system compared to cages. Same authors also concluded that increased housing density has adverse effect on performances, especially because it is in positive correlations to poor hygiene conditions. In the former studies published by Perić et al. (2007b) which were performed on the same farm, the differences between cage and non-cage system were much higher. Actually, the difference in egg production was 42 eggs per average hen, which is in accordance with the results of this trial, but the differences in mortality rate and in second grade eggs were much higher in favour of cage systems. That means that certain period of adaptation is needed to overcome the challenges of new systems of production.

## CONCLUSION

Housing systems of keeping laying hens showed a significant effect on main production parameters. Significant differences were obtained between cage and non-cage housing systems in number of laid eggs, percentage of second grade eggs, mortality rate and feed conversion ratio in favour of cage systems. The best results were realized in cage system with lower housing density, and the worst results were obtained in hens housed in floor system with an access to free range.

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## **UTICAJ RAZLIČITIH SISTEMA DRŽANJA NA PROIZVODNE OSOB- INE NOSILJA KONZUMNIH JAJA**

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SINIŠA BJEDOV

### **Izvod**

Cilj ovog rada je da prikaže uticaj sistema držanja na proizvodne rezultate kokoši nosilja konzumnih jaja. Kokoši su držane u 5 različitih sistema: konvencionalni kavezi sa dve gustine naseljenosti, obogaćeni kavez, podni sistem sa ispustom i podni sistem sa slobodnim ispustom. Ispitivani hibrid bio je HyLine brown. Praćeni su osnovni proizvodni parametri: broj snesenih jaja, broj jaja II klase, mortalitet, utrošak hrane, masa jaja i konverzija. Najbolji rezultati ostvareni su u baterijskim kavezima sa manjom gustinom naseljenosti, dok su najlošiji rezultati ostvareni kod kokoši koje su držane u podnom sistemu sa slobodnim ispustom.

**Ključne reči:** kokoši, nosilje, sistemi držanja, performanse

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## HORSERADISH ROOT YIELD DEPENDING ON ORGANIC AND MINERAL FERTILIZERES

ZOLTAN PERLAKI, MIHAL DJUROVKA<sup>1</sup>

*SUMMARY: The paper studied the effects of different types and amounts of mineral and organic fertilizers and their combinations on total yield and main root weight in horseradish. A three-year study was conducted and it was determined that the cultural practice of fertilizer use had a significant effect on the studied parameters. The yields increased with increasing potassium rates. The highest total yield and the greatest main root weight were recorded when farmyard manure 40 t/ha + Cropcare 600 kg/ha were used.*

**Key words:** horseradish, fertilizeres, yield.

### INTRODUCTION

Horseradish (*Armoracia rusticana*) is regarded as a Russian vegetable that was introduced to the Balkan peninsula by migrating Slavs. The field production of horseradish originated in Germany, as did the breeding work on this plant. The crop is grown on the American continent on about 1,400-1,700 ha (Bratsch, 2006). Each year, around seven million kilograms of horseradish are processed in the U.S. by the food industry (Ravindran et al., 2005). The neighboring Hungary also has quite a long tradition of horseradish growing, with a total area of 800-1,000 ha and a total yield of 4,000–5,000 tons. In the Serbian province of Vojvodina, the collection of wild horseradish began a long time ago, and the particular ecotype collected, called Novosadski, was highly sought after by the Austro-Hungarian court thanks to its exceptional quality (Vögel, 1996). In Serbia, large-scale production of horseradish on plantations occurred between 1975 and 1985 (at the town of Futog) as well as from 1991 until present (95 ha at Feketić), with a growing trend. Horseradish is a crop that needs a lot of nutrients, as its powerful root system drains large amounts of soil moisture and nutrient reserves. To obtain high yields, it is suggested that horseradish should be grown either on soils fertilized by farmyard manure or on soils in which the previous crop had been fertilized by such manure (Ubavić et al., 2002). Of the three major macronutrients, horseradish has the largest

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uptake of potassium, followed by nitrogen, and then phosphorus. The required nutrient ratio is N:P:K = 2:1:4. To obtain a yield of 1,000 kg of the root, N 8–10 kg, P 4–5 kg, and K 18–20 kg are required (Géczi, 1999). Growing horseradish in the U.S. has shown that the crop needs a lot of potassium, moderate amounts of phosphorus, and small to moderate amounts of nitrogen as well as that fertilization must include the addition of 2.5 kg/ha of boron and 17–28 kg/ha of elemental sulphur. Such a treatment can produce yields of up to 13.5 t/ha (Bratsch, 2006). Organic fertilizers use is of special importance in horseradish production.. Besides 40 t of farmyard manure, the plant needs 50 kg/ha of additional nitrogen in the form of ammonium nitrate and 60 kg/ha of K<sub>2</sub>O in the form of KCl-a (Géczi, 1998). The total yield of this crop is closely linked with the weight of the main root, because the better this parameter is, the higher the sales will be. Of the total biological yield of horseradish, 60% is commercial horseradish, while the rest is nursery material (Stojčevski, 2008).

The objective of this paper was to investigate how different kinds and quantities (rates) of mineral and organic fertilizers and their combinations affect the total yield of horseradish and the weight of the main root, which is commercially the most important part of the plant.

## MATERIALS AND METHODS

The study was conducted on one of the best Hungarian varieties of horseradish, Bagameri 93/1. Cropcare Standard (NPK 5:14:28) and NPK (8:16:24) were the basis of the mineral fertilizer treatment. In some treatments, as needed, additional quantities of nitrogen and potassium were added in the form of AN (33% N) and KCl (40% K<sub>2</sub>O). The organic fertilizers were mixed farmyard manure and Fertor.

Table 1. Types and quantities of fertilizers used

Tabela 1. Korišćene vrste i količine đubriva

No. br.	Treatment/varijanta	kg/ha				
		N	P <sub>2</sub> O <sub>5</sub>	K <sub>2</sub> O	MgO	S
1.	Control/Kontrola	0	0	0	0	0
2.	NPK 100:75:100	100	75	100	-	-
3.	NPK 100:75:150	100	75	150	-	-
4.	NPK 100:75:200	100	75	200	-	-
5.	NPK 100:75:250	100	75	250	-	-
6.	NPK 150:75:200	150	75	200	-	-
7.	Fertor 5 t/ha	180	135	110	45	-
8.	Farmyard manure 40 t/ha	200	100	240	44	-
9.	Cropcare (5:14:28) 600 kg/ha	30	84	168	12	66
10.	Fertor 5 t/ha + 600 kg/ha NPK 8:16:24	228	231	254	45	-
11.	Farm. manure 40 t/ha + 400 kg/ha NPK 8:16:24	232	164	336	44	-
12.	Farm. manure 40 t/ha + Cropcare 600 kg/ha	230	184	408	56	66

The trial was carried out at Feketić on a chernozem soil having a high humus content (3.26%), a pH 7.39 in KCl, a pH of 8.26 in H<sub>2</sub>O, 0.23% total nitrogen, 22.7 mg/100g

Al- P<sub>2</sub>O<sub>5</sub>, 18.7 mg/100g Al-K<sub>2</sub>O, and 13.98% CaCO<sub>3</sub>. The soil was slightly alkaline and well supplied with readily available phosphorus and potassium. A randomized block design with four replicates was used and the experimental unit was 25 m<sup>2</sup> in size. There were 12 different nutrition treatments and the study was carried out in 2005, 2006 and 2007 using standard cultural practice. In each year of the study, the trial was set up in the spring and the harvesting and measurements were performed in autumn the same year.

## RESULTS AND DISCUSSION

Over the three study years, the total average yield of horseradish root was 13,634.34 kg. The highest yield – 18,512 kg/ha - was recorded in the treatment combining farmyard manure + Cropcare (Treat. 12), which is in agreement with previous results reporting a favorable influence of combined use of organic and mineral fertilizers on horseradish root yield (Géczi, 1998; Bjelić 2004). A significant increase in yield relative to control was observed when the highest rates of potassium (250 kg K<sub>2</sub>O/ha) and nitrogen (150 kg N/ha) were used as well as in treatments with a combination of organic and mineral fertilizers, (Tab. 2).

Table 2. Total yield of horseradish roots (kg/ha) in the years 2005-2007.

*Tabela 2. Ukupan prinosa korena rena (kg/ha) u periodu 2005 – 2007. godine*

Treat./year Var./god.	2005	2006	2007	$\bar{x}$
1.	13,788	8,885	11,504	11,392.3
2.	12,303	9,720	12,850	11,624.3
3.	10,715	10,750	11,750	11,071.7
4.	9,523	8,768	11,743	10,011.3
5.	11,370	13,945	15,033	13,449.3
6.	11,308	17,830	13,053	14,063.7
7.	10,813	16,463	15,985	14,420.3
8.	11,100	14,203	15,985	13,762.7
9.	12,303	14,833	12,615	13,250.3
10.	13,195	17,495	14,600	15,096.7
11.	12,015	20,585	18,268	16,956.0
12.	13,797	22,663	19,078	18,512.7
$\bar{x}$	11,852.5	14,678.3	13,284.3	13,634.34

LSD/NZR	YEAR/GOD	TREAT./VAR	YEAR* TREAT./GOD*VAR
1 %	410.00	820.00	1,420.00
5 %	309.00	618.00	1,070.00

Different study years produced different yields. The lowest average yield was recorded in 2005 - 11,852.5 kg/ha, which was significantly lower compared with the other two years. The highest yield, 14,678.3 kg/ha, was produced in 2006. The year 2007 had a significantly lower yield than the year before but significantly outyielded the first year of the study (13,284.3 kg/ha) (Fig. 1). This can be attributed to varying weather condi-

tions in different study years. The first year of the trial (2005) was characterized by an extremely large amount of precipitation during the growing season (537.4 mm), but the distribution of rainfall was unfavorable. There was almost no precipitation at the start of the season and the plants were subsequently not able to compensate for the lack of rainfall in the early stages of development, so the yields were reduced considerably. The second year (2006) had a sufficient amount (437,6 mm) and a favorable distribution of rainfall. At the start of the season in April, there was 66 mm of rain, while in May there was 70.1 mm, which was 40% more than the long-term average and 91.42% more than in the year 2005. The third year of the study (2007) had an annual total of 469.1 mm of precipitation, but the distribution was very uneven. Also, September and October of 2007 were quite rainy, which coincided with the third phase of horseradish development, in which the plants require a lot of water and yield formation takes place. For these reasons, the yield was lower than in 2006, when the weather conditions were the best, but it was higher than in the year 2005, which was marked by extremely unfavorable meteorological conditions for horseradish production at the start of the growing season .

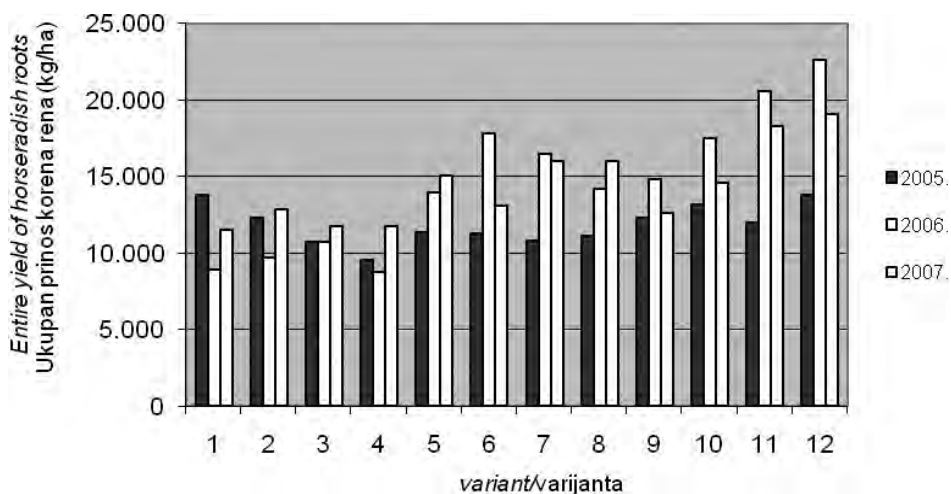


Figure . 1. Total yield of horseradish roots (kg/ha) in the years 2005-2007.

Graf. 1. Ukupan prinosa korena rena (kg/ha) od 2005 – 2007. godine.

Weight of the main root is one of the most important traits and root yield components in horseradish. The main root is the most highly prized part of the root, and it is important that it has not only a certain shape, color and wrinkle but adequate weight as well. This is the most important trait of the plant for industrial processing and fresh use alike. Over the three years of the present study, the average weight of the main root was 233.4 g/plant, which can be considered a fairly good yield. Application of 40 t/ha farmyard manure + 600 kg/ha Cropcare produced the highest average yield - 310.4 g/plant. The difference was highly significant relative to all the other treatments, except for the one with the highest rate of potassium (250 kg K<sub>2</sub>O/ha), which produced a yield of 260.5

g/plant. Here, the difference was only significant. These findings are in agreement with previous results (Barnóczki, 1998). In relation to the control treatment, use of the highest rates of nitrogen and potassium and the combination of organic and mineral fertilizers resulted in highly significant increases in the weight of the main root (Tab. 3).

Table 3. Mass of the main root (g/plant) in the years 2005 – 2007.

*Tabela 3. Masa glavnog korena (g/biljci) u periodu 2005 - 2007. godine.*

Treat./year Var./god.	2005	2006	2007	$\bar{X}$
1.	221.2	167.3	192.5	193.7
2.	181.1	186.5	205.5	191.1
3.	172.6	215.9	206.4	198.3
4.	177.4	145.9	235.0	186.1
5.	171.5	359.0	250.9	260.5
6.	180.1	370.7	223.9	258.2
7.	219.2	309.9	194.7	241.3
8.	202.7	291.6	227.1	240.5
9.	187.6	268.3	183.6	213.2
10.	207.9	365.4	190.2	254.5
11.	201.4	337.2	219.3	252.6
12.	260.4	421.2	249.6	310.4
$\bar{X}$	198.6	286.6	214.9	233.4

LSD/NZR	YEAR/GOD	TREAT./VAR	YEAR* TREAT./GOD*VAR
1 %	24.81	51.27	88.80
5 %	17.27	38.73	67.09

Looking at the trial year by year, the lowest average yield of the main root was recorded in 2005 (198.6 g/plant) and the highest in 2006 (286.6 g/plant). These results are in agreement with those for total yield, because main root weight contributes a great deal to total yield, as evidenced by the highly significant positive correlation between the former and the latter ( $r=0.912^{**}$ ).

## CONCLUSION

Fertilizer application significantly influenced the total yield and main root weight of horseradish. The yields increased with increasing potassium rates. In all three study years, the highest total yield (18,512.7 kg) and the greatest main root weight (310.4 g/plant) were recorded when farmyard manure 40 t/ha + Cropcare 600 kg/ha were used. This fertilization system can be recommended for obtaining high and stable horseradish yields of good quality.

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## **PRINOS KORENA RENA U ZAVISNOSTI OD ORGANSKIH I MINERALNIH ĐUBRIVA**

ZOLTAN PERLAKI, MIHAL DJUROVKA

### **Izvod**

Ispitivan je uticaj različitih vrsta i količina mineralnih i organskih đubriva i njihovih kombinacija na ukupni prinos i masu glavnog korena rena. Na osnovu trogodišnjeg ispitivanja uočen je značajan uticaj đubrenja kao agrotehničke mere na ispitivane parametre korena rena. Zabeleženo je povećanje prinosa sa povećanjem doze kalijuma. Najveće prosečne vrednosti za prinos korena i masu glavnog korena rezultiralo je đubrenje kombinacijom đubriva stajnjak 40 t/ha + cropcare 600 kg/ha.

**Ključne reči:** ren, đubrenje, prinos

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## ECONOMIC ANALYSIS OF AGRICULTURAL BUDGET ASSETS OF AUTONOMOUS PROVINCE OF VOJVODINA IN 2007-2009

PETRANA ODAVIĆ, NEBOJŠA NOVKOVIĆ<sup>1</sup>

*SUMMARY: Budget of the AP of Vojvodina during past two years recorded an average real decrease of about 10%, regarded inflation. Nominally, it is at the level of about 700 million €. Part of budget assets which was directed to agriculture, water management and forestry, noted a real growth of approximately 20% in the same period. During 2008 provincial agricultural budget was 21 million €, while in 2009 it was planned to reach 25 millions. In structure of provincial agricultural budget most of assets were directed to multipurpose of using and protecting water - 33% average and 24% average for agricultural land protection and land use. The rest of agricultural budget assets were directed to rural development of Vojvodina, professionally agricultural departments, Provincial Fund for development of agriculture, improvement of animal production, forestry, hunting, fishery and the other development programs of agriculture in Vojvodina.*

**Keywords:** budget, agriculture, budget assets

### INTRODUCTION

Key fields of interest of modern economical policy in Serbia are scientific researches in agricultural policy. Up to now development of agriculture budget assets had significant role. Resources were used for supporting individual farmers in new kind of livestock induction, contemporary mechanization and for stimulating the use of new variety and hybrids. Great extent of budget assets was also directed to current agricultural production financing. Since 2004 Serbian agricultural policy had strong swerve in strategic directions and mechanism of their implementation (Bogdanov and Sevarlic, 2006). Reformed agricultural policy since that year was directed towards competition of private enterprises and farms increasing as well as new investments stimulation. Limiting factors

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Original scientific paper / *Originalni naučni rad*

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were reflected in the instability of agricultural budget in terms of founding sources, and direct linking to the government institutions decisions.

The share of agricultural budget funds in the total budget is very small, ranged from 2% to 4%, which is not comparable with the EU, where this share ranges up to 70%, including funds designed for rural and underdeveloped areas development (Novkovic and Somodi 1999). This fact is overwhelming as Vojvodina is specific manageable terrain with ideal geological structure and favourable climate conditions for the development and improvement of agricultural production.

The aim of this paper is to point out that the budget funds were and still are insufficient. Having the high share of the agricultural budget in the total funds is very important as well as directing assets to agricultural and food production within our region.

## REFERENCES AND THE METHOD OF THE STUDY

Data processing, using mathematical, statistical and analytical methods, led to the important parameters for this research and economic analysis of nominal indicators. Budgetary support of agriculture of the Autonomous Province of Vojvodina, which is presented in this paper, is based on the data of the Act of budget of the Autonomous Province of Vojvodina, its Amendments and also is based on data of the Act of budget of Republic of Serbia in observed period. The functional layout and structural indicators of agriculture, water management and forestry has been pointed out, with the review of the funding sources. Period of observation and analysis of data is from 2007 to 2009.

## RESULTS AND DISCUSSION

In spite of modest growth of the assets directed to agriculture, water management and forestry in the Province, their share in the overall budget is low.

The share of the agricultural budget assets in the total budget of Autonomous Province of Vojvodina in 2007, 2008 and 2009 (Act of budget of the AP of Vojvodina for 2007, 2008 and 2009), is given in the Table 1.

Table 1. The share of agricultural budget assets in the overall budget of Autonomous Province of Vojvodina in 2007-2009

In million €

Year	Budget of the AP of Vojvodina	Agricultural budget of the AP of Vojvodina	Share (%)
	1	2	3=2:1
2007	748	16	2,1
2008	716	21	2,9
2009 (plan)	656	25	3,8

Functional contents of the overall and agricultural budget of the Autonomous Province of Vojvodina were presented in the Table 2



Table 2. Overall budget and agricultural budget assets of Vojvodina and their functional structure in 2007-2009 (Act of budget of the AP of Vojvodina for 2007, 2008 and 2009) In 000

	2007			2008			2009		
	Budget funds	Additional resources	Total	Budget funds	Additional resources	Total	Budget funds	Additional resources	Total
	1	2	3=1+2	4	5	6=4+5	7	8	9=7+8
Overall budget of the AP of Vojvodina	401.175	255.214	656.389	650.249	65.429	715.678	715.245	32.900	748.145
Agricultural budget	9.030	16.191	25.221	9.956	10.790	20.746	5.845	10.178	16.023
1 Agriculture	2.421	0	2.421	2.929	0	2.929	1.279	513	1.792
a Fund for the development of agriculture	1.436	0	1.436	1.964	0	1.964	2.63	513	775
b Professional associations and non-profit institutions	0	0	0	76	0	76	114	0	114
c Other agricultural functions	986	0	986	888	0	888	903	0	903
2 Professional agricultural services	1.880	0	1.880	1.717	0	1.717	1.403	0	1.403
3 Multipurpose using and protection of water resources	0	8.483	8.483	0	6.217	6.217	7	5.754	5.761
4 Agricultural land protection and land use	0	7.556	7.556	0	4.418	4.418	419	3.000	3.419
5 Improvement of animal production	1.000	0	1.000	901	0	901	713	0	713
6 Measures and actions in the agriculture	94	0	94	119	0	119	119	0	119
7 Rural development	2.278	0	2.278	2.683	0	2.683	630	750	1.380
8 GIS of Vojvodina	56	0	56	60	0	60	63	0	63
9 Development programs of agriculture	333	0	333	357	0	357	125	0	125
10 Fishery	0	133	133	0	145	145	0	156	156
11 Forestry and hunting	967	19	986	1.190	10	1.200	1.087	6	1.093

Analyzing the individual functions (structure) of agriculture, water management and forestry, as the part of overall budget, one can say that the greatest share of funds were for the multipurpose of using and protecting of water resources - 34%, then for agricultural land protection and use - 30%, while the remaining funds were distributed by the features as in the Table 3.

Table 3. Share of the particular functions of agriculture, water management and forestry in the total agricultural budget of Vojvodina  
(Act of budget of the AP of Vojvodina for 2007, 2008 and 2009)

	Participation in %		
	2007	2008	2009
Agricultural budget of the AP of Vojvodina	100%	100%	100%
<b>Functions:</b>			
Multipurpose using and protection of water resources	36%	30%	34%
Agricultural land protection and land use	21%	21%	30%
Agriculture	11%	14%	10%
whereint: Provincial Fund for the development of agriculture	5%	9%	6%
Rural development	9%	13%	9%
Professional agricultural services	9%	8%	7%
Improvement of animal production	4%	4%	4%
Forestry and hunting	7%	6%	4%
Development programs of agriculture	1%	2%	1%
Fishery	1%	1%	1%
Measures and actions in the agriculture	1%	1%	0%

In table 4 an overview of changes of the agricultural budget of the Province has been shown. It can be concluded that: the overall budget of the Province expressed low real decrease in assets, but Agricultural budget of the Province shows real rising trend.

Table 4: Changes of the total and agricultural budget of the Province in 2006-2009  
(Act of budget of the AP of Vojvodina for 2006, 2007, 2008 and 2009)

In million €

	2006	2007	2008	2009
Total budget	370	748	716	656
Agricultural budget	14	16	21	25
Nominal (%) Growth/fall	of total budget of Vojvodina		115.6%	0.4%
	of agricultural budget		25.6%	35.9%
Real <sup>2</sup> (%) Growth/fall	of total budget of Vojvodina		100.5.%	-10.6%
	of agricultural budget		16.8%	21.1%

However, this growth can be neglected since the level of agricultural budget is nominally low and even high percentage of growth gives no results if amount of assets is low and insufficient. Budget of Vojvodina had great increase in 2007 thanks to the establishment of the Fund for capital investment of AP Vojvodina. Fund assets were determined in the amount of about 274 millions €, while the entire provincial budget expressed nominal growth of 116%.

Agricultural budget of Serbia in 2009 amounts to 228 million € and represents only 2.7% of the total national budget. About 84% of this amount will be directed to agriculture subsidies, only for registered farmers. According to the Minister of agriculture dr Sasa Dragin, all the rest, i.e. agricultural enterprises as well as unregistered farms, will not be allowed to get any kind of subsidies. It is evident that Ministry of agriculture still owes to the farmers 10% unpaid subsidies from previous year. This debt increases 4 times in relation to the 2007.

The review of subsidies and their share in agricultural budget of the Republic of Serbia (Government share programs of subsidies in agriculture for 2009; Act of budget of Republic of Serbia for 2009), can be seen from the table 5:

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<sup>2</sup> Real growth implies a nominal growth corrected for the growth index of retail price that officially announces the Statistical Office of the Republic of Serbia. For period 2007/2006 it was 107.5; 2008/2007-112.3; while the projected rate of inflation in the "Memorandum on the budget and economic and fiscal policy for 2009, with projections for 2010 and 2011", is at the level of 8.2%.

Table 5. Subsidies in agricultural budget of Serbia for 2009

In million €

		2009	Share (In %)
	Agricultural budget of the republic of serbia	227.8	100
	Subsidies total 1+2+3+4	192.4	84
<b>1</b>	Unpaid liabilities from the previous year	22.2	10
<b>2</b>	Market measures	148.3	65
	2.1 Regression of agricultural production and intervention on the market	111.1	49
	2.2 Selection and genetic improvement of animal production	14.7	6
	2.3 Support to insurance in agriculture	0.8	0
	2.4 Premiums for milk	7.8	3
	2.5 Improvement of beekeeping	0.7	0
	2.6 Support for non-commercial farms	6.7	3
	2.7 Export incentives	6.7	3
<b>3</b>	Investment support for agricultural and food production and rural development	15.6	7
<b>4</b>	Other measures	6.3	3

The Act of budget of Vojvodina for 2009 determines all financial sources, of which agriculture, water management and forestry is funded from the: incomes from the budget, own revenues of budget users, income from the repayment of such loans, undistributed surplus of previous years, but most revenues is from privatization. The rest of assets come from prescribed fees (Ministry of finance, 2004).

In 2008 funds from the leasing of agricultural land were 26.2 million € but only 7.9 million € belonged to Province (30%). From using and protecting water was charged 4.8 million €. Funds for using forests are modest and at the level of only 886,000 €. The Law of the competencies of Vojvodina, which is at the final stages of development, will further regulate the share of the Autonomous Province of Vojvodina in the budget revenue originated from charges at its territory. Namely, some competences of the Province will be returned to it and the Vojvodina's share in the revenue, collected by fees and taxes charging on its territory, will increase.

## CONCLUSIONS

Data presented and analyzed in this paper refer to the conclusion that the budget funds for agriculture, water management and forestry are insufficient. Despite the fact that in Vojvodina and Serbia agricultural and food industry has an important role in the GDP, only 3% of the total budget is allocated to agriculture. Agricultural policy must be radically changed, overvalue of the domestic currency should be stopped and the situation in which farm prices are very low and commercial prices much higher should be prevented (Pejanovic and Tica, 2005). Therefore, farmers should not lose value of their products. Subsidies should be directed to improvement of animal production since the stock fund is reduced and bisected in the last decade.

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## **EKONOMSKA ANALIZA SREDSTAVA AGRARNOG BUDŽETA AUTONOMNE POKRAJINE VOJVODINE U PERIODU OD 2007. DO 2009. GODINE**

PETRANA ODAVIĆ, NEBOJŠA NOVKOVIĆ

### **Izvod**

Budžet AP Vojvodine u poslednje dve godine beleži realan pad sredstava u proseku za oko 10%, uzimajući u obzir indeks rasta cena na malo. Nominalno se zadržava nivo od oko 700 miliona evra. Učešće poljoprivrednog budžeta u ukupnom je izrazito malo i kreće se od 2% u 2007. godini, do nepunih 4% u 2009. Deo sredstava koja se usmeravaju sekretarijatu za poljoprivredu, vodoprivredu i šumarstvo evidentira realan rast i to za oko prosečno 20% u istom periodu, uzimajući u obzir godišnji indeks rasta cena na malo. U 2008. godini pokrajinski agrarni budžet iznosio je oko 21 milion evra, dok je u 2009.

planiran na nivou od 25 miliona. U strukturi pokrajinskog poljoprivrednog budžeta, najveći deo sredstava se usmerava za višenamensko korišćenje i zaštitu voda, u proseku oko 33%, zatim slede sredstva za zaštitu, korišćenje i uređenje poljoprivrednog zemljišta. Ostatak sredstava se raspoređuje za ruralni razvoj Pokrajine, stručne poljoprivredne službe, Pokrajinski fond za razvoj poljoprivrede, unapređenje stočarstva, šumarstvo i lovstvo, ribarstvo i ostale programe razvoja poljoprivrede u AP Vojvodini.

**Ključne reči:** budžet, poljoprivreda, budžetska sredstva.

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## BASIC PARAMETERS OF ARTIFICIAL PRODUCTION OF PHEASANT (*PHASIANUS COLCHICUS L.*) WITH THE MEASURES PROPOSAL

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VLADIMIR BAROVIĆ<sup>1</sup>

*SUMMARY: At the end of the year producers of pheasant game should, with the goal of better success, make a production plan for the next year. To get a more precise plans it is necessary to use the information about the average loss for every stage. This information has been gathered over the years and is based on the large amount of samples. When the parameters are aquired we suggest that, while production plans are in the development, these standards should be used (in december for the next year).*

*Recommendations that should be considered: that the reproduction flock should be in 1:8 to 1:10 sex ration (in favor of the female) in group voliers and 1:8 in families. Minimum surface of the volier for reproduction should be 3 m<sup>2</sup> for each pheasant; that the total number of unfertilized eggs should be 12.75%; the percent of dead embryos from total fertilized eggs (21.84%) and the percent of dead embryos from total of deposited eggs is 19.05%; losses in raising batteries (up to 14 days of age) are 7.16% and losses in raising houses (from 14 to 42 days of age) and corresponding percentage (7.69%).*

**Key words:** pheasant, reproduction flock, mating ratio, fertilization of eggs

### INTRODUCTION

Pheasant game is being continuously “helped” for the last 50 years, using artificial production at local farms and introduction to our hunting grounds.

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Production has begun in a first half of 20<sup>th</sup> century, using pheasant chicks under hens, and in second half of 20<sup>th</sup> century production modernized. Modernization of production included incubators for pheasant eggs, nurturing pheasant chicks after hatching in batteries or on the floor system, nurturing in houses until six weeks old and after that nurturing in “getting wild” enclosures with adequate space.

## **MATERIAL AND METHODS**

Material for this investigation was obtained at one of our largest pheasant farms - “Ristovača” near Bač, for 14-year period. Complete evidention was precisely saved, as well as statistics regarding whole production process and comparisons of results with other similar pheasant farms in the state and abroad. Method of work was statistical processing at every stage of production, and calculating mean values and average per stages.

## **RESULTS AND DISCUSSION**

In order to achieve the best possible results, it is necessary:

- To provide optimal living space for reproduction flock (3 to 5 m<sup>2</sup> per bird), to provide concentrated food for pheasant hens for a month before formation of reproduction flock, to provide concentrated food during whole egg laying period, to do a quality selection in February not only according to phenotype, but also a genotype, and with obligatory inoculation.
- To do a complete disinfection, dissection and deratization of all objects within the pheasant farm.
- To repair and complete all necessary equipment before start of the production at a farm.
- To employ a veterinary doctor at every pheasant farm in order to provide preventive protection, as well as other qualified staff, since raising pheasant chicks is one of most sensitive stages in production of pheasants at pheasant farms.
- In the first stage, it is necessary to considerably enhance hygiene, as well as temperature regulation and ventilation.
- Obligatory selection in one-day chicks.

When completing production plans, it is recommended that pheasant farms use following parameters:

- Mating ratio in established flock should be 1:8 to 1:10 in favor of females, and in families 1:8;
- minimal area within “getting-wild” enclosure should be 3 m<sup>2</sup> per bird;
- average number of unfertilized eggs is 12.75%;
- average dying of embryos is 21.84% from total fertilized eggs and 19.05% from total deposited eggs;
- average mortality of pheasant chicks in batteries is 7.16% (up to 14 days old);
- average mortality in raising houses is 7.69% (from 14 to 42 days).



These parameters must be rounded upwards, for instance 12.75% becomes 13% in order to facilitate calculations when production plans are made.

In the second stage, raising houses for pheasant chicks must be perfected in order to reduce influence of weather and all other external factors. This stage is directly connected to the third one, which is raising in shelters of hunting societies, in order to enable pheasants for independent life in hunting grounds.

Today we have a number of pheasant farms where pheasants are produced in obsolete incubators, without even minimal conditions for first or second stage, let alone for raising adult pheasants. Only several farms are able to provide all conditions for raising adult pheasants.

If all these recommendations are fulfilled, we are certain that survival rate of artificially bred pheasants will be higher than it presently is. This is the basic task and the aim to be sought. Today in our hunting grounds, number of pheasant chicks introduced is several times lower than fifteen years before. Reasons are numerous. It is necessary that newly introduced pheasants are healthy and of high quality, and this is often not the case. This production is liable to large improvisation, and that is unacceptable.

### **Reproduction flock**

The most important prerequisite for successful pheasant production in farms is a good and healthy reproduction flock. It is formed in February, and sometimes in March - depending on climate conditions. The reproduction flock is formed from the "material" that is being bred for this purpose. Choosing pheasants for reproduction flock is very important. Only the strongest pheasant chicks of highest quality are being left from first batches in production, and with no external flaws. When individuals are being caught and transferred to egg-laying enclosure, they are inoculated against plague and cholera, and they get goggles to prevent pecking the eggs. The reproduction flock may be kept in "families" or in large groups in separated enclosures: 1 rooster and 7-10 hens. In this way, number of eggs and their fertility are somewhat higher, but larger groups (90 to 120 individuals per enclosure) are more practical and more often used than families. In group enclosures, space of 3 to 5 m<sup>2</sup> per individual is being used.

In group enclosures in "Ristovača", groups were formed with 80 hens and 8 roosters with area of reproduction enclosures of 270 m<sup>2</sup> or 3.07 m<sup>2</sup> per bird. At pheasant farm „Ristovača“ group enclosures were used, so from 1982 to 1992 average mating ratio was 8.52 hens per a rooster. The maximum was noted in 1986, when this ratio was 1:10.67, and minimum was in 1992 with 1:7.31.

In period between 1993 and 2006 group enclosures were still used, with average mating ratio 1:9.63; maximum was 1:10 in period from 1995 to 2005, and minimum was 1:8.00 in 1993, 1994, and 2006. Laying eggs is being planned before laying period (using Gauss laying curve) on the basis of data from previous years that include time when laying begun, frequency of laying and planned time when laying will stop, usually at the end of May, or until mid-June. On the basis of this plan, plans are made to put eggs into incubators, hatching and raising chicks. Graph is made at a paper with Gauss curve, and during a season, a real number of laid eggs is added. Jovetić (1957) in group enclosures 26 by 10 m uses mating ratio 1:12, and in his investigations he even used 1:16 and 1:20 so

he recommends 1:16 ratio. Andrašić (1970) recommends 1:7 as a mating ratio for pheasant hens in mobile group enclosures 1.5 by 3.5 m. 1:7. Trpkov (1971) recommends mating ratio 1:7. Jovetić says he used mating ratio 1:2 with average annual number of 30 eggs. Andrašić (1970) had average number of 33.91 eggs between April 1st and June 30th. Trpkov (1971) in pheasant farm “Trubarevo” had 54 eggs in average. Jovetić (1957) had average fertilization of 85% with mating ratio 1:12. Andrašić (1970) says he had average fertilization, with mating ratio 1:7, between 81.60% and 84.94%. Trpkov (1971) says that, with different dietary regimes for hens, had average fertilization between 79.00% and 89.96%, with mating ratio 1:7.

### **Deposition of eggs, ovoscopy and hatching**

In order to rationally use all stages of hatching and raising chicks, eggs are not put into incubator all at once, i.e. they may not all be with the same date, but in accordance to previously established program. Eggs depositing program mostly takes into account capacity of hatching equipment and warm batteries, but it also counts for total number of eggs available. Therefore “batches” are formed. In pheasant farm “Ristovača” batches were 8,820 eggs, 17,640 eggs, 25,032 eggs, 26,880 eggs, 30,574 eggs, 32,424 eggs. All this must be coordinated with present hatching equipment where eggs are transferred after 21 days in pre-hatching equipment. Ovoscopy of eggs is being done after 6 and 14 days in pre-hatching equipment. In larger pheasant farms, as in “Ristovača”, it is done only at 14 days after deposition. The percent of unfertilized eggs varies during laying period, mostly between 10 and 17%. At pheasant farm “Ristovača” during period observed there was total of deposited 2,691,050 eggs, from which unfertilized eggs were 343,093 or 12.75%. The lowest percent during period observed (1993–2002) was 10.63% in 1996.

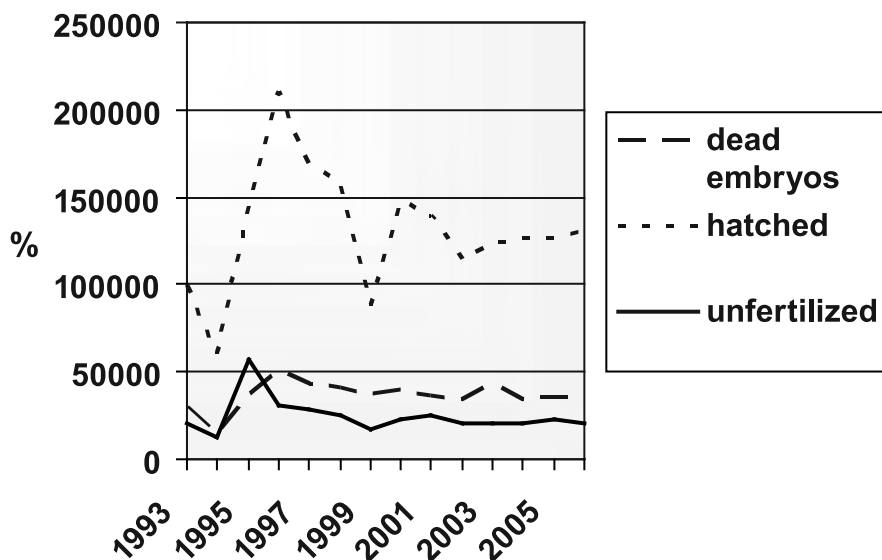
For 10 years of investigating production in Croatia, Darabuš (1980) established percent of unfertilized eggs at 17.95%. In investigations of Pekić (1969) in pheasant farm “Dobanovački zabran”, percent of unfertilized eggs was between minimal 5% and maximal 22% or averagely 15.50%. Investigations of Gajić and Jović (1969) in pheasant farm “Dobanovački zabran” infertilization between 12.11% and 16.79% was found, or in average 14.52% for period observed. Investigations in Czechoslovakia by Hanuš and Fišer (1975), in incubation using hens, hatching is 65% (from number of eggs deposited). Same investigators found that in artificial hatching, in incubator, 80 to 85% pheasant chicks are hatched from fertilized eggs, and eggs fertilization in artificial production must be between 85% and 95% (unfertilized eggs were between 5% and 15%). Average percent of fertilized eggs from total deposited eggs in “Ristovača” pheasant farm during period observed (1993-2006) was 87.25% (2,347,957 fertilized eggs from total of 2,691,050 deposited), while minimum was noted in 1995 (76.18%) and maximum in 1996 (89.97%).

### **Embryo mortality and hatching of one-day chicks**

Embryo mortality during incubation is expressed as a percent from total number of deposited eggs or from number of fertilized ones. Biologically, it has more sense to take into account only a percent of dead embryos from number of fertilized eggs.

In period observed, in pheasant farm “Ristovača” (1993-2006) total of 512,727 dead embryos were found (Graph 1). Average percent of dead embryos from number of fertilized eggs was 21.84%. Average annual percent of dead embryos from total deposited eggs was 19.05%. Gajić and Jović (1969) found that average percent of dead embryos from total of deposited eggs at pheasant farm “Dobanovački zabran” was 18.47%. During period observed (1993-2006) in pheasant farm “Ristovača” total of 1,835,230 one-day pheasant chicks were hatched, which is in average 78.28% from number of fertilized eggs (2,347,957) or 68.30% from number of deposited (2,691,050) eggs. The minimal percent of hatched eggs was in 1995 (60.69%) and maximum was in 1996 ( 71.74 %). On the basis of investigations by Jović, between 1957 and 1960 percent of chicks hatched was between minimal 50.28% and maximal 81.39% or averagely 72.48% from number of fertilized eggs.

In Croatia, Darabuš (1980) found that percent of eggs hatched was 64.19% from total deposited eggs. At the time, present incubation equipment enabled reaching up to 70% hatching from total deposited eggs, and somewhat lower hatching was consequence of increased nonfertilization, and also in human factor regarding incubator operation.



Graph. 1. Relationship between chicks, nonfertilized and fertilized embryos

### RAISING PHEASANT CHICKS

In raising pheasant chicks between day one and 6 weeks old, data were collected regarding number of chicks introduced (in batteries and in raising houses), number of chick mortality in the first and second stage of raising, and number of chicks raised until 6 weeks old, when they are ready to be delivered to hunter’s societies with appropriate shelters (Pekeč et al. 2008). For period observed (1993-2006) in pheasant farm

“Ristovača” total of 1,837,865 one-day pheasant chicks was produced. In first 14 days, when chicks were in batteries, mortality was 131,535 chicks or averagely 7.16%. Investigations by Jović (1964) in pheasant farm “Dobanovački zabran”, during three years observed average loss percent was 7.92% for first 20 days. In the first stage (floor and battery system) in investigations by Darabuš (1980) for 1969-1979 period, mortality was 7.89% in average, but losses may be brought to only 3-6%. This percent has been reached by certain pheasant farms in Croatia and it must be the future goal.

In raising houses in “Ristovača” pheasant farm, during 1993-2006 period, total of 1,706,330 pheasant chicks was introduced when 14-15 days old, or 92.84% from total hatched one-day chicks. In these houses, 131,138 chicks died, being old between 14 and 42 days. Average mortality in raising houses was 7.69%.

In second stage, Darabuš (1980) found mortality of 12.96% and concluded that this is still very high. Such high mortality is a consequence of climate influence and of human factor. In “Ristovača” 1.575.192 pheasant chicks were raised until 6 weeks old, which is 58.53% from total eggs deposited (2.691.050). Corresponding percent in Croatia, after investigations by Darabuš (1980), is 50.10%. Darabuš concludes that this is a low percentage and that all flaws must be removed in order to increase it in following period.

## CONCLUSION

Researches were conducted in one of largest pheasant farms in Europe, and in the largest one in Serbia, “Ristovača”, in 1993-2006 period, with the aim to establish exact parameters in production and to keep production economically worthwhile. When saying “worthwhile” we must not think of the cheapest production. On the contrary - in the last ten or so years this is one of most important elements in decision to buy pheasant chicks. The pheasant quality is the paramount objective and it was proposed to think about introducing standards in all categories of pheasant chicks and adult pheasants that are being sold to hunters’ societies. Unfortunately, very few pheasant farms have such plans, and without plans there is no real calculation in prices. Pricing is done flat-rate, without any data and without real calculation.

Monitoring of results in pheasant production in pheasant farm “Ristovača” begun in 1993, and was finished in 2006. In the pheasant farm, following parameters were monitored: optimal time of separating the reproduction flock (last decade in February and first decade in March), mating ratio in reproduction flock ( 1:8 to 1:10 in favor of hens), minimal space per bird in reproduction enclosure (3 do 5 m<sup>2</sup>, and if pheasants wear goggles it may be reduced even up to 50%), losses in reproduction flock from forming to dissolving (do 10%), total number of eggs laid per hen (up to 45), total number of eggs laid annually for whole reproduction flock (planned 42 to 45 per hen), total number of fertilized eggs (between 83 and 90%, average 87.25%), percent of unfertilized eggs (between 10 and 17%, average 12.75%), total number of dead embryos, percent of dead embryos from total of deposited eggs (19.05%), percent of dead embryos from total fertilized eggs (21.84%), total number of chicks hatched (78.28% from number of fertilized eggs or 68.30% from total number of deposited eggs), losses in raising batteries and corresponding percentage (7.16%), losses in raising houses and corresponding percentage

(7.69%). All these parameters are necessary in production of pheasant game in order to establish plans that will be realistic management plans in such production.

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## OSNOVNI PARAMETRI PRI VEŠTAČKOJ PROIZVODNJI FAZANA (*PHASIANUS COLCHICUS* L.) SA PREDLOGOM MERA

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VLADIMIR BAROVIĆ

### Izvod

Proizvođači fazanske divljači radi ekonomičnosti proizvodnje potrebno je da krajem godine izrade planove proizvodnje za narednu godinu. Da bi dobili realne planove

potrebno je da koriste uprosečene gubitke po fazama, do kojih smo došli na osnovu dugogodišnjeg istraživanja i na osnovu velikog uzorka. Na osnovu dobijenih parametara predlažemo da pri izradi planova proizvodnje (koje treba uraditi u decembru predhodne za narednu proizvodnu godinu) koriste po fazama sledeće proseke. Preporuke prilikom proizvodnje fazana u fazanerijama da se kao planske veličine uzimaju: da matično jato bude sa odnosom polova 1:8 do 1:10 (u korist koke) u grupnim volijerama i 1:8 u porodicama; da minimalna površina volijere za reprodukciju - parenje mora biti oko 3 m<sup>2</sup> po svakoj jedinki; da prosečna neoplođenost jaja se planira sa procentom od 12,75%; da prosečna smrtnost embriona se planira sa procentom od 21,84% od broja oplođenih jaja, odnosno 19,05% od ukupnog broja uloženi jaja; da su prosečni gubici u baterijama (do 14-og dana starosti) sa smrtnošću od 7,16% i da su prosečni gubici u kućicama za odgoj (od 14-42 dana starosti) sa smrtnošću od 7,69%.

**Ključne reči:** fazan, matično jato, odnos polova, oplodnja jaja.

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## DEVELOPMENT TENDENCIES OF AGRICULTURE THE REPUBLIC OF SERBIA

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*SUMMARY: Authors considered developing problems of agriculture of the Republic of Serbia. The agriculture takes, traditionally, the leading place in the structure of the industry of the Republic of Serbia. For development of this branch of industry there are natural and human potentials. However, indicators of development in the time of transition show that there are serious limitations of development of this activity. The biggest limitation is wrong economic and agrar politics of the state and the second period of development neglects this activity, does not invest enough in it, which has negative consequence on the agriculture, which stays behind the potential possibilities of development, and to villages which are involved in the proces of depopulation, deagrarisation and senilisation.*

**Key words:** *agriculture, agrar politics, development, the Republic of Serbia, limitations, transition.*

### INTRODUCTION

Agriculture of Serbia went through different phases through the historical period: from agrar overpopulation, through deagrarisation up to agriculture in transition where it is today. However, in whichever phase it is, our agriculture was always in the inconvenient position and insufficient investment from the state, and also bad position of this branch, whose basic task was to secure social peace and feed the population (Pejanović and Tica, 2005).

Starting hypothesis in this paper is that the agriculture of the Republic of Serbia is in permanent cryses which just had different shapes through history. Problem is considered

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Original scientific paper / *Originalni naučni rad*

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by method of descriptive analyses and official statistic data is used.

Current state of the agriculture in Serbia, its potentials and limitations still show us the same trend-that there are smaller investments in agriculture than it needs and according to that, it gets less than it's possible.

Agriculture takes the leading place in the structure of industry of the Republic of Serbia and about 20% population of Serbia lives from the income from the agriculture. Natural potentials are not used enough, there is still fast deagrarisation, high level of motivation among employees because of low average actual incomes. Agrotechnical equipment is on low level, ageing of tractors is high, usage of mineral fertilazer is considerably lessen, which again results in decreased yield . Involvement of individual agricultural households is dominant, level of market is low and also intensity of production. Division of the property is pointed, farms whose property is up to 3 ha dominate.

Republic of Serbia is relatively small country, so it is in her interest to develop cooperation on all possible levels of European and world economy. Foreign trade exchange is one of the most important shapes of cooperation and while in the 90s deficit was pointed out in the exchange of agrar products, in the period 2001 – 2008 tendencies of growth in the export of food and agricultural products is spotted. That tell s us about the importance and possibilities of the Republic of Serbia in the production of food.

Agroindustry is the most important industrial area of the Republic of Serbia that participates with about 20% in the making of social product of the country (GDP). And, beside that it is still on a very low level of profitability. From the mid-90s one of the most prominent ways of investment is agrar budget, which unfortunately shows some considerable oscillations in the period from 2001-2009 (Pejanović, Milanović, Cvijanović, 2006).

## **POTENTIALS AND LIMITS OF AGRICULTURAL DEVELOPMENT OF THE REPUBLIC OF SERBIA**

Agriculture takes the leading place in the structure of the industry of Serbia and about 20% of the population of Serbia lives upon income from the agriculture. The importance and role of agriculture were especially emphasise in the time of sanctions in the 90s of the last century were the agriculture showed it self as the most vital industrial sector. Social product of the agriculture of Serbia was falling slower then the social product of industry, which resulted in the increase of the relative importance participation of agriculture in the social product of Serbia (Pejanović and Tica, 2005).

### **Natural potentials**

Serbia has about 5 092 000 ha of agricultural area (0,68 ha per capita), 4 218 000 ha cultivated area (0,56 ha per capita), which is above the standard of the countries in Europe. The danger of ireversible degradation of the soil is becoming bigger, because of the soil's depletion (Pejanović, 1995).

Water regime is also acceptable, but not used enough. The canal Dunav-Tisa-Dunav, the biggest and the most unique hydrosystem in the world, is not used for agricultural production or that is very little. From the total of cultivated area only about 1,6% of the



area is irrigated (78 000 ha).

### **Human potentials**

According to the listing from 2002 Serbia had 7 498 001 population (without Kosovo and Metohija) where 4 225 896 of the population lives in cities, and 3 272 105 of the population lives in villages. The results of the listing show that in the last period between the two listings, the process of intensive demographic ageing of the population is continued. There is less and less young people in the villages of Serbia. Close to 200 villages doesn't have any inhabitants younger than 20 years. A lot of villages in the close future will be left without inhabitants, primarily in the mountainous areas (Pejanović, et al., 2007).

However, even beside some marked migrational tendencies of the population in the relation village-city, that is from agricultural into non-agricultural sector, today in Serbia relatively big number of population still makes the income from the agricultural activity that brings us to the conclusion that the labour, watched in total, is not the factor of the limitation in the development of agriculture.

### **Agrotechnical equipment**

The agriculture of Serbia has about 400 000 tractors of all kinds. In private sector more than 386 000, actually, more than 97% of the total number. One tractor goes approximately to 10,4 ha on the private, and 57,2 ha on the social sector. The number of harvesters in the last five years is constantly decreasing. Also, it is estimated that the tractors are old (over 15 years), and that significantly increases the costs of exploitation. The usage of mineral fertiliser in the last 5,6 years is significantly decreased. Lower usage of mineral fertilisers confirms the thesis about natural comparative advantages of our agrar area.

However decrease intake of the nutritious substances will condition (unless the consumption increases in the next period) greater fall of the yield in the upcoming years. The yield in the last ten years has decreased for about 20% with wheat (from 4,5 t/ha to 3,7 t/ha) and with sugar beet over 27% (from 47,0 t/ha to 37,0 t/ha). In the dry years (2000 and 2003) decrease of the yield is even more drastic (Pejanović and Njegovan, 2008).

### **Subjects of purchasing**

Participation of individual agricultural households which take about 85% of the cultivated area is dominant, 91,8% of the number of cattle, 97,1% of the total number of tractors, 82,5% of the social product of agriculture in accordance to agricultural firms and cooperative. The level of goods taken to the market from these households is very low (their involvement in the repurchasing and realisation of agricultural products on the market is only 36%), that shows that individual sector is not capable for large, mass production, that is the percent of natural production is high. Also, the level of intensity is low (0,46 number of cattle per ha), the size of the household is small and the level of production per unit of the area is low. On the other hand, in agricultural firms and cooperatives we come across the problem of inconvenient structure of production (wheat and industrial plants) old equipment and mechanisation and with high level of nonliquidity and obligeness

(Pejanović and Tica, 2005).

In 871 000 private farms – division of properties is emphasised, households dominate – farms whose property is up to 3 ha (58,1%), only 0,8% of the households have the property 15 – 20 ha, and 0,5% property bigger than 20 ha (in Great Britain the average size of the farm is 69,3 ha, France 41,7 ha; Denmark 42,6 ha; Holand 18,6 ha; Germany 31,0 ha; Belgium 20,6 ha) (Pejanović and Andrić, 2008).

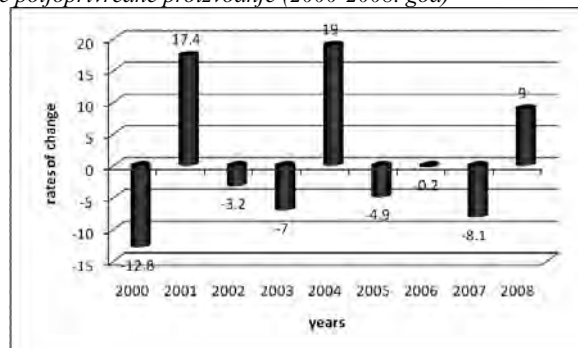
## INDICATORS OF THE DEVELOPMENT OF AGRICULTURE OF THE REPUBLIC OF SERBIA

### Movement of the agricultural production

All the problems that we inherited from the previous period, and at the same time several new challenges, but also problems that are put in front of our country in the process of transition, make the agriculture produce slower growth for a couple of years, according to its possibilities. That can value the movement of the size of agricultural production, that moving in the whole period of transition has positive effect only in 2001, 2004 and 2008. Reasons for that are various, and in this paper we turn to only some of them.

Graph 1: Agricultural production in the period 2000-2008

*Graph. 1: Kretanje poljoprivredne proizvodnje (2000-2008. god)*



Source: RIS

Among various causes which effected this kind of moving of the size of agricultural production, we can take out some incovinient climate changes (draughts, floods), and above all insufficient investments, actual insufficient size of investments which would affect on the positive movement of the size of the production (Pejanović, Njegovan, 2008).

### **Involvement of the agriculture in making of the social product and national income**

Agriculture and village today have very important role and place in the whole development of industry in Serbia. Agroindustry represents the most important industrial area in the Republic of Serbia which takes part in the making of social product of the country (GDP) with about 20% and that is:

Table 1: Involvement of the agriculture in making of the social product of the Republic of Serbia  
*Tabela 1: Učešće agroindustrije u stvaranju društvenog proizvoda Republike Srbije*

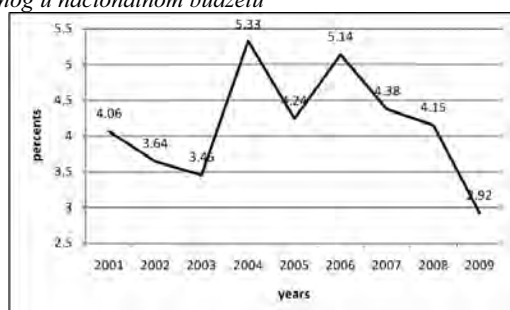
Year	Agricultural production	Food industry	Other
2002.	14,8 %	5,9 %	79,3 %
2003.	13,6 %	5,7 %	80,7 %
2004.	15,0 %	5,4 %	79,6 %
2005.	13,5 %	5,4 %	81,1 %
2006.	12,6 %	5,3 %	82,1 %
2007.	10,8 %	5,2 %	84,0 %

Source of data: RIS

However, beside that agriculture in the Republic of Serbia is still of very low profitability, so that agrar budget presents the most important way of investing in agriculture from the mid ninties, and that budget is of great imoportance to the people in villages, producers who live of this production. In the conditions in which our agriculture is today, none of the agricultural producers can survive without protection and subventions from the state, and exactly that agrar budget shows some important oscillations in the period from 2001-2009 which is shown on the graphs (2 and 3) (Pejanović, 2006).

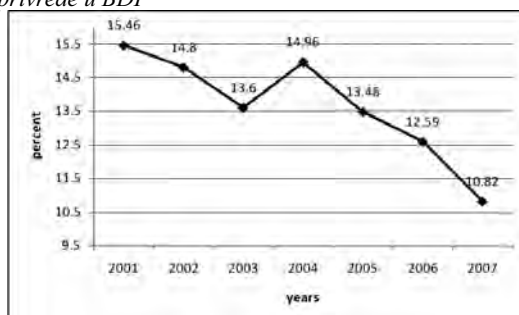
Graph 2: Participation of agrarian in the national budget

*Graf. 2: Učešće agrarnog u nacionalnom budžetu*



Graph 3: Participation of agricultural production in GDP

*Graf. 3: Učešće poljoprivrede u BDP*



Source:RIS

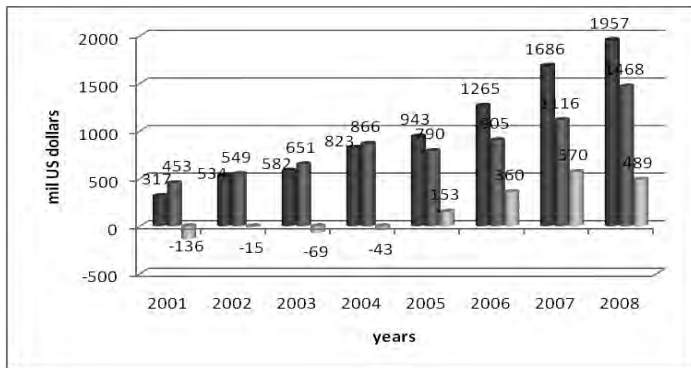
## The foreign trade exchange

The Republic of Serbia is relatively small country, so in her interest is to develop cooperation on all possible levels of European and world economy. Foreign trade exchange is maybe one of the most important areas of cooperation, and in order to improve exchange of agricultural products it is important to know international market well, and to follow trends and major tendencies on that market (Pejanović and Njegovan, 2008).

In the period from 2001-2008 we can see the tendencies of growth of the export in food and agricultural products, in the size which slowly overcomes the import and make one positive saldo or balance of foreign trade exchange.

Graph 4: Foreign trade exchange of food and agricultural products of Serbia

Graf. 4: Spoljnotrgovinska razmena poljoprivredno-prehrambenih proizvoda Srbije (2001-2008. god)



Source: RIS

Finally, if we take into consideration only the previous year, we can come to the following conclusion: the total exchange of the goods in agrar of Serbia with the world in 2008, was 3.425,4 milions of Us dollars, from which on export goes 1.957,5 and on import 1.467,9 milions of US dollars. In this period agrar made surplus in the trade with the world of 489,6 milions of US dollars. Acording to the same period in 2007, the export of the agrar was bigger for 16,1%, while the export grew for 30,8% at the same time. Coverage of the import with export in the agrar of Serbia was 133,3% while in the same period last year it was 150,2%.

## CONCLUSION

Serbia is a highly agrar country, with huge comparative advantages for the development of agriculture and village. Serbia has importanat land potentials for the development both plant and cattle breeding. For example, AP Vojvodina as the land where wheat is grown in the Republic of Serbia, can feed "half the Europe" with its potentials. Serbia also has human, traditionally capable resources for production of food.

Above mentioned and many other comparative advantages unfortunately are not transformed into competitive advantages. There aren't enough investements in this stra-

tegic industrial activity in Serbia. Many indicators confirm that. On the other side, foreign trade surplus of agrar products shows unused possibilities of the industry in the Republic of Serbia.

The state did not accept and still does not, the fact that the agriculture, because of its specific production, permanently needs extra-foreign resources of finances. Economical crisis in which the whole world is now will surely stay noted down in the annals of the economy, as one of the strongest crisis to which human civilisation was faced. How it will end and when is still to be seen, but one thing is sure: there will be radical changes in the world economy and that will show in our industry and agriculture as one part of it. The question stays, whether will, led by experience from the past, the agriculture be used again for keeping temporary social peace and will this crisis be transferred to its back or will the right thing be done this time-invest in agriculture and its development because Serbia is agrar country and that resource and that possibility should be used as one of the biggest advantages and wealths that we own according to the urban world.

Thus, radical changes are needed in the strategy of industrial development of the Republic of Serbia. Agroindustrial sector should be the leading one, key sector of the development of industry and society. Transition reforms, which are happening now, should lead to this goal, instead of avoiding agriculture and village, leaving them to "cruel minds" of privatisation, liberalisation and pauperisation.

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# RAZVOJNE TENDENCIJE POLJOPRIVREDE REPUBLIKE SRBIJE

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ADRIJANA RADOSAVAC

## Izvod

Autori razmatraju razvojne probleme poljoprivrede Republike Srbije. Poljoprivreda zauzima, tradicionalno, vodeće mesto u strukturi privrede Republike Srbije. Za razvoj ove privredne grane postoje prirodni i ljudski potencijali. Međutim, indikatori razvoja u vreme tranzicije pokazuju da postoje ozbiljna ograničenja razvoja ove delatnosti. Najveće ograničenje je pogrešna ekonomska i agrarna politika države, koja u dugom periodu razvoja zapostavlja ovu delatnost, nedovoljno ulaže u nju, što ima negativne posledice na poljoprivredu, koja zaostaje za potencijalnim mogućnostima razvoja, i na sela, koja su zahvaćena procesom depopulacije, deagrarizacije i senilizacije.

**Ključne reči:** poljoprivreda, agrarna politika, razvoj, Republika Srbija, ograničenja, tranzicija.

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## FINDINGS OF *STREPTOCOCCUS AGALACTIAE* IN COW UDDER, PROPOSAL OF CONTROL AND ERADICATION

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*SUMMARY: To provide hygienically correct milk it is necessary for mammary gland to be free from bacteria which can lead to disorder in secretion, changes in quality and quantity of milk. One of the most significant causes of mastitis is Streptococcus agalactiae, which leads to chronic mastitis with latent clinical picture and seldom to acute mastitis. In certain percent of infected cows there are no significant changes in quality and quantity of milk and their milk meets quality standards. Animals that release bacteria with milk are reservoir of infection. We have isolated Streptococcus agalactiae from animals on four from total five farms. Average somatic cell count in infected cows was  $219 \cdot 10^3/\text{ml}$  to  $1813 \cdot 10^3/\text{ml}$  milk. Cows with findings of Streptococcus agalactiae in udder represent potencial reservoir for spread of infection, because they can not be identified with additional tests for secretion disorder detection.*

*Key words: mastitis, Streptococcus agalactiae, latent infection*

### INTRODUCTION

*Streptococcus agalactiae* is considered to be an obligate pathogen of the udder. The bacteria penetrates the acinar epithelium, causing edema and extravasation of neutrophils into the lumen, resulting in subclinical or clinical mastitis as well as possible systemic infection. Because of changes in mammary gland reduction of milk production can happen (Jones et al 1984). In clinical acute mastitis milk is changed organoleptic and unless there is medication on time, total los of function can occur. Besides direct losses, indirect losses are important too because of reduction of milk production in clinical cured quarters. In order to diagnose infection with *Streptococcus agalactiae* on time it

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Original scientific paper / *Originalni naučni rad*

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is necessary to conduct bacteriological examination of quarter milk and cumulative milk samples in certain period of time. For mastitis control it is necessary to detect source of infection, and those are cows with infection in mammary gland or in other organ (Bobos 2005). Young animals with latent infection of mammary gland are important source of infection and with beginning of lactation they excrete bacteria in milk.

## MATERIAL AND METHODS

Research are done on five farms of holstein cows. There were totally 111 cows in different stages of lactation. Clinical examen of mammary glands and CMT test were done before taking samples.

Milk samples for bacteriological examination were taking from all cows when there were no sings of clinical mastitis. Sampling was done during morning milking after washing and disinfection of teats. Samples were taken aseptically in sterile test-tubes. For somatic cells count determination milk is sampled with a test which enables to take average sample, because there are mild variations in number of somatic cells in beginning and in the end of milking. Samples were taken during morning and evening milking and those two samples were mixed together in one average sample. Natrium-azid was added in samples as preservative. Bacteriological examination of samples was done in Laboratory of Faculty of Agriculture in Novi Sad, Department of veterinary medicine, and counting of somatic cells was done in laboratory of Mlekara Subotica by flow cytometry. Prepared milk samples were inoculated on blood agar plates and after 48 hours of incubation reading of substratum was done. For differentiation of *Streptococcus agalactiae* from other *streptococci*, CAMP, esculin test, catalase test, C-hydrate fermentation, hydrolysis of Na-hypurate and latex agglutination were used.

## RESULTS AND DISCUSSION

Number of cows with isolated *Streptococcus agalactiae* from cumulative milk samples is shown in table 1.

Table 1: Cows with *Streptococcus agalactiae* findings in cumulative milk  
Tabela 1: Krave sa nalazom *Streptococcus agalactiae* u zbirnom mleku

Farm Farma	A	B	C	D	E	Total Ukupno
Total number of cows Ukupan broj krava	17	18	38	16	22	111
Procent of cows with isolated <i>Str. agalactiae</i> Procenat krava sa izolovanim <i>Str. agalactiae</i>	17,6%	11,1%	/	43,7%	13,6%	13,5%
Number of cows with isolated <i>Str. agalactiae</i> Broj krava sa izolovanim <i>Str. agalactiae</i>	3	2	/	7	3	15

In table 1 composite infections of *Streptococcus agalactiae* and other microorganisms are shown too.



We can see in table 1 that there is significant difference in percent of infected cows between farms, so on farm D 40% of cows is with isolated *Streptococcus agalactiae*, and on farm C all milk samples were without *Streptococcus agalactiae*. On other three farms percent of infected cows was approximately the same, this is according to Andersen et al 2003 and Hamann 2002.

Table 2 : Average somatic cell count in cows with *Streptococcus agalactiae*

Tabela 2: Prosečan broj somatskih ćelija kod krava sa izolovanim *Streptococcus agalactiae*

Farm Farma	A	B	C	D	E
Average somatic cell count ( $\cdot 10^3$ ) Prosečan broj somatskih ćelija ( $\cdot 10^3$ )	1.186	219	/	1.187	1.813

Clinical and laboratory results indicate that the percentage of infected cows udder with *Streptococcus agalactiae* in the farm D was 43.7% and a total in all five surveyed farms was 13.5% (table 1). Tolle et al. (1977) in his anti-mastitis study suggest bacteriological examination of all udder quarters when the somatic cell count is over 500 000/ml, and that is in accordance with our findings of *Streptococcus agalactiae* isolated from udders.

Results shown in table 2 point that udder infection with *Streptococcus agalactiae* most often lead to subclinical mastitis when only prove of infection is increasing of somatic cell number. This is according to (Ward and Schultz 1998, Jayarao et al 2004, Radinovic et al 2008) who also found increasing of somatic cell count in cows with isolated microorganism. Average number of somatic cells in cumulative milk samples from cows with *Streptococcus agalactiae* on three farms was 1 186 000 to 1 813 000 in 1 ml of milk (table 2).

CMT pointed that certain cows have secretion disorder. Milk samples from farm B did not point on secretion disorder, so cytological analysis is not most reliable for detection of latent infection with *Streptococcus agalactiae*. Infected animals are permanent carriers and they have great influence on expansion of infection. In order to identify animals with latent infection it is necessary to conduct bacteriological examination quarter and cumulative milk samples. Results of bacteriological findings would point that animals eradiate bacteria with milk even when there is no secretion disorder and organoleptic changes in milk, according to Green et al 2004.

## CONCLUSION

Udder infection with *Streptococcus agalactiae* is proven on 4 from 5 examined farms and represents serious trouble in milk production. Mastitis most often passes in subclinical form and it is hard to diagnose without additional examination. Determination of somatic cell count in most infected cows pointed on secretion disorder, and in less number of cows udder infection is without increasing of somatic cell count. Only eradiation of bacteria in milk can point on infection, and that is reservoir for spread of infection. In order to decrease number of infected cows it would be necessary, in every milk farm to conduct bacteriological examination of quarter and cumulative milk sam-

ples at least once a year and according to results to conduct therapy measures to eradicate bacteria from mammary gland. Therapy can be implemented during lactation, with penicillin preparation, to prevent eradication of bacteria in milk. Limits for this therapy is wasting of milk during waiting period and efficiency of 75%. If therapy is implemented during dry-off period efficiency is above 90% ( Bobos et al 2006). When therapy is implemented during dry-off bacteriological examination must be repeated after calving.

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## NALAZ STREPTOCOCCUS AGALACTIAE U VIMENU KRAVA, MERE KONTROLE I ERADIKACIJE

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### Izvod

Za dobijanje higijenski ispravnog mleka neophodno je da mlečna žlezda bude slobodna od infekcija bakterijskim uzročnicima koji dovode do poremećaja sekrecije i utiču na kvalitet i količinu mleka. Jedan od najznačajnijih uzročnika mastitisa je *Streptococcus agalactiae*, koji najčešće dovodi do hroničnih mastitisa sa latentnom kliničkom slikom

a retko do akutnog kataralnog mastitisa. Kod određenog procenta inficiranih krava promene u količini i kvalitetu mleka nisu značajne i njihovo mleko odgovara standarima za kvalitet mleka, a te životinje mlekom izlučuju uzročnika i predstavljaju rezervoar infekcije. *Streptococcus agalactiae* je izolovan iz zbirnih uzoraka mleka krava sa četiri od ukupno pet farmi u ogledu. Prosečan broj somatskih ćelija kod inficiranih krava kretao se od 219.000/ml do 1.813.000/ml mleka. Krave sa nalazom *Streptococcus agalactiae* u vimenu predstavljaju potencijalne rezervoare za širenje infekcije u stadu, zbog toga što pomoćnim testovima za otkrivanje poremećaja sekrecije ne mogu da se identifikuju.

**Ključne reči:** mastitis, *Streptococcus agalactiae*, rezervoar infekcije

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## THE POSSIBILITIES FOR ORGANIC SEED PRODUCTION OF SMALL GRAINS IN SERBIA\*

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*SUMMARY: Organic agriculture production of some states attains already ten percents of the total agricultural production. In such a way the need to provide a seed which is in correspondance with strict demands of organic agriculture and to reserve undisrupted realization of such production of this kind of more and more respected food on the market arise. Many of serious seed companies in the world started with production of organic seed of some grown species. In Serbia, possibilities for this kind of production were getting by adoption of Organic agriculture law. The first cooperatives in this area were founded, the production begun to develops more and more significantly, but the problems related to supply of organic seed of many field and vegetable crops arise. Small Grains Research Centre in Kragujevac started production of symbolic quantities of organic seed of small grains in the goal to initiate future more serious production. In the view of production of organic seed as the most perspective were imposed next species and cultivars of small grains: winter rye (cv. Raša), winter triticale (cv. Triumf), winter and spring oats (cvs. Vranac, Slavuj, Rajac and Lovćen). Besides of that, cvs. of winter wheat and barley of medium or high steam, high technological quality and very good to immune resistance or tolerance to more important diseases and pests causers could be also interesting for organic agriculture. Conlusions and discussion related to our first experiences, problems and proposals on certified organic seed production of small grains were presented.*

**Key words:** *Organic seed, small grains, rye, oat, triticale, wheat, barley, production*

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Review paper / Pregledni rad

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## INTRODUCTION

According to Kovačević and Oljača (2005), small grains play very important role in the crop rotation in conventional agriculture, but their role in organic agriculture (OA) is even more important. Their importance in OA reflects in at the first place in the fight against weeds, as the most important problem of organic agriculture. They contribute to more successful and natural withstanding of weeds in generally by their better competing abilities and allelopathy. Besides of that, monocropping as sistem of plant production could be important source of infection by numerous diseases and pests. Besides of contribution in fight against weeds, according to Horrigan et al. (2002), small grains have favourable influence on prevention of erosion, moisture conservation in the soil, increasing of biodiversity, improvement of microbiological activity etc. Their remnants after harvest have usage in preparation of organic fertilizers, but also contributes to significant increasing of organic mater in the soil. Besides of that, remnants of harvest with success have usage for mulching in production of different field, vegetable and fruit crops. Small grains (esp. winter) are distinguished by ability of relative fast growth and forming of biomass on low temperatures, during the winter and the first spring months (Milovanović et al., 2001, 2002, 2005). By their distinct favour to tiling they contribute in providing of generally good crop density, capturing vegetative area and in such a way pressing the weeds ecologically, and examples of allelopathic influences especially in rye were noticed, too (Stojanović et al., 1998; Vulić et al., 1994).

The representatives of UN (Kofi Anan, former gen. secr.) were turned on attention to undeveloped and states in development, pointing on their comparative advantages and recommending development of OA. Development of OA in the last few decades in the world receives more and more significance. The OA in some states of world achieved 8-13% from the total agricultural production (Horrigan et al. 2002; Mirecki, 2002). In parallel with development of OA, also appeared a need for providing of „organic seed“ (Steven et al., 2005; Milovanović et al., 2007). Seed producing companies in developed states started with production of organic seed and its offer by catalogues.

According to Horrigan et al. (2002), lower offer and more and more high demand of organic food in the world caused significant higher prices and secured market for certified production. Besides of other, development of this kind of production could contribute to better employment (higher engagement of labour), preservation of environment, soil and unrenuwable resources, as well as advancement of inhabitants health and in this manner to total sustainable development. This kind of production is in conflict with principles propagated in generally in the name of multinational companies from the interceders of the first, and nowadays of the second green revolution. Those who contributed, in specially at the second half of the last century, to the polution of our planet with synthetical mineral fertilizers, pesticides and by erosion of biodiversity, nowadays offer „the second green revolution“ and introduction of GMO and some other products of contemporary biotechnology in the goal of decreasing usage of chemicals and synthetic fertilizers. It is most frequently against of their interests and at the least case it leaves space for doubt in existing of good intentions.

In Serbia were created conditions for development of OA by adoption of Law about organic production and organic products (Sl. gl. RS 62/06). The first eco-cooperatives (about 70) were founded, and OA begun to develop in 10 regional centers. In the 2007<sup>th</sup>

was formed Union of producers of organic food (Vuković, 2007).

In the beginning of development of OA in Serbia, appeared problems with supply of “organic seed” of the field and vegetable crops for this kind of production. Until now our producers were leaned in generally on expensive and frequently unattainable imported “organic seed” or on the seed from own production. Until nowadays in Serbia was not produced certified organic seed in accordance with Law about seed and Law about organic production. Because of aforementioned, investigations in the goal of initiation and advancement of production of organic seed are very important, which can enable more successful future development of OA on our spaces (Milovanović et al., 2007, 2008; Milovanović, 2008). Seed of small grains is very significant for OA due to:

- they present the best mechanized grown plants for production;
- impossible development of organic animal husbandry without of OA of small grains;
- producing of new possibilities in processing industry (Kovačević and Oljača, 2005).

According to Stojković (2008), in development of OA Serbia have certain advantages, which reflect in generally in favorable climatic and soil conditions. Because of long duration crisis in our agriculture, during the last two decades in generally were applied extensive agrotechnical measures (minimum of pesticides and mineral nutrients). Besides of that, in favor of OA comes tradition of serbian producers too, as well as great areas of unworked soil and outstanding unemployment. Our shortages in generally reflects for now in: insufficiently organized certification, pure informed and educated producers, shortage of certified organic seed, shortage of support from the government in the area of investments, subventions and disposal, shortage of organized appearance on the market, as well as eroded ethic and ecologic conscience.

## **RESULTS AND DISCUSSION**

### **Production of organic seed**

Development of OA is unconceivable without development of animal husbandry, for which needs in opposite is necessary to supply sufficient quantities of organic produced bulky and grain cattle fodder, then in correspondence with that imposes as unavoidable need for development of organic field crops growing in which in our country an rest of world, small grains have strategic important role (Kovačević and Oljača, 2005). Among of small grains, in the sense of high competition abilities in relation to weed species are especially famous: winter rye, winter triticale, winter barley and oat and finally winter wheat and spring oat, barley and triticale. Different varieties of same species at that, demonstrates higher or lower advantages (Milovanović et al., 2001, 2005, 2008; Stojanović et al., 1998; Vulić et al., 1994). Because of all mentioned, in the goal of creation of more favorable base for development of organic animal husbandry in our country, priority in production of certified organic seed was given to varieties of winter and spring oat and winter triticale.

According to some estimations (Vučinić and Pešić, 2001), over than 20% of soils in Serbia nowadays are usable for OA, and there are significant areas of unworked soil, too. Besides of that, period of long duration recession in the country contributed to situation that Serbia as well as in last 15 years stay among last places of European countries in

use of pesticides and synthetic mineral nutrients, which contributed to lower pollution of our soils and waters and to its more easy conversion for purposes of OA. Also, in favor of development of OA in Serbia comes more and more high demand on the market of so-called „healthy food“ and macrobiotic products.

Until now production of „organic seed“ in Serbia was out of certification system according to the Law about seed, or, it was at some species supplied from the importation. It is well-known that production of organic seed is subjected to higher risks from appearance of diseases, pests and weeds in relation to production of conventional seed (Steven et al. 2005). Because of preservation of interests of organic food producers, as well as consumers, organic seed would have to satisfy standards of IFOAM, besides of criteria of seed quality according to Law about seed. European Union adopted own regulations in this area (regulative EEC 2092/91 and subsequent regulations of member states) following the model of IFOAM standards (International Federation of Organic Agriculture Movements). In our country, also were created legal bases for development of this area by adoption of Law about organic production and organic products, as well as corresponding sub-law regulations (rules) in the period of last few years.

Because of aforementioned in the frame of Innovational project (Ev. No. 451-01-02960/2006-15), which was financed from Ministry of science and technological development of RS, under the title “Investigation of new technologies of usage of small grains”, in Small Grains Research Centre in Kragujevac was successfully realized establishment of new production line for production of high categories of organic seed of small grains, as one of activities. The first initial areas were intended for production of high categories of organic seed of winter and spring oat and winter triticale.

According to Kovačević and Oljača, (2005), one of prerequisites for production of organic seed are resistant and tolerant varieties, which enables lower usage of pesticides or their complete exclusion, and which is one of prerequisites for OA, too. Also, it is essential, invention of adequate technology for this kind of production in our conditions, since we do not have such experiences in our country until now. Since, in Small Grains Research Centre for a long series of years in the structure of integral measures of protection was studied resistance of small grains varieties to harmful organisms (Stojanović et al., 1996; Staletić et al., 2005, 2007; Labudović et al., 2000), on the base of results of these investigations were selected few varieties and species of small grains, which demonstrated its high resistance or tolerance, and together as economic in the view of demands for nutrition (Nikolić et al., 2004), with high potential for yield and quality of grain adequate to demands of OA. Selected varieties and species of (these conventional) small grains because of its quality can be used with success for production of high quality cattle feed, as well as in processing industry (Milovanović et al., 1994, 2005a and b; Maksimović, 1998).

In that sense during the 2007<sup>th</sup> year was realized production of the first quantities of certified seed of organic oat, spring variety Slavuj, category elite (breeder's seed) on area of 1 ha. Also, in 2008<sup>th</sup> year, it was attained its multiplication on area of 1 ha, as well as of cultivar Vranac on 2 ha, at two certified organic producers from the village Pajazitovo near Kragujevac. Besides of that, in the 2008<sup>th</sup> year were sown variety of winter triticale Triumf on the area of about 0,2 ha, and variety of winter oat Vranac on the area of 0,4 ha, as well as variety of spring oat Slavuj on the area of about 0,6 ha, and

everything in the goal of further production of certified organic seed of small grains, categories elite and super elite (breeders seed). All these areas were reported for certification of organic production (Table 1). Theirs further multiplication will be carried out in concordance with Low, at seed companies or at certified organic producers. As could be noticed, it is a question of symbolical areas, which make possible only initiation of future production of certified organic seed of KG varieties of small grains.

Table 1. Production of high categories of certified «organic seed» of KG cultivars of small grains in 2007/08. god.

Crop-cultivar	Seed category	Area (ha)
Winter titicale-Trijumf	Breeders seed	0,2
Winter oat - Vranac	Breeders seed	0,4
Spring oat – Slavuj	Breeders seed	0,6
Spring oat - Slavuj	Basic seed	1
Winter oat – Vranac	Basic seed	2
<b>Total</b>	-	<b>4,2</b>

For the purpose of OA were selected as the most perspective species and KG varieties of small grains: winter rye (Raša), w. oat (Vranac), w. triticale (Triumf), spring oats (Rajac, Slavuj and Lovćen), w. six rowed fodder barley (Grand), w. wheats (Studenica, Toplica, Takovčanka). At some of mentioned varieties production of certified organic seed was not still initiated, but it is in plan, in according with demands of market.

### Legal regulative and certification

Low about seed (Official herald of RS, no. 45/05), with its regulations is almost in completeness synchronized with international conventions and standards related to variety and seed (OECD, ISTA, UPOV), so it does not present disturbances for export and import of seed.

Low about organic production and organic products (with its regulations), prohibits strictly synthetic chemical products and GMO. Seed for the purposes of OA understands duty that it originates from the organic production according to methods and standards of OA (Official herald of RS, no. 62/2006). This Low is solidly accorded with standards of IFOAM and EU regulative EEC 2092/91, but appears problem at export, since in abroad were not recognized certificates of our Ministry of agriculture, so organic producers, which in generally deal for export were directed on foreign certification firms (Vuković, 2007). During 2007<sup>th</sup> year temporary permission for certification of organic production in Serbia had Association for organic agriculture TERRA'S from Subotica.

Licensed certifying firms in Serbia in 2008<sup>th</sup> year were:

SUOLO E SALUTE SERBIAN d.o.o., V. Plana, Momira Gajića 8;

SGS-BEOGRAD d.o.o., Belgrade, Bože Jankovića 39 and

EVROCET d.o.o., Belgrade, Desanke Maksimović 4/3.

As could be noticed, there is still small number of foreign certifying firms, and that



certainly have unfavourable influence on prices, which is required to made better in the future period.

### **Finishing, treatment and depoting of seed**

According to Low about organic production and organic products, finishing of seed have to perform with separate technologic lines or by existing lines for finishing but with obligate previous cleaning, washing and disinfection by means permitted in OA. Also, depoting of organic seed have to perform in separate and marked depots or separate from the others products.

Some of the early used materials and methods for treatment of seed, as example: ashes of wood, salt, slaked lime, saltpeter,  $\text{CuSO}_4$ , hot water (Leukel, 2008), as well as scald from chamomile, could be applied after examination and study in nowadays conditions for treatment of organic seed, too. For treatment of organic seed in the world in recent years were investigated possibilities of usage of different materials and methods (Munzer et al. 2000; Saidi et al. 2001; Anders, 2004; Steven et al. 2005). Treatment of seed by extracts of hemp, eucalyptus, thuja and *Datura stramonijum* demonstrated controversial results, more or less successful depending from geographical origin of mentioned plants. Much better and acceptable results in control of diseases which are transferable by seed demonstrated treatment of seed by thyme oil, as well as skimmed milk powder, wheat flour, dilutions of acetic and lactic acids, vinegar. All mentioned direct us on examination of these means and to search the most adequate for purposes of OA in our conditions.

### **Experiences**

Past experiences in production of certified organic seed point out on some specificities which have to be respected in technology of seed production in the aim of obtaining as better as possible results (Steven et al. 2005; Kovačević and Oljača, 2005). On the first place have to turn care on choose of previous crops favorable for small grains (the best are leguminous and row crops from system of OA), at which presence of weeds was not great problem. Since OA on conventional areas anticipates period of conversion from three years, it is possible to utilize existing virgin soils or long standing uncultivated parcels, about whom there is evidence in the books of field (which was the case with some parcels in Small Grains Research Centre). It was noticed at that, that optimal sowing time is compatible with terms recommending in conventional agriculture for discrete species and varieties of small grains. OA is considerably more sensitive on posterior terms of sowing. At that in late terms obtains extremely worse results, especially at real winter varieties (in winter sowing) and at spring oat (in spring sowing). Because of that, to producers of organic seed (and generally to organic producers of small grains), could be recommended to pay special attention to prescribed optimal sowing terms by the owners of varieties. Besides of that, because of something inferior plant development (tilering, habitus and biomass) in the system of OA, for the purpose of obtaining as possible as better results and crop constitution as the most important bearer of grain yield, it is necessarily to search demands for increasing the sowing density in relation to

that which was recommended until now for the purposes of conventional agriculture at discrete varieties and species of small grains. Appearance of quarantine weed species (wild oat and cleavers) and other weeds was eliminated by proper choosing of uninfected parcel, and individual plants are removed by picking before of weed seed dispersal. Treatment against diseases and pests was unnecessary by favor of proper choice of resistant or tolerant varieties. Fertilizing is possible by application of certified organic and organic mineral fertilizers regular according to Law, that might be found on our market, although their choice is very humble. By reason of decreasing losses (esp. at oat), it is necessary to accomplish harvest in optimal terms, at endwise of waxy and beginning of full ripeness. Certification, inspection, approbation and declaration shall be performed by respect of Law about seed and Law about organic production and theirs under low rolls, as well as standards of IFOAM. Also, in practice it presents a problem order less of sanitary secure production in our country according to HACCP-standard, which reduces competitiveness of our production for the purpose of exportation. Imposed by low prohibition of GMO production in our country gives us advantage in OA because of elimination of possibility of contamination by GMO pollen.

As some of objective problems in realization of production of certified organic seed, might be emphasized: in practice inadequately organized system of certification of OA in our country, small number of licensed agencies for certification of OA (in generally foreign) and high price of certification, insufficient education of vocational services, inspections and organic producers. As the second part of problem in realization of this activity appeared superimposed and unfavorable conditions for sowing of small grains during the past autumn (early winter and precipitations). In this way, realization of results, whose possibility was potential much greater, was almost focused in question by late sowing and lower areas from possible, which influenced obtaining of humble results.

Besides of mentioned might be emphasized still some specificities about whom one shall take care in the technology and process of production of organic seed (Law about organic production and organic products):

- obligate crop rotation in the service of enhancement of biodiversity;
- essential analysis of soil and fertilizers for presence of heavy metals (Cd, Hg, Pb, Zn, Cr, Ni, Cu, Mo, As);
- usage of healthy organic seed packed in bioretrogressive bags, prohibited PVC package;
- allowed organic and natural mineral fertilizers→ in accordance to Law about OA;
- allowed substances for protection→ in accordance to Law about OA;
- application, control, approbation and certification→ in accordance to Laws about OA and about seed, registration for OA, essential separate evidence in the book of field for parcels under OA.

Also, according to our consideration at this production ought to keep in vision needs for: choice of varieties and species resistant, tolerant, good competitors and of humble demands; opportuneness and high-quality of previous sowing soil preparation and sowing; more labor for weed control, elimination of atypical and diseased plants, higher costs; leaving of fixed passages for the corridor of labor (on 2-3 m); more intensive marketing in the direction to organic producers.

Those our observations could be compared with similar experiences in the world (Steven et al. 2005). Mentioned authors emphasize advantage of developing countries in the question of better economic alternative for production and sale of organic products. They quotes next problems in production: absence of reproductive material at many species or non-existence of adequate varieties; inconveniences in obtaining of high quality organic seed comparable to that from the conventional production; for some of grown species, organic produced seed is more costly and in practice producers might choose conventional seed. Also, they emphasize that OA requests even higher quality of reproductive material than conventional. Embargo of application of chemicals in OA directs on requirement of higher vigour of sowing material, as well as healthy seed. This is not circumstance at grains, wherein is already producing organic seed in the world, but frequently of inferior germination than conventional due, to appearance of fungous diseases transferring by seed. Also, problem presents a great variation in availability of organic seed on the market of Europe. For some of grown species in Europe is permitted exclusively utilization of organic seed, until at other frequently, with permission, in absence of organic could be allowed use of conventional seed. At some species, even does not exists the need for permission of use of conventional seed, since at them still does not exist organic. In other parts of the world the circumstance with organic seed is even worse. Because of prohibition of usage of chemicals during production, organic seed has greater risks from the contamination (by weed species and plant pathogens). Mentioned authors emphasise that at treatment of organic seed the best results were accomplished with thyme oil which is allowed for OA according to regulative EEC 2092/91 and FAO *Codex Alimentarius*. In Rome in 2004<sup>th</sup> year was maintained The First Conference of Organic Seed, on which participated 270 scientists from 57 states. All this demonstrates how much is raising significance of OA and consequently of production of organic seed in the world.

We hope also, that those our investigations and results could contribute to future initiation of organic production of seed at other our institutions and seed companies, as well as that it shall involve at that all important grown plants at which OA should be developing on our spaces.

## CONCLUSION

On the basis of these investigations can be important to draw the following conclusions:

- in OA the small grains are of irreplaceable role in crop rotation systems, particularly for ecological suppression of the weeds, diseases and pests, as well as for the needs of organic animal husbandry;
- in Serbia, there are adequate uncontaminated areas, capacities and knowledge for the production of certified “organic seeds” of small grains of high quality;
- it was initiated the production of high categoris of the varietal certified organic seeds of small grains in KG Center (advantage was given to resistant and tolerant more extensive species and varieties, of the high technological quality). Similar initiation of production of organic seeds should be desirable by the other of our institutes and seed companies, too, for all major grown species in the OA. Institutes and owners

of varieties have to start the first with the production of certified organic seeds of high categories (breeders seed), to enable to seed companies further reproduction by methods of OA;

- it is very important in systems of OA to provide sowing in today recommended optimal terms for individual species and cultivars. OA is much more sensitive to late sowing.
- KG most perspective cultivars for OA are: winter rye Raša, w.oat Vranac, w. triticale Triumpf, w. barley Grand and winter wheats Studenica, Takovčanka and Toplica;
- it is necessary to ascertain the most efficient and the most acceptable methods and substances for the treatment of organic seed in conditions of our OA (concentration, dosages, combinations, new means);
- higher costs are evident in the OA of small grains in relation to the conventional;
- it is necessarily for states to organize more efficient and cheaper certification, support would be essential in subsidizing the costs of certification, especially in the period of conversion, as well as in subsidizing of OA with greater resources per hectare compared to the conventional.

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# MOGUĆNOSTI ZA PROIZVODNJU ORGANSKOG SEMENA STRNIH ŽITA U SRBIJI

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## Izvod

Organska proizvodnja u nekim zemljama već dostiže preko deset procenata od ukupne poljoprivredne proizvodnje. Samim tim nameće se potreba za obezbeđenjem semena koje će odgovoriti strogim zahtevima organske poljoprivrede i obezbediti nesmetanu realizaciju ove proizvodnje hrane sve više cenjene na tržištu. Mnoge semenske kompanije u svetu započele su sa proizvodnjom organskog semena pojedinih gajenih vrsta. U našoj zemlji stvorene su mogućnosti za ovom vrstom proizvodnje usvajanjem Zakona o organskoj poljoprivredi. Proizvođači u organskoj poljoprivredi kod nas su do sada bili prinuđeni da se uglavnom oslanjaju na uvezno organsko seme i nije bilo ozbiljnijih poduhvata u proizvodnji domaćeg sertifikovanog organskog semena strnih žita. Centar za strna žita u Kragujevcu je započeo sa proizvodnjom simboličnih količina organskog semena strnih žita u cilju da inicira ozbiljniju buduću proizvodnju. U pogledu proizvodnje organskog semena kao najperspektivnije se nameću sledeće vrste i sorte strnih žita: ozima raž (Raša), ozimi tritikale (Trijumf), ozimi i jari ovas (Vranac, Slavuj, Rajac i Lovćen). Pored toga za organsku poljoprivredu bi mogle biti interesantne i sorte ozime pšenice i ječma srednje visoke i visoke stabljike, visokog tehnološkog kvaliteta, veoma dobre i odlične otpornosti i tolerantnosti prema važnijim bolestima i štetočinama.

**Ključne reči:** Organsko seme, raž, ovas, tritikale, pšenica, ječam, proizvodnja.

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## INFECTIOUS DISEASES OF THE CATTLE CLAWS\*

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*SUMMARY: Among the many factors which negatively affect the productivity of cattle, claws diseases are very common, and for its importance in the pathology of cattle classified at third place, following reproductive disorders and mastitis. Diseases of cattle acropodium are of a different etiology and localization of pathological changes. Etiology of this diseases are different in relation to the nature of causing factors, which can be infectious and noninfectious. In the group of infectious diseases there are: interdigital phlegmon, interdigital dermatitis, heel horn erosion, digital dermatitis. The paper presents critical review the etiology, epidemiology, pathology, therapy and prevention of infectious diseases of cattle acropodium.*

**Key words:** *interdigital phlegmon, interdigital dermatitis, digital dermatitis, acropodium, cattle*

### INTRODUCTION

Etiology of acropodium diseases at cattle is different in relation to the nature of causing factors, which can be infectious and noninfectious. In addition, this group of diseases can be divided on the basis of localization of pathological processes, as diseases of horn, diseases of corium and diseases of acropodium skin. In this paper we gave critical review of etiology, clinical symptoms, pathomorphologic changes, diagnosis and therapy of interdigital phlegmon, interdigital dermatitis, heel horn erosion and papillomatous digital dermatitis. Group of these diseases can be named as a syndrome of skin diseases of cattle acropodium.

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Review paper / Pregledni rad

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## INTERDIGITAL PHLEGMON

The important factor of pathogenesis of interdigital phlegmon (IP) is the mechanical trauma of interdigital space that allows entry pathogenic bacteria (Bergsten, 1997). The most often isolated bacteria from pathological tissue is *Fusobacterium necrophorum*. Sometimes, in addition to this bacteria can simultaneously isolate and *Porphyromonas levii* (Berg and Franklin, 2000). For the emergence of infection may be of importance and bacteria from the genera *Prevotella* and *Peptostreptococcus*, and spirochetes (Doherty et al., 1998). IP occurs sporadically, as in dairy, as well as fattening cattle (Berg and Franklin, 2000). In our research, we found that the IP often occurs in the colder period of year (Stevančević and Toholj, 2007). Breed predisposition is not detected, but is known that breed cattle Jersey is less affected. The disease occurs more frequently in cows in the free system of breeding, probably because lower level of hygiene in these facilities (Toholj et al., 2007). Interdigital phlegmon, in the initial phase of infection is manifested by the appearance of fissure and skin necrosis of interdigital space. In addition to these signs of infection, there is pain, and sometimes hyperpyrexia with loss of appetite and reduced milk production. Characteristic odour smell indicates the presence of *Fusobacterium necrophorum*. (Bergsten, 1997). Diagnosis is usually, based on the clinical signs. Treatment is based on the parenteral application of antibiotics during the 3 to 5 days (Cook and Cutler, 1995). In the treatment of IF as antibiotics of choice are used amoxicillin, ceftiofur, erythromycin and sulphadimetoxin, due to the excellent therapeutic effect. Sometimes, in more severe clinical form of the disease, which also quickly progressing, there is poor therapeutic effect of antibiotics. This clinical form of the disease described in the UK (Cook and Cutler, 1995) and the United States in the (Guard, 2002). The prevention of this disease, is effective periodical, local application of antiseptic solutions to acropodium (footh bath). For that purpose can be used water solution of different substances (copper -sulphate, zinc-sulphate, formalin etc.). Very important factor for prevention of this disease, and other acropodium disease is improving of hygienic norms on farm. Today, vaccines developed with *Fusobacterium* specific toxin are using for for immunoprophylaxis IF (Checkley et al., 2005, Clark et al., 1986).

## INTERDIGITAL DERMATITIS

The interdigital dermatitis (ID) is bacterial infectious disease, but important part for developing of this disease are predisposing factors, such as moisture, urine and feces. Causes of infection are *Dichelobacter nodosus* and *Fusobacterium necrophorum* (Blowey, 1994; Guard, 1995; Van Amstel and Bemis, 1998). Some authors believe that interdigital dermatitis and digital dermatitis are different forms of the same diseases. In both diseases bacteria spirochetes can be isolate from pathological tissue, with the development of similar pathohistological changes, which indicates that may be the same disease (Blowey, 1994, Read and Walker, 1994, Walker et al., 2002). ID is often occurs together with the heel horn erosions, and some authors believe that it is the same disease (Bergsten, 1997; Somers et al., 2005b). ID more often occurs at the hind limbs, which can explain by permanent contamination of hind limbs with urine and/or feces. This disease goes as acute or chronic and is clinically manifested as superficial skin



inflammation of interdigital space (Chelate, 1974; Van Amstel and Bemis, 1998). There is evident of appearance of erosion in the early stages of disease. The clinical picture often is without lameness. Chronic lesions characterized by thickening in the beginning, and later hyperkeratinisation of skin, which is visible from the dorsal and palmar side of interdigital space (Bloway, 1994; Guard, 1995). Lesions are usually painful to touch. For the treatment locally use of antibiotics are the commonly way of therapy. Good effect in the prevention of these infection is the foot-bath with copper sulphate (Toholj and Stevančević 2007). When corrections of hoofs perform, special attention should be pay on the processing of all erosions of hooves because infectious agents located in such erosion can avoid the effect of antiseptic and antibiotics (Guard, 1995).

### **HEEL HORN EROSIONS**

As a possible cause of this infective disease indicated the *Dichelobacter nodosus*, which is often present in interdigital lesions (Raven et al., 1989). Disease is present in the population of cattle in large groups, with higher values of prevalence of infection in cows in the free system of breeding (Toholj, 2008b). Bergsten and Herlin also reported frequent occurrence of this disease at dairy cows in a free system of breeding (Bergsten and Herlin, 1996). Prevalence of this disease is also increased with number of calving (Enevoldsen et al., 1991). Manske point to the significant correlation in appear heel erosion and digital dermatitis (Manske et al., 2002). Other authors believe that interdigital dermatitis (IDD) and heel horn erosions are the same disease where heel horn erosion present later stage of IDD (Somers et al., 2005b). Disease is less present in herds of cows where all zoohygiene values are in recommended norms (Bergsten and Herlin, 1996). Heel horn erosions may be spread on small part of horn, or so intense that heel horn almost does not exist. Depth of erosion is different, from very shallow, to the depth almost to the corium. Lameness is usually, not clinically manifested. Diagnosis is based on the clinical examination findings and present of erosions (Collick et al., 1997). In the treatment of disease the application of antibiotics is approved only in complicated clinical cases. For the prevention of disease, effective can be foot-bath with antiseptics. There is evidence of a different prevalence of disease at the farm which use similar foot-bath management to apply antiseptic in order to prevent this disease. Therefore special attention should be pay on the removal of heel horn during hoof trimming procedure (Collick et al., 1997; Raven et al., 1989).

### **DIGITAL DERMATITIS**

Digital dermatitis (DD) is a skin disease of bovine acropodium with the most frequent localization at the plantar side of interdigital space (Laven and Hunt, 2004). Mortellaro and Chelli first described this disease at 1974. in Italy, and since then this disease were diagnosed at cows all over the world. This disease is with multicausal etiology. As infectious causes of this disease, the bacteria of the genus *Treponema* are present in lesions. DD commonly occurs in dairy cows in lactation. It's observed the higher value of prevalence of infection among younger throat (Tadić, 1990). Predisposing factors for the occurrence of this disease are inadequate environmental conditions (Somers et al.,

2005). In a free stalls, the disease is often present, due to a number of present sources and ways to convey infection in the flock (Laven and Hunt, 2004; Toholj et al. 2008). It is not entirely clear way of transfer of infection, but it is known that the disease in healthy herds may enter with the introduction of infected animals. In endemic areas, disease, often occurs in cows with lower parity of calving (Holzehauer et al., 2006; Somers et al. 2005). In California, the disease usually occurs in spring and summer (Read and Walker, 1994). In contrast to these countries in the European countries, this infection is usually registered during the cold winter months (Blowey, 1994; Brizii, 1993). Artificial infection in cows, is made possible only with the synergistic action of predisposing factors (moisture, urine, feces) and bacterias *Trepnemes* (Berry et al., 2004). Due to the presence of pathological changes, cows feel constantly pain.

Because of pain cows they lost appetite, and eat less, which in the further may cause diseases like indigestion, metabolic disorders and a decrease in milk production (Laven and Hunt, 2004). Pathological changes, the most commonly occurring at the hind limbs, unilaterally or bilaterally. Bilateral changes occur in 30% of affected animals (Somers et al., 2005). Pathomorphologic, disease manifested with appearance of ulcerations and proliferation, which can reach up to dermal papillas. In addition to these changes, there is present of hyperplasia of epidermis, paraceratosis and hyperceratosis at the edge of ulcerations. The lesions are 2-6 cm in diameter, circular or oval shape, surrounded by the white necrotic ring. Lesion area is covered with filliform papillas, length from 1mm to 3 cm in diameter of 0.5-1mm (Brizii, 1993, Read and Walker, 1998). These lesions are bleeding when touch. Pathohistologycaly is observed: akantoic epidermis with papillomatous proliferation and colonization of spirochetaes; loss of stratum granulosum, and infiltration with neutrophils, plasma cells, lymphocytes and eosinophils (Read and Walker, 1998). Diagnosis of diseases is based on the characteristic localization of pathological changes in the skin-horn junction, the presence of the white ring surrounding the lesion, as well as the presence of hypertrichosis (Read and Walker, 1998). DD therapy is usually conducted with local use of antibiotics. Usually applied antibiotics are: linkomicin, oxytetracyclin and erythromycin. Parenteral application of antibiotics does not provide a satisfactory therapeutic effect. Periodic use solution of zinc or copper sulphate is a good prevention of this disease (Toholj and Stevančević, 2007). For prevention of this disease, are available and commercial products, offten designed to make foam in contact with water wich provide better mechanics effect in remove of dirtyness.

## CONCLUSION

Infectious diseases of acropodium at cattle are often present. Development of infection, contribute the present of predisposing factors, such overpopulation, inadequate conditions in stalls like moist, urine feces etc. Therapy of these diseases can be done with local application of antibiotics and / or antiseptic. Prophylaxis of these diseases, is carried out with periodic application of antiseptic solutions. However, only improvement of hygienics conditions can ensure prevention of these diseases, which is important for eradication.

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## **INFektivNA OBOLJENJA PAPAka KOD GOVEDA**

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### **Izvod**

Među brojnim faktorima koji negativno utiču na produktivnost goveda, oboljenja akropodijuma sve su češća, te se po svojoj važnosti u patologiji goveda svrstavaju na treće mesto, odmah iza reproduktivnih poremećaja i poremećaja u sekreciji mleka. Oboljenja akropodijuma krava su različite etiologije i lokalizacije patoloških promena. Etiologija oboljenja akropodijuma krava se razlikuje u odnosu na prirodu etioloških uzročnika, koji mogu biti infektivni i neinfektivni. Grupi infektivnih oboljenja pripadaju: interdigitalna flegmona, interdigitalni dermatitis, erozije rožine pete i digitalni dermatitis. U radu je prikazana etiologija, epidemiologija, patologija, terapija i prevencija infektivnih

oboljenja akropodijuma krava.

**Ključne reči:** interdigitalna flergmona, interdigitalni dermatitis, digitalni dermatitis, akropodijum, goveda

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## IMPORTANCE OF LEPTIN GENE POLYMORPHISM IN CATTLE

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*SUMMARY: Leptin is a protein hormone with a key role in feed intake regulation and energy expenditure. Leptin expression and secretion is highly correlated with body fat mass and adipocyte size. Leptin is thought to be a metabolic signal that regulates nutritional status effects on reproductive function. Leptin receptors are found in the ventromedial and arcuate regions of the hypothalamus and are thus positioned anatomically in regions associated with the control of appetite and reproductive neuroendocrine function. It is interesting that neuropeptide Y (NPY) is present in the hypothalamic regions involved in neuroendocrine control of feed intake. In contrast to leptin, NPY is a powerful stimulator of feed intake and inhibitor of gonadotropin secretion. Leptin receptors have been localized on hypothalamic NPY neurons, and it has been revealed that leptin downregulates NPY expression. Investigations of leptin gene single nucleotide polymorphism (SNP) revealed that certain nucleotide substitutions may lead to changes in leptin expression. Gene-specific single nucleotide polymorphisms in the regulatory region (promoter) of the bovine leptin gene were detected that show associations with serum leptin concentration, growth rate, body weight, feed intake, feeding behaviour, and measures of carcass merit. The polymorphisms may also be predictive of other important traits in cattle such as milk yield and composition. However, further efforts are required to validate these findings in other bovine populations before their application in marker-assisted selection.*

**Key words:** *Leptin, single nucleotide polymorphism, economically important traits, cattle.*

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## INTRODUCTION

Leptin (from Greek “leptos” meaning thin) is a 16kDa protein hormone which regulates energy intake and expenditure, appetite and metabolic rate. Leptin is one of the most important adipose tissue derived hormones (Brennan and Mantzoros, 2006), although leptin can also be produced in small amounts in various tissues such as brown adipose tissue, placenta, ovaries, skeletal muscle, stomach (lower parts of fundic glands), mammary epithelial cells, bone marrow, pituitary and liver (Margetic et al., 2002). The gene for leptin (locus *Ob* or *Lep*, *Ob* for obese, *Lep* for leptin) is located on chromosome 7 in humans (GreGreen et al., 1995), and on chromosome 4 in cattle (Stone et al., 1996).

The effects of leptin were observed by studying mutant obese mice that arose at random within a mouse colony at the Jackson Laboratory in 1950 (Ingalls et al., 1950). Namely, these mice were massively obese and hyperphagic. The leptin itself was discovered by Friedman et al. in 1994. by studing these mice at the Rockefeller University in the United States (Zhang i sar., 1994). In last couple of decades it has been realised that leptin has important roles not only in regulation of food intake and energy expenditure, but also in regulation of neuroendocrine and immune functions and in modulation of glucose and fat metabolism (Bluher and Mantzoros, 2009).

Obesity is a major health issue in much of the human population. In the United States it is estimated that over 30% of the population is overweight, and this proportion is increasing. Most attempts to treat obesity to date, except for the several types of surgical removal of the tissue, have failed to result in a sustained reduction of obesity (Houseknecht et al., 1998).

Although the obesity is not a major health problem in animal agriculture, changes in the fat composition in animal bodies with an aim to provide more meat and better productive efficacy are one of the main goals in modern zootechnique (Maratos-Flier, 2008). In addition, regulation of feed intake and energy balance in the bodies of domestic animals are important for optimization of growth, reproduction, lactation and overall health and well-being. Thus, understanding the basic mechanisms that regulate adiposity, feed intake and energy metabolism in livestock may lead to new technologies that will futrher enhance animal performance and health. (Houseknecht et al., 1998).

## ROLE OF LEPTIN IN THE REGULATION OF REPRODUCTION

Literature data concerning role of leptin in the control of reproduction are rapidly developing. At this time, the majority of information in this area has been obtained form research with human subjects and laboratory rodents. The importance of adequate nutritional intake in maintaining reproductive function is well-established (Asdell, 1949; Armstrong and Britt, 1987; Peters et al., 2008). Inadequate nutrition delays or prevents the onset of puberty and interferes with normal cyclicity (Armstrong i Britt, 1987). In males, undernutrition is accompanied by hypogonadism and infertility. Analysis of various species revealed that undernutrition results in decreased gonadotropin secretion (Cameron i sar., 1993; Faria Tda et al., 2008).

The mechanisms responsible for communicating nutritional status to the repro-

ductive system have been sought for many years. A commonly held belief at one time was that the amount of body fat was a controlling factor in the onset of puberty and the maintenance of adult reproduction. More recent research has shown that metabolic and/or nutritionally induced changes in reproductive function can occur without changes in body fat (Beltranena et al., 1993). A variety of hormones may act as possible signals of nutritional status to the reproductive system. In addition, metabolites can exert potent effects on endocrine systems and have been implicated in the control of gonadotropin secretion. It is believed that leptin could represent an indicator of nutritional status that allows reproductive processes to proceed. Leptin is produced mainly in adipose tissue, which actively responds to nutritional and metabolic changes. The production of leptin increases with feeding and body fat content (Hamann and Matthaei, 1996). Leptin receptors are found in the ventromedial and arcuate regions of the hypothalamus and are thus positioned anatomically in regions associated with the control of appetite and reproductive neuroendocrine function (Dyer et al., 1997; Cottrell et al., 2009). Thus, leptin could provide an accurate, circulating signal of nutritional status.

Much of the evidence for the role of leptin as a reproductive hormone has been derived from *ob/ob* mice, which do not produce a functional leptin protein. An *ob/ob* female mouse is sterile and remains essentially in a constant prepubertal state (Tortorello et al., 2007). Ovarian and uterine weights, sex steroid concentrations, and pituitary gonadotropin secretion are depressed in these animals. Administration of recombinant leptin to *ob/ob* female mice completely restores gonadotropin secretion, secondary sex organ weight and function, and fertility (Barash et al., 1996).

Similar evidence has been obtained in *ob/ob* male mice. (Farooqi, 2002). Male *ob/ob* mice demonstrate very low levels of fertility, low gonadotropin secretion and are hypogonadal (Mounzih et al., 1997). Semeniferous tubules contain few mature sperm, and Leydig cells are severely atrophied. As in female *ob/ob* mice, leptin administration to the male mice restores fertility (Mounzih et al., 1997).

Undernutrition results in a condition analogous to the *ob/ob* genotype, with inhibited leptin secretion and reproductive function (Yura et al., 2008). The effects of undernutrition on reproduction in non-obese animals also can be ameliorated by leptin treatment. The starvation-induced delay in ovulation in non-obese female mice is prevented by leptin treatment (Ahima et al., 1996). Similarly, serum LH and testosterone levels are increased by leptin administration in fasted male mice (Ahima et al., 1996). Restricting nutrition to 80% of ad libitum feed intake causes a >50% reduction in ovarian and uterine weights that is completely prevented by twice-daily injections of leptin (Cheung et al., 1997).

The finding that leptin treatment allows reproductive maturation in malnutrition and normally fed animals, raises the question: does leptin have any role in the normal onset of puberty? It has been found that serum concentrations of leptin are elevated at the onset of puberty in mice (Chehab et al., 1996). Also, before the onset of puberty there is a transient increase of leptin secretion in boys (Mantzoros et al., 1997). These observations suggest that there is a causal link between increasing leptin secretion and sexual maturation.

A logical first step in understanding the mechanisms by which leptin influences reproduction is to determine the location of functional receptors for this hormone (Grze-



gorzewska et al., 2008). Leptin receptor mRNA has been localized in ventromedial and arcuate hypothalamic nuclei and in anterior pituitary tissue of sheep (Dyer et al., 1997). In rats, leptin receptor mRNA can readily be detected in the ovary, testis, uterus, hypothalamus and pituitary gland (Zamorano et al., 1997). Localization of the receptor in reproductive tissues likely occurs across species, because leptin receptor mRNA also is found in human ovaries and testes (Cioffi i sar., 1996).

Thus, leptin could act at multiple sites in the reproductive system. Leptin treatment enhances gonadotropin secretion (Barash i sar., 1996; Kosior-Korzecka et al., 2006). Increased uterine weight in leptin-treated *ob/ob* mice seems to occur as a result of proliferative responses to increased ovarian estrogen production (Barash i sar., 1996). Similarly, trophic responses in seminal vesicles are likely a result of increased testosterone production (Barash i sar., 1996). Although the most accepted hypothesis is that the overall leptin-induced stimulation of reproductive function occurs secondarily to increased gonadotropin secretion, the possibility of direct effects can not be discounted.

It is interesting that neuropeptid Y (NPY) is present in the hypothalamic regions involved in neuroendocrine control of feed intake. In contrast to leptin, NPY is a powerful stimulator of feed intake and inhibitor of gonadotropin secretion (Kalra i Kalra, 1996; Gupta et al., 2009). Undernutrition elevates the experssion of the gene for NPY in nucleus arcuatus of the hypothalamus and leads to the elevated concentration of NPY in the cerebrospinal fluid (Kaye i sar., 1990). The application of leptin decreases NPY experssion in n. arcuatus, possibly due to removing the inhibition of GnRH release. These data have led to the speculation that receptors for leptin may exist on NPY neurons. In fact, leptin receptors have been localized on hypothalamic NPY neurons in mice and sheep (Houseknecht i sar., 1998). In addition, *ob/ob* mice that also are homozygous for a recessive mutant NPY allele have been generated (Erickson i sar., 1996). These animals lack leptin and NPY and are less obese and more fertile than *ob/ob* mice with intact NPY production.

## APPLICATIONS OF LEPTIN IN ANIMAL AGRICULTURE

Although obesity per se is not a major problem in animal agriculture, improvement of productive efficiency, carcass composition, and animal health and well-being are important goals. If leptin biology is similar for livestock species and human and rodent species, it is clear that leptin has myriad effects on tissues and endocrine system that ultimately lead to the coordination of whole-body energy metabolism. Therefore, leptin could have important influence the performance ane well-being of livestock species. (Farooqi and O’Rahilly, 2009). Leptin may be classified as a „metabolism modifier“; thus we can predict that the manipulation of leptin expression and/or action will be of interest to scientists and pharmaceutical companies wishing to improve productive performance of animals. Furthermore, if leptin is involved in animal responses to disease or stress, the manipulation of leptin action may become an important therapy in the treatment of animal disease. Successful enhancement of reproductive function or manipulation of nutrient partitioning are more likely to be achieved through regulation of leptin production or sensitivity to leptin through regulation of leptin production or sensitivity to leptin through nutritional or metabolic manipulation. Genetic selection

also could be used to this end. Expressed (Matteri et al., 1998) and intronic (Sasaki et al., 1996) polymorphisms in the leptin gene that may be useful in RFLP-based selection have been discovered.

## POLYMORPHISM OF THE LEPTIN GENE IN CATTLE

As mentioned, the leptin gene has been mapped to bovine chromosome 4 (Stone et al., 1996). Polymorphisms in the coding regions of the leptin gene in cattle have been associated with serum leptin concentrations (Leifers et al., 2003), feed intake (Leifers et al., 2002), milk yield (Leifers et al., 2002) and body fatness (Nkrumah et al., 2004). Although previous studies have focused on associations between polymorphisms in the coding regions of the leptin gene and economically important traits, studies in humans and other species have shown that polymorphisms in the leptin promoter may be of major importance (Nkrumah et al., 2005). This is because such polymorphisms are generally associated with the sequence elements and factors regulating gene expression and may completely abolish the inducibility of promoter (Miller et al., 1996) or decrease its activity significantly (Mason et al., 1998). The bovine leptin promoter has been sequenced by Taniguchi et al. (2002).

Nkrumah et al. (2005) investigated association between single nucleotide polymorphisms (SNP) in the leptin gene promoter in cattle and economically important phenotypic characteristics (serum leptin concentration, growth, feed intake, feeding behaviour and measures of carcass merit). They detected three bi-allelic single nucleotide substitutions, namely UASMS1, UASMS2 and UASMS3, in the bovine leptin promoter located at nucleotide positions 207, 528 and 1759. UASMS1 and UASMS2 are substitutions of cytosine with thymine (C→T), whereas UASMS3 is a substitution of cytosine with guanine (C→G). The analysis revealed significant linkage disequilibrium between UASMS2 and UASMS3, and both SNP separately show associations with performance, feed intake, and feeding behaviour in the experimental cattle population. In addition, the UASMS2 SNP shows significant associations with serum leptin concentration and measures of body fatness.

With respect to UASMS2 the results presented showed that serum leptin concentrations, body weight, marbling score and ultrasound backfat thickness were higher in animals with genotype TT compared to animals with genotypes CC or CT. Also, analysis of UASMS3 showed that animals with the genotype GG have higher growth rate and body mass, increased feed intake and higher feeding duration. (Nkrumah et al., 2005).

The significant linkage disequilibrium between the two polymorphisms is not surprising as the two SNP are only 1231 bp apart, and it suggests that the effect of one of the SNP may reflect an indirect effect of the other. However, because UASMS2 shows stronger associations with serum leptin concentration and body fatness, it may be speculated that UASMS2 may be more functionally significant. (Nkrumah et al., 2005). Significantly higher growth rates, body weight, and body fatness of the animals with higher serum leptin concentration and genotype TT for UASMS2 is consistent with previous evidence in humans (Larsson et al., 1998) and cattle (Leifers et al., 2003), showing that serum leptin concentration is positively related to body weight and body fatness.

Nonetheless, the observed higher daily feed consumption of animals with higher

serum leptin concentration and genotype TT for UASMS2 is surprising and in contrast to evidence in humans (Larsson et al., 1998). Namely, high concentration of leptin in humans is associated with lower habitual food consumption.

There is a considerable interest in the application of molecular technologies in the form of specific DNA markers that are associated with various quantitative trait loci, to promote more efficient and relatively easy selection and breeding of farm animals with an advantage for an inheritable trait of growth rate, body weight, carcass merit, feed intake, and milk yield and composition. Several quantitative trait loci for performance and meat production in cattle have been identified, and a number of potential candidate genes have been identified and selected for analysis based on a known relationship with physiological or biochemical processes and production traits. It is seldom reported that one particular polymorphism in a candidate gene would influence several traits of economic importance in livestock at the same time. The leptin gene, however, seems to be one of the exceptions, as its involvement in the regulation of several biologically important processes in the body makes it, perhaps, one of the best physiological gauges for energy balance, body weight, and body fat content in mammals. Several studies have been conducted to characterize the relationship of circulating leptin with traits of economic importance in beef cattle. For example, Ehrhardt et al. (2000) and Delavaud et al. (2002) showed that circulating leptin levels are correlated with body weight, food intake, nutritional status, and adipose tissue mass. Circulating leptin concentrations are also correlated with the regional distribution of body fat (Yamada et al., 2003) and could be used as a predictor of carcass merit in cattle (Geary et al., 2003). Several polymorphisms have been described in the bovine leptin gene (Haegeman et al., 2000). Fitzsimmons et al. (1998) reported a positive association between a microsatellite marker (*BMI500*; located approximately 3.6 kb away from the leptin gene) and body fatness in cattle. Polymorphisms have also been reported in the coding regions of the leptin gene that show considerable associations with feed intake (Oprzadek et al., 2003), carcass merit (Buchanan et al., 2002), milk quantity and quality (Buchanan et al., 2003), and serum leptin (Liefers et al., 2003) in cattle.

The exact molecular and physiological mechanisms underlying the association of the polymorphisms with the variety of traits reported in the present study are unknown. It is assumed that SNP, particularly UASMS2 in the regulatory region of the leptin gene contributes to the expression of leptin gene in cattle, or otherwise it serves as surrogate for causative SNP that are yet to be detected. Several putative Sp1, CCAAT/enhancer binding protein (C/EBP), and TATA box binding sequences were detected in the vicinity of the above mentioned SNP (Taniguchi et al., 2002). Studies in humans have shown that mutations in the C/EBP- $\alpha$  region of the leptin promoter abolished the inducibility of the promoter by C/EBP- $\alpha$  (Miller et al., 1996). Mason et al. (1998) showed that mutations in the C/EBP- $\alpha$  and TATA motifs, as well as in a consensus Sp1 site of leptin gene, decreased promoter activity by 10-, 10-, and 2.5-fold, respectively, and abolished binding of these factors.

As for the polymorphisms in the coding regions of the bovine leptin gene, it should be mentioned that C→T transition in exon 2 of leptin that encodes an Arg25Cys substitution is associated with body fat deposition in beef cattle (Buchanan et al., 2002). In addition, it has been established that TT genotype has a great influence to milk produc-

tion, especially in early lactation. Namely, cows with the genotype TT have increased milk production and increased milk protein content without changes in yield of milk fat (Buchanan et al., 2003). These characteristics of milk have economic importance.

On the other hand, selection of cows for increased milk production has a negative impact on their fertility (Pryce i sar., 2000). Dairy cows have small, but sometimes serious negative energy balance during early lactation, which influences duration of anoestrus period after calving. If there is a correlation between polymorphism of the leptin gene and milk yield, body weight, feed intake and fertility, it could be used not only for a discoveries of leptin mechanisms of action, but also in future programmes of cow breeding (Leifers i sar., 2002).

It should be mentioned that despite numerous literature data about biochemical and physiological effects of leptin, little is known about possible genotoxic and mutagenic effects of leptin. Namely, some hormones act as endogenous mutagens (Djelić, 2001; Djelić and Djelić, 2002, Djelić and Anderson, 2003; Djelić et al., 2005; Djelić et al., 2006; Djelić et al., 2007), therefore it would be interesting to examine the ability of leptin to induce mutagenic effects or to modulate mutagenic effects of hormones or environmental pollutants (Djelić and Djelić, 2000; Stanimirović et al., 2005; Stanimirović et al., 2007; Stevanović et al., 2008).

In conclusion, gene-specific single nucleotide polymorphisms in the regulatory region (promoter) of the bovine leptin gene were detected that show associations with serum leptin concentration, growth rate, body weight, feed intake, feeding behaviour, and measures of carcass merit. The polymorphisms may also be predictive of other important traits in cattle such as milk yield and composition. However, further efforts are required to validate these findings in other bovine populations before their application in marker-assisted selection.

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## ZNAČAJ POLIMORFIZMA GENA ZA LEPTIN KOD GOVEDA

NINOSLAV ĐELIĆ, ZORAN STANIMIROVIĆ, JEVROSIMA STEVANOVIĆ,  
MILENA RADAKOVIĆ

### Izvod

Leptin je proteinski hormon koji ima ključne uloge u regulaciji unosa hrane i potrošnje energije. Ekspresija i sekrecija leptina su veoma povezani sa količinom masnog tkiva i veličinom adipocita. Smatra se da je leptin metabolički signal koji reguliše efekte nutritivnog statusa na reproduktivnu funkciju. Receptori za leptin pronađeni su u ventromedijalnom i arkuatnom regionu hipotalamusa, tako da su anatomske pozicionirani u regionima uključenim u kontrolu apetita i reproduktivne neuroendokrine funkcije. Interesanto je da se u hipotalamusu nalazi neuropeptid Y (NPY) u regionima uključenim u neuroendokrinu kontrolu unosa hrane. Nasuprot leptinu, NPY je moćan stimulator unosa hrane i inhibitor sekrecije gonadotropina. Receptori za leptin su lokalizovani na NPY neuronima hipotalamusa i pokazano je da leptin umanjuje ekspresiju NPY. Istraživanja polimorfizma pojedinačnih nukleotida (SNP) u okviru gena za leptin otkrila su da određene supstitucije nukleotida mogu voditi ka promenama u ekspresiji leptina. Detektovani su gen-specifični polimorfizmi pojedinačnih nukleotida u regulatornom regionu (promotoru) gena za leptin goveda koji su udruženi sa koncentracijama leptina u serumu, stopom rasta, telesnom težinom, unosom hrane, hranidbenim ponašanjem i karakteristikama trupa. Polimorfizmi bi mogli biti od značaja za predviđanje drugih važnih fenotipskih karakteristika kod goveda kao što je prinos i sastav mleka. Međutim, potrebni su dodatni napori da se dobijeni nalazi potvrde u drugim populacijama goveda pre njihove primene u selekciji na osnovu specifičnih genskih markera.

**Ključne reči:** Leptin, polimorfizam pojedinačnih nukleotida, ekonomski važne osobine, goveda

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