



INSTITUT ZA HIGIJENU I TEHNOLOGIJU MESA – BEOGRAD  
INSTITUTE OF MEAT HYGIENE AND TECHNOLOGY – BELGRADE

# ZBORNIK KRATKIH SADRŽAJA *BOOK OF ABSTRACTS*

MEĐUNARODNO  
56. SAVETOVANJE INDUSTRIJE MESA  
*INTERNATIONAL*  
*56<sup>th</sup> MEAT INDUSTRY CONFERENCE*

MESO I PROIZVODI OD MESA – BEZBEDNOST,  
KULTURA, RAZVOJ, KVALITET ŽIVOTA  
*MEAT AND MEAT PRODUCTS – SAFETY,*  
*CULTURE, DEVELOPMENT, LIFE QUALITY*

Tara – Hotel “Omorika”  
12-15. juni 2011. godine  
12<sup>th</sup>-15<sup>th</sup> June 2011



CIP - Каталогизacija у публикацији  
Народна библиотека Србије, Београд

637.5(048)

614.31:637.5(048)

664.9(048)

МЕЂУНАРОДНО саветовање индустрије меса Месо и  
производи од меса - безбедност, култура, развој, квалитет  
живота (56 ; 2011 ; Тара)

Zbornik kratkih sadržaja = Book of Abstracts / Међународно  
56. savetovanje industrije mesa Meso i proizvodi od mesa  
- bezbednost, kultura, razvoj, kvalitet života, Tara, 12-15. juni  
2011. godine = International 56th Meat Industry Conference  
Meat and Meat Products - Safety, Culture, Development,  
Life Quality 12th-15th June, 2011 ; [organizator] Institut za  
higijenu i tehnologiju mesa, Beograd = [organizer] Institute of  
Meat Hygiene and Technology, Belgrade ; [glavni i odgovorni  
urednici, editors in chief Dragan Milićević, Aurelija Spirić].  
- Beograd : Institut za higijenu i tehnologiju mesa = Belgrade  
: Institute of Meat Hygiene and Technology, 2011 (Beograd :  
Beoknjiga). - 167 str. ; 29 cm

Uporedno srp. tekst i engl. prevod. - Tiraž 250. - Napomene i  
bibliografske reference uz tekst.

ISBN 978-86-82547-06-8

1. Институт за хигијену и технологију меса (Београд)

а) Месо - Апстракти б) Месне прерађевине - Апстракти

COBISS.SR-ID 184233228



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**ISBN 978-86-82547-06-8**

**Tiraž/Number of copies printed  
250 primeraka**

**Štamparija/Printing House:  
„Beoknjiga” - Beograd**

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Štampanje Zbornika kratkih sadržaja finansijski je pomoglo Ministarstvo za prosvetu  
i nauku Republike Srbije  
*Publication of Book of Abstracts is financially supported by Ministry of education  
and science of the Republic of Serbia*

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**I TEMATSKA OBLAST**  
***1<sup>ST</sup> THEMATIC TOPICS***

**BEZBEDNOST MESA I PROIZVODA OD MESA**  
***SAFETY OF MEAT AND MEAT PRODUCTS***



## POREĐENJE EFIKASNOSTI TRETMANA KOŽE VODENIM I ALKOHOLNIM RASTVOROM ŠELAKA U CILJU „IMOBILIZACIJE” MIKROBIOTA NA KOŽI GOVEDA

Antić Dragan<sup>1</sup>\*, Blagojević Bojan<sup>1</sup>, Bunčić Sava<sup>1</sup>

Nedavno je predložen novi, alternativni pristup unapređenju efikasnosti tretmana kože goveda u redukciji mikroorganizama sa kože na trupove: tretman kože šelakom, prirodnom smolom dozvoljenom za upotrebu u hrani, koja se može koristiti radi imobilizacije mikrobiota na koži. U ovoj studiji, eksperimentalno su ocenjeni efekti tretiranja čistih i suvih koža goveda vodenim i alkoholnim rastvorom šelaka u redukciji mikrobnog prenosa briseva na sundere, kao i prenosa sa koža na meso goveda putem direktnog kontakta na laboratorijskom model sistemu. Za svaki od tretmana mikrobne imobilizacije na koži, kao kontrola su korišćeni netretirani komadi kože.

Na komadima koža tretiranim prskanjem vodenim rastvorom šelaka, prenos mikrobiota (ukupnog broja bakterija–TVC, broja *Enterobacteriaceae* i broja generičke *E. coli*) na sundere za uzorkovanje bio je značajno redukovano: do  $2,0 \log_{10}$  CFU/cm<sup>2</sup>, dok je rastvor šelaka u etanolu malo više, ali statistički značajnije efekte u redukciji, do  $1,0 \log_{10}$  CFU/cm<sup>2</sup> više u odnosu na vodeni rastvor šelaka.

U drugom delu laboratorijskog istraživanja, simulacijom direktnog kontakta kože sa mesom, tretmani čistih i suvih komada kože različitim tipovima rastvora šelaka delovali su na sličan način i imali značajne antimikrobne efekte u redukciji prenosa ukupnih mikrobiota sa kože na komade mesa. Bolji efekat u redukciji utvrđen je nakon tretmana rastvorom šelaka u etanolu, najverovatnije zbog izvesnog baktericidnog efekta samog etanola.

Sveukupno, u ovoj studiji potvrđen je dobar efekat šelaka u imobilizaciji mikrobiota na koži goveda, kako rastvora u etanolu, tako i vodenog rastvora, pa će stoga ova sredstva biti dalje ispitivana i u realnim uslovima u komercijalnoj klanici.

**Ključne reči:** koža, mikrobna imobilizacija, vodeni rastvor šelaka, rastvor šelaka u etanolu, goveda.

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## COMPARASION OF EFFECTIVENESS OF HIDE TREATMENTS WITH AQUEOUS AND ETHANOL SHELLAC SOLUTION TO „IMMOBILIZE” MICROBIOTA ON CATTLE HIDES

Antić Dragan<sup>1\*</sup>, Blagojevic B.<sup>1</sup>, Bunčić Sava<sup>1</sup>

A novel, alternative approach to improve the effectiveness of hide treatments in reducing microbial transfer from hides on carcasses has been proposed recently: treatment of hides with Shellac, an on-hide microbiota-immobilizing, natural, food-grade resin. In this study, the effects of treating clean and dry hides with aqueous and ethanol Shellac solution in reduction of microbial sponge swab recoveries and microbial transfer from hides onto beef *via* direct contact (in a laboratory model systems), were experimentally evaluated. For each of the microbial immobilization treatments, untreated hides were used as a control.

On hides spray-treated with an aqueous Shellac solution, swab recoveries of general microbiota (total viable count of bacteria-TVC, *Enterobacteriaceae* counts and generic *E. coli* counts) were greatly reduced: up to 2.0 log<sub>10</sub> CFU/cm<sup>2</sup> reductions, while Shellac in ethanol solution gave slightly, but significantly better reduction effect, up to 1.0 log<sub>10</sub> CFU/cm<sup>2</sup> more than aqueous Shellac solution.

In the hide-to-beef direct contact laboratory experiments, treatments of clean and dry hides with different types of Shellac solutions followed similar pattern and gave significant antimicrobial effects in reduction of transfer of general microbiota from hide onto meat. Slightly better reduction effect was observed with Shellac in ethanol solution, possibly due to bactericidal effect of ethanol itself.

Overall, this study confirmed good on-hide microbiota-immobilizing effect of Shellac, either dissolved in ethanol, or in water, so it will be further evaluated in real-life abattoir conditions.

**Key words:** hide, microbial immobilisation, aqueous Shellac, Shellac in ethanol, beef.

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## ZNAČAJ PREDVIĐANJA RAZVOJA PATOGENE MIKROFLORE ZA BEZBEDNOST OHLAĐENOG MESA SKLADIŠTENOG U DUŽEM PERIODU

Dagmara S. Batayeva<sup>1\*</sup>, Mariya Krasnova<sup>1</sup>

Od nedavno, bezbednost sirovina i prehrambenih proizvoda je postala veoma značajna. U praksi, temperature na kojima se skladišti ohlađeno meso se ne poštuju uvek, što dovodi do njegovog kvarenja i skraćanja roka trajanja. Trenutno, od najveće važnosti je određivanje mogućeg roka trajanja ohlađenog mesa na osnovu principa predviđanja rizika stvaranja patogene i higijenski indikativne mikroflore. U budućnosti, tačnost korišćenih algoritama testirati će se u praksi. U VNIIMP su izvedena istraživanja sa ciljem ispitivanja dinamike razvoja *L. monocytogenes* u komadima ohlađenog mesa. Kao rezultat ovog ispitivanja dobijena je mogućnost predviđanja vremena skladištenja vakuumiranog mesa, koje će u punoj meri osigurati njegovu bezbednost u vezi sa razvojem *L. monocytogenes*. Razvoj ovakvih preventivnih modela će omogućiti određivanje stepena bezbednosti prehrambenih proizvoda tokom svih stadijuma proizvodnje, počev od dolaska sirovine do realizacije i konzumiranja finalnog proizvoda.

**Ključne reči:** ohlađeno meso, patogeni mikroorganizmi, predviđanje, bezbednost.

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## IMPORTANCE OF PREDICTION OF PATHOGENIC MICROFLORA DEVELOPMENT FOR SAFETY OF CHILLED MEAT TO BE STORED FOR LONG TIME PERIODS

Dagmara S. Batayeva<sup>1\*</sup>, Mariya Krasnova<sup>1</sup>

Recently, safety of food raw materials and food products has become very important. In practice, storage temperatures for chilled meat are not always observed, which leads to its spoilage and decrease of shelf life. At the present time the determination of possible shelf life of chilled meat based on the principles of prediction of the risks of pathogenic and sanitary-indicative microflora is of immediate concern. In future, the accuracy of the used algorithms will be tested in practice. At VNIIMP the investigations were carried out aimed at the study of the dynamics of development of *L. monocytogenes* in chilled meat cuts. As a result of the investigations the possibility to predict storage time of meat packed under vacuum was obtained, which

in full measure will ensure its safety with regard to *L. monocytogenes* development. The development of such preventive models will allow determination of the degree of safety of food products during their production on all the stages, beginning from the time of raw materials arrival to realization and consumption of final product.

**Key words:** chilled meat, pathogenic microorganisms, prediction, safety.

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## ULOGA MIKROFLORE KOŽE U OCENI PROCESNE HIGIJENE U KLANICAMA ZA SVINJE

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U dve klanice za svinje, 100 svinja je nasumično odabrano i uzorkovano. Od svake životinje, sunderom su uzeta dva brisa: a) odmah nakon omamljivanja, sa približno 1500 cm<sup>2</sup> površine kože; i b) na kraju linije klanja (pre hlađenja), sa iste površine svakog odgovarajućeg trupa. U svakom uzorku (ukupno 200), određeni ukupan broj bakterija (TVC), broj *Enterobacteriaceae* (EC) i prevalenca *Salmonella* su korišćeni za uklapanje procesne higijene u klanicama. Rezultati su ukazali da jednostavno grupisanje srednjih vrednosti TVC i/ili EC finalnih trupova u zadovoljavajuće, prihvatljive i nezadovoljavajuće kategorije procesne higijene (u skladu sa trenutnim EU mikrobiološkim kriterijumima procesne higijene) nije omogućilo karakterizaciju procesa klanja i obrade trupova u skladu sa mogućnošću redukcije prenosa mikroflora sa kože na obrađene trupove. S druge strane, određivanje odnosa između srednjih TVC i/ili EC na finalnim trupovima i na odgovarajućim kožama je omogućilo znatno precizniju ocenu higijene procesa, kao i pouzdaniju diferencijaciju klanica. Međutim, prevalenca *Salmonella*, koja zavisi od raznih faktora uključujući i one na farmi i/ili tokom transporta, nije se pokazala korisnom u karakterizaciji procesne higijene, ali je korisna u svrhu ocene izloženosti potrošača i redukcije patogena.

**Ključne reči:** svinjsko meso, klanica, procesna higijena, mikroflora kože, mikroflora trupa.

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## THE ROLE OF SKIN MICROFLORA IN PROCESS HYGIENE ASSESSMENT IN PIG ABATTOIRS

Blagojević Bojan<sup>1</sup>, Antić Dragan\*, Dučić Miroslav, Bunčić Sava

In two pig slaughterhouses, 100 pigs were randomly selected and sampled. From each animal, two sponge-swabs were taken: a) immediately after stunning, from approximately 1500 cm<sup>2</sup> area of skin; and b) and at the end of the slaughter line (before chilling), from the same sized area of each corresponding carcass. In each swab-sample (200 in total), total viable count (TVC), *Enterobacteriaceae* count (EC) and *Salmonella* occurrence were determined and used to assess process hygiene in the abattoirs. The results indicated that simply fitting mean TVC and/or EC on final carcasses into a satisfactory, acceptable or unsatisfactory process hygiene category

(according to current microbiological EU process hygiene criteria) did not enable characterisation of each slaughtering and carcass dressing process with respect to its ability to reduce the transfer of incoming microbial loads (i.e. on skins) onto dressed carcasses. On the other hand, determining the ratio between mean TVC and/or EC on final carcasses and those on corresponding skins enabled more precise assessment of the hygiene of each abattoir process, as well as more reliable differentiation between abattoirs. However, the occurrence of *Salmonella*, being dependant on varying factors including those on-farm/transport, did not appear to be very useful for characterisation of the process hygiene but is valuable for the purposes of consumer exposure assessment and pathogen reduction.

**Key words:** pork, abattoir, process hygiene, skin microflora, carcass microflora.

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## ISPITIVANJE OSETLJIVOSTI MIKROBIOLOŠKE METODE ZA SKRINING ANTIBIOTIKA U JETRI PILIĆA I BUBREGU SVINJE

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Prisustvo ostataka antibiotika u tkivima životinja najčešće nastaje kao posledica terapije obolelih jedinki. U uslovima farmskog gajenja, gde je veliki broj jedinki na malom prostoru, antibiotici se daju radi prevencije širenja oboljenja, a često i kao promotori rasta. Utvrđivanje prisustva antibiotika u tkivima životinja ima značaj, kako za industriju mesa tako i za zdravlje potrošača. Prisustvo rezidua antibiotika u tkivima omogućava razvoj rezistentnih bakterijskih sojeva, koji otežavaju lečenje obolelih ljudi. Detekcija ostataka antibiotika u hrani zahteva metode, dovoljno osetljive za detekciju ispod vrednosti ili na vrednosti MRL (Maximum Residue Limit). Mikrobiološke metode zasnivaju se na osetljivosti određenih bakterijskih sojeva prema određenoj grupi antibiotika. Ovaj rad deo je *in-house* validacije STAR-protokola za skrining ostataka beta laktama i makrolida u jetri brojlera i bubregu svinja. Ukupno je korišćeno 120 blanko uzoraka, netretiranih životinja: 60 pilećih jetri i 60 bubrega svinje. Maksimalno dozvoljene količine antibiotika u ispitivanim matriksima propisane su u Commission Regulation (EU) br. 37/2010, dok se Pravilnikom o količinama pesticida, metala i metaloida i drugih otrovnih supstancija, hemioterapeutika, anabolika i drugih supstancija koje se mogu nalaziti u namirnicama („Sl. list SRJ“, br. 5/92, 11/92 – ispr. i 32/2002), zabranjuje prisustvo ostataka antibiotika u mesu i proizvodima od mesa.

Korišćene su sledeće hranljive test agar podloge: test agar pH 8 sa sojem *K. varians* ATCC 9341 za makrolide, i test agar po Kundrau sa inokulisanim sojem *B. stearothermophilus* ATCC 10149 za  $\beta$ -laktame. Po 30  $\mu$ l radnog rastvora vrednosti koncentracije  $\frac{1}{2}$  MRL, 1 i 1,5 MRL nanošeno je na po dva papirna diska na površini inokulisane hranljive podloge. Uzorci bubrega, odnosno jetre, prethodno samleveni, obogaćeni su radnim rastvorima pojedinih antibiotika da se dobiju koncentracije  $\frac{1}{2}$  MRL, 1 i 1,5 MRL, i homogenizovani. Zamrznuti pripremljeni uzorci pomoću kružnog bušača, oblikovani su u diskove  $\varnothing = 9$  mm, i debljine 2 mm. Po dva diska iste koncentracije postavljena su na odgovarajuću test agar ploču. Ploče inokulisane sojem *K. varians* inkubirane su 24 h, pri temperaturi 37°C, a ploče sa *B. stearothermophilus* 12–15h pri 55°C. Merenje širine zone inhibicije rasta pokazuje da je: u uzorcima pileće jetre moguće detektovati svih 7 ispitivanih antibiotika  $\beta$ -laktamske grupe, na nivou  $\frac{1}{2}$  MRL, i više (zona inhibicije > 4mm). Eritromicin i tilozin iz grupe makrolida, takođe je moguće detektovati na nivou  $\frac{1}{2}$  MRL i više, u matriksu pileće jetre. Antibiotici iz beta laktamske grupe u obogaćenim uzorcima u koncentracijama na nivou MRL i višem moguće je detektovati u bubregu svinje, dok se dva predstavnika makrolida, mogu detektovati u uzorcima na nivou  $\frac{1}{2}$  MRL.

**Ključne reči:** jetra, bubreg, antibiotici, STAR protokol.

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## MICROBIAL SUSCEPTIBILITY TESTING METHOD FOR SCREENING OF ANTIBIOTICS IN CHICKEN LIVER AND PORK KIDNEY

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Presence of antibiotic residues in animal tissues most often occurs as consequence of medical treatment of diseased animals. In farming conditions, where many animals are housed on small surfaces, antibiotics are administered as prevention against disease spreading, and often as growth promoters. Determination of the presence of antibiotics in animal tissues is significant not only for meat industry, but also for consumers health. Presence of antibiotic residues in tissues enables development and growth of bacterial strains which are additionally hindering the treatment of sick people. Detection of antibiotic residues in food requires methods sensitive enough to detect bellow or at MRL value (Maximum Residue Limit). Microbiological methods are based on sensitivity of certain bacterial strains towards certain group of antibiotics. This paper is part of *in-house* validation of STAR-protocol for screening of beta-lactam and macrolide residues in liver of broilers and pig kidneys. In total 120 blank samples were used from non-treated animals: 60 chicken livers and 60 pig kidneys. Maximum residue limit of antibiotics in tested matrixes are stipulated by Commission Regulation (EU) no. 37/2010, whereas Regulation/Rulebook on quantity of pesticides, metals and metalloids, and other toxic substances, chemotherapeutics, anabolics and other substances found in foodstuffs („Official Journal of SRJ“, No. 5/92, 11/92 – corr. and 32/2002), prohibits the antibiotic residues of in meat and meat products.

The following agar mediums were used: Test agar pH 8 with a strain ATCC 9341 *K.varians* for macrolides, and the Kundrat test medium inoculated with *B. stearothersophilus* strain ATCC 10149 for the  $\beta$ -lactams. Working solution in concentrations  $\frac{1}{2}$  MRL, 1MRL and 1.5 MRL were prepared and 30  $\mu$ l of each solution were pipetted per two paper disks and put on the surface of inoculated agar. Samples of kidney and liver, previously grounded, were spiked with working solutions of certain antibiotics to give a concentration  $\frac{1}{2}$  MRL, MRL 1 and 1.5, and homogenized. Samples were frozen and shaped with cork borer in discs  $\varnothing = 9$  mm and 2 mm thickness. Two disc of the same concentration were placed on appropriate test agar plate. Plates inoculated with strain *K. varians* were incubated at 37°C for 24 h, and plates with *B. stearothersophilus* at 55°C for 12-15h. Measuring the width of the growth inhibition zone shows that: in the samples of chicken liver, all of the seven tested  $\beta$ -lactam antibiotics can be detected at  $\frac{1}{2}$  MRL, and higher (zone of inhibition > 4

mm). Erythromycin and tylosin from macrolides group, were detectable at  $\frac{1}{2}$  MRL, and higher, in the chicken liver matrix (zone of inhibition  $> 2$  mm). The  $\beta$ -lactam antibiotics in the samples at MRL level and higher can be detected in the kidney of pigs, while the two representatives of macrolides, can be detected in samples at  $\frac{1}{2}$  MRL.

**Key words:** liver, kidney, antibiotics, STAR protocol.

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## MAKRO I TOKSIČNI ELEMENTI U JESTIVOM TKIVU GAJENE PASTRMKE (*Oncorhynchus mykiss*)

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Uzgoj ribe je, poslednjih godina u svetu, zbog povećanih zahteva za potrošnju ribe, rapidno rastao. Poznata je činjenica da konzumiranje ribe predstavlja dobrobit za čoveka. Osim što je dobar izvor belančevina, riba sadrži i omega-3 masne kiseline, koje smanjuju rizik od nastajanja određenih vrsta kancera i kardiovaskularnih oboljenja kod čoveka. Sa druge strane, u cilju zaštite potrošača, fenomen biakumulacije i biomplifikacije štetnih toksičnih elemenata u ribi, posebno žive, proučavan je u mnogim studijama.

Industrijske aktivnosti u okruženju akvakulturnih objekata dovele su do kontaminacije okoline i, shodno tome, i biodiverziteta toksičnim elementima. Literaturni podaci ukazuju da perzistentni i teško razgradivi kontaminanti mogu prouzrokovati toksične efekte kod riba i da se u lancu ishrane mogu akumulirati do veoma toksičnih nivoa, koji predstavljaju potencijalni rizik po ljudsko zdravlje.

U prezentovanom radu ispitano je stanje zagađenja pastrmke (*Oncorhynchus mykiss*), gajene u ribnjaku sa intenzivnim uzgojem "Riboprodukt", Požega, toksičnim elementima (Hg, Cd, Pb, Cu, Zn, Se, As, Fe i Mn). Riba različitih kategorija (predkonzumna riba, konzumna riba, maticе; n = 6) je hranjena ekstrudiranom tonu-ćom paletiranom hranom, u skladu sa dobrom akvakulturnom praksom. Priprema uzoraka za instrumentalno određivanje je urađena mikrotalasnom digestijom. Ispitivanja su izvršena atomskim apsorpcionim spektrometrom Varian "SpectrAA 220", različitim tehnikama. Cu, Zn, Fe i Mn su detektovani plamenom, Cd i Pb grafitnom, As i Se hidridnom tehnikom a Hg tehnikom hladnih para.

U cilju ispitivanja uticaja različitog uzrasta ribe na bioakumulaciju toksičnih elemenata, koja je gajena u istom ribnjaku, rezultati su statistički obrađeni pomoću MINITAB Statistical Software (Release 14 for Windows). Ovaj efekat se smatra značajnim, ukoliko je  $p < 0,05$ . Korišćena je analiza varijanse (ANOVA, Tukey's test) sa značajnošću korelacije od 95%.

Dobijeni rezultati ukazuju da su koncentracije As, Cd, Pb i Mn u svim ispitanim uzorcima ribe (predkonzumna riba, konzumna riba, maticе) bile ispod limita detekcije (LD, mg/kg, i to: As < 0,05; Cd < 0,005; Pb < 0,05; Mn < 0,2). Imajući u vidu sve kategorije ribe, Cu nije detektovan (LD: 0,2 mg/kg) samo u maticama.

Količine Hg, Cu, Fe, Zn i Se su detektovane u opsegu koncentracija: 0,010–0,056; < 0,2–0,3; 3,71–5,19; 4,26–4,89 i 0,03–0,04 mg/kg respektivno.

Statističkom analizom dobijenih rezultata utvrđena je značajna razlika ( $p < 0,05$ ) u koncentraciji žive između sve tri kategorije ribe. Značajna razlika ( $p < 0,05$ ) utvrđena je i za koncentraciju gvožđa između konzumne pastrmke i maticе.

Dobijeni rezultati ukazuju da količine makro i toksičnih elementa u ribi iz akvakulture ne predstavlja opasnost po zdravlje potrošača.

**Ključne reči:** makro i toksični elementi, jestivo tkivo gajene pastrmke.

**Napomena:** Rezultati su proistekli iz rada na realizaciju projekta ev. broj TR 31075, koji, u okviru Programa istraživanja u oblasti tehnološkog razvoja, finansira Ministarstvo prosvete i nauke.

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## MACRO AND TOXIC ELEMENTS IN EDIBLE TISSUE OF FARMED RAINBOW TROUT (*Oncorhynchus mykiss*)

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The fishery culture has been growing rapidly worldwide due to the increasing demand for fish as a food source. It is known that fish consumption is nutritional benefit for human. Apart from being a good source of protein fish is known to contain omega-3 fatty acids that help human organism to reduce the risk of certain types of cancer and cardiovascular disease. On the other hand, because of public health concern the phenomena of bioaccumulation and bioamplification of harmful trace elements (especially mercury) in fish was investigated in many studies.

Industrial activities nearby aquaculture farms have led to trace metal contamination of the environment and consequently of biodiversity. These highly persistent and non-biodegradable contaminants have been reported to cause toxic effects in fish and may be bioaccumulated via food chain to hazardous levels, thus posing potential health risk to human health.

The present work aimed to examine the pollution with trace elements (Hg, Cd, Pb, Cu, Zn, Se, As, Fe and Mn) of rainbow trout (*Oncorhynchus mykiss*) reared in intensive fish farm - "Riboprodukt", Pozega. Fish of different categories (fingerlings, marketable size fish and fish from broodstock; n = 6) were manually feed extruded sinking pelleted diets according to good aquaculture practice. For trace element analysis, samples were prepared by microwave digestion. Analyses were carried out on Atomic Absorption Spectrometer Varian "SpectrAA 220" by different techniques. Cu, Zn, Fe and Mn were detected by flame, Cd and Pb by graphite furnace, As and Se by hydride generation and Hg by cold vapor technique.

In order to compare the effect of growing on trace elements bioaccumulation in fish from the same aquiculture system data were statistically analysed by using MINITAB Statistical Software (Release 14 for Windows). This effect was declared significant if  $P < 0.05$ . Analysis of variance (ANOVA) with Tukey's test (95% confidence intervals) was applied.

The obtained data indicate that concentrations of As, Cd, Pb and Mn in all analysed fish samples (fingerlings, marketable size fish and fish from broodstock) were below the limit of detection (LD, mg/kg, as follows: As < 0.05, Cd < 0.005, Pb < 0.05, Mn < 0.2). Comparing all fish categories, Cu was detected below the limit of detection (0.2 mg/kg) only in fish from broodstock.

Quantities of Hg, Cu, Fe, Zn and Se were detected in the range of 0.010–0.056, < 0.2–0.3, 3.71–5.19, 4.26–4.89, and 0.03–0.04 mg/kg respectively.

By statistical evaluation of the obtained results it was established a significant difference ( $p < 0.05$ ) in the concentration of mercury between all three fish categories. Significant difference ( $p < 0.05$ ) was established for iron between marketable size fish and fish from broodstock too.

The obtained results indicated that quantities of macro and trace elements in edible tissue of farmed rainbow trout were satisfactory, what enable consumption of safe fish.

**Key words:** macro and toxic elements, edible tissue of farmed rainbow trout.

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**Note:** *This work was supported by grants of the Ministry of Science and Technological Development of Republic of Serbia (project no. TR 31075).*

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**BIOHEMIJSKE KARAKTERISTIKE AEROMONAS VRSTA  
IZOLOVANIH IZ PASTRMKE**

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Sa povećanjem učešća ribe u ishrani stanovništva, došlo je do povećanja i alimentarnih trovanja ljudi ovom namirnicom zato je potrebno utvrditi značaj poznavanja biohemijskih osobina bakterija iz roda *Aeromonas* izolovanih iz pastrmki. Ispitali smo prisustvo bakterija iz roda *Aeromonas* u uzorcima kože i mišića pastrmske. Ispitali smo biohemijske karakteristike izolovanih vrsta bakterija primenom klasičnih metoda mikrobiološke dijagnostike i komercijalnih testova API 20 E (bioMerieux). Za izvođenje eksperimenta pastrmka je skladištena u hladnjaku „poleđivanjem“ u odnosu 50% : 50%. Za izolaciju bakterija iz roda *Aeromonas* korišćeni su koža ( površine 17x2 cm<sup>2</sup>) i mišić ribe ( mase od 25 g. ). Prisustvo *Aeromonas spp.* vršeno je na selektivnim podlogama na svakih 48 sati. Ispitivanje riba obuhvaćenih ogledom trajalo je 17 dana. Izolovanje pokretnih *Aeromonas spp.* vršeno je primenom klasičnih metoda mikrobiološke dijagnostike i prema postupku opisanom u priručniku „Microbiological Methods for the Meat Industry“. Identifikacija izolovanih vrsta bakterija vršena je primenom klasičnih i komercijalnih metoda mikrobiološke dijagnostike ( API 20E, bioMerieux). Izolovano je 12 sojeva bakterija iz roda *Aeromonas* od kojih je 7 (58.3%) pripadalo sojevima *A. hydrophila* grupe 1, a 5 (41.6%) je pripadalo sojevima *A. hydrophila* grupe 2. Svi izolovani sojevi *Aeromonas hydrophila* iz pastrmke na osnovu biohemijskih osobina (oksidaza pozitivni, katalaza pozitivni, arginin pozitivni, ornitin pozitivni, H<sub>2</sub>S negativni, ureaza negativni, triptofan deaminaza negativni, želatin negativni, fermentuju manitol, fermentuju inositol, fermentuju rhamnosu, fermentuju saharozu, pokretni su, hemolitični su, hidrolizuju škrob) odgovarali su tipičnim predstavnicima vrste. Prilikom identifikacije izolovanih bakterija iz roda *Aeromonas* ustanovljeno je da 91.67 % izolata poseduje β galaktosidasu, citrat je pozitivno, indol pozitivno, sorbitol negativno, arabinoza pozitivno, produkuje NO<sub>2</sub>, vrši njihovu redukciju do N<sub>2</sub>, 83.33% izolata je Voges-Proskauer pozitivno, melibioza negativno, 66.67% izolata je lizin dekarboksilaza pozitivno, amigdalini pozitivni, 58.33% izolata je glukoza pozitivna. Iz ispitivanih uzoraka pastrmke od šestog dana skladištenja poleđivanjem izolovane su pokretne *Aeromonas* vrste. Svi sojevi *Aeromonas hydrophila* izolovani iz pastrmke na osnovu biohemijskih osobina odgovarali su tipičnim predstavnicima vrste.

**Ključne reči:** *Aeromonas spp.*, pastrmka, biohemijske osobine.

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## BIOCHEMICAL CHARACTERISTICS OF THE AEROMONAS SPECIES ISOLATED FROM THE TROUT

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With the increase of share of fish meat in human diet, the incidence of food borne poisonings caused by this food stuff also increased, therefore it is necessary to determine the significance of the knowledge of biochemical properties of bacteria of the *Aeromonas spp.* isolated from trout. The presence of bacteria of *Aeromonas spp.* in samples of skin and muscles of trout were investigated. Biochemical properties of isolated species of bacteria using conventional methods of microbiological diagnostics and commercial tests API 20 E ( bioMerieux). For the purpose of this study, trout was stored in freezer on crushed ice - „superchilling“ in ratio 50% : 50%. For isolation of bacteria of *Aeromonas spp.*, fish skin (surface of 17x2 cm<sup>2</sup>) and muscle (mass of 25 g) were used. Presence of *Aeromonas spp.* was determined on selective mediums every 48 hours. Study of fish included in the trial lasted 17 days. Isolation of mobile *Aeromonas spp.* was done by applying conventional methods of microbiological diagnostics and according to procedure described in the manual „Microbiological Methods for the Meat Industry“. Isolated bacteria species were identified by using conventional and commercial methods of microbiological diagnostics (API 20E, bioMerieux). Total of 12 bacteria strains from *Aeromonas spp.* were isolated, 7 (58.3%) belonged to strain *A. hydrophila* group 1, and 5 (41.6%) belonged to strain *A. hydrophila* group 2. All isolated strains of *Aeromonas hydrophila* from trout, based on biochemical properties (oxidase positive, catalase negative, arginin positive, ornitin positive, H<sub>2</sub>S negative, urease negative, tryptophane deaminaza negativni, gelatin negativni, mannitol fermenting, inositol fermenting, rhamnose fermenting, saccharose fermenting, mobile, hemolytic, starch hydrolyzing), corresponded to typical representatives of the species. In identification of isolated bacteria of the *Aeromonas spp.* it was established that 91.67 % of isolates has  $\beta$  galactosidase, were citrate positive, indol positive, sorbitol negative, arabinose positive, produced NO<sub>2</sub> and reduced it to N<sub>2</sub>, 83.33% of isolates were Voges-Proskauer positive, melibiose negative, 66.67% of isolates were lysine decarboxylase positive, amigdalinal positive, 58.33% of isolates were glucose positive. Mobile *Aeromonas* species were isolated from studied trout samples, after six days of storage on crushed ice – superchilling. All strains of *Aeromonas hydrophila* isolated from trout based on biochemical properties corresponded to typical representatives of the species. All isolated strains of *Aeromonas hydrophila* from trout according to the studied biochemical properties corresponded to representative of the species

**Key words:** *Aeromonas spp.*, trout, biochemical properties.

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## KOZIJE MESO, MOGUĆI IZVOR *Yersinia enterocolitica*

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*Yersinia enterocolitica* je crevni patogen. Obično je uzročnik enteritisa i septicemija kod mladih koza. Bakterija može biti izolovan iz fecesa klinički zdravih koza. Klinički znaci se obično javljaju zbog stresa koji nastaje usled transporta, gladovanja, promene hrane i smeštaja, hladnoće, šišanja ili kao prateće oboljenje, gastroenteritisa izazvanog gastrointestinalnim parazitima i kokcidiozom. *Yersinia enterocolitica* je enteroinvazivna i/ili destruktivna vrsta koja obično naseljava kolon i terminalni ileum. Iako je ovaj patogen prisutan u celom svetu, postoje regionalne razlike u vrsti inficiranih životinja i prevalenciji bolesti. Kod ovaca, koza, goveda i jelena izaziva enterokolitis.

Ovaj mikroorganizam izolovan je iz zemlje, vode i iz različitih namirnica. *Yersinia enterocolitica* na čoveka može da se prenese sa životinje, zatim horizontalno sa čoveka na čoveka ili preko svežeg mesa, odnosno termički netretiranih proizvoda od mesa. Infekcija sa *Yersinia enterocolitica* obično se javlja kod dece. Simptomi su groznica, ponekad krvava dijareja i bol u abdomenu oko posle nedelju dana od infekcije. Infektivna doza za čoveka je  $10^8$ - $10^9$  bakterija u jednom mililitru ili gramu namirnice. Imajući ovu činjenicu u vidu, na liniji klanja, potencijalnom mestu za kontaminaciju mesa, od klinički zdravih, zaklanih koza i jaradi, uzimali smo uzorke fecesa i delova uma. Ukupno smo ispitali 150 uzoraka fecesa (92 fecesa koza i 58 fecesa jaradi) i 30 uzoraka ileuma uzetih od jaradi. Uzorci fecesa i creva su inokulisani u PBS rastvor (hladno predobogaćenje) a tokom 14 dana rastvor je presejavan trećeg, sedmog i četrnaestog dana, na selektivni agar yersinia sa dodatkom faktora rasta i antibiotika i na MacConkey agar. Zasejane podloge inkubirane su na temperaturi od 30°C tokom 48 sati u aerobnim uslovima. Za identifikaciju kulture primenjeno je bojenje po Gramu, ocena morfologije kolonija kao i biohemijske aktivnosti, primenom komercijalnih testova (BBL Crystal E/NF ID kit).

*Yersinia enterocolitica* izolovana je iz 22 fecesa koza, 8 fecesa jaradi i iz 15 uzoraka creva. Nalaz ovog patogena u fecesu i crevima zaklanih, klinički zdravih koza i jaradi ukazuje da u klanici može doći do kontaminacije mesa sa *Yersinia enterocolitica*.

**Ključne reči:** *Yersinia enterocolitica*, koze, čovek, klanica, toksoinfekcija.

**Napomena:** Istraživanja su izvršena u okviru projekta TR 31053 Primena novih biotehnoških rešenja gajenja goveda, ovaca i koza u cilju dobijanja biološki vredne i zdravstveno bezbedne hrane.

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## GOAT MEAT, A POSSIBLE SOURCE OF YERSINIA ENTEROCOLITICA

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*Yersinia enterocolitica* is an intestinal pathogen. It is usually the cause of enteritis and septicemia in young goats. The organism can be isolated from feces of clinically healthy goats. Clinical signs usually occur in goats due to stress caused by transportation, starvation, changes in food and accommodation, cold, shearing or as an accompanying disease, especially along with gastroenteritis caused by gastrointestinal parasites and coccidiosis. *Yersinia enterocolitica* is the enteroinvasive and/or destructive species that normally inhabits the colon and terminal ileum. Although this pathogen is present throughout the world, there are regional differences in the type of infected animals and prevalence of disease. In sheep, goats, cattle and deer it causes enterocolitis. This microorganism was isolated from soil, water and from different foodstuff. *Yersinia enterocolitica* can be transmitted on humans from animals, then horizontally from person to person or through fresh meat or uncooked meat products. Infection with *Yersinia enterocolitica* usually occurs in children. Symptoms include fever, diarrhea, sometimes bloody, and abdominal pain that occurs almost after a week of infection. The infectious dose for humans is  $10^8$ - $10^9$  bacteria per milliliter or gram of food.

The aim of this paper is to determine are there latent infected goats in our flocks. With this in mind, on the slaughter line, the potential place for contamination of meat, feces samples were taken from of clinically healthy slaughtered goats and kids.

We examined 150 feces samples in total (92 – goats and 58 – kids) and 30 samples of ileum taken from kids. Samples were inoculated in PBS solution (cold enrichment) and during 14 days, the solution is inoculated 3<sup>rd</sup>, 7<sup>th</sup> and 14<sup>th</sup> day on *Yersinia* selective agar (with added factors of growth and antibiotics) and MacConkey agar. Media were incubated at 30°C for 48 hours under aerobic conditions. For identification of culture staining by Gram is used the evaluation of morphology of colonies as well as the results of biochemical activities by commercial tests. In the identification it was used also BBL Crystal E/NF ID kit.

*Yersinia enterocolitica* was isolated in 22 feces of goats, 8 feces samples of kids and 15 samples of ileum.

The presence of this pathogen in the feces of slaughtered clinically healthy goats and kids indicates that the slaughter house can be potentially critical place where the contamination of meat with *Yersinia enterocolitica* is possible.

**Key words:** *Yersinia enterocolitica*, goats, humans, slaughter house, toxoinfection.

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**Note:** Results presented in this study are results of the research carried out within the project TR 31053.

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**PROCENA UNOSA ŽIVE KROZ KONZUMACIJU RIBE U SRBIJI**

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Nutritivna korist od konzumacije ribe ogleda se, pre svega u sadržaju visoko vrednih proteina, vitamina, makro i mikroelemenata i omega-3 polinezasićenih masnih kiselina. Sa druge strane, riba i proizvodi od ribe su u značajnoj meri podložni hemijskoj kontaminaciji ubikvitarnim zagađivačima kao što su teški metal i polihlorovana organska jedinjenja. Zbog svega ovoga, konzumacija ribe se smatra jednim od najznačajnijih izvora izloženosti navedenim kontaminantima. U radu je ispitivana kontaminacija živom koja se u spoljašnjoj sredini može naći kao posledica prirodnih procesa (vulkanska aktivnost, erozija tla i klimatska dešavanja koja doprinose prisustvu žive u vodi, zemljištu i atmosferi), kao i aktivnosti čoveka (eksploatacija ruda, sagorevanje fosilnih goriva, emisija industrijskih gasova, direktna primena veštačkih đubriva i fungicida, kao i neadekvatno odlaganje čvrstog otpada).

Sadržaj ukupne žive je određivan u svežoj i konzervisanoj ribi sa srpskog tržišta. Ispitano je 469 uzoraka: 252 uzorka morske ribe (oslić–*Merluccius merluccius*, skuša–*Scomber scombrus*, sardela–*Sprattus sprattus*, šarpina–*Scorpaena scrofa*, orada–*Sparus aurata*, inćun–*Engraulidae*, losos–*Salmo salar*) i 217 uzoraka konzervisane ribe (tuna i sardela). Svi uzorci su analizirani tokom 2010. godine. Priprema uzoraka je izvedena mikrotalasnom digestijom (ETHOS Milestone). Sadržaj žive je određivan metodom atomske apsorpcione spektrometrije na uređaju Varian „SpectrAA 220“ sa VGA 77 hidridnim sistemom korišćenjem tehnike hladnih para. Limit kvantifikacije je iznosio 5 ngg-1. Kontrola kvaliteta je izvedena korišćenjem sertifikovanog referentnog materijala BCR 186. Rezultati analiza u replikatima bili su u okviru sertifikovanih vrednosti.

Za procenu unosa korišćeni su podaci iz „GEMS/Food Consumption Cluster Diets database“. Prema ovom izvoru, procenjena prosečna nedeljna konzumacija morske ribe iznosi 106,4 g dok je ova vrednost za konzervisane riblje proizvode 18,2 g.

Sadržaj žive u morskoj ribi se kretao u opsegu od 0,005 do 0,286  $\mu\text{gg-1}$  (srednja vrednost 0,034  $\mu\text{gg-1}$ ) dok se u konzervisanim ribljim proizvodima sadržaj žive kretao od 0,005 do 0,502  $\mu\text{gg-1}$  (srednja vrednost 0,058  $\mu\text{gg-1}$ ).

Nivo žive u svim ispitanim uzorcima je bio ispod maksimalno dozvoljenih vrednosti propisanih relevantnom legislativom EU kao i domaćim propisima.

Procenjeni nedeljni unos ukupne žive zasnovan na srednjoj vrednosti sadržaja žive u morskoj ribi i proizvodima od ribe, kao i na prosečnoj telesnoj težini od 70 kg, je 0,067  $\mu\text{g/kg t.m./nedelja}$ .

Na osnovu preporuka FAO/WHO od 5  $\mu\text{g/kg t.m./nedelja}$ , kao i na osnovu dobijenih rezultata, može se zaključiti da je unos žive pri konzumaciji morske ribe i konzervisanih ribljih proizvoda, niži od preporučenih graničnih vrednosti.



**Ključne reči:** unos, riba, živa.

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## ASSESSMENT OF MERCURY INTAKE ASSOCIATED WITH FISH CONSUMPTION IN SERBIA

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Nutritional benefits of fish can be attributed in the first place to the content of high-quality proteins, vitamins, elements and omega-3 polyunsaturated fatty acids. On the other hand, fish and fishery products are susceptible to contamination by chemicals that have been recognized as ubiquitous environmental pollutants such as heavy metals and polychlorinated organic compounds. Fish consumption could be therefore considered as one of the major sources of human exposure to all above-mentioned environmental contaminants. This work has been focused on mercury (Hg) that enters the environment by natural means (such as volcanic activity, erosions and weathering which contribute to the presence of Hg in water, soil and the atmosphere) and human activities - mining, fossil fuel combustion, industrial emissions, direct application of fertilizers and fungicides as well as disposal of solid waste.

Total concentrations of Hg were measured in fish and canned fish products available on Serbian market. Total of 469 samples were analyzed: 252 samples of marine fish (hake-*Merluccius merluccius*, mackerel-*Scomber scombrus*, sprat-*Sprattus sprattus*, scorpanea-*Scorpaena scrofa*, gilthead-*Sparus aurata*, anchovy-*Engraulidae*, salmon-*Salmo salar*) and 217 samples of canned fish products (tuna and sardines). These data were collected during 2010. Samples for Hg analysis were prepared by microwave digestion (ETHOS Milestone). Analyses were carried out on atomic absorption spectrometer Varian “SpectrAA 220” with VGA 77 hydride system. Cold vapor technique was applied. The limit of quantification (LOQ) for Hg was 5 ngg-1. Analytical quality control was achieved by using certified reference material BCR 186. Replicate analyses were in the range of certified values.

For the purpose of intake assessment, we used the data obtained from the GEMS/Food Consumption Cluster Diets database. According to this source, estimated average weekly consumption of marine fish is 106.4 g/week and of canned fish products is 18.2 g/week.

Mercury concentrations in marine fish were in the range of 0.005-0.286 µgg-1 (mean 0.034 µgg-1) and in canned products in the range of 0.005-0.502 µgg-1 (mean 0.058 µgg-1). All analyzed samples contained mercury below the maximum level established by the European Union legislation and Serbian national regulation.

The estimated weekly intake for total mercury, based on mean mercury value in fish and average body mass of 70 kg, was 0.067 µg/kg b.w./week.

Based on FAO/WHO recommended safe limit of 5 µg/kg b.w./week and on obtained results, we can conclude that the intake of mercury in the case of consumption of marine fish and canned fish products is bellow the safe limit.

**Key words:** intake, fish, mercury.

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## UTVRĐIVANJE PRISUSTVA STAFILOKOKNOG ENTEROTOKSINA U NAMIRNICAMA ANIMALNOG POREKLA METODOM ELISA TESTA

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*Staphylococcus aureus* i druge vrste bakterija, potencijalni kontaminanti hrane, predstavljaju ozbiljan problem na globalnom nivou. Vreme i temperatura su bitni faktori koji kod enterotoksigenih stafilokoka dovode do sinteze enterotoksina, pro-uzrokovaca alimentarne intoksikacije. Količina od 100 do 200 ng enterotoksina dovodi do klasičnih simptoma stafilokokne intoksikacije. Premda se čovek smatra primarnim izvorom kontaminacije *S. aureus-a*, značajni su i putevi prenošenja preko životinja, vazduha, prašine i kontaktnih površina. Do kontaminacije namirnica može da dođe tokom proizvodnje i/ili obrade u domaćinstvima ili industrijskim pogonima, usled povećanog broja kolonija *S. aureus-a* i povećane koncentracije stafilokoknog enterotoksina. Stafilokokni enterotoksini su termorezistentni i ostaju biološki aktivni nakon izlaganja visokim temperaturama.

Ovaj rad obuhvata utvrđivanje stafilokoknih enterotoksina u mleku, proizvodima od mleka i sirovom mesu metodom ELISA testa. ELISA testovi su puzdani, visokospecifični i visoko senzitivni.

Ukupno je analizirano petnaest proizvoda od mleka (sirevi proizvedeni u domaćinstvima, jogurt i sladoled) i deset uzoraka sirovog mesa na prisustvo stafilokoknih enterotoksina. Korišćen je TRANSIA set koji omogućava jednostavnu i brzu pripremu uzoraka. Metod je vrlo osetljiv – nivo osetljivosti je ispod 0,25 ng SE/gr uzorka (SEA, SEB, SEC1, SEC2, SEC3, SED i SEE).

Prisustvo stafilokoknih enterotoksina utvrđeno je samo u sirevima koji su proizvedeni u domaćinstvima.

Iako se u rutinskoj dijagnostici koriste klasične metode za izolaciju i identifikaciju *S. aureus-a*, sa sanitarnog i higijenskog aspekta, preporučljivo je određivanje stafilokoknog enterotoksina direktno iz uzoraka.

**Ključne reči:** *Staphylococcus aureus*, toksin, ELISA, proizvodi od mesa.

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## DETECTION OF STAPHYLOCOCCAL ENTEROTOXINS IN FOODSTUFFS OF ANIMAL ORIGIN BY ELISA METHOD

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The problem of *Staphylococcus aureus* and other species as food contaminants supply remains significant on a global level. Time and temperature abuse of a food product contaminated with enterotoxigenic staphylococci can result in formation of enterotoxin, which can produce food borne illness when the product is ingested. Between 100 and 200 ng of enterotoxin can cause symptoms consistent with staphylococcal intoxication. Although humans are the primary reservoirs of contamination, animals, air, dust, and food contact surfaces can serve as vehicles in the transfer of this pathogen to the food supply. Foods may become contaminated during production or processing and in homes or food establishments, where the organism can proliferate to high concentrations and subsequently produce enterotoxin. The staphylococcal enterotoxins are highly heat stable and can remain biologically active after exposure to high temperatures.

This paper comprises detection of staphylococcal enterotoxins (SEs) presence in milk, milk products and raw meat by using ELISA test. The enzyme-linked immunosorbent assays are highly specific, highly sensitive, and rapid for the detection of enterotoxin in foods.

Fifteen milk products (home made cheese, yogurt, ice cream) and ten raw meat samples were analyzed at presence of staphylococcal enterotoxins (SEs). For the detection we have used TRANSIA set plate. This set enables simplified and faster sample preparation with sensitive level of bellow 0.25 ng S. enterotoxins/gram sample (SEA, SEB, SEC1, SEC2, SEC3, SED and SEE).

The presence of staphylococcal enterotoxins was detected only in home made cheese.

For sanitary and hygienic purposes, an effective approach is to detect the staphylococcal enterotoxins directly in foods, rather than detect, count and type the isolated *S. aureus* strains, because the toxin is the causative agent of food borne illness.

**Key words:** *Staphylococcus aureus*, toxin, ELISA, meat products.

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## PRISUSTVO REZIDUA OHRATOKSINA A U TKIVIMA BROJLERA – ZNAČAJ U ANALIZI RIZIKA

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Bazirano na podacima Globalnog monitoringa zaštite životne sredine – monitoringu kontaminacije hrane i programu procene rizika od mikotoksina (GEMS/food, FAO/WHO), kao i podacima drugih nacionalnih agencija o zastupljenosti mikotoksina u namirnicama, mikotoksini predstavljaju veoma ozbiljan problem u sistemu snabdevanja stanovništva hranom, naročito u zemljama u razvoju. Posebnu opasnost po zdravlje ljudi predstavlja mogućnost pojave rezidua mikotoksina i njihovih metabolita u namirnicama životinjskog porekla. Iako je potrošnja mesa u Srbiji u poređenju sa zemljama Evropske unije (EU) mala, pileće meso predstavlja važan deo ishrane stanovništva Srbije (17 kg/per capita/godišnje). Stoga je cilj ovih preliminarnih istraživanja bio da se u sklopu monitoringa rizika značajnih za zdravlje potrošača, utvrdi prisustvo rezidua ohratoksina A (OTA) u tkivima redovno zaklanih brojlera, poreklom iz različitih regiona Srbije. Za ovu vrstu istraživanja odabrane su farme poreklom sa regiona gde je razvijena intenzivna živinarska proizvodnja. Brojleri su odgajani na komercijalnim farmama, pri čemu su se poštovale zootehničke preporuke vezane za intenzivan uzgoj. Za ishranu su korišćene kompletne smeše standardnog sirovinskog sastava, shodno normativima. Uzorkovano je ukupno po 90 uzoraka jetre, bubrega i mišićnog dela želuca brojlera. Određivanje prisustva rezidua OTA vršeno je tehnikom visokoeфикаsne tačne hromatografije sa fluorescentnim detektorom (HPLC-FD). Zastupljenost rezidua OTA u tkivima brojlera kretala se od: 16,6% ( $\bar{x}$  0,14 ± 0,92 ng/g) u uzorcima mišićnog dela želuca, do 25,6% u uzorcima jetre ( $\bar{x}$  0,36 ± 1,18 ng/g). Međutim, najniže prosečne vrednosti sadržaja OTA utvrđene su u jetri ( $\bar{x}$  0,14 ± 0,92 ng/g), dok su u uzorcima bubrega i jetre prosečne koncentracije bile identične ( $\bar{x}$  0,36 ± 1,18 i 0,36 ± 1,49 ng/g, ponaosob). Relativno niske vrednosti standardne devijacije ukazuju da je sadržaj OTA u ispitanim tkivima bio u uskom intervalu. Rezultati preliminarnih istraživanja prisustva rezidua OTA u tkivima brojlera ukazuju da je sadržaj OTA u ispitanim tkivima daleko ispod vrednosti koje predstavljaju opasnost po zdravlje potrošača, s obzirom na to da je preporuka Naučnog komiteta Evropske agencije za bezbednost hrane (SC, EFSA) da tolerantni dnevni unos (TDI) za OTA bude ispod 5 ng/kg/TM.

**Ključne reči:** mikotoksini, ohratoksin A, monitoring.

**Napomena:** Rad je realizovan u okviru projekta „Razvoj brzih metoda za determinaciju ohratoksogenih plesni, njihovih metabolita i analiza rizika od ohratoksina A u lancu ishrane ljudi“, ev. broj TP-20207A, koji u okviru Programa istraživanja u oblasti tehnološkog razvoja finansira Ministarstvo za nauku i tehnološki razvoj Republike Srbije.

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## OCHRATOXIN A RESIDUE IN BROILER TISSUES - RISK ASSESSMENT

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Based on a data of the Global monitoring of environment protection, food contamination and program of the mycotoxins risk assessment (GEMS/food, FAO, WHO), and also on data from national agencies for mycotoxins, we may say that their presence in food chain is very serious problem, especially in developing countries. Special risk for consumer health is possibility of mycotoxin residue presence in form of its metabolites in foodstuffs of animal origin. Poultry meat consumption in Serbia is very important (17 kg/per capita/year), but in comparison to EU states, it is small. Considering that, the goal of this preliminary investigation is ascertainment of ochratoxin A residues (OTA) in regularly slaughtered broilers originating from different parts of Serbia, under the monitoring programme. Farms were selected from the regions with intensive poultry production, broilers were reared commercially, under the zootechnical recommendations for intensive breeding. Broilers were fed with normative based complete food mixtures of standard feed composition. Total samples number of liver, kidney and muscle of the stomach of chickens were 90. During slaughtering procedure, following the random pattern, total of 90 samples of liver, gizzard and kidney were taken. OTA residues were determined by using the high efficient method of liquid chromatography with fluorescent detection (*HPLC-FD*). Presence of OTA residues in broiler tissues ranged from: 16,6% ( $\bar{x}$  0,14 ± 0,92 ng/g) in gizzard, up to 25,6% in liver ( $\bar{x}$  0,36 ± 1,18 ng/g) and kidneys 25,6% (0,36 ± 1,49 ng/g). Average concentrations in liver and kidney samples were identical. Relatively low values of standard deviation point the narrow interval in which OTA is present in tissues. The preliminary study results of OTA presence in broiler tissues points that actual concentration is generally very low, below recommended values of Scientific Committee of European Food Safety Authority (SC, EFSA) where tolerable daily intake (TDI) for OTA is BELOW 5 ng/kg/body weight.

**Key words:** mycotoxins, ochratoxin A, monitoring

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**Note:** *This study was realized as a part of Project „Development of rapid methods for determination techniques of ochratoxigenic moulds, its metabolites and risk analysis of ochratoxin A in food chain”, project code TP-20207A, which is part of researches in the field of technological development funded by the Ministry of Science and Technological Development of the Republic of Serbia.*

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## KONTAMINACIJA HRANE I HRANIVA MIKOTOKSINIMA U HRVATSKOJ

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U Hrvatskoj, istraživanje mikotoksina je počelo pre oko 30 godina, kada je primjećena sličnost između lezija bubrega kod osoba koje pate od balkanske endemske nefropatije (BEN) i bubrega svinja kod kojih je utvrđena mikotoksinska nefropatija. Nefropatija kod svinja je veoma česta pojava u Skandinavskim zemljama, posebno u vlažnim godinama. Ohratoksin A (OTA), koji je agens koji izaziva nefropatiju svinja, takođe se smatra da učestvuje u etiologiji BEN, i to ne samo u Hrvatskoj, već i u Bosni, Bugarskoj, Rumuniji i Srbiji. Od tada, koncentracija OTA se meri u različitim proizvodima, kao i ljudskoj krvi.

Analiza kontaminacije hrane OTA mikotoksinom je urađena u nekoliko studija koje su uključivale uzorke sakupljene u regionu gde postoji endemska nefropatija. Već u prvoj studiji, ispitivanju uzoraka pšenice, kukuruza i ječma iz regiona gde je prisutna BEN, registrovana je visoka varijabilnost koncentracija OTA u uzorcima sakupljenim u različitim godinama. U većini ispitivanja, sadržaj OTA u hrani nije viša u endemskim regionima u poređenju sa drugim, ali zastupljenost OTA pozitivnih uzoraka jeste. Zastupljenost OTA pozitivnih uzoraka se povećavala signifikantno kada je manje osetljiva TLC metoda zamenjena HPLC metodom koja ima niži prag detekcije. Ispitivanja urađena na uzorcima pasulja (*Phaseolus vulgaris* L.) sakupljenim neposredno nakon žetve u 13 okruga u Hrvatskoj su pokazala ukupnu srednju koncentraciju OTA koja nije bila velika. Učestalost OTA pozitivnih uzoraka je bila mnogo veća u severnim okruzima u poređenju sa južnim, a kontaminacija se isključivo dešavala sa vrstama *Penicillium* ili *Aspergillus* spp. Ispitivanja kontaminacije vina mikotoksinom OTA su otkrila da je vino u našoj zemlji često kontaminirano ovim mikotoksinom, ali njegova koncentracija je niža nego u susednim zemljama. Kontaminacija mikotoksinom OTA je veća u crnom vinu nego u belom, i pokazuje geografske varijacije. Učestalost OTA pozitivnih uzoraka, kao i srednja vrednost koncentracije OTA je veća u južnim nego u severnim okruzima.

U nekoliko studija je dokazano da aflatoksin B<sub>1</sub> (AFB<sub>1</sub>) kontaminira žitarice koje su proizvedene u Hrvatskoj za ljudsku potrošnju, kao i za ishranu životinja (kukuruz, pšenica, ječam, ovas) nivoa koji se mogu tolerisati. U kobasicama iz različitih krajeva Hrvatske (Zagorje i Slavonija) AFB<sub>1</sub> je utvrđen zajedno sa OTA. Međutim, AFB<sub>1</sub> je kontaminirao spoljašnji deo kulena, dok se OTA nalazio i u unutrašnjosti.

Trihoteceni T-2 toksin, diacetoksiscirpenol (DAS) i deoksinivalenol su otkriveni u žitaricama I stočnoj hrani, I to veoma često. Njihova koncentracija je obično niska, i samo mali broj T-2 toksina- i DAS-kontaminirane hrane za živinu su imali veće koncentracije od preporučenih nivoa od strane hrvatskih nadležnih organa za hranu za živinu.

Najčešći kontaminanti žitarica u Hrvatskoj su zearalenon (ZEA), fumonizin B<sub>1</sub> (FB<sub>1</sub>), aflatoksin B<sub>1</sub> (AFB<sub>1</sub>) i OTA. U nekim istraživanjima, među najčešćim mikotoksinima je bio ZEA, a u drugim FB<sub>1</sub>.

Veoma česta pojava su različiti mikotoksini u različitim vrstama proizvoda. U svim istraživanjima gde su ispitivani različiti mikotoksini, utvrđena je njihova zajednička pojava, što ukazuje na to da propisi moraju uključivati multi-toksičnu kontaminaciju hrane i hraniva.

**Ključne reči:** mikotoksini, kontaminacija, hrana, hraniva, Hrvatska.

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## MYCOTOXINS CONTAMINATION OF FOOD AND FEED FROM CROATIA

Maja Peraica<sup>1\*</sup>, Dubravka Flajs<sup>1</sup>

In Croatia the mycotoxins research started about 30 years ago when a similarity between kidney lesions in persons suffering from Balkan endemic nephropathy (BEN) and kidney of pigs with mycotoxin nephropathy was noticed. Porcine nephropathy was frequent in Scandinavian countries, particularly in wet years. Ochratoxin A (OTA) which was found to be causative agent of porcine nephropathy was supposed to be involved in the etiology of BEN known not only in Croatia, but also in Bosnia, Bulgaria, Rumania and Serbia. Since then the concentration of OTA was measured in various commodities as well as in human blood.

Analyzes of food contamination with OTA was performed in several studies that included samples collected in region with endemic nephropathy. Already in the first study on wheat, maize and barley samples from BEN region the high variability of OTA concentrations in samples collected in different years was noticed. In most studies the concentration of OTA in food was higher in endemic than in the other regions of Croatia. In some studies the mean OTA concentration was not higher in endemic than in other regions, but the frequency of OTA-positive samples was. The frequency of OTA-positive samples increased significantly when less sensitive TLC method was substituted by HPLC method with lower detection limit. Studies on beans (*Phaseolus vulgaris* L.) collected shortly after the harvest in 13 counties of Croatia showed that overall mean concentration of OTA is not high. The frequency of OTA positive samples is much higher in Northern than in Southern counties and the contamination exclusively occurs in the samples contaminated with *Penicillium* or *Aspergillus* spp. Studies on OTA contamination in wine revealed that wine in our country is frequently contaminated with this mycotoxin, but its concentration is lower than in neighbouring countries. OTA contamination is higher in red than in white wine and shows geographical variations. The frequency of positive samples as well as mean OTA concentration is higher in Southern than in Northern counties.



In several studies it was proved that aflatoxin B<sub>1</sub> (AFB<sub>1</sub>) contaminates cereals produced in Croatia intended for human and animal consumption (maize, wheat, barley and oat), but its concentration never exceeds the recommended maximal tolerable levels. In sausages from different parts of Croatia (Zagorje and Slavonija) AFB<sub>1</sub> was found together with OTA. However, AFB<sub>1</sub> contaminated outer part of kulen, while OTA was also inside.

Trichothecenes T-2 toxin, diacetoxyscirpenol (DAS) and deoxynivalenol were detected in cereals and animal feed rather frequently. Their concentration is usually low, and only small number of T-2 toxin- and DAS-contaminated poultry feed contained higher concentrations that recommended by the Croatian regulatory levels for poultry feed.

The most frequent contaminants of cereals in Croatia are zearalenone (ZEA), fumonisin B<sub>1</sub> (FB<sub>1</sub>), aflatoxin B<sub>1</sub> (AFB<sub>1</sub>) and OTA. In some studies the most frequent is ZEA and in the others FB<sub>1</sub>.

The co-occurrence of various mycotoxins is frequent in various commodities. In all studies when various mycotoxins were analyzed, the co-occurrence was found which indicates that the legislation should include multitoxic contamination of food and feed.

**Key words:** mycotoxins contamination, food, feed, Croatia.

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## REZISTENCIJA SOJEVA *C. jejuni* IZOLOVANIH SA TRUPOVA PILIĆA TRETIRANIH FLUMEKVINOM

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Mnogi problemi vezani za bezbednost hrane dovode se u vezu sa primarnom proizvodnjom. Primena antimikrobnih lekova u terapiji, profilaksi i za promociju rasta kod životinja dovela je do razvijanja rezistencije kod bakterija koje se nalaze u organizmu životinja i mogućnosti njihovog prenosa kroz lanac ishrane do čoveka što može rezultirati do neuspeha u lečenju oboljenja ljudi. Fluorohinoloni su antimikrobni lekovi koji se pored beta-laktama najčešće koriste u terapiji živine. Fluorohinoloni su takođe lekovi izbora za neka oboljenja ljudi. Cilj rada bio je da se ispita povezanost između prisustva sojeva *C. jejuni* rezistentnih prema flumekvinu i perapije pilića flumekvinom.

Opis ogleđa: pilići su inficirani sojem *C. jejuni* ATCC 29428 osetljivim prema flumekvinu (MIC flumekvina 0.500 µg/g) u trećoj nedelji života kada se obično i događa spontana infekcija kampilobakterijama. Lečenje flumekvinom (12 mg/kg/tm) počelo je nakon pet dana. Pilići su zaklani i obrađeni na živinskoj klanici nakon perioda karence za flumekvin. Izolacija i identifikacija kampilobakterija izvršena je prema standardnoj proceduri sa Novog Zelanda. Ispitivanje osetljivosti prema flumekvinu je izvršeno agar dilucionom metodom.

Terapija flumekvinom dovela je do pojave rezistentnih sojeva na trupovima živine, *C. jejuni* sojevi rezistentni prema flumekvinu su izolovani sa 22.23% trupova (MIC flumekvina 16 µg/g). U kontrolnoj grupi nakon klanja nisu izolovani sojevi rezistentni prema flumekvinu *C. jejuni*.

Ogledom je dokazano da se nakon upotrebe veterinarskih lekova u primarnoj proizvodnji javljaju rezistentni patogeni na finalnim proizvodima (trupovima životinja). Klanje živine na kraju perioda karence ne eliminiše rizik od pojave rezistentnih sojeva *C. jejuni* na trupovima. Rešavanje problema rezistentnih patogena koji se prenose hranom počinje u primarnoj proizvodnji primenom odgovarajućih profilaktičkih mera

**Ključne reči:** bezbednost hrane, *C. jejuni*, rezistencija.

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## FLUOROQUINOLONE RESISTANCE OF *C. jejuni* STRAINS ISOLATED FROM CARCASSES OF BROILERS TREATED WITH FLUMEQUINE

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Jelena Krasić<sup>3</sup>

Food safety problems bring into focus the importance of primary production. The application of antimicrobial drugs in therapy, prophylaxis and growth promotion in food producing animals raised the question of development of bacterial resistance while still they are in the body of an animal, possible transfer on humans via food chain and development of human diseases treatment failures. Fluoroquinolones are antimicrobial drugs which, beside beta-lactams, are most often used in poultry breeding. Fluoroquinolones are also very important for treatment of some human diseases. Relationship between presence of flumequine resistant *C. jejuni* in poultry carcasses and flumequine treatment of poultry was examined in the experimental design.

Experimental design: the chickens were inoculated with fluoroquinolone-sensitive *C. jejuni* ATCC 29428 strain (MIC flumequine 0.500 µg/g). They were inoculated in the 3<sup>rd</sup> week, when spontaneous infection with campylobacters usually occurs. Treatment with flumequine (12 mg/kg/tt) started after five days. Chickens were slaughtered in the poultry abattoir, after the end of withdrawal period. Isolation and identification of campylobacters were performed according to New Zealand standard procedure. Antimicrobial susceptibility testing was conducted by agar dilution method.

Treatment with flumequine selects resistant strains in chickens carcasses, *C. jejuni* strains resistant to flumequine were isolated from 22.23% carcasses (MIC flumequine 16 µg/g). In control groups, after slaughtering resistant *C. jejuni* strains were not isolated.

The experiment proved that the usage of veterinary drugs in primary production results in appearance of resistant pathogens in the final products. The slaughtering of chickens after the end of withdrawal period can't eliminate the risk of presence resistant *C. jejuni* strains in poultry carcasses. Solution of problems with resistant pathogens in food must start at primary production, but the problem is to be solved by appropriate prophylactic measures.

**Key words:** food, safety, *C. jejuni*, resistance.

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## HIGIJENSKI RIZICI PRI PROMETU NEUPAKOVANOG RASEČENOG PILEĆEG MESA U MALOPRODAJI

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Pileće meso je vredan prehrambeni proizvod, njegova potrošnja u Srbiji beleži konstantan porast i trenutno iznosi 17,4 kg godišnje po stanovniku. Pileće meso se distribuira kroz veleprodajne i maloprodajne lance do potrošača. Prodaje se originalno upakovano, upakovano i neupakovano (rinfuz). Tema našeg rada je procena higijenskih rizika pri prodaji neupakovanog pilećeg mesa, rasečenog u osnovne delove. Pileće meso se tada u samom objektu, od strane radnika, vadi iz zbirnih pakovanja i prebacuje u prodajne vitrine. Meso tako postaje izloženo mikroambijentu maloprodajnog objekta, dolazi u kontakt sa rukama radnika, alatom i opremom. Kako bi se obezbedio prihvatljiv nivo zaštite zdravlja ljudi postoji potreba za procenom higijenskog rizika koje ovaj vid prometa pilećeg mesa nosi sa sobom. Za bezbedan proizvod životinjskog porekla se smatra proizvod sa niskim prihvatljivim rizikom od mikroorganizama. Radi toga je sprovedena studija dvogodišnje provere higijenskih uslova prometa pilećeg mesa u za to specijalizovanom lancu maloprodajnih objekata u Srbiji. U periodu od dve godine uzimani su brisevi sa ruku radnika, alata i opreme. Ispitivanje briseva je rađeno prema Pravilniku o metodama vršenja mikrobioloških analiza i superanaliza životnih namirnica („Sl. list SFRJ“, br. 25/80), utvrđivano je prisustvo mikroorganizama: *Salmonella* spp., *E. coli*, koagulaza pozitivne stafilokoke, sulfitoredujuće klostridije, kao i fekalne streptokoke i aerobne mezofilne bakterija. Brisevi su ispitivani modifikovanom metodom po Kelchu. Ukupno je uzeto 920 briseva, u 29% briseva je utvrđeno prisustvo mikroorganizama. Poseban rizik predstavljaju kese kojim radnici uzimaju meso pri usluživanju potrošača (80%), zatim lodne u kojima se meso drži u vitrinama (67%), ruke radnika (30%), mašine za narezivanje (29%), hvataljke za meso (18%), daske za rasecanje mesa (10%) i noževi (8%). Dobijeni rezultati ukazuju na to da, pri maloprodaji neupakovanog rasečenog pilećeg mesa, postoje rizici. Pri manipulaciji sa mesom tokom skladištenja, izlaganja i same prodaje u maloprodajnom objektu postoji mogućnost kontaminacije, tako da je preporučljivo rasečeno pileće meso prodavati u originalnim pakovanjima. Na taj način bi se minimalizovao kontakt sa ambijentom maloprodajnog objekta, sam stepen manipulacije sa mesom od strane radnika bi bio smanjen, dok bi se dobio prostor za detaljno praćenje temperaturnog režima skladištenja, izlaganja i prodaje pilećeg mesa.

**Ključne reči:** maloprodaja pilećeg mesa, brisevi, neupakovano pileće meso, promet pilećeg mesa.

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## HYGIENIC RISKS IN SALE OF UNPACKED CUT POULTRY MEAT IN RETAIL

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Poultry meat is valuable food, its consumption in Serbia is in a constant increase, at the moment it is 17,4 kg a year/per capita. Poultry meat is distributed through mega markets and retail shops, as originally packed, packed and unpacked. Topic of our paper was to assess hygienic risks in sale of unpacked cut poultry meat (breast, drumstick, wings, back) in retail. The workers in retail, pull out the cut parts of poultry meat from the collective packed units (5 – 10 kg), and then place it in sale show cases. During handling, poultry meat is subjected to the influences of retail shop environment (equipment, tools, worker's gloves). In order to identify potential hygienic risks and to provide acceptable hygienic sale condition, the two year study was conducted in specialized retail stores. During that period the swabs were taken from equipment and worker's hands. Swabs were analyzed according to Serbian „Regulation on methods for microbiological analyses and super analyses of foodstuffs” („Official Journal of SFRY”, No. 25/80)”. The swabs were examined for presence of bacteria: *Salmonella* spp., *E. coli*, coagulase positive staphylococci, sulphito reducing clostridia, *Streptococcus* spp. and aerobic mesophilic bacteria. Swabs were examined by Kelch modified method. Risk analysis was conducted in order to provide acceptable hygienic level for consumers. Our regulation defines safe product as product with low acceptable microbiological risk. Totally 920 swabs were taken, and 29% were positive on bacterial presence. Equipment of high risk level is: plastic bags which workers use for taking meat parts from the show cases (80%); then plastic dishes in show cases (67%); workers' hands (30%), machine for meat cutting (29%); meat grabbers (18%); meat cutting plates (10%) and knives (8%). Obtained results indicate the increased hygienic risk level in sale of unpacked cut poultry meat in retail. Extensive handling during storage and displaying of products significantly increase hygienic risks. Poultry meat in retail should be presented as originally packed. Accordingly the interaction between poultry meat and micro environment is reduced to minimum, so workers should be focused on temperature check mode and high quality customer compliment.

**Key words:** retail, poultry sale, swabs, unpacked poultry meat, poultry meat commerce.

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## IMUNOENZIMSKA METODA ZA BRZU I OSETLJIVU DETEKCIJU TRINAEST SULFONAMIDA U HRANI

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Sulfonamidi su grupa lekova širokog spektra, koji se koriste u veterinarskoj praksi u profilaktičke i terapijske svrhe, u tretmanu bakterijskih infekcija. Takođe se koriste kao aditivi u hrani koji imaju ulogu promotera rasta. Kao posledica, sulfonamidi mogu biti prisutni u hrani životinjskog porekla, i mogu izazvati alergijske reakcije, hepato- i nefrotoksičnost, povećanje broja i vrsta otpornih bakterija kod izloženih potrošača/konzumenata.

Maksimalne dozvoljene količine sulfonamida su određene odnosno propisane u mnogim zemljama. U Evropskoj Uniji, u SAD i Kanadi, maksimalno dozvoljena količina od 100 µg/kg je propisana za ukupne sulfonamide u jestivim tkivima i mleku, a upotreba ovih lekova nije dozvoljena kod koka nosilja. Za med nema utvrđenih granica.

U radu je predstavljena metoda *I'screen* Sulfa QL, imunoenzimski test semikvantitativnog skrininga najmanje trinaest različitih sulfonamida u mesu, mleku, jajima i medu. Osetljivost testa je u skladu sa limitom detekcije propisanim EU regulativom (37/2010/EC). Pozitivne kontrole se dobijaju u cilju identifikovanja kontaminiranih uzoraka u različitim presecima: 10 ili 50 ppb sulfametazina u mesu, 15 ppb sulfametazina u jajima, 20 ppb sulfametazina u mleku i 8 ppb sulfatiazola u medu. Prema unakrsnoj reaktivnosti testa, oko 8 sulfonamida se može otkriti sa osetljivošću od ispod 5 ppb. Visoka specifičnost je dobijena za „blank“ uzorak.

Eksperimentalni rezultati pokazuju da je metoda *I'screen* Sulfa QL pouzdan a za brzo i specifično otkrivanje prisustva životinjskog porekla. Takođe, to je jedina imunoenzimska metoda na tržištu koja može da otkrije sa visokom osetljivošću veliki broj ovih lekova koji su među najčešće korišćenim.

**Ključne reči:** imunoenzimski test, sulfonamidi, skrining, analiza na višestruke rezidue, mišić.

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## ENZYME IMMUNOASSAY FOR RAPID AND SENSITIVE DETECTION OF THIRTEEN SULFONAMIDES IN FOOD

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Sulfonamides are a group of broad antibacterial drugs widely used in veterinary medicine for prophylactic and therapeutic purposes in the treatment of bacterial infections. They are also used as growth-promoting feed additives. As a consequence, sulfonamides can be present in food from animal origin, and allergic reactions, hepato- and nefrotoxicity, selection of resistant bacteria could arise in exposed consumers.

Maximum residue limits (MRL) for sulfonamides have been established in many countries. In the European Union, in the USA and in Canada MRL of 100 µg/Kg was set for total sulfonamides in edible tissue and in milk, while the use of these drugs is unauthorised in eggs producing animals. No limits were fixed for honey.

Here we present *I'screen* Sulfa QL, an enzyme immunoassay for the semi-quantitative screening of at least thirteen different sulfonamides in meat, milk, eggs and honey. Assay sensitivity is compliant with detection capabilities required by the EU regulation (37/2010/EC). Positive controls are provided in order to identify contaminated samples at different cut-offs: 10 or 50 ppb of sulfamethazine in meat, 15 ppb of sulfamethazine in eggs, 20 ppb of sulfamethazine in milk and 8 ppb of sulfathiazole in honey. According to cross-reactivities of the assay, about eight other sulfonamides can be detected with sensitivities up to 5 ppb or less. High specificity was obtained for blank samples.

Experimental results show that *I'screen* Sulfa QL is a reliable tool for a rapid and specific screening for the presence of sulfonamide residues in food of animal origin. Moreover, it is the only enzyme immunoassay on the market that can detect with high sensitivity such a large number of the most frequently used among these antimicrobial drugs.

**Key words:** enzyme-immunoassay, sulfonamides, screening, multi-residue analysis, meat.

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## ISPITIVANJE MIKROBIOLOŠKOG STATUSA ZAMRZNUTOG PILEĆEG MESA

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U Srbiji se godišnje proizvede 490.000 tona mesa, što je za 250.000 tona manje nego pre deceniju i po. Srbija u evropskoj proizvodnji mesa učestvuje sa oko 1% inalazisena 19. mestu (FAO, 2009). Potrošnja mesa je upoređenju sa zemljama Evropske unije (EU) mala. U ovom periodu i potrošnja po jednom stanovniku je opala sa 65 na oko 36 kg, što je upola manje nego u EU, gde je prosečna potrošnja mesa 86,7 kg po stanovniku i po potrošnji mesa samo je Albanija iza naše zemlje. Sve to se odražava i na zdravstveno stanje i životni vek stanovnika.

S druge strane, proizvodnja pilećeg mesa u svetu beleži stalni porast. Proizvodnja živinskog mesa u svetu ove godine trebalo bi da dostigne rekordnih 85 miliona tona (u 2015. godini očekuje se 100 miliona, a 2030. čak 143 miliona tona, što će činiti 40 odsto svetske proizvodnje mesa), dok će u izvozu biti devet miliona tona. U proizvodnji i trgovini najdalje je otišao Brazil, gde je proizvodnja više nego udvostručena: porasla je sa 4,2 na 9,6 miliona tona, dok će ovogodišnja proizvodnja biti veća od 10 miliona tona.

Danas, živinarska proizvodnja obezbeđuje potrebe u proteinima životinjskog porekla za oko 30% stanovništva, a živinsko meso se ubraja među namirnice životinjskog porekla koje su najdostupnije najširim slojevima potrošača.

Potrošnja živinskog mesa u Srbiji, danas iznosi oko 16 kilograma po stanovniku, što je znatno niže od evropskog proseka, ali značajno više u odnosu na devedesetih godina, kada je iznosila oko 5 kilograma.

S druge strane, meso i proizvodi od živinskog mesa su značajni faktori oboljenja izazvanih hranom. U slučajevima masovnih oboljenja izazvanih hranom, po navodima nekih autora, ovi proizvodi učestvuju sa čak 33%. Smatra se da su uglavnom salmonele (*S. typhimurium*, *S. enteritidis*), uzročnici bakterijskog trovanja živinskim mesom, ali to može da bude i *Campylobacter jejuni/coli*. *Listerijamonocitogenes*, svrstava se u uzročnike alimentarnih toksikoinfekcija

Pileće meso se za ishranu pripadnika MO i VS koristi u proseku od 20 do 25% od ukupne potrošnje mesa. Snabdevanje jedinica i ustanova MO i VS pilećim mesom, vrši se na osnovu ugovora između MO i dobavljača, a u skladu sa Zakonom o javnim nabavkama, Pravilnikom o kvalitetu mesa pernate živine („Sl. list SFRJ“, broj 1/81 i 51/88) i tehničkom specifikacijom.

Cilj našeg ispitivanja bio je da se utvrdi mikrobiološka ispravnost pilećeg mesa, zamrznutog („ekstra A klase“, konfekcionirano – „file“, konfekcionirano – „batak i karabatak“), proizvedenog za potrebe Ministarstva odbrane i Vojske Srbije.

Uzorci su uzimani u skladištu proizvođača, u proseku dva puta mesečno. U periodu od 2009. do 2010. godine ukupno je analizirano 206 uzoraka pilećeg mesa. Za mikrobiološko ispitivanje korišćene su propisane metode i hranljive podloge iz



Pravilnika o metodama vršenja mikrobioloških analiza i superanaliza životnih namirnica („Sl. List SFRJ“, broj 25/80), a bakteriološka ispravnost tumačena je prema Pravilniku o mikrobiološkoj ispravnosti namirnica u prometu („Sl. List SRJ“, broj 26/93, 53/95 i 46/02).

U prvoj godini, analizom mikrobiološkog statusa, utvrdili smo da od 85 ispitanih uzoraka, 58 (68,24%) bilo je negativno na prisustvo bakterija, dok je u 27 (31,76%) uzoraka utvrđeno njihovo prisustvo. U drugoj godini je ispitan 121 uzorak, 88 (72,73%) uzorak bilo je negativno na prisustvo bakterija, a broj pozitivnih uzoraka je iznosio 33 (27,27%). Svi pozitivni uzorci su proglašeni kao zdravstveno nebezbedni za ishranu i stavljeni proizvođačima na raspolaganje.

Prisustvo bakterija ukazuje da je pileće meso bilo kontaminirano sadržajem poreklom iz digestivnog trakta, ili sekundarnom kontaminacijom, a kao posledica smanjenog nivoa održavanja procesne higijene, kao i nepoštovanje principa dobre higijenske prakse i dobre proizvođačke prakse, koji su preduslov za proizvodnju zdravstveno bezbedne hrane.

**Ključne reči:** pileće meso, analize, mikrobiološki status

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## EXAMINATION OF THE MICROBIOLOGICAL STATUS OF FROZEN CHICKEN MEAT

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Annual production of meat in Serbia is 490.000 tons, which is by 250.000 tons less than fifteen years ago. Serbia accounts for approx. 1% of meat production in European Union, and it is on the 19<sup>th</sup> place (FAO, 2009). Meat consumption, compared to other countries of European Union (EU) is low. In this period, also consumption per capita decreased from 65 to approx. 36 kg, which is by half less than in EU where average consumption of meat is 86.7 kg per capita, and in regard to meat consumption, only Albania is behind our country. This reflects on health condition and life expectancy of population.

On the other hand, production of poultry in the World is constantly increasing. Production of poultry in the world this year should reach the record of 85 million tons (in 2015 annual production of 100 million tons is expected, and in 2030 even 143 million tons, which will account for 40% of world meat production), whereas nine million tons will be exported. In production and trade, Brazil has gone the furthest, the production has been doubled: it has increased from 4.2 to 9.6 million tons, and production this year will be over 10 million tons.

Today, poultry production provides and satisfies requirements for animal proteins for about 30% of population, and poultry meat is considered as food of animal origin mostly available/accessible to grassroot consumers.

Consumption of poultry meat in Serbia, today, is approx. 16 kilograms per capita, which is significantly lower than European average, but significantly higher compared to the nineties, when it was only 5 kilograms.

On the other hand, poultry meat and poultry meat products are significant factors in food borne diseases. In cases of mass disease caused by food, according to some authors, these products account for 33%. It is considered that mainly salmonella strains (*S.typhimurium*, *S.enteritidis*) are causers of bacterial poisoning by poultry meat, but it can also be *Campylobacterjejuni/coli*. *Listeria monocitogenes* is also considered to be cause of alimentary toxic infections.

Poultry is used in nutrition of members of the Ministry of Defense and Serbian Army in average of 20 to 25% of total meat consumption. Supply of units and institutions of the Ministry of Defense and Serbian Army is done based on contracts between the Ministry of Defense and supplier, according to the Law on Public Procurement, Regulation/Rulebook on quality of poultry meat („Official Journal of SFRY“, number 1/81 and 51/88) and technical specification.

Aim of this objective of our research was to determine the microbiological safety of frozen chicken meat, („extra A class“, cut/confectioned– „fillet“, cut/confectioned– „thigh and drumstick“), produced for the needs of the Ministry of Defense and Serbian Army.

Samples were taken in the producers' warehouse, in average twice per month. In the period from 2009 to 2010, total of 206 samples were analyzed. For microbiological testing regulated methods and nutritive mediums were used according to the Regulation/Rulebook on methods for microbiological analyses and super analyses of animal foodstuffs („Official Journal SFRY“, number 25/80), and bacteriological safety was interpreted according to Regulation/Rulebook on microbiological safety of foodstuffs in trade („Official journal of SRY“, number 26/93, 53/95 and 46/02).

In the first year, by analysis of microbiological status, we established that out of 85 tested samples, 58 samples (68.24%) were negative on presence of bacteria, whereas in 27 samples (31.76%) the presence of bacteria was detected. In the second year, total of 121 samples were tested, 88 samples (72.73%) were negative for presence of bacteria, and number of positive samples was 33 (27.27%). All positive samples were declared unfit for consumption and were returned to producers.

Presence of bacteria indicated that chicken meat was contaminated by contaminants originating from the digestive tract, or by secondary contamination, as consequence of lower level of process hygiene, as well as violation of principles of good hygiene practice and good manufacturing practice, as pre-conditions for production of healthy and safe food.

**Key words:** chicken meat, analyses, microbiological status.

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## ISPITIVANJE ODRŽIVOSTI MESA I PROIZVODA OD MESA ŽIVINE U SKLADU SA NOVIM DOMAĆIM PROPISIMA

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Ustaljena je praksa da se održivost svakog novog proizvoda PP Topiko ispita u saradnji sa Institutom za higijenu i tehnologiju mesa. Živinsko meso, kao i sam način obrade i dobijanja živinskog mesa, poseduje niz specifičnosti koje umnogome utiču na održivost mesa i proizvoda od mesa. Na održivost mesa i proizvoda od mesa živine utiču brojni faktori. Prema Pravilniku o opštim i posebnim uslovima higijene hrane u bilo kojoj fazi proizvodnje, prerade i prometa („Sl. glasnik RS”, 72/10) prilikom izrade proizvoda sprovode se studijska ispitivanja radi utvrđivanja usklađenosti sa kriterijumima održivosti proizvoda. Studijska ispitivanja oduhvataju: specifikacije o fizičkim i hemijskim osobinama proizvoda, kao što su pH vrednost, aktivnost vode, sadržaj soli, koncentracija konzervansa i način pakovanja, uslove skladištenja i prerade, mogućnost pojave kontaminacije i predviđeni rok upotrebe kao i korišćenje naučne literature i rezultata ispitivanja koji se odnose na rast i preživljavanje mikroorganizama.

Prehrambeni proizvodi ne smeju da sadrže mikroorganizme, njihove toksine i metabolite u količinama koje predstavljaju neprihvatljiv rizik za ljudsko zdravlje. Regulativa Evropske unije, kao i naša regulativa nalaže da hrana ne sme biti u prometu ako je nebezbedna. Održivost je sastavni deo bezbednosti hrane.

Codex alimentarius definiše održivost kao period tokom koga proizvod poseduje mikrobiološku bezbednost pri određenom temperaturnom režimu, kada se skladišti i čuva na odgovarajući način. Proizvođač ima obavezu da sam odredi rok održivosti za svoje proizvode na osnovu sprovedenih studija.

Tokom studije održivosti prati se:

- procesna higijena, uzimanjem briseva sa alata, opreme i sa trupova živine (kožica vrata)
- ispravnost sirovina, aditiva, začina, poluproizvoda i dr.
- senzorna svojstva proizvoda
- mikrobiološki status proizvoda
- hemijske karakteristike proizvoda

Jedan deo ispitivanja se sprovodi u samom pogonu, a jedan deo u laboratorijama Instituta.

Za svaku studiju održivosti pravi se plan ispitivanja. Plan ispitivanja treba, između ostalog, da sadrži: proizvođačku specifikaciju proizvoda, vrstu mesa, pH mesa nakon procesa hlađenja, temperaturu mesa posle hlađenja, mikrobiološki status opreme i površina na liniji klanja i obrade trupova, mikrobiološki status pilećih trupova, zapis o kontinuiranom praćenju temperature mesa, mikrobiološki status opreme i

površina u kontaktu sa mesom prilikom tehnološkog procesa izrade proizvoda, pH proizvoda, temperaturu proizvoda, mikrobiološki status proizvoda, senzorna ispitivanja, hemijska ispitivanja (kiselinski broj, mg KOH/g, peroksidni broj, mmol/kg,  $a_w$  itd.). Za svaki proizvod plan ispitivanja je specifičan u zavisnosti od niza faktora koji mogu da utiču na održivost proizvoda.

**Ključne reči:** održivost, živinsko meso, rok upotrebe

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## STUDY OF THE SHELF LIFE OF POULTRY MEAT AND MEAT PRODUCTS IN ACCORDANCE WITH NEW DOMESTIC REGULATIONS

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It is common practice that the shelf life of every new product of PP Topiko is examined in cooperation with the Institute of Meat Hygiene and Technology. Poultry meat, handling of processing and manufacturing of poultry meat, has series of specificities which greatly contribute the shelf life of meat and meat products. Shelf life of poultry meat and meat products are affected by many factors. According to the Rulebook on general and specific conditions regarding food hygiene in any stage of production, processing and trade („Official journal of RS”, No. 72/10), in development of the product, study investigations are carried out in order to determine the compliance with criteria of the product sustainability. Study examinations include: specification on physical and chemical properties of the product, such as pH value, water activity, salt content, conservant concentration, packaging, storing conditions, processing conditions, potential contamination and anticipated shelf life, as well as use of scientific literature and research results which relate to growth and survival of microorganisms.

Food products cannot contain microorganisms, their toxins and metabolites in amounts which are considered an unacceptable risk for human health. Regulations of European Union, as well as our regulations, stipulate that food cannot be sold if it is not safe. Shelf life is the main part of the food safety.

Codex alimentarius defines the sustainability as a period during which the product has microbiological safety in specific temperature regime, when stored and kept in adequate manner.

Producer has the obligation to self-determine the shelf life for own products based on executed studies.

In shelf life study, the following is monitored:

- process hygiene, taking swabs of tools, equipment and poultry carcasses (neck skin)

- safety of raw materials, additives, spices, meat preparations, etc.,
- sensory properties of the product
- microbiological status of the product
- chemical characteristics of the product

One part of the study is carried out in the facility, and the other in the laboratory of the Institute.

For each shelf life study a plan of the examination is prepared.

The plan should, among other things, contain the following: producer's specification of the product, meat type, pH of meat, pH subsequent to chilling, meat temperature subsequent to chilling, microbiological status of the equipment and surfaces at the slaughtering and carcass processing line, microbiological status of chicken carcasses, record of continuous monitoring of the meat temperature, microbiological status of the equipment and surfaces in contact with the meat during processing of manufacturing of the product, product pH, product temperature, microbiological status of the product, sensory analyses, chemical analyses (acid number, mg KOH/g, peroxide number, mmol/kg,  $a_w$  etc.).

The plan is product specific and depends on series of factors which can have impact on the sustainability of the product.

**Key words:** shelf life, poultry meat.

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## SADRŽAJ UKUPNIH FOSFATA U BARENIM KOBASICAMA

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U radu je prikazan sadržaj fosfata izraženog kao  $P_2O_5$  (fosfor-pentoksid) u barenim kobasicama koje se nalaze na našem tržištu. Analiza dobijenih rezultata je rađena zbog povećanog broja uzoraka čiji sadržaj ukupnih fosfata prelaze granicu od 7,0 g/kg u odnosu na 2009 godinu. Sadržaj fosfata određen je spektrofotometrijskom metodom prema standardu SRPS ISO 13730: 1996 (Određivanje sadržaja ukupnog fosfora–spektrofotometrijska metoda). Navedeni podaci obuhvataju period od 01.01.2010. do 28.02. 2011. Dobijeni rezultati fosfata izraženog kao  $P_2O_5$  u ovim proizvodima je najviše u intervalu između 5,00–5,50 g/kg ili 22,97%, a 5,41% proizvoda je imalo sadržaj fosfata izraženog kao  $P_2O_5$  iznad maksimalno dozvoljene količine 7,0 g/kg.

**Ključne reči:** fosfati, fosfor-pentoksid, barene kobasice.

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## TOTAL PHOSPHATES CONTENT IN COOKED SAUSAGES

Jovanović Ivanka<sup>1</sup>, Vulićević Predrag<sup>1\*</sup>, Ivkov Jelena<sup>1</sup>

The paper describes the content of phosphate expressed as  $P_2O_5$  (phosphorus pentoxide) in cooked sausages that can be found on our market. Obtained results were analyzed because of the increased number of samples with total phosphate content exceeding the limit of 7,0g/kg in comparison to year 2009. Phosphate content was determined by spectrophotometric method according to ISO 13730: 1996 (Determination of total phosphorus-spectrophotometric method). These data cover the period from 01.01.2010 to 28.02.2011. Obtained results for phosphate expressed as  $P_2O_5$  in these products show that in 22,97% of products it ranged from 5,00–5,50g/kg and 5,41% of the products had the content of phosphate expressed as  $P_2O_5$  above the maximum allowable amount of 7,0g/kg.

**Key words:** phosphate, phosphorus pentoxide, cooked sausages.

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## UPRAVLJANJE RIZIKOM MIKOTOKSINA U PREHRAMBENOJ INDUSTRIJI

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Kontaminacija mikotoksinima, sekundarnim metabolitima plesni, je neizbežna i nepredvidiva, što je čini jedinstvenim izazovom u borbi sa prirodom.

Cilj rada je bio da se prikažu moguća mesta (pozicije/tačke u procesima) i opasnosti koje mogu dovesti do mikrobiološke kontaminacije proizvoda, dobijenih mikološkom analizom u pet različitih pogona prehrambene industrije (proizvodnja kolača; proizvodnja mesa i proizvoda od mesa; proizvodnja brašna i drugih mlinskih proizvoda; proizvodnja hleba i peciva; pakovanje smrznutih proizvoda). Ustanovljene mikološke opasnosti su: ruke radnika koji rade u zoni proizvodnje (16,25 cfu/cm<sup>2</sup>), oprema (*mašina za mlevenje oraha sa 46 cfu/cm<sup>2</sup>, rezač tost hleba sa 250 cfu/cm<sup>2</sup>*), dio proizvodnog pogona (*fermentacione komore, sa 95 cfu/cm<sup>2</sup>*), materijal za pakovanje (*folije za pakovanje, sa 6,75 cfu/cm<sup>2</sup>*), kao i povratna ambalaža (*npr. korpe za hleb, sa 27 cfu/cm<sup>2</sup>*).

Usled neprovođenja stalne mikološke kontrole ulaznih materijala, odnosno zbog neodgovarajuće prijemne kontrole, u ispitivanim pogonima prehrambene industrije, neke od sirovina predstavljaju rizik u pogledu kontaminacije finalnog proizvoda toksigenim plesnima (*Penicillium* i *Aspergillus*), koje predstavljaju rizik pojave mikotoksina (aflatoksina i ohratoksina A). Utvrđeno je prisustvo mikotoksina kod: mlevenih oraha (4,01 µg/kg aflatoksina B<sub>1</sub>, 0,36 µg/kg aflatoksina G<sub>1</sub>), termički neobrađenih kolača (0,33 µg/kg aflatoksina B<sub>1</sub>), začina-piment (1,33 µg/kg aflatoksina B<sub>1</sub>, 0,42 µg/kg aflatoksina G<sub>1</sub>, 6,0 µg/kg ohratoksina A) i pšenice (1,21 µg/kg aflatoksina B<sub>1</sub>, 1,8 µg/kg ohratoksina A).

Uvođenjem mikrobiološkog nadzora proizvodnje, mikološkog i mikotoksikološkog nadzora ulaznih materijala i gotovih proizvoda, kao preventivnih mera nadzora celokupnog procesa proizvodnje uspostavljen je sistem upravljanja rizikom mikotoksina u prehrambenoj industriji.

**Ključne riječi:** kontaminacija, plesni, mikotoksini, bezbednost hrane.

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## MYCOTOXINS RISK MANAGEMENT IN FOOD INDUSTRY

Snježana Mandić<sup>1</sup>, Sandra Stojković<sup>1</sup>, Ana Velemir<sup>1</sup>

Contamination by mycotoxins, secondary metabolites of moulds, is inevitable and unpredictable, which makes it a unique challenge in the struggle with nature.

The aim of this work was to present possible sites (positions / points in the process) and the hazards that can lead to microbiological contamination, obtained by mycological analysis in five different plants of the food industry (production of cakes, plants for production of meat and meat products, manufacture of flour and other mill products, manufacture of bread and rolls, packing frozen products). Established mycological hazards are the hands of workers who work in the area of production (16,25 cfu/cm<sup>2</sup>), equipment (*walnuts grinder* 46 cfu/cm<sup>2</sup>, *toasted bread cutter* 250 cfu/cm<sup>2</sup>), part of the manufacturing plant (*fermentation chambers*, 95 cfu/cm<sup>2</sup>), materials for packaging (*foils for packaging*, 6.75 cfu/cm<sup>2</sup>), as well as the return packaging (e.g. *bread baskets*, 27 cfu/cm<sup>2</sup>).

Due to the lack of implementation of permanent mycological control of input materials, or due to inadequate control of receiving, in the tested plants of the food industry, some of the raw materials pose a risk in terms of contamination of final product toxigenic moulds (*Penicillium* and *Aspergillus*), which present the risk of appearance of mycotoxins (*aflatoxin* and *ochratoxin A*). The presence of mycotoxins was established in: ground walnuts (4.01 µg/kg of aflatoxin B<sub>1</sub>, 0.36 µg/kg of aflatoxin G<sub>1</sub>), thermally untreated cake (0.33 µg/kg aflatoxin B<sub>1</sub>), spices-allspice (1.33 µg/kg of aflatoxin B<sub>1</sub>, 0.42 µg/kg of aflatoxin G<sub>1</sub>, 6.0 µg/kg ochratoxin A) and wheat (1.21 µg/kg of aflatoxin B<sub>1</sub>, 1.8 µg/kg ochratoxin A).

By the introduction of microbiological monitoring of production, mycological and mycotoxicological control of incoming materials and final products, as well as preventive measures of control of the entire production process, it has been established a system of risk management of mycotoxins in the food industry.

**Key words:** contamination, mould, mycotoxins, food safety.

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## **SPECIFIČNOSTI IFS STANDARDA I STANDARDA ISO 22000 U ODNOSU NA ZAHTEVE HACCP SISTEMA**

Vojin Vranić<sup>1</sup>, Mladen Rašeta<sup>1</sup>, Zoranka Grbić<sup>2</sup>, Mira Grubić<sup>2</sup>

HACCP sistem je u svetu priznat kao najbolji način za postizanje bezbednosti hrane. HACCP je sistemski preventivni prilaz bezbednosti hrane kojim se identifikuju potencijalne opasnosti, procenjuju rizici, i preduzimaju odgovarajuće mere u cilju njihovog otklanjanja. HACCP sistem je baziran na osnovu preporuka Codex alimentarius-a za primenu opštih principa higijene hrane (CAC/RCP 1-1969, Rev. 4-2003).

Po našim važećim propisima Zakon o veterinarstvu („Sl.glasnik RS”, br. 91/2005 i 30/2010) i Zakon o bezbednosti hrane („Sl.glasnik RS“, br. 41/2009) primena HACCP sistema je obaveza svih subjekata u poslovanju hranom.

Zakon o veterinarstvu nalaže da „Pravno lice i preduzetnik koji obavlja delatnost klanja životinja, proizvodnju i promet hrane životinjskog porekla, hrane za životinje, kao i sakupljanje, preradu i uništavanje sprednih proizvoda životinjskog porekla dužan je da ima Sistem za osiguranje bezbednosti proizvoda koji je uveden i koji se održava na principima dobre proizvođačke i higijenske prakse i analize opasnosti i kritičnih kontrolnih tačaka u proizvodnji“. Rok za primenu odredbi ovog zakona je bio 1. januar 2009. godine.

Zakon o bezbednosti hrane nalaže da su svi subjekti u poslovanju hranom dužni su da uspostave sistem za osiguranje bezbednosti hrane u svim fazama proizvodnje, prerade i prometa hrane, osim na nivou primarne proizvodnje, u svakom objektu pod njihovom kontrolom, u skladu sa principima dobre proizvođačke i higijenske prakse i analize opasnosti i kritičnih kontrolnih tačaka. Primena odredbi ovog zakona počinje od juna 2011. godine.

ISO 22 000: 2005 se pojavio 2005 godine kao prvi međunarodni standard za upravljanje bezbednošću hrane. Standard ISO 22 000:2005 se može primeniti u svim vidovima poslovanja u prehrambenom lancu kao i kod proizvodnje hrane za životinje, uključujući i proizvođače opreme, ambalaže, dodataka, sredstava za čišćenje i dezinfekciju, i ostalog što ulazi u oblast industrije mesa. Prednosti ovog standarda su u tome što pored sistema upravljanja bezbednošću hrane, ovde se primenjuje i uvodi i sistem upravljanja kvalitetom koji daje velike prednosti kako velikim tako i malim sistemima. To znači da se standard ISO 22 000 zasniva na principima HACCP sistema (akcenat stavlja na detaljno i dosledno sprovođenje prethodno potrebnih programa), ali uz sebe inkorporiše i zahteve standarda ISO 9001.

Standard ISO 22 000, kao i ostali standardi, nema zakonsku obavezu primene, već je njegovo uvođenje dobrovoljna kategorija.

IFS standard je namenjen proceni brendiranih prehrambenih proizvoda dobavljača za trgovce na veliko i malo. 2003. godine Nemačko udruženje trgovaca je ra-

zvalo prvu verziju IFS standarda, sledeće godine priključilo se Francusko udruženje trgovaca i nastala je nova verzija, dok se 2005. godine priključilo i Italijansko udruženje trgovaca i nastala je trenutno važeća verzija 5. Kasnije je IFS standard prihvatila većina zapadnoevropskih zemalja.

Veliki trgovački lanci naše zemlje takođe postavljaju zahtev za primenu IFS standarda svojim dobavljačima među kojima se nalaze i brojni proizvođači mesa.

IFS standard postavlja niz specifičnih zahteva koji se baziraju na preporukama Svetske zdravstvene organizacije, propisima Evroopske unije za bezbednost hrane, kao i na načelima HACCP sistema.

Važno je da se napomene da primenu HACCP sistema kontroliše veterinarska inspekcija i nije obavezna dodatna sertifikacija od strane akreditovanih sertifikacionih tela. Standard ISO 22000 i IFS standard podležu redovnoj sertifikaciji od strane akreditovanih sertifikacionih tela.

**Ključne reči:** HACCP, ISO 22000, IFS standard.

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## **SPECIFICITIES OF IFS STANDARD AND ISO 22000 STANDARD COMPARED TO REQUIREMENTS OF THE HACCP SYSTEM**

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HACCP system is recognized in the world as the best way to ensure food safety. HACCP is a systematic preventive approach to the food safety which identifies potential hazards, assesses risks and takes certain adequate measures in order to remove them. HACCP system is based on recommendations of the Codex alimentarius pertaining to implementation of general principles of food hygiene (CAC/RCP 1-1969, Rev. 4-2003).

According to current regulations, Veterinary law („Official journal of RS”, No. 91/2005 and 30/2010) and Food safety law („Official journal of RS”, No. 41/2009), implementation of HACCP system is mandatory for all food business operators.

Veterinary law stipulates that „Legal entity and entrepreneur engaged in slaughtering of animals, production and trade of food of animal origin, as well as collection, processing and disposal of animal by-products, are obligated to have in place System ensuring the product safety, introduced and maintained according to principles of good manufacturing and hygiene practice, hazard analysis and determination of critical control points in production”. Deadline for implementation of the provisions of this law was January 1<sup>st</sup> 2009.

Food safety law stipulates that all food business operators are obligated to establish system ensuring the food safety in all stages of production, processing and trade of food, except at the level of primary production, in every facility under their

control, and according to the principles of good manufacturing and hygiene practice hazard analysis and determination of critical control points in production". Implementation of the provisions of this law has started from June 2011.

ISO 22 000 : 2005 was introduced in 2005 as the first international standard for management of the food safety. Standard ISO 22 000 : 2005 can be applied in all businesses within the food chain, as well as in production of animal feed, including producers of equipment, wrapping material, additives, cleaning and disinfection preparations, and other things considered as part of the meat industry. Advantages of this standard, in addition to the system of food safety management, are introduction and implementation of the quality system which is beneficial for large as well as small systems. This means that standard ISO 22 000 is based on principles of the HACCP system (emphasis is on detailed and consistent execution of previously needed programs), but it incorporates also requirements of ISO 9001 standard.

Standard ISO 22 000, like other standards, has no legal implementation obligation, its introduction is voluntary.

IFS standard is intended for the assessment of brand food product suppliers for whole and retail sellers. In year 2003, German trade association developed the first version of IFS standard, next year the French trade association joined and the new version was developed, and in 2005 also the Italian trade association joined which resulted in the final and currently valid version 5. Later, the IFS standard was accepted by majority of European countries.

Large retail/trade chains in our country also require application of the IFS standard for all their suppliers, among which are also numerous meat producers.

IFS standard sets series of specific requirements based on recommendations of World Health organization, regulations of the European Union relating to food safety, as well as principles of the HACCP system.

It is important to mention that the application of HACCP system is under the control of the veterinary inspection and it is not obligatory additional certification by accredited certification bodies. Standard ISO 22 000 and IFS standard subject to regular certification by accredited certification bodies.

**Key words:** HACCP, ISO 22000, IFS standard.

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## **USLOVI PRIJEMA, SKLADIŠTENJA, DISTRIBUCIJE I PRODAJE MESA I PROIZVODA OD MESA U MALOPRODAJNIM OBJEKTIMA DELTA MAXI GRUPE U CILJU OBEZBEĐIVANJA ZDRAVSTVENO BEZBEDNIH NAMIRNICA I OČUVANJA KVALITETA**

Mirković Sanja<sup>1\*</sup>, De Lungin Srđan<sup>1</sup>, Nenić Nemanja<sup>1</sup>, Damnjanović Milena<sup>1</sup>

Radi pružanja kvalitetnog i zdravstveno bezbednog mesa i proizvoda od mesa potrošačima neophodna je jednaka pažnja kako u procesu proizvodnje tako i u procesima transportovanja, skladištenja i same prodaje – retail segmentu. Savremeno tržište je uslovalo razvoj najrazličitijih vrsta pakovanja mesa, sa ciljem zaštite proizvoda i očuvanja kvaliteta tokom distribucije i skladištenja. Kao odgovor na zahteve tržišta Delta Maxi Grupa je u svoje poslovanje uvrstila najsavremenije svetske načine monitoringa svih koraka u lancu kretanja proizvoda analimalnog porekla kroz sistem ka potrošačima.

Prijemna kontrola, koja podrazumeva proveru svih ključnih pokazatelja kvaliteta i higijenske ispravnosti svežeg mesa i proizvoda od mesa, je u Delta Maxi Grupi rutinskim operacijama dovedena do nivoa kojim je apsolutno onemogućeno puštanje u promet mesa koje ne ispunjava interne kriterijume koji predstavljaju osnovne postulata sistema bezbednosti hrane.

Skladištenje, kao jedan od suštinski važnih koraka u lancu centralizovanog snabdevanja, je strogo kontrolisano u pogledu svih parametara koji mogu da utiču na proizvode ovog tipa gde je akcenat na konstantnom monitoringu poštovanja temperaturnih režima u skladu sa vrstama proizvoda. Uvođenjem RF (radio frekvencija) sistema u skladištima, Delta Maxi Grupa je nivo poštovanja principa FIFO i FEFO dovela na visok nivo.

Distribucija i prodaja, kao sledeće karike u lancu snabdevanja, ujedno predstavljaju i najveći izazov u obezbeđivanju i očuvanju kvaliteta mesa i proizvoda od mesa gde je od ključnog značaja održavanje hladnog lanca uz mere dobre higijenske prakse kao još jednog izuzetno bitnog parametra. Uvođenjem TMS-a (transport menadžment sistema) mi smo učinili napor da u potpunosti obezbedimo sve zahteve ovog segmenta.

**Ključne reči:** kontrola, skladištenje, RF, distribucija, prodaja.

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## **THE CONDITIONS OF RECEIPT, STORAGE, DISTRIBUTION AND SALE OF MEAT AND MEAT PRODUCTS IN DELTA MAXI GROUP RETAIL STORES TO ENSURE HEALTH SAFETY OF FOODS AND PRESERVE THE QUALITY**

Sanja Mirković<sup>1\*</sup>, Srđan De Lungin<sup>1</sup>, Nemanja Nenić<sup>1</sup>, Milena Damnjanović<sup>1</sup>

In order to provide quality and healthy meat and meat products to consumers, equal attention is necessary during the production process as well as in the process of transportation, storage, and sale - retail segment. The contemporary market has caused the development of various types of meat packaging in order to protect and preserve the quality of products during distribution and storage. As a response to market demands, Delta Maxi Group has introduced in its operation the latest modern world wide used ways of monitoring of all steps in the chain of movement of animal products through the system and towards the consumers.

The reception control, which means checking of all key indicators of quality and hygienic safety of fresh meat and meat products, in the Delta Maxi Group routine operations are brought to the level that is absolutely impossible to introduce meat that does not meet the internal criteria which represent the basic principles of food safety system.

Storage as one of the essentially major steps in the centralized supply chain is strictly controlled in terms of parameters that can influence the products of this type where the emphasis is on constant monitoring of compliance with the temperature regime in accordance with the types of products. By introduction RF (radio frequency) system in warehouses of Delta Maxi Group, the level of compliance with the principles of FIFO and FEFO were brought to a high level.

Distribution and sales, as next links in the supply chain, also represent the biggest challenge in securing and preserving the quality of meat and meat products in which it is of crucial importance to maintain the cold chain with measures of good hygiene practice as another very important parameter. By introduction of TMS (transport management system) we made an effort to fully secure all demands in this segment.

**Key words:** control, storage, RF, distribution, sale.

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## KVALITET VODE U POGONU ZA PRERADU MESA I PRIPREMU HRANE

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Usvajanjem novog Zakona o hrani i Pravilnika o ispravnosti vode za piće i osnivanjem Agencije za sigurnost hrane Bosne i Hercegovine izvršeno je usklađivanje lokalnog zakonodavstva sa zakonodavstvom zemalja Evropske unije. Na ovaj način se higijensko–epidemiološki nivo uslova pripreme i proizvodnje hrane izjednačio sa standardima Evropske zajednice.

U radu će se na osnovu novog Pravilnika o ispravnosti vode za piće prikazati način određivanja broja uzoraka za redovnu kontrolu i periodičnu proveru vode kao i određivanja mesta i vremena uzimanja uzoraka.

Raspravom o pojedinim parametrima koji se ispituju kao zaključak će se dati popis parametara koje je potrebno ispitivati kod redovnih kontrola i periodičnih provera vode.

**Ključne riječi:** voda, hrana, redovna kontrola, periodična provera.

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## WATER QUALITY IN FACILITIES FOR MEAT PROCESSING AND FOOD PREPARATION

Trožić Emir<sup>1\*</sup>, Trožić Irhad<sup>2</sup>

By adoption of the new Food Act and the Regulations on the quality of drinking water and the establishment of the Food Safety Agency of Bosnia and Herzegovina harmonization of local legislation with European Union legislation was carried. In this way, the level of sanitary and epidemiological conditions in preparation and production of food was harmonized to the standards of the European Community.

Based on the new Ordinance on Drinking Water Quality, it will be presented how to determine the number of samples for full control and periodic review of water and determining of the location and time of sampling.

In the discussion on certain parameters that are being tested, as a conclusion, a list of parameters that need to be examined at regular review and periodic inspections of water will be given.

**Key words:** water, food, regular review, periodic checks.

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## SMANJENJE BUKE I GUBITKA ENERGIJE SPOLJNE JEDINICE SA TRI KOMPRESORA I TRI INVERTERA U SISTEMU ZA HLAĐENJE PROSTORIJA

Trožić Enver<sup>1</sup>, Trožić Emir<sup>2\*</sup>, Trožić Irhad<sup>3</sup>

Kada u sistemu za hlađenje koristimo tri istosmerna rotacijska klipna kompresora, kod delimičnog opterećenja rade u spoljnim jedinicama od 14 KS i 16 KS, poboljšavaju se ekološki zahtevi, kako i energetske učinke, tako i udobnost.

Istosmerni dvostruki klipni kompresor optimiranim položajem ispusta i manjom širinom zasuna smanjuje gubitak kompresije i otpora pri trenju. Veća površina magnetskih rotora i dodatni prorezi povećavaju učinak i smanjuju nastanak buke.

Svaki motor radi s jednim kompaktnim, snažnim magnetskim rotorom i s manjim gubicima vrtložne struje. Kompletna inverterska regulacija omogućuje još tačnije upravljanje iskorištenjem sistema. Učinak vektorskog upravljanja invertera daje glatku sinusnu krivulju, koja povećava učinak celog sistema. Vektorski upravljani inverter brzo pretvara struju u glatku sinusnu krivulju kako bi se omogućio mirniji hod istosmjernog motora.

Kontinuirano upravljanje regulira broj okretaja kompresora gotovo bez prekida, u koracima od 0,1 Hz. Preciznim reagiranjem u skladu s trenutno potrebnim učinkom fino podešavanje minimizira gubitak energije kod promjena frekvencije te stvara ugodno okruženje uz minimalne temperaturne promene.

**Ključne reči:** smanjenje buke, vektorski upravljani inverter, sistem za hlađenje, klipni kompresor.

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## **REDUCTION OF NOISE AND ENERGY LOSS OF THE OUTDOOR UNIT WITH 3 COMPRESSORS AND 3 INVERTERS IN THE SYSTEM FOR COOLING OF PREMISES**

Trožić Enver <sup>1</sup>, Trožić Emir <sup>2\*</sup>, Trožić Irhad <sup>3</sup>

When in the cooling system three direct rotary piston compressors are used, at partial load operation of the outdoor units of 14 hp and 16 hp, the environmental requirements are improved, as well as energy efficiency, and comfort.

Same-direction dual piston compressor with optimized position outlet valve and the smaller width reduces the loss of compression resistance and fretting. Larger surface magnetic rotor and additional slots maximize production and reduce the occurrence of noise.

Each engine works with a compact, powerful magnetic rotor and reduces eddy current losses. Complete inverter control enables more accurate utilization management system. Effect of vector control inverter provides smooth sinus curve, which increases the effect of the entire system. Vector controlled inverter converts quickly into a smooth power curve of the sinus in order to provide a smoother stroke of same-direction motors.

Continuous control regulates speed compressor almost without interruption, in increments of 0.1 Hz. Precise response in accordance with the currently required performance fine-tuning to minimize energy loss by frequency changes and creates a comfortable environment with minimal temperature changes.

**Key words:** noise reduction, vector-controlled inverter, cooling system, piston compressor.

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## KOMPJUTERSKA PODRŠKA U MJERNO-REGULACIONOJ TEHNICI SISTEMA ZA REGULACIJU PROCESNIH STANJA KOD AUTOMATSKE KONTROLE U CA HLADNJAČI

Trožić Enver<sup>1</sup>, Trožić Emir<sup>2\*</sup>, Trožić Irhad<sup>3</sup>

Automatska kontrola procesnih stanja u CA hladnjači, uključuje korištenje merno-regulacione tehnike u sistemu za regulaciju procesnih stanja. Merno-regulaciona tehnika se uglavnom sastoji od više regulacijskih „krugova“ zaduženih za održavanje temperature, sadržaja bioloških gasova, vlažnosti, pritiska, a po potrebi i drugih stanja. Kod automatske regulacije važno je imati kvalitetna merna osjetila koja su smeštena na referentnim mestima i na taj način daju realnu sliku parametra koji se meri. Od mernog osjetila, instrumenta za regulaciju i izvršnog organa zavisi brzina „odaziva“ na promene određenog procesnog stanja. Zbog toga je vrlo bitno kod kupovine hladnjača sa kontroliranim atmosferom posvetiti posebnu pažnju kvalitetu sistema za automatsku regulaciju. Regulacijski krugovi (za temperaturu, pritisak, koncentraciju bioloških gasova, vlažnost itd.) obično se kontroliše preko ugrađenog PLC sistema. Zato je vrlo važno da se PLC integriše sa kompjuterskom podrškom te se stiču uslovi o pamćenju istorije procesnih događaja unutar CA hladnjače. Na ovaj način se mogu i naknadno očitati parametri procesnih stanja kao što su temperatura, pritisak itd. Procesna stanja unutar komore se održavaju uz pomoć izvršnih organa a to su: generatori azota, skruberi, izmjenjivači toplote (isparivač) itd.

**Ključne reči:** kompjuterska podrška, merno-regulacijska tehnika, automatska kontrola, CA hladnjača.

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## COMPUTER SUPPORT IN THE MEASURING - REGULATORY TECHNIQUE OF THE SYSTEM FOR REGULATION OF PROCESS CONDITIONS IN AUTOMATIC CONTROL OF CA COLD STORAGE

Trožić Enver<sup>1</sup>, Trožić Emir<sup>2\*</sup>, Trožić Irhad<sup>3</sup>

Automatic control of process conditions in CA cold storage includes the use of measuring and control technology in the system for the regulation of process condi-

tions. Measuring and control technology is mainly composed of multiple regulatory circuits responsible for maintaining the temperature, the contents of biological gases, humidity, pressure, and if necessary, other conditions. In automatic control it is important to have quality measurement sensors that are located at reference points and thus give a realistic picture of the parameter being measured. The speed of responding to changes in certain procedural conditions depends on the measuring sensor, the instrument for the regulation and the execution. Therefore, it is very important in purchasing of controlled atmosphere cold storage to pay special attention to quality systems for automatic regulation. Control circuit (temperature, pressure, concentration of biological gases, humidity, etc.) are typically controlled via built-PLC system. It is therefore important to integrate with PLC computer support and acquired conditions of the procedural history of memory of events within the CA cold storage. In this way we can later read the parameters of process conditions such as temperature, pressure, etc. The process conditions within the chamber are maintained with the help of executive authority as follows: nitrogen generators, scrubbers, heat exchangers (evaporator), etc.

**Key words:** computer support, measurement and control technique, automatic control, CA refrigerator.

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## **EKOLOŠKE PREDNOSTI RASHLADNIH SISTEMA MESNE INDUSTRIJE SA ISTOSMERNIM DVOSTRUKIM ROTACIJSKIM KLIPNIM KOMPRESOROM U NAPREDNOM VEKTORSKOM UPRAVLJANJU INVERTERA**

Trožić Enver<sup>1</sup>, Trožić Emir<sup>2\*</sup>

Istosmerni dvostruki rotacijski klipni kompresori u vektorskom upravljanju invertera rashladnih sistema postiže se učinski koeficijent (COP) od 6,41 (uz delomično opterećenje od 50 %).

Primenom ovog kompresora postiže se potpuna kontrola sistema i ravnomerna temperatura iz prostorije u prostoriju. Inteligentno VRF upravljanje garantuje pravilan srednji protok hladnoće, kako bi se zadovoljile potrebe svake pojedine prostorije bez obzira na dužinu cevi i ugrađenu unutarnju jedinicu.

Sa ovakvim upravljanjem mogu se podesiti ravnomerne temperature, dek je ranije bez inteligentnog VRF upravljanja, s jedne strane bilo prekomerno, a s druge strane preslabo snabdevanje. Izvođenje sistema može obuhvaćati maksimalnu ekvivalentnu dužinu do 235 metara. Na ovaj način se olakšava izvođenje sistema u mnogo malih prostorija u istom nivou čak i tamo gde se raspored prostorija često preuređuje.

Za iste dimenzije 1830 mm (V) ×x 1210 mm(Š) × 780 mm (D), vanjska jedinica povećava učinak. Odnosno, za iste nazivne karakteristike zahteva manju površinu za montažu, što predstavlja izazov kompaktnoj veličini modula, kako bi se omogućila maksimalna sloboda u oblikovanju.

Na ovaj način je i težina opreme manja i montaža brža.

**Ključne reči:** rashladni sistem, srednji protok hlađenja, inteligentno upravljanje, ravnomerna temperatura.

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## **ENVIRONMENTAL BENEFITS OF THE MEAT INDUSTRY COOLING SYSTEMS WITH SAME-DIRECTION TWIN ROTARY PISTON COMPRESSOR WITH ADVANCED VECTOR CONTROL INVERTER**

Trožić Enver<sup>1</sup>, Trožić Emir<sup>2\*</sup>

Same-direction twin rotary piston compressors in vector control inverter cooling system achieve a performance factor (COP) of 6.41 (with a partial load of 50%).

By using this compressor, a complete control system and a uniform temperature from room to room is achieved. Intelligent VRF management guarantees a proper flow of cold medium, in order to meet the needs of each premise regardless of the length of the tube and built-in indoor unit.

With this control equal temperature can be set, whereas earlier, without the intelligent management VRF, on the one side there was excessive supply and on the other weak supply.

Performing of the system may include a maximum equivalent length to 235 meters. In this way the performance of systems in many small rooms at the same level is facilitated, even where the arrangement of premises is often changed. For the same dimensions of 1830 mm (H) x 1210mm (W) x 780mm (D), the outdoor unit increases the effect. That is, for the same nominal characteristics it requires less area for installation, which represents a challenge to the compact size of the module, to allow maximum freedom in design. In this way the weight of the equipment is smaller and faster assembly.

**Key words:** cooling system, cooling medium flow, intelligent control, uniform temperature.

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## UTICAJ INDUSTRIJE MESA NA ŽIVOTNU SREDINU

Đekić Ilija<sup>1\*</sup>, Šmigić Nada<sup>1</sup>

Porast svesti o potrebi za zaštitom životne sredine kao i razvoj alata za analizu uticaja različitih industrija na životnu sredinu doveo je do većeg broja istraživanja i dostupnih rezultata. Rezultati su potvrdili da industrija mesa utiče na životnu sredinu. Ovaj rad daje prikaz različitih alata koji su korišćeni u cilju ispitivanja uticaja industrije mesa na životnu sredinu i dobijene rezultate kao što su energetska efikasnost, emisija gasova staklene bašte, čistija proizvodnja i ocena životnog ciklusa.

**Ključne reči:** alati za ocenu uticaja na životnu sredinu, industrija mesa.

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## ENVIRONMENTAL IMPACT OF MEAT INDUSTRY

Đekić Ilija<sup>1\*</sup>, Šmigić Nada<sup>1</sup>

Rise of environmental awareness and development of several tools for analyzing environmental impacts of certain industries resulted in the increase of number of available research and results thereof. These results show that current production processes for meat products have an impact on the environment. This paper gives an overview of various assessment tools used and results obtained through various environmental footprints in the meat industry – energy efficiency, Green House Gasses (GHG) emission, cleaner production and life cycle assessment (LCA).

**Key words:** environmental assessment tools, meat industry.

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## ODABIR OPTIMALNOG REŠENJA ZBRINJAVANJA ISKORIŠTENIH VODA IZ MALIH PROIZVODNIH POSTROJENJA – FARME

Trožić Emir<sup>1\*</sup>

Kod projektovanja, izgradnje i eksploatacije malih proizvodnih postrojenja za tov junadi i pilića bitan je odabir optimalnog rešenja za zbrinjavanje iskorištenih voda.

Ako se iskorištene vode pravilno tretiraju ima ćemo garanciju da ćemo očuvati životnu sredinu, higijenu i zdravlje u farmi, a time ćemo dobiti kvalitetan i zdrav finalni prizvod.

Ovde ćemo prikazati nekoliko mogućih rešenja zbrinjavanja iskorištenih voda na primeru farme brojlera kapaciteta 12 000 komada i godišnjim planom kroz 5 turnusa, odnosno ukupnim prinosom od 60 000 do 70 000 komada, i farme za tov 1700 komada goveda.

Na osnovu opisa tehnološkog procesa, odnosno potreba za vodom za tov i higijenu izračunate su količine iskorištenih voda koje treba adekvatno tretirati pre ispuštanja u recipijent.

Nakon analize prikazanih mogućih rešenja predložit će se optimalno rešenja zbrinjavanja iskorištenih voda.

**Ključne reči:** optimalno rešenje, zbrinjavanje iskorištenih voda, farma, tehnološki proces.

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## SELECTION OF OPTIMAL SOLUTION FOR DISPOSAL OF WASTE WATER FROM SMALL MANUFACTURING PLANT – FARM

Trožić Emir<sup>1\*</sup>

In designing, constructing and exploitation of small facilities for fattening cattle and chickens, selection of the optimal solution for the disposal of used water is essential.

If used water is properly treated, it will ensure the protection of environment, hygiene and health on the farm, and thus we will obtain high quality and healthy final product.

Several potential solutions for disposal of used water will be presented, in case of farm of broiler capacity of 12 000 units and annual plan for 5 cycles and total yield of 60000-70000 birds, and farm for fattening of cattle, capacity of 1700 animals.

Based on the description of the technological process, namely the water requirements for breeding and hygiene, quantity of used water that needs to be adequately treated before discharging into the recipient was calculated.

After analysis of possible solutions presented, the optimal solution for disposal of used water will be suggested.

**Key words:** optimal solution, disposal of used water, farm and process.

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## TRETMAN ISKORIŠĆENIH VODA JEDNE FARME ANAEROBNIM PREGRADNIM REAKTOROM (ARB) I UMJETNOM MOČVAROM

Trožić Emir<sup>1\*</sup>

U cilju zaštite životne sredine neophodno je sav otpad koji nastaje na farmama zbrinuti na adekvatan način.

Postupanje sa čvrstim otpadom se definiše posebnim ugovornim odnosima sa privrednim društvima koja se bave zbrinjavanjem ovakvog otpada.

Postupanje sa tečnim otpadom kao i sa iskorištenim vodama sa farme vrši se na osnovu prethodno odabranog optimalnog rešenja.

Ovde ćemo za konkretni primer farme za tov 1700 komada goveda i odabrano optimalno rešenje prikazati osnovne faze zbrinjavanja i tretmana iskorištenih voda pre ispuštanja u recipijent.

Na prikazanim skicama će se objasniti tretman iskorištene vode u anaerobnom pregradnom reaktoru (ARB) i umjetnoj močvari.

**Ključne reči:** anaerobni pregradni reaktor (ARB), tretman iskorištenih voda, veštačka močvara.

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## THE TREATMENT OF USED WATER PARTITION A FARM BY ANAEROBIC REACTOR (ARB) AND AN ARTIFICIAL POND

Trožić Emir<sup>1\*</sup>

In order to protect the environment it is essential that all waste generated on farms disposed of properly. Dealing with solid waste is defined by special contractual relations with business enterprises engaged in disposal of such waste. Treatment of liquid waste as well as exploited the waters from the farm is done on the basis of pre-selected optimal solution.

Here we will for the specific example of the farm for fattening cattle and 1700 pieces were selected optimal solution to show basic phases of treatment and disposal of used water before discharging into the recipient. In a draft will be used to explain the treatment of water in the anaerobic reactor partition (ARB) and artificial wetlands.

**Key words:** anaerobic reactor partition (ARB), the treatment of used water, artificial wetlands.

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## KOMPARATIVNA ANALIZA SADRŽAJA NATRIJUM-HLORIDA I NATRIJUMA U PROIZVODNIM ŠARŽAMA PROIZVODA OD MESA RAZLIČITIH GRUPA

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Mašković Pavle<sup>1</sup>

Natrijum-hlorid je vekovima ostao esencijalni dodatak mesnim proizvodima, jer povećava rastvorljivost proteina miofibrila i omogućuje vezivanje mesa, vode i masti u formaciju gela poželjne teksture, uvećava emulgujući kapacitet, produžava održivost snižavanjem  $a_w$  vrednosti, suštinski je za ukus (preko receptora u jeziku) i smanjuje gubitak tečnosti u termički obrađivanim proizvodima pakovanim u vakuumu. Značajan deo populacije ljudi, naročito u zapadnim zemljama, pati od kardiovaskularnih bolesti (od kojih je hipertenzija najrasprostranjenija). Kod dela navedene rizične populacije postoji rast krvnog pritiska kada je natrijum prisutan u ishrani. Jedna od predloženih strategija za smanjenje rizika Svetske zdravstvene organizacije (WHO) je da se u svoj proizvedenoj hrani mora redukovati sadržaj natrijuma za 60%. Mesom i proizvodima od mesa se natrijum unosi 12 do 20% od ukupnog unosa hranom, i jedan su od prioritarnih proizvoda za smanjenje njegovog sadržaja. U tom smislu je i koncipiran rad sa ciljem da se ispita sadržaj natrijum-hlorida i natrijuma u proizvodima od mesa poreklom od tri različite proizvodne partije (šarže) jednog lokalnog proizvođača. Ispitivani proizvodi su: kulen (fermentisana kobasica), slaninska (grubo usitnjena barena kobasica), dimljeni svinjski vrat (dimljeni proizvod) i suva svinjska pršuta (suvomesnati proizvod). Sadržaj natrijum-hlorida je određen metodom po Volhardu (volumetrijski). Sadržaj natrijuma je određen iz odnosa natrijuma i hlora u natrijum-hloridu utvrđenom u proizvodu. Najveći prosečan sadržaj natrijum-hlorida utvrđen je u suvoj svinjskoj pršuti (5,718 g/100g ili 5,718%), što je očekivana vrednost za suvomesnate proizvode. Dimljeni svinjski vrat je sadržao prosečno 5,469% natrijum hlorida, slaninska kobasica 3,768%, a najmanji sadržaj natrijum-hlorida utvrđen je u kulenu (3,451%). Upoređivanjem dobijenih vrednosti sa vrednostima drugih autora za grupe dimljenih, barenih i fermentisanih kobasica došli smo do zaključka da su naši ispitivani proizvodi imali znatno veće koncentracije soli. Razlike u sadržaju natrijum-hlorida ispitivanih proizvoda od mesa između merenja po proizvodnim šaržama, nisu se pokazale statistički značajne, ukazujući da se u proizvodnom procesu tehnologija soljenja striktno poštuje. Vlasniku prerade mesa su ponuđena rešenja kako da modifikuje tehnološki proces, i poveća nutritivna svojstva proizvoda sa zdravstvenog aspekta.

**Ključne reči:** natrijum-hlorid, kulen, slaninska kobasica, dimljeni svinjski vrat, suva svinjska pršuta.

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## COMPARATIVE ANALYSIS OF THE CONTENTS OF SODIUM CHLORIDE AND SODIUM IN THE PRODUCTION BATCHES OF MEAT PRODUCTS OF VARIOUS GROUPS

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Sodium chloride for centuries remained an essential additive in meat products, because it increases the protein solubility and allows the binding of meat myofibrils, water and fat in the formation of the desirable gel texture, increased emulsifying capacity, extends the viability of lowering the  $a_w$  value is essential for the taste (via receptors in the tongue) and reduces fluid loss in heat-treated products packed in vacuum. A significant sector of the population, especially in Western countries is suffering from cardiovascular disease (of which hypertension is most common). The growth of blood pressure when sodium is present in the diet was noticed in a part of the already mentioned high-risk population. One of the proposed risk-reduction strategies World Health Organization (WHO) is that in their manufactured food has reduced sodium content by 60%. Meat and meat products of the sodium brought 12 to 20% of total food intake, and are one of the priority products to reduce its content. In this sense, the paper had been conceived in order to examine the content of sodium chloride and sodium in meat products originating from 3 different production batch of a local manufacturer. The tested products are: Kulen (dry fermented sausage), Bacon sausage (coarsely grounded cooked sausage), smoked pork neck (smoked product) and dry pork ham (dry meat products). Sodium chloride content was determined by the Volhard (volumetric). Sodium content was determined from the ratio of sodium and chlorine in sodium chloride determined in the product. The highest average content of sodium chloride was found in the dry pork ham (5.718 g/100g or 5.718%), which is the expected value for dry meat products. Smoked pork neck contained an average of 5.469% sodium chloride, Bacon Sausage 3.768%, the lowest content of sodium chloride fortified in Kulen (3.451%). Comparing the obtained values and the values of other authors for the group smoked, cooked and fermented sausages, we concluded that our tested products had significantly higher concentrations of salt. No statistically significant differences in the sodium chloride content tested meat products between measurements at production batches, indicating that the manufacturing process technology salting strictly adhered to. Owner of the meat processing are offered solutions on how to modify the technological process, and increase the nutritive properties of products from the medical point.

**Key words:** sodium chloride, Kulen, Bacon sausage, smoked pork neck, dry pork ham.

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## SADRŽAJ NATRIJUM HLORIDA U PROIZVODIMA OD MESA

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Kuhinjska so je prvi dodatak hrani čiji je konzervirajući efekat poznat već jako dugo. Zastupljenost u svakodnevnoj ishrani doprinela je da kuhinjska so bude jedan od prvih proizvoda dizajniranih kao „funkcionalna hrana“. Međutim, dokazano je da prekomerno unošenje soli, odnosno natrijuma, predstavlja jedan od čestih uzroka hipertenzije i utiče na pojavu različitih drugih oboljenja. Poznato je da natrijum-hlorid utiče na senzorska i mikrobiološka svojstva proizvoda o kvalitetu i drugim zahtevima za proizvode od mesa, s jedne strane, ali i na zdravlje ljudi sa druge strane. Pošto važećim Pravilnikom (Sl. list SCG br. 33/2004) nije propisan sadržaj natrijum-hlorida u proizvodima od mesa kao parametar kvaliteta, cilj našeg rada bio je da se utvrdi sadržaj natrijum-hlorida u različitim proizvodima od mesa na novosadskom tržištu. Ukupno je ispitano 260 uzoraka proizvoda od mesa, i to: oblikovano mleveno meso, vegeterijanski namazi, dimljeni proizvodi, fermentisane suve kobasice, fino usitnjene barene kobasice, konzerve od mesa u komadima i kuvane kobasice. Sadržaj natrijum-hlorida određen je volumetrijski. Najmanji prosečni sadržaj natrijum-hlorida utvrđen je u uzorcima oblikovanog mlevenog mesa i iznosio je 2,53%. U uzorcima vegeterijanskih namaza prosečan sadržaj natrijum-hlorida bio je 3,55%, u kuvanim kobasicama 2,95%, a u konzervama od mesa u komadima i u dimljenim proizvodima prosečan sadržaj natrijum-hlorida bio je 3,44%. U fino usitnjenim baranim kobasicama sadržaj natrijum-hlorida bio je 3,06%, a najveći sadržaj natrijum-hlorida izmeren je u fermentisanim suvim kobasicama i iznosio je 3,71%. Svetska zdravstvena organizacija preporučuje da dnevni unos soli za odrasle, zdrave ljude ne treba da bude veći od 5 – 6 gr. Kako dobijeni rezultati ukazuju da je u pojedinim ispitivanim uzorcima sadržaj natrijum-hlorida veoma blizu gornje granice preporučene vrednosti, neophodna je dalja neprekidna i sistematska kontrola kako bi se dobili što realniji podaci o sadržaju natrijum-hlorida u proizvodima od mesa.

**Ključne reči:** natrijum-hlorid, proizvodi od mesa.

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## SODIUM CHLORIDE CONTENT IN MEAT PRODUCTS

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Common salt is the first food additive whose preserving effect has been known for a long time. Presence of common salt in every day nutrition has contributed

that it becomes one of the first products designed as „functional food“. However, it is proven that excessive intake of salt, i.e. sodium, represents one of the most common causes of hypertension and influences incidence of numerous diseases. It is known that sodium chloride influences sensory and microbiological properties of meat products, on one hand, but also human health, on the other. Since the sodium chloride content in meat products is not regulated (Official Journal of SCG No. 33/2004) as quality parameter, objective of our paper was to establish the quantity of sodium chloride content in various meat products on the market in Novi Sad. In total 260 samples of meat products were tested: shaped minced meat, vegetarian sprads/creams, smoked meat products, dry fermented sausages, fine chopped cooked sausages, meat cans and boiled sausages. Sodium chloride content of was determined volumetrically. The lowest average content of sodium chloride was determined in samples of minced meat – 2,53%. In samples of vegetarian creams the average of sodium chloride content was 3,55%, in boiled sausages – 2,95%, and meat cans and smoked meat products the average of sodium chloride content was 3,44%. In fine chopped cooked sausages it was 3,06%, and the highest content of sodium chloride was determined in fermented dry sausages – 3,71%. World Health organization recommends the daily intake of salt for adults, healthy persons should not be over 5 – 6 gr. Since obtained results show that in certain tested samples the determined amount of sodium chloride was very close to the top recommended value, continuous and systematic control is necessary in order to obtain the most realistic data on of sodium chloride content in meat products.

**Key words:** sodium chloride, meat products.

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## REZIDUALNE MATERIJE NA RIBNJAKU NA KOME SE POŠTUJU PRINCIPI ORGANSKE PROIZVODNJE

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Svest o ekološki bezbednoj hrani otvara perspektivu jednoj novoj poljoprivrednoj grani koja se pre svega oslanja na tradicionalna znanja u proizvodnji. Organska proizvodnja na ribnjacima zasniva se na prirodnoj produkciji bentosnih i planktonskih organizama kao izvora belančevina i dodatka žitarica i uljarica kao energetske komponente. Kvalitet vode iz recipijenta mora biti bez rezidualnih materija i niske organske produkcije koji bi morao zadovoljiti kvalitet vode za preradu u prehrambenoj industriji ili kvalitet pijaće vode, što je u našim uslovima veoma teško ostvariti bar što se tiče šaranske proizvodnje. Najpogodnija voda za punjenje ribnjaka je bunarska, koja ne samo da ima optimalan hemijski sastav, već nema ni etioloških uzročnika virusnih, bakterijskih i parazitskih infekcija. Bunarska voda ima prednost nad vodom iz drugih recipijenata jer nam olakšava borbu sa korovskim vrstama riba. Za građenje ribnjaka može se upotrebiti samo zemljište čiji je sadržaj štetnih supstanci ispod propisanih maksimalno dozvoljenih količina i gde ne postoji nijedan aerozagađivač. Kompletna hrana, odnosno izbalansirani obroci treba da sadrže ekstrudirane komponente žitarica, soje i uljarica jer na taj način povećavamo biološku sigurnost i svarljivost hrane, što smanjuje organsko opterećenje životne sredine. U organskoj proizvodnji riba isključena je upotreba ribljeg i mesnog brašna jer su to najčešći uzročnici kontaminacije rezidualnim i otrovnim materijama. U kompletnim hranivima ne mogu se koristiti stimulatori rasta, hemioterapeutici, sintetske aminokiseline i probiotici sitetskog porekla. Ovim načinom proizvodnje izbegava se sadržaj svih materija u hrani koje imaju neželjeno delovanje na zdravlje ljudi. Potencijalno, u hrani se mogu naći rezidue mnogih hemijskih supstanci, čiji se ukupan broj kreće do više desetina hiljada. U ove hemijske supstance spadaju hemikalije koje se koriste u poljoprivredi, kao i supstance koje potiču iz industrije i kotaminiraju životnu sredinu. Rezidue iz grupe industrijskih zagađivača uključuju teške metale i halogenovane ugljovodonike, dok ostaci iz grupe hemikalija koje se koriste u poljoprivredi uključuju: insekticide hlorovane ugljovodonike, insekticide organofosfate, herbicide, fungicide, rodenticide i hemijska đubriva. Uzorci dvogodišnjih riba i to šarana, linjaka, soma i tolstolobika uzeti su sa ribnjaka u Mošorinu, na kojem se poštuju principi organske proizvodnje. Takođe je ispitan i kvalitet bunarske vode i sediment sa dna ribnjaka. U filetima dvogodišnjih riba utvđivan je sadržaj organohlornih pesticida (lindan, alfa- HCH, beta- HCH, aldrin, dieldrin, heptahlor, cis- i trans- heptahlorepoksid, endrin, HCB, alfa- i gama- hlordan). Takođe, u istim uzorcima ribe određivani su i polihlorovani bifenili. Od teških metala iz uzoraka mišićnog tkiva ribe, korišćenjem masenog detektora, određivan je sadržaj arsena, kadmijuma, olova i žive. Sadržaj rezidualnih materija ne samo da ne prelazi granice propisane zakonima već je značajno niži od dozvoljenih vrednosti i uklapa se u najstrožije

kriterijume vezane za organsku proizvodnju riba. Pošto je ribarska proizvodnja specifična po tome što kvalitet vode predstavlja limitirajući faktor predložimo da proizvodnja na bunarskoj vodi bude sinonim za organsku proizvodnju.

**Ključne reči:** organska proizvodnja, bunarska voda, rezidualne materije, kvalitet vode, sediment.

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**Napomena:** *Ovaj rad je deo tehnološkog projekta Ministarstva za nauku i tehnološki razvoj Republike Srbije, pod nazivom „Uticaj kvaliteta komponentata hrane za ciprinidne vrste riba na kvalitet mesa, profitabilnost i gubitke“, ev.broj 031011*

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## RESIDUES IN THE POND WHICH MEETS THE PRINCIPLES OF ORGANIC PRODUCTION

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Awareness of the ecological perspective of safe food opens a new branch of agriculture that relies primarily on traditional knowledge in production. Organic production in fish ponds is based on the natural production of benthic and planktonic organisms as a source of protein and adding cereals and oilseeds as energy components. The water from the pond must be free of residual organic matter and organic production in the pond must be low. Required quality of water in the pond has to meet water quality in the food processing industry or the quality of drinking water, which in our conditions is very difficult to achieve especially in carp production. The most appropriate water for filling the pool is well water, that has an optimal chemical composition, but has not etiologic agents of viral, bacterial and parasitic infections. Well water has the advantage over the water from other recipients, because it contributes to easier fight with the weed species of fish. To build fish ponds can be used only land of which the content of harmful substances is below the prescribed maximum allowable amount, and where there are no pollutants. Extruded components of wheat, soybeans and oilseeds should be included in complete feed mixtures and balanced meals because in this way are increased the biosafety and digestion, which reduce the organic load of the environment. The use of fish and meat meal is excluded in the organic production of fish, as these feedstuffs are the most common causes of residual contamination and toxic substances. Growth promoters, chemotherapeutic, synthetic aminoacids and synthetic probiotics can be used as ingredients of complete feed. The production of content of all substances in foods that

have adverse effects on human health is avoided by this method. Potentially, residues of many chemicals, whose total number is moving up to tens of thousands, can be found in the food. These chemicals are chemicals that are used in agriculture, and substances from industry which pollute environment. Residues from industrial pollutants include heavy metals and halogenated hydrocarbons, while the remains from chemicals used in agriculture include: chlorinated hydrocarbon insecticides, organophosphate insecticides, herbicides, fungicides, rodenticides and chemical fertilizers. Samples of two-year old carp, tench, catfish and silver carp were taken from ponds in Mošorin, which meets the requirements for organic production. The quality of well water and sediment from the bottom of the pond are also investigated. The content of organochlorine pesticides (lindane, alpha-HCH, beta-HCH, aldrin, dieldrin, heptachlor, cis-and trans-heptachlorepoxid, endrin, HCB, alpha-and gamma-chlordane) is determined in fillets of two-year old fish. Also, polychlorinated biphenyls were determined in the same fish samples. Arsenic, cadmium, lead and mercury were determined in fish meat samples, by atomic absorption spectrometry. The content of residual materials was not exceed the limit prescribed by law and it was significantly lower than the allowable values, so it fits into the strict criteria related to organic production. The fishery production is specific for requirements in water quality which is a limiting factor in fishery so we suggest that the production on the well water become synonym for organic production.

**Key words:** organic production, well water, residues, water quality, sediment.

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**Note:** *This research is part of a project of the Ministry of Science and Technological Development, Republic of Serbia, „The influence of the quality of the components of food for cyprinid fish species on the quality of meat, losses and the profitability of production“, No. 31011.*

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**II TEMATSKA OBLAST**  
***2<sup>nd</sup> THEMATIC TOPIC***

**MESO RIBE U ISHRANI**  
***FISH MEAT IN NUTRITION***



## POUZDANOST ELISA METODE U DETEKCIJI HLORAMFENIKOLA U MESU KALIFORNIJSKE PASTRMKE

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Prisustvo rezidua hloramfenikola u hrani životinjskog porekla, kao i mesu riba je vrlo značajno u smislu zaštite zdravlja ljudi. Zbog mogućnosti ilegalne upotrebe zabranjenih supstanci, kojim pripada i hloramfenikol, efikasno praćenje njegovih rezidua u namirnicama životinjskog porekla je od izuzetnog značaja. U tu svrhu se koriste vrlo specifične i senzitivne metode, za koje su u Evropskoj uniji Odlukom CD 2002/657/EC uspostavljeni minimalni potrebni zahtevi za prag detekcije - MRPL (engl. minimum required performance limit) za analitičke metode koje se koriste u detekciji hloramfenikola za koji nije uspostavljena maksimalno dozvoljena količina u namirnicama životinjskog porijekla, uključujući i meso riba. MRPL kao minimalni sadržaj analita hloramfenikola u uzorku koji mora biti detektovan i potvrđen u cilju harmonizacije performansi analitičkih metoda, je uspostavljen kao 0,3 µ/kg za rezidue hloramfenikola, kako u mesu, jajima, urinu, medu, tako i proizvodima akvakulture.

U cilju utvrđivanja trenutnog stanja po pitanju spremnosti veterinarske službe da odgovori na incidentne situacije, odlučili smo se za tzv. „*what if*“ studiju, odnosno simulaciju upotrebe zabranjene supstance – hloramfenikola, na ribnjaku gde se uzgaja kalifornijska pastrmka, namenjena daljoj prodaji i/ili preradi na tržištu.

Upotreba hloramfenikola na životinjama koje se koriste u ishrani ljudi u Bosni i Hercegovini i Evropskoj uniji je zakonski zabranjena. Uprkos navedenoj zabrani, hloramfenikol je još uvek u nekim zemljama lek od izbora, zato što je relativno jeftin i lako dostupan na tržištu, što stvara određene pretpostavke o njegovoj ilegalnoj upotrebi. Na osnovu tog saznanja u sklopu predstavljenog rada želeli smo simulirati upotrebu navedene supstance u propisanoj terapijskoj dozi u bazenima sa kalifornijskom pastrmkom.

Prilikom provedbe eksperimenta, tokom analitičke obrade uzetih uzoraka, koristili smo se dostupnim brzim orijentacijskim metodama (engl. screening) (ELISA) u okviru trenutno raspoloživih laboratorijskih kapaciteta u Bosni i Hercegovini. Zbog nepostojanja adekvatne laboratorijske opreme za obavljanje konfirmacijskih metoda (LC-MS/MS) u Bosni i Hercegovini, iste smo radili izvan granica naše zemlje.

**Ključne riječi:** hloramfenikol, elisa, pastrmka.

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## RELIABILITY OF ELISA METHOD IN DETECTION OF CHLORAMPHENICOL IN MEAT OF RAINBOW TROUT

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The presence of chloramphenicol residues in food of animal origin is a matter of concern for public health. Due to the possibility of illegal use of the banned substances, the monitoring of their residues in food of animal origin is essential. For these purposes very specific and sensitive analytical methods have to be used. In European Decision 2002/657/EC, it has been laid down minimum required performance limits (MRPL) of analytical methods for chloramphenicol for which no permitted limit has been established in products of animal origin, including fish meat. MRPL as a minimum content of an analyte in sample, which at least has to be detected and confirmed to harmonize the analytical performance of methods, has been set at 0.3 µg/kg for CAP residues in meat, eggs, milk, urine, honey and aquaculture products.

In order to determine the current situation in terms of readiness of veterinary service to respond to the incident situation, we decided to do „*What if?*” studies, i.e. simulation of using banned substance - chloramphenicol, on the pond where rainbow trout is bred, intended for further sale and/or for processing market.

Usage of chloramphenicol on the animals used for human consumption in Bosnia and Herzegovina and European Union is legally forbidden. In spite of mentioned ban, chloramphenicol is still a drug of choice in some countries, because it's relatively cheap and available on the market, choice which presumes its illegal usage. According to this knowledge in the scope of presented work we would like to simulate usage of mentioned substance in prescribed dose in the basins with rainbow trouts.

During the implementation of the experiment, and during the analytical processing of collected samples, we used the available screening methods (ELISA) in the currently available laboratory capacities in Bosnia and Herzegovina. Due to the lack of adequate laboratory equipment to perform conformational methods (LC-MS/MS) in Bosnia and Herzegovina, we have performed them outside our country.

**Key words:** chloramphenicol, elisa, trout.

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## UPOREDNA ANALIZA HEMIJSKOG I MASNOKISELINSKOG SASTAVA MLAĐI I KONZUMNE KALIFORNIJSKE PASTRMKE (*ONCORHYNCHUS MYKISS*)\*

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Kalifornijska pastrmka (*Onchorhynchus mykiss*) je jedna od najpoznatijih vrsta ribe u prirodi. U mnogim zemljama je uzgajana vrsta, zbog brzog rasta i odličnog nutritivnog kvaliteta (povoljan sadržaj proteina, masti, mineralnih materija i vitamina, kao i značajan sadržaj nezasićenih masnih kiselina, posebno n-3 polinezasićenih masnih kiselina, PNMK). Promene u hemijskom sastavu mesa ribe su povezane sa starošću i veličinom ribe. Sadržaj holesterola u tkivima životinja povezan je sa načinom i kvalitetom ishrane, uprkos regulatornom mehanizmu sinteze i apsorpcije holesterola.

Cilj ovog ispitivanja je bio određivanje i poređenje hemijskog sastava i masnokiselinskog profila mlađi i konzumne kalifornijske pastrmke iz akvakulture. Uzorci mlađi (prosečne mase 99 g i dužine 18,6 cm) i konzumne kalifornijske pastrmke (prosečne mase 229 g i dužine 23,3 cm) su sakupljeni u avgustu 2010. godine u ribnjaku „Ribnik“, Mrkonjić grad, Republika Srpska. Mlađ i konzumna pastrmka su hranjene kompletnom hranom za pastrmku, sličnog sastava (riblji proizvodi, ulja i masnoće, proizvodi od žita i semena uljarica).

Sadržaj proteina je određen metodom po Kjelahlu. Sadržaj vode, ukupnih lipida i pepela je određen standardnim SRPS ISO metodama. Sastav masnih kiselina je određen gasnom hromatografijom (GC/FID), a sadržaj holesterola tečnom hromatografijom (HPLC/PDA).

Rezultati ispitivanja su pokazali da nema statistički značajne razlike ( $p > 0,05$ ) u sadržaju ukupnih lipida (3,81%, mlađ i 4,17%, konzumna pastrmka) i pepela (1,27%, mlađ i 1,29%, konzumna pastrmka). U filetima konzumne pastrmke je utvrđen veći sadržaj proteina (18,69%) i manji sadržaj vode (75,40%) u poređenju sa njihovim sadržajem u filetima mlađi (17,72% proteina i 77,11% vode). Sadržaj holesterola je bio 82,59 mg/100g (mlađ) i 70,12 mg/100g (konzumna pastrmka).

U filetima mlađi i konzumne pastrmke utvrđena je statistički značajna razlika ( $p < 0,05$ ) u sadržaju ukupnih zasićenih masnih kiselina, (31,81% i 29,14%, respektivno), PNMK (33,93% i 36,78%, respektivno) i n-3 masnih kiselina (17,17% i 19,20%, respektivno). Sadržaj mononezasićenih masnih kiselina je bio sličan i iznosio je u mlađi 33,30% i u konzumnoj pastrmci 33,05%. Nije postojala statistički značajna razlika ( $p > 0,05$ ) u sadržaju ukupnih n-6 masnih kiselina u mlađi (16,76%) i konzumnoj ribi (17,58%). Sadržaj eikozapentaenske (EPA, C20:5 n-3) i dokozaheksaenske kiseline (DHA, C22:6 n-3) bio je 2,78% i 8,21% u mlađi i 3,36% i 9,29% u konzumnoj ribi, respektivno. Sadržaj EPA+DHA u ukupnim masnim kiselinama je bio 10,99% u mlađi i 12,65% u konzumnoj kalifornijskoj pastrmci. Konzumiranjem

200 g ove ribe unos poželjnih masnih kiselina, EPA i DHA, iznosi 0,84 g za mlađ, odnosno 1,08 g za konzumnju kalifornijsku pastrmku, što je u skladu sa preporukom Američkog udruženja za srce za osobe sa kardiovaskularnim oboljenjima (dnevni unos: ukupno 1g EPA i DHA).

Veće količine n-3 PNMK u filetima mlađi (17,17%) i konzumne pastrmke (19,20%) i manje količine n-6 PNMK (16,76% u mlađi i 17,58% u konzumnoj pastrmci) daju povoljan odnos n-3 i n-6 (1,02 u mlađi i 1,09 u konzumnoj pastrmci).

Rast pastrmke je bio praćen povećanjem sadržaja proteina, smanjenjem sadržaja vode i povećanjem PNMK, naročito n-3 esencijalnih masnih kiselina. Zbog značajnog sadržaja proteina i nezasićenih masnih kiselina i male količine masti, kalifornijska pastrmka se može svrstati u jednu od nutritivno najvrednijih namirnica u ishrani ljudi.

**Ključne reči:** Kalifornijska pastrmka, hemijski sastav, masne kiseline, n-3 PNMK.

**\*Napomena:** Rezultati su proistekli iz rada na realizaciji Projekta „Monitoring vodenih ekosistema u cilju dobijanja higijenski ispravnih i kvalitetnih akvakulturnih proizvoda, konkurentnih tržištu EU“, Ev. br. 20122, koji, u okviru Programa istraživanja u oblasti tehnološkog razvoja, finansira Ministarstvo za nauku i tehnološki razvoj Republike Srbije.

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## COMPARATIVE ANALYSIS OF CHEMICAL AND FATTY ACID COMPOSITION OF FINGERLING AND MARKETABLE SIZE RAINBOW TROUT (*ONCORHYNCHUS MYKISS*)\*

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Rainbow trout (*Onchorhynchus mykiss*) is one of the most popular fish species in the nature. In many countries it is also farmed species, because of rapid growth and excellent nutritional quality (favourable content of proteins, fats, mineral substances and vitamins, as well as significant content of unsaturated fatty acids, especially polyunsaturated fatty acids (PUFA). Changes in chemical composition of fish meat are associated with age and size of fish. Cholesterol content in animal tissues is associated with feeding method and quality of food, in spite of regulatory mechanism of cholesterol synthesis and absorption.

Objective of this study was determination and comparison of chemical composition and fatty acid profile of fingerling and marketable size rainbow trout from aquaculture. Samples of fingerling (average mass of 99 g and length of 18.6 cm) and marketable size rainbow trout (average mass of 229 g and length of 23.3 cm) were

collected in August 2010, in the fishpond „Ribnik“, Mrkonjić city, Republic Srpska. Fingerling and marketable size rainbow trout were fed with complete mixture of similar composition for bought fish categories (fish products, oils and fats, cereal products and oil seeds).

Protein content was determined according to method of Kjeldahl. Contents of water, total lipids and ash were determined by standard methods SRPS ISO. Fatty acids profile was determined by gas chromatography (GC/FID), and cholesterol content by liquid chromatography (HPLC/PDA).

Research results showed that there was no statistically significant difference ( $p > 0.05$ ) in content of total lipids (3.81%, fingerling and 4.17%, marketable size trout) and ash (1.27%, fingerling and 1.29%, marketable size trout). Higher protein content was determined in commercial trout fillets (18.69%), as well as lower water content (75.40%) compared to their content in fingerling (17.72% proteins and 77.11% water). Cholesterol content was 82.59 mg/100g (fingerling) and 70.12 mg/100g (commercial trout).

Statistically significant differences ( $p < 0.05$ ) in content of total saturated fatty acids was established between fingerling and marketable size trout (31.81% and 29.14%, respectively), also in PUFA (33.93% and 36.78%, respectively) and n-3 fatty acids (17.17% and 19.20%, respectively). Content of monounsaturated fatty acids was similar and ranged from 33.30%, in fingerling, to 33.05% in commercial trout. There was no statistically significant difference ( $p > 0.05$ ) in content of total n-6 fatty acids in fingerling (16.76%) and commercial fish (17.58%). Content of eicosapentaenoic acid (EPA, C20:5 n-3) and docosahexaenoic acid (DHA, C22:6 n-3) was 2.78% and 8.21% in fingerling and 3.36% and 9.29% in commercial fish, respectively. Content of EPA+DHA in total fatty acids was 10.99% in fingerling and 12.65% in marketable size rainbow trout. By consumption of 200 g of this fish intake of desirable fatty acids, EPA and DHA, is 0.84 g in fingerling, and 1.08 g in commercial rainbow trout, which is in accordance with recommendation of the American Heart Association for persons with cardiovascular disease (daily intake: total 1g EPA and DHA).

Higher quantities of n-3 PUFA in fingerling (17.17%) and commercial trout (19.20%) and lower quantities of n-6 PUFA (16.76% in fingerling and 17.58% in commercial trout) result in favourable n-3/n-6 ratio (1.02 in fingerling and 1.09 in commercial trout).

Trout growth was accompanied by increase content of proteins, decrease content of water and increase content of PUFA; especially n-3 essential fatty acids. Due to significant content of proteins and unsaturated fatty acids and smaller amounts of fat, rainbow trout can be considered as one of the most valuable food stuffs in human nutrition.

**Key words:** Rainbow trout, chemical composition, fatty acids, n-3 PUFA.

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*\*Note: Results presented in this study are results of the research carried out within the project „Monitoring of aquatic eco-systems in order to obtain aquaculture products of proper hygiene and high quality, competitive on the EU market“, No. 20122, financed by the Mini-*



*stry of Science and Technological Development of Serbia within the program of technological development.*

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## **HACCP PLAN KAO DIO INTEGRALNOG SISTEMA SIGURNOSTI HRANE U NEKONVENCIONALNOJ PROIZVODNJI MESA PUŽA**

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Zakonodavni okvir za zdravu, sigurnu i kvalitetnu hranu u Bosni i Hercegovini je Zakon o hrani („Službeni glasnik BiH“ broj 50/04), usaglašen sa Uredbom EC (Regulativom (EC) No 178/2002), koji je jasno definisao: obaveze subjekata u poslovanju s hranom, njihovu opštu odgovornost za higijenu i zdravstvenu ispravnost hrane, specifične uslove higijene hrane, odgovornost u vezi s hranom koja ne udovoljava propisanim zahtevima, mogućnost sledljivosti hrane, kao i obavezne zahteve koji se odnose na sistem samokontrole HACCP.

U radu je prikazan HACCP plan kao deo integralnog sistema sigurnosti hrane u nekonvencionalnoj proizvodnji mesa puža koji definitivno danas nije nepremostiva barijera za domaće subjekte u poslovanju s hranom. HACCP je postao obaveza i uslov poslovanja s partnerima na međunarodnom tržištu. Higijena hrane je rezultat provedenih preduslovnih programa i postupaka zasnovanih na HACCP principima. Preduslovni programi koji su temelj za efikasno uvođenje HACCP plana, morali su biti ustanovljeni pre implementacije postupaka zasnovanih na HACCP principima.

**Ključne reči:** Preduslovni programi, HACCP plan, meso puža.

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## **HACCP PLAN AS PART OF THE INTEGRATED FOOD SAFETY IN UNCONVENTIONAL PRODUCTION OF SNAIL MEAT**

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The legal framework for healthy, safe and high quality food in Bosnia and Herzegovina is the Food Law (Official Gazette B and H, No. 50/04), harmonized with the EC Regulation (Regulation (EC) No. 178/2002), which is clearly defining: (who) obligations of food business operators, their general responsibility for hygiene and food safety, (what) the specific requirements of food hygiene, responsibility in connection with food that does not comply with the prescribed requirements, (how) traceability (tracking) of food, as well as mandatory requirements relating to the HACCP system of self-control.

This paper presents the HACCP plan as part of an integrated system of food safety in the unconventional production of snail meat, which today certainly is no longer an insurmountable barrier to domestic food business operators. HACCP has

become the obligation and requirement of doing business with partners on the international market. Food hygiene is the result of preconditioned implemented programs and procedures based on HACCP principles. Preconditioned Programs are the foundation for effective HACCP plan and had to be established before the implementation of procedures based on HACCP principles.

**Key words:** preconditioned programs, HACCP plan, snail meat.

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**III TEMATSKA OBLAST**  
***3<sup>rd</sup> THEMATIC TOPICS***

**SUŠENI I FERMENTISANI PROIZVODI OD MESA**  
***DRY AND FERMENTED MEAT PRODUCTS***



III-1

**PROCENA RIZIKA U TRADICIONALNOJ PROIZVODNJI  
HERCEGOVAČKOG PRŠUTA**

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Proizvodnja tradicionalnih prehrambenih proizvoda može da predstavlja problem bezbednosti u uslovima proizvodnje u individualnim porodičnim gazdinstvima, koju je veoma teško nadzirati. Tradicionalna proizvodnja hercegovačkog pršuta kao i ostalih namirnica životinjskog porekla namenjenih potrošnji ne prati postojeće propise o hrani, što predstavlja potencijalnu opasnost za ljudsko zdravlje.

Imajući u vidu napred navedeno, cilj i zadaci ispitivanja, u okviru ovog rada, usmereni su na procenu rizika od različitih kontaminata kod tradicionalne proizvodnje hercegovačkog pršuta.

Procena rizika rađena je na osnovu ispitivanja hercegovačkog pršuta na području opštine Nevesinje. Rezultati ispitivanja su pokazali da proizvodnja pršuta nije standardizovana, što se odrazilo na znatno variranje kvaliteta ispitivanih uzoraka na senzorna svojstva. Procenom procesa tradicionalne proizvodnje hercegovačkog pršuta ustanovljeno je da postoji rizik u proizvodnji, ukoliko se ne poštuju propisane norme proizvodnje i prometa ovog proizvoda.

Na osnovu sagledavanja uslova proizvodnje, razlika u načinu rada i dobijenih rezultata, predložene su određene mere standardizovanja proizvodnje, koje će u budućnosti pomoći prilikom izrade proizvođačke specifikacije, odnosno registracije hercegovačkog pršuta i dobijanja oznake geografskog porekla.

**Ključne riječi:** procjena rizika, hercegovački pršut.

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**RISK ASSESSMENT IN TRADITIONAL PRODUCTION  
OF HERZEGOVINA HAM**

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Production of traditional food products can pose safety problems in conditions of individual family farms, which is very difficult to monitor. Traditional production

of Herzegovina ham and other foods of animal origin intended for public consumption, does not comply with existing regulations concerning food, which poses a potential threat to human health.

Bearing in mind what we mentioned before, the aim and research tasks in this paper are aimed at the risk assessment of different contaminants in the traditional production of Herzegovina ham. Risk assessment is done on the basis of testing the Herzegovina ham in the municipality of Nevesinje. The results showed that the production of ham is not standardized, which resulted in considerable variability in the quality of the tested samples on the sensory properties.

Assessment process of traditional production of Herzegovina ham found that there is a risk in production unless you don't follow the prescribed norms of production and trade of this product.

From analysing of production conditions, the difference in the way of work and given results, some measures have been proposed for the goal of standardizing production, which will be helpfull during making manufacturing specifications, registration of Herzegovina ham and obtaining indications of geographical origin.

**Key words:** risk assessment, Herzegovina ham.

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III-2

**OSNOVNE ODLIKE SENZORNOG I HEMIJSKOG KVALITETA  
„VISOČKE PEČENICE“\***

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„Visočka pečenica“ je suvomesnati proizvod od goveđeg mesa (*m. longissimus dorsi*), koji se tradicionalno, već decenijama proizvodi na području Visočke regije (Bosna i Hercegovina). Poslednjih desetak godina ova proizvodnja poprima i industrijsku dimenziju. Industrijalizacijom, tehnologija „Visočke pečenice“ u značajnoj mjeri je modifikovana, što se u konačnici odražava na sam kvalitet gotovog proizvoda.

Istraživanje je imalo za cilj da jasno definiše tehnološke procese proizvodnje tradicionalne „Visočke pečenice“, utvrdi i izvrši poređenje senzornog i hemijskog kvaliteta uzoraka iz zanatske i industrijske proizvodnje. Za ispitivanje je korišćeno 30 uzoraka iz zanatske radinosti i 20 uzoraka iz industrije.

Rezultati senzornih ispitivanja pokazali su da su uzorci iz zanatske radinosti u proseku bolje ocenjeni od industrijskih. Od senzornih pokazatelja, najbolje je ocenjena boja kod zanatskih, odnosno, miris kod industrijskih uzoraka. Nasuprot tome, izgled preseka, kod prve, odnosno, konzistencija kod drugu grupe uzoraka, najlošije su ocenjeni senzorni parametri.

Hemijska ispitivanja su pokazala da je u uzorcima zanatskih proizvođača u proseku ustanovljeno: vode 43,28 %, masti 20,73 %, proteina 28,21 %, NaCl-a 7,70 % i ukupnog pepela 8,79 %. S druge strane, kod uzoraka iz industrije ustanovljen je sledeći hemijski sastav: vode 40,99 %, 27,22 %, proteina 25,82 %, NaCl-a 4,96 % i ukupnog pepela 5,82 %.

**Ključne rieči:** „Visočka pečenica“, tradicionalna proizvodnja, senzorni i hemijski kvalitet.

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**Napomena:** *Istraživanje je finansirano od strane Ministarstva poljoprivrede, vodoprivrede i šumarstva FBiH, Projekat: „Provođenje procedure za dobijanje oznake izvornosti ili geografskog porijekla za Visočku pečenicu i recenzija Priručnika“, Broj: 04-14-256/08.*

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## MAIN PROPERTIES OF SENSORY AND CHEMICAL QUALITY OF „VISOČKA PEČENICA“

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„Visočka pečenica“ is dried beef product (*m. longissimus dorsi*) which has traditionally been produced for several decades in region of the town Visoko (Bosnia and Herzegovina). In the last ten years, meat plants started with production of this product.

Technology of production of „Visočka pečenica“ in meat plants was modified, which as a consequence had the modification of the quality of this product.

The aim of this investigation was to define clearly the traditional technology and to compare sensory and chemical quality of „Visočka pečenica“ with products obtained in meat establishments. In study used were 30 samples of traditional product and 20 samples of industrial product.

Results of sensory evaluation showed better quality of traditional product. The colour of the traditional product and the odour of the industrial product were given the highest scores. Despite that, the appearance of cross section of traditional products and consistency of industrial products were given the lowest scores.

In the chemical analysis of the composition of traditional products the following was established: moisture content of 43.28%, fat content 20.73%, protein content 28.21%, NaCl content 7.70% and total ash content 8.79%. In samples of industrial products, moisture content was 40.99%, fat content 27.22%, protein content 25.82%, NaCl content 4.96% and total ash content 5.82%.

**Key words:** „Visočka pečenica“, traditional production, sensory and chemical quality

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**Note:** *This investigation was supported by Ministry of agriculture, water and wood management of Bosnia and Herzegovina, no 04-14-256/08.*

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## SENZORNI I NUTRITIVNI KVALITET TRAJNIH KOBASICA PROIZVEDENIH U INDUSTRIJSKIM USLOVIMA

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U radu je ispitan senzorni i nutritivni kvalitet dve grupe trajnih čajnih kobasica proizvedenih na industrijski način. Prva grupa je proizvedena sa dodatkom nitritne soli i GDL-a, a druga grupa sa dodatkom nitritne soli i starter kulture.

Analizom rezultata dobijenih u ovom ispitivanju utvrđeno je da bolji senzorni i nutritivni kvalitet imaju čajne kobasice proizvedene sa dodatkom GDL-a .

**Ključne reči:** čajna kobasica, industrijska proizvodnja, kvalitet.

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## SENSORY AND NUTRITIONAL QUALITY OF FERMENTED DRY SAUSAGES PRODUCED IN INDUSTRIAL CONDITIONS

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In this paper, results of the investigation of the sensory and nutritional quality of two groups of dry sausages of tea type produced in industrial conditions, are presented. The first group was produced with the addition of the nitrite salt and the GDL and the second group with the addition of nitrite salt and starter culture.

In the analysis of the results obtained in this study, better sensory and nutritional quality were established in tea sausage produced with the addition of a GDL.

**Key words:** tea sausage, industrial production quality.

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## SADRŽAJ MASTI, HOLESTEROLA I MASNOKISELINSKI PROFIL U SUVOMESNATIM PROIZVODIMA OD SVINJSKOG MESA

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Meso i proizvodi od mesa, kao izvori nutritivno vrednih sastojaka, predstavljaju namirnice koje imaju veoma značajno mesto u ishrani ljudi. Međutim, pored visokog sadržaja proteina, minerala i vitamina, ove namirnice sadrže i masti sa značajnim udelom zasićenih masnih kiselina. Prema podacima iz literature, dugotrajno prekomerno konzumiranje takvih proizvoda predstavlja značajan faktor rizika za nastanak ateroskleroze i kardiovaskularnih oboljenja. U tom pogledu, poseban značaj imaju proizvodi od mesa podvrgnuti termičkim procesima, u tehnološke ili kulinarske svrhe, kada je moguće formiranje štetnih produkata oksidacije masti, masnih kiselina i holesterola. Objavljeni podaci o sadržaju i sastavu masti kao i količini holesterola u različitim vrstama mesa i proizvodima od mesa pokazuju veliku varijabilnost, koja je najčešće povezana sa genetskim faktorima, ishranom životinja, ali i tehnologijom obrade i prerade mesa. Poznavanje ovih nutritivnih parametara, potrošačima omogućava izbalansirano konzumiranje proizvoda od mesa sa ostalim namirnicama, u skladu sa principima pravilne ishrane.

Cilj našeg rada je bio da se u visokokvalitetnim suvomesnatim proizvodima od svinjskog mesa, koji se tradicionalno konzumiraju na našim prostorima i imaju značajan izvozni potencijal, odredi prosečan sadržaj masti, masnokiselinski sastav i sadržaj holesterola. Ispitane su četiri vrste proizvoda od mesa, iz tri različite proizvodne partije – suva pršuta, suvi vrat, buđola i panceta.

Sadržaj ukupnih masti određen je standardnom SRPS ISO metodom, sastav masnih kiselina gasnom hromatografijom na aparatu GC/FID Shimadzu 2010, dok je sadržaj holesterola određen tečnom hromatografijom na aparatu HPLC Waters 2695 Separation modul/PDA.

Rezultati ispitivanja pokazuju da je prosečan sadržaj ukupne masti najmanji u suvoj pršuti (6,05%), a najveći u panceti (43,81%). U suvom vratu je utvrđeno 23,29%, a u buđoli 25,71% masti. Razlike u utvrđenom sadržaju masti su očekivane, s obzirom na prirodno različit sadržaj masti u mesu i mesnatoj slanini, kao polaznim sirovinama. Sadržaj holesterola u ovim proizvodima je bio 45,62 mg/100 g (panceta), 65,32 mg/100 g (buđola), 70,31 mg/100 g (suvi vrat) i 77,68 mg/100 g (suva pršuta). Imajući u vidu preporuke o maksimalnom unosu holesterola hranom od 300 mg dnevno, može se reći da povremena upotreba umerenih količina ovih suvomesnatih proizvoda, za zdrave osobe, ne predstavlja zdravstveni rizik.

Sa aspekta masnokiselinskog sastava lipida u ispitivanim proizvodima, najveći je udeo mononezasićenih masnih kiselina (od 46,15%, panceta do 51,31%, suva pršuta). Sadržaj ukupnih zasićenih masnih kiselina kod suvog vrata je iznosio 44,03%, buđole 43,42%, pancete 41,79% i suve pršute 39,76%. Sadržaj ukupnih polinezasićenih masnih kiselina je iznosio od 8,77% (suva pršuta) do 10,63% (panceta).

S obzirom da je u oceni nutritivnog kvaliteta lipida, pored utvrđenih količina, bitan i odnos (n-6) i (n-3) polinezasićenih masnih kiselina (PNMK), kao i odnos polinezasićenih i zasićenih masnih kiselina (P/S indeks), u proizvodima su određeni i ovi odnosi. Odnos n-6/n-3 polinezasićenih masnih kiselina se kretao od 12,69 do 19,79, što je u skladu sa podacima iz literature za ovu grupu proizvoda od mesa i posledica je pre svega načina uzgoja i ishrane životinja. Odnos polinezasićenih i zasićenih masnih kiselina (P/S indeks) je iznosio 0,18 (suva pršuta); 0,19 (suvi vrat); 0,20 (budola) i 0,21 (panceta).

**Ključne reči:** ukupna mast, holesterol, masnokiselinski profil, suvomesnati proizvodi.

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## CHOLESTEROL AND FAT CONTENT AND FATTY ACID PROFILE IN DRY PORK MEAT PRODUCTS

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Meat and meat products, as sources of nutritionally valuable ingredients, represent foodstuffs which are very important in human consumption. However, in addition to high content of proteins, minerals and vitamins, these foodstuffs contain also fats with significant share of saturated fatty acids. According to literature data, long term excessive consumption of such products is significant risk factor in incidence of atherosclerosis and cardio-vascular diseases. In that regard, especially important are heat treated meat products, subjected to heat processes either in technological or culinary purposes, which can lead to forming of harmful products of the fat oxidation, fatty acids and cholesterol. Published data on composition and content of fat, as well as quantity of cholesterol in different types of meat and meat products, show high variability, most often associated with genetic factors, animal nutrition, but also meat treatment and processing technology. Knowledge of these nutritive parameters enables the consumers to balance consumption of meat products with other foodstuffs, according to principles of correct nutrition.

Objective of our work was, in high quality dry pork meat products, which are traditionally consumed in our country and have considerable export potential, to determine average content of fat, fatty acid composition and cholesterol content. Four types of meat products were analyzed, from three different production batches - dry pork ham (prsuta), dry pork neck, budjola sausage and pancetta bacon.

Content of total fats was determined by using the standard SRPS ISO method, composition of fatty acids by using gas spectrophotometry on apparatus GC/FID Shimadzu 2010, whereas the cholesterol content was determined by liquid chromatography on apparatus HPLC Waters 2695 Separation module/PDA.

Research results show that average content of total fats was the lowest in dry pork ham-prsuta ham (6.05%), and the highest in pancetta bacon (43.81%). In dry pork neck value of 23.29% was established, and in budjola sausage 25.71% of fat. Differences in established content of fat were expected, considering the naturally occurring differences in fat content in meat and meaty bacon, as initial raw materials. Cholesterol content in these products was 45.62 mg/100 g (pancetta), 65.32 mg/100 g (budjola), 70.31 mg/100 g (dry pork neck) and 77.68 mg/100 g (dry pork ham-prsuta). Considering recommendation on maximum intake of cholesterol through food of 300 mg per day, it can be said that moderate consumption of these dry meat products, does not pose any health risk or hazard for health persons.

From the aspect of fatty acid composition of lipids in examined products, the share of monounsaturated fatty acids was the highest (from 46.15%, pancetta to 51.31%, dry prsuta ham). Content of total saturated acids in dry pork neck was 44.03%, of budjola 43.42%, pancetta 41.79% and dry prsuta ham 39.76%. Content of total polyunsaturated fatty acids ranged from 8.77% (dry prsuta ham) to 10.63% (pancetta).

Considering that in the assessment of nutritive quality of lipids, in addition to determined quantities, also very important ratio of (n-6) and (n-3) poly unsaturated fatty acids (PUFA), as well as ratio between poly unsaturated and saturated fatty acids (P/S index), were determined in the products. The ratio between n-6/n-3 poly unsaturated acids ranged from 12.69 to 19.79, which is in accordance with literature data for this group of products and is consequence primarily of the animal farming method/system and animal nutrition. The ratio between poly unsaturated and saturated acids (P/S index) was 0.18 (dry prsuta ham); 0.19 (dry pork neck); 0.20 (budjola) and 0.21 (pancetta).

**Key words:** total fat, cholesterol, fatty acid profile, dry meat products.

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## KVANTITATIVNA ANALIZA POLICIKLIČNIH AROMATIČNIH UGLJOVODONIKA U DIMLJENIM MESNIM PROIZVODIMA

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Asortiman hrane koja se konzumira se stalno povećava, proširuje, i menja se obrazac ishrane. Nove tehnologije se uvode u proizvodnju, skladištenje i distribuciju proizvoda, što utiče na povećanje spektra korišćenja, kao i količine hemijskih komponenti koje se koriste.

Hrana se može smatrati bezbednom ako nema toksični, kancerogeni, teratogeni, mutageni ili neki drugi nepovoljni uticaj na ljudski organizam, ukoliko se unosi u uobičajenim količinama. Mnogi predstavnici grupe policikličnih aromatičnih ugljovodonika – polycyclic aromatic hydrocarbons (PAH) imaju izrazito kancerogeni efekat. Trenutno, oko 17 jedinjenja koja se mogu ubrojiti u grupu PAH jedinjenja je poznato. Predstavnici ove grupe jedinjenja se mogu naći u izduvnim gasovima, proizvodima sagorevanja retni i toplana, duvanu i dimu koji se koristi u mesnoj industriji, prisutni su u vazduhu, zemljištu i vodi.

Ispitivanja izvedena početkom 90-tih u Nemačkoj su pokazala da se najveća količina čitavog spektra PAH unosi u ljudski organizam kroz hranu, uključujući dimljene proizvode. Među PAH jedinjenjima, benzo( $\alpha$ )piren se smatra najaktivnijim kancerogenim jedinjenjem koje se ubraja u prvu grupu najopasnijih jedinjenja, i njegov unos u organizam može imati lokalni i sistemski kancerogeni efekat.

Izvedena su eksperimentalna ispitivanja kvantitativnog određivanja benzo( $\alpha$ )pirena u dimljenim proizvodima od mesa korišćenjem metode visokoeфикаsne tečne hromatografije (HPLC) sa fluometrijskom detekcijom. Ispitivana je dinamika sadržaja rezidua benzo( $\alpha$ )pirena u dimljenim mesnim proizvodima, uzimajući u obzir recepturu, tehnološki postupak i dimljenje, kao i materijale koji se koriste za pakovanje proizvoda.

**Ključne reči:** kancerogene supstance, policiklični aromatični ugljovodonici (PAH), benzo( $\alpha$ )piren, visoko efikasna tečna hromatografija (HPLC).

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## QUANTITATIVE ANALYSIS OF POLYCYCLIC AROMATIC HYDROCARBONS IN SMOKED MEAT PRODUCTS

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At the present time the range of foods being consumed is continually extending, and the pattern of nutrition is changing. New technologies are introduced into production processes, storage and distribution of products, the spectrum of use and the amount of chemical components are increasing.

The foods can be considered safe if they have no toxic, carcinogenic, teratogenic, mutagenic or other unfavorable effect on human organism when they are consumed in usual quantities. Many representatives of the class of polycyclic aromatic hydrocarbons (PAH) have pronounced carcinogenic effects. Presently, about 17 compounds that can be attributed to the group of PAH compounds are known. The representatives of this group of compounds are found in exhausts of engines, burning products of ovens and heating plants, tobacco and curing smoke, they are present in air, soil and water.

The investigations carried out in the early 1990 in Germany have shown that the largest amount of the whole spectrum of PAH are introduced into humans' organism with foods, smoked products included. Among PAH benzo( $\alpha$ )pyrene is considered as the most active carcinogenic compound that can be attributed to the first class of danger and if entering the organism, it has both local and systemic carcinogenic effect.

The experimental investigations were carried out for the quantitative determination of benzo( $\alpha$ )pyrene in smoked meat products by the method of high power liquid chromatography (HPLC) with fluorometric detection. The dynamics of the contents of benzo( $\alpha$ )pyrene residues in smoked meat products, taking into consideration recipe, technological process and smoking, packaging materials has been studied.

**Key words:** carcinogenic substances, polycyclic aromatic hydrocarbons (PAH), benzo( $\alpha$ )pyrene, high power liquid chromatography (HPLC).

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## SENZORSKE OSOBINE „LEVAČKE“ KOBASIČE PROIZVEDENE NA TRADICIONALAN NAČIN

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U radu je postavljen zadatak da se ispituju senzorske osobine „levačke“ kobasice, izrađene u skladu sa tradicionalnim načinom proizvodnje. Kobasice su proizvedene u tri ponavljanja, tj. fermentacije: prva fermentacija – IF (kobasice proizvedene u prve tri nedelje septembra); druga fermentacija – IIF (kobasice proizvedene u prve tri nedelje oktobra); treća fermentacija – IIIF kobasice proizvedene u poslednjoj nedelji oktobra i prvoj polovini novembra).

Pomoću kvantitativnog deskriptivnog testa, na skali intenziteta od 1–10, analizirano je jedanaest senzorskih svojstava ovih kobasica (boja, izgled preseka, koherentnost – povezanost mišićnog i masnog tkiva, miris, kvalitet masnog tkiva, kiselost, sočnost, nežnost, ukus, naknadni ukus i ukupna prihvatljivost). Boja i čvrstoća kobasica su određeni instrumentalnim metodama. Boja je merena aparatom Chromameter CR-400, po CIE L\*, a\*, b\* sistemu, a čvrstoća aparatom Instron 4301, određivanjem sile presecanja i penetracije.

Ukupna prihvatljivost „levačke“ kobasice iz treće fermentacije ( $8,00 \pm 0,00$ ), proizvedene u poslednjoj nedelji oktobra i prvoj polovini novembra, bolje je ocenjena od ukupne prihvatljivosti „levačke“ kobasice iz prve fermentacije ( $5,20 \pm 0,45$ ) proizvedene u prve tri nedelje septembra, a razlika je bila statistički veoma značajna ( $p < 0,001$ ). Poređenjem ukupne prihvatljivosti „levačke“ kobasice iz treće fermentacije ( $8,00 \pm 0,00$ ) i „levačke“ kobasice iz druge fermentacije ( $6,90 \pm 0,22$ ) proizvedene u prve tri nedelje oktobra, razlika je takođe bila statistički veoma značajna ( $p < 0,001$ ). Rezultati instrumentalnih analiza boje i čvrstoće „levačke“ kobasice su u skladu sa rezultatima senzorske ocene. U radu je potvrđeno da se najbolja senzorska svojstva „levačke“ kobasice postižu u kasnu jesen, što se podudara sa periodom godine kada se u našim krajevima proizvodila i proizvodi ova vrsta kobasice.

**Ključne reči:** „levačka“ kobasica, senzorska analiza, instrumentalna analiza boje i teksture.

**Napomena:** *Prezentovani rezultati su deo istraživačkog projekta: „Tehnološke i protektivne osobine autohtonih sojeva bakterija mlečne kiseline, izolovanih iz tradicionalno fermentisanih kobasica i mogućnost njihove primene u industriji mesa“ finansiran od strane Ministarstva nauke, Republike Srbije (broj projekta: 20127)*

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## SENSORY PROPERTIES OF TRADITIONALLY FERMENTED „LEVAČKA“ SAUSAGE

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The authors set the task to determine sensory properties of „Levačka“ sausage, manufactured in a traditional way. Sausages were produced in three intervals: September (the first fermentation – IF), October (the second fermentation - IIF) and November (the third fermentation – IIIF).

Using quantitative descriptive test, with grading scale from one to ten, eleven sensory properties of sausages were assessed (colour, surface cut, consistency – interconnection/coherence of meat and fatty tissue, smell, fatty tissue quality, acidity, juiciness, tenderness, taste, after taste and overall acceptability). Colour and firmness of the sausages was determined instrumentally. Colour was measured using Chromameter CR-400 (Minolta Co. Ltd.) (CIE L\*, a\*, b\* system), while the firmness was measured by Instron 4301 (determination of cutting and penetration forces).

The overall acceptability of „Levačka“ sausage in the third fermentation ( $8.00 \pm 0.00$ ) was better than in the first ( $5.20 \pm 0.45$ ) or the second fermentation ( $6.90 \pm 0.22$ ), and the difference established was highly statistically significant ( $p < 0.001$ ). The results of instrumental analyses of colour and firmness are in agreement with the results of the sensory evaluation.

**Key words:** „Levačka“ sausage, sensory analysis, instrumental analysis of colour and firmness.

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**Note:** *The results presented in this paper are performed within research of the project Technological and protective properties of autochthonous strains of lactic acid bacteria, isolated from traditional fermented sausages and the possibility of their application in meat industry”, funded by Ministry of research, Republic of Serbia (number of project: 20127).*

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## SENZORSKA PRIHVATLJIVOST SREMSKE KOBASICE IZRAĐENE OD MESA SVINJA RAZLIČITE STAROSTI

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Suve fermentisane kobasice su jedna od najcenjenijih grupa proizvoda od mesa. Specifični ambijentalni uslovi nametali su tehnologiju proizvodnje, koja je ostala gotovo nepromenja do današnjih dana. Ovi proizvodi poseduju specifične, nekada jedinstvene senzorne karakteristike. Jedan od najpoznatijih proizvoda, iz ove grupe, u našoj zemlji je sremska kobasica. Tradicionalno se sremska kobasica proizvodila od mesa kasnostasnih rasa svinja koje su klane starije od 12 meseci, a koje su tokom prošlih decenija, zbog poznatih razloga, potisnute od strane plemenitih rasa i njihovih meleza. Danas se kao sirovina koristi meso tovljenika starih oko 6 meseci, kao i svinja starijih od 12 meseci.

Ukus i miris sušenih i fermentisanih proizvoda formiraju se, između ostalog, aktivnošću endogenih proteinaza, peptidaza i lipaza, a poznato je da su njihov nivo i aktivnost uslovljeni starošću svinja. Intenzitet i postojanost boje, takođe važan senzorni parametar kvaliteta fermentisanih kobasica, u tesnoj je vezi sa bojom mesa koje je korišćeno kao sirovina, a tekstura proizvoda rezultat je složenih uticaja od kojih se mogu istaći: sastav i kvalitet masnog tkiva, dinamika i intenzitet promena pH vrednosti, kao i razvijenost vezivnotkivnih komponenti sirovine.

U radu je ispitivan je uticaj starosti svinja, na biohemijske i senzorne parametre sremske kobasice, tokom proizvodnje i tromesečnog skladištenja. U ispitivanjima su korišćeni meso i masno tkivo: svinja rase švedski landras, i to šestomesečnih tovljenika (A) i krmača starih 12 meseci izlučenih iz priploda (B).

Biohemijske promene u kobasicama izrađenim od mesa svinja starosti od 6 i 12 meseci, u osnovi se malo razlikuju. Dinamika pH vrednosti i sadržaja neproteinskog azota (NPN) pokazuje veoma slične tendencije, kao i elektroforetski profili sarkoplazmatskih i miofibrilarnih proteina. Uticaj starosti svinja na senzorne karakteristike ispitivanih varijanti sremske kobasice je izražen. Kobasice varijante A imale su bolji spoljašnji izgled i teksturu, u odnosu na B, 14, 60. i 105. dana ogleđa. Boja proizvoda A bila je takođe bolja tokom ispitivanja. U pogledu ukusa i mirisa varijanta A je 14. dana bila inferiorna, ali su se tokom skladištenja ukus i miris ove varijante poboljšavali, za razliku od varijante B kod koje su se ukus i miris pogoršavali. Kobasice varijante A su značajno svetlije su na preseku ( $P < 0,05$ ). Na površini i na preseku kobasica varijante A, utvrđeno je i statistički značajno veće učešće crvene boje ( $a^*$ ), u odnosu na varijantu B.

**Ključne reči:** sremska kobasica, senzorni kvalitet, starost svinja.

**Napomena:** Rad je finansiran iz sredstava projekta 46009 i 46010 Ministarstva za nauku i Tehnološki razvoj Republike Srbije.

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## SENSORY ACCEPTABILITY OF SREMSKA SAUSAGE MADE FROM THE MEAT OF PIGS OF VARIOUS AGE

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Dry fermented sausages are one of the most valued groups of meat products. Specific environmental conditions dictated the production technology, which has remained mostly unchanged until the present day. These products possess specific, sometimes unique sensory characteristics. One of the most famous products in our country, belonging to this group, is sremska sausage. Traditionally, sremska sausage was made from the meat of late maturing pig breeds that were slaughtered above 12 months of age and which, during the last decades, for well-known reasons, were suppressed by modern breeds and their crossbreeds. Today, the pork of pigs about six months of age, as well as pigs older than 12 months, is used for sausage production.

The taste and odor of dry and fermented products are formed, among other things, by the activity of endogenic proteinases, peptidases and lipases, and it is well-known that their levels and activity are conditioned by the age of pigs. Colour intensity and stability, another important sensory parameter indicating the quality of fermented sausages, is closely linked to the colour of meat that was used in production, while the texture is a result of complex influences, including: the composition and quality of fatty tissue, dynamics and intensity of pH value changes and the presence of connective tissue in the fresh meat.

This paper examines the impact of pig age on biochemical and sensory parameters in sremska sausage during production and a three-month storage period. Meat and fatty tissue used in the experiments were from: Swedish Landrace, more specifically six-month old pigs (A) and 12-month old cull sows (B).

Biochemical changes in sausages made from the meat of pigs between six and 12 months of age basically differed only slightly. The dynamics of pH value and the content of non-protein nitrogen (NPN) showed similar tendencies, as well as the electrophoretic profiles of sarcoplasmic and myofibrillar proteins. The impact of pig age on sensory characteristics of sremska sausage was pronounced. Variant A sausages had the best appearance and texture when compared to variant B on days 14, 60 and 105 of the experiment. The colour of product A was also more appealing during the experiment. As for taste and aroma, variant A was inferior on day 14, but

during storage, the taste and aroma of this variant improved, unlike those of variant B, in which these parameters deteriorated. Variant A sausages had a much lighter cross-section ( $P < 0.05$ ). On the surface and the cross-section of variant A there was a statistically significant greater participation of red colour ( $a^*$ ), than in variant B.

**Key words:** sremska sausage, sensory quality, pig age.

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**Note:** *This paper was financed by funds from projects 46009 and 46010 of the Serbian Ministry of Science and Technological Development.*

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## STANDARDIZACIJA KVALITETA I BEZBEDNOSTI TRADICIONALNIH FERMENTISANIH KOBASICA

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Tradicionalni proizvodi od mesa u tipu fermentisanih suvih kobasica, sa određenog geografskog područja Srbije, proizvode se uglavnom u seoskim domaćinstvima, prema iskustvu i tradicionalnoj tehnologiji. Brojni faktori utiču na kvalitet finalnih proizvoda, a varijabilnost kvaliteta limitira mogućnost postizanja većeg obima proizvodnje i učešća ovih proizvoda na inostranom tržištu.

U ovom radu predočene su specifičnosti izrade fermentisanih suvih kobasica (Petrovačke kobasice) i zahtevi koje treba ostvariti pri standardizaciji proizvodnje tradicionalnih kobasica u kontrolisanim uslovima, radi očuvanja karakterističnih svojstava i vrhunskog kvaliteta. Da bi se taj cilj postigao potrebno je potpuno objasniti fizičko-hemijske, biohemijske i mikrobiološke promene u toku spontane fermentacije ovih proizvoda u tradicionalnoj proizvodnji, a potom preneti uočene modele fermentacije, sušenja i zrenja u kontrolisane uslove proizvodnje.

**Ključne reči:** tradicionalni proizvodi, geografsko poreklo, fermentisane suve kobasice, standardizacija kvaliteta.

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## QUALITY AND SAFETY STANDARDIZATION OF TRADITIONAL FERMENTED SAUSAGES

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Traditional meat products, dry fermented sausages, which are coming from particular geographic areas of Serbia, are mainly produced in rural households, according to experience and traditional technology. The quality of final products is affected by numerous factors. Variability of this quality limits the possibility for achieving higher production rates and presence of these products at foreign markets.

This paper represents the specifics of traditional dry-fermented sausages (*Petrovská klobása*) production process and requests which have to be accomplished during this standardization in controlled conditions, aiming to preserve specific properties and superior quality. In order to achieve this goal it is necessary to fully

understand physicochemical, biochemical and microbiological changes during spontaneous fermentation of these products in traditional manufacturing process, and then transferred the perceived models of fermentation, drying and ripening in controlled production conditions.

**Key words:** traditional products, protected designation of origin, dry fermented sausages, standardization quality.

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## TRADICIONALNA TEHNOLOGIJAS PROIZVODNJE DOMAĆE KOBASICE U OKOLINI PRESPANSKOG JEZERA U MAKEDINIJU

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Tradicionalne domaće kobasice koje se proizvode u domaćinstvima u okolini Prespanskog jezera u Makedoniji, poznate su pod imenom „lukanke ili lukanice”. Domaće kobasice – lukanke su izrađene od goveđeg mesa (20%) svinjskog mesa (75%), i čvstog masnog tkiva (5%), soli za salamurenje, mlevene slatke i ljute crvene paprike, crnog bibera i prženog praziluka.

Usitnjavanjem goveđeg, svinjskog mesa i čvstog masnog tkiva vrši se u mašini za usitnjavanje mesa. Nadev se spravlja ručnim mešanjem u velikom sudu, uz dodavanje soli za salamurenje i začina. Praziluk koje se dodaje nadevu prethodno se termički obrađuje. Posle postizanja potrebne izjednačnosti mesa i začina, nadev kobasice se ručno puni u tanka svinjska creva.

Kobasice se oblikuju u obliku potkovice. Nakon punjenja ostavljaju se da prosuše 2–3 dana, a nakon toga se dime u klasičnim pušnicama 6 časova. Nakon dimljenja kobasice se suše na promajnom mestu u trajanju od 5-6 dana.

**Ključne reči:** lukanice, tradicionalne domaće kobasice, goveđe i svinjsko meso, praziluk.

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## TRADITIONAL PRODUCTION TECHNOLOGY OF NATIONAL SAUSAGE AROUND PRESPA LAKE IN MACEDONIA

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Traditional sausages produced in households in the area of Prespa Lake in Macedonia, are known as the „lukanke or lukanice”. Homemade sausages - lukanki are made of beef (20%), pork meat (75%), and fat (5%), curing salt, ground sweet and hot red pepper, black pepper and fried leek.

Grinding of beef, pork and fat are done in grinder machine. Mixture is manually mixed in a court and is added curing salt and spices. Leek that is added is pre-heated. After mixing the meat and the spices, mixture is manually filled in the pig intestines.

The form of the handmade sausages is shaped in a horseshoe. After filling sausages are left first to dry during a period of 2-3 days, followed by smoking in traditional smokehouse for a period of six hours. After smoking sausages are dried. Drying is done on drafty place for a period of 5-6 days.

**Key words:** Lukanke, traditional sausages, beef and pork meat, leek.

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## PROMENA BOJE PETROVAČKE KOBASICE TOKOM SUŠENJA I ZRENJA U TRADICIONALNIM USLOVIMA PROIZVODNJE

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U radu su ispitane promene boje četiri grupe Petrovačkih kobasica (A1, A2, B1 i B2), suvih fermentisanih kobasica, tokom sušenja i zrenja u tradicionalnim uslovima proizvodnje. Ispitani uzorci kobasica su proizvedeni po istoj recepturi u domaćinstvu od krstog svinjskog mesa i čvrstog masnog tkiva, uz upotrebu kuhinjske soli, mlevene začinske paprike i drugih prirodnih začina. Kobasice A grupe su proizvedene od toplog, a kobasice B grupe od ohlađenog mesa, pri čemu su kobasice A1 i B1 grupe napunjene u prirodni, a A2 i B2 grupe u veštački omotač.

Boja i odživost boje na preseku izrađenih kobasica ocenjena je senzorno, a instrumentalno su utvrđeni pokazatelji boje ( $L^*$ -svetloća;  $a^*$ -udeo crvene boje;  $b^*$ -udeo žute boje) uređajem Minolta i to: 2, 4, 6, 9, 12, 15, 30, 60. i 90. dana od dana proizvodnje.

Instrumentalno određena boja na preseku ispitanih kobasica 2. dana proizvodnje (nakon 1 dana dimnjenja), kretala se u intervalu od 38,96 (B2) do 42,86 (B1) za vrednost svetloće ( $L^*$ ), odnosno od 27,50 (B1) do 33,14 (A2) za vrednost udela crvene boje ( $a^*$ ) i od 29,77 (B2) do 34,46 (A1) za vrednost udela žute boje ( $b^*$ ). Utvrđene razlike, ni kod jednog ispitanih pokazatelja, nisu statistički značajne ( $P > 0,05$ ), osim za udeo crvene boje koji je bio statistički visoko značajno veći na preseku kobasica A2 grupe u odnosu na B1 grupu ( $P < 0,01$ ).

Tokom procesa sušenja i zrenja svetloća ( $L^*$ ) kobasica se smanjivala, a na kraju procesa tj. 90. dana sušenja i zrenja, kada su kobasice bile spremne za konzumiranje, na preseku svih ispitanih kobasica utvrđeno je visoko statistički značajno smanjenje ( $P < 0,01$ ) svetloće boje, odnosno nastajanje tamnije boje na preseku kobasica u odnosu na boju nadeva na početku procesa proizvodnje. Vrednosti svetloće ( $L^*$ ) kretale su se u rasponu od 29,61 (B1) do 34,43 (A2). Takođe, na kraju procesa sušenja i zrenja utvrđeno je visoko statistički značajno smanjenje ( $P < 0,01$ ) udela crvene i žute boje. Udeo crvene boje ( $a^*$ ) kretao se u rasponu od 18,68 (B1) do 25,72 (A2), dok je udeo žute boje ( $b^*$ ) iznosio od 13,68 (B1) do 23,09 (A2). Kobasice A1 grupe imale su na preseku, 90. dana sušenja i zrenja visoko statistički značajno veći ( $P < 0,01$ ) udeo crvene boje i statistički značajno veći ( $P < 0,05$ ) udeo žute boje od kobasica B1 i B2 grupe i ocenjene su nižom senzornom ocenom (3,75) za boju i održivost boje na preseku. Ispitani uzorci kobasica A2 grupe, koje su senzorno ocenjene sa ocenom 4,00, imale su visoko statistički značajno veći udeo crvene i žute boje ( $P < 0,01$ ) kao i visoko statistički značajno veću svetloću boje na preseku ( $P < 0,01$ ) u odnosu na te vrednosti utvrđene na preseku kobasica B1 i B2 grupe 90. dana sušenja i zrenja.

Na kraju procesa sušenja između kobasica B1 i B2 grupe, koje su ocenjene istom senzornom ocenom za boju i održivost boje na preseku, odnosno maksimalnom ocenom 5,00, nije utvrđena statistički značajna razlika ( $P > 0,05$ ) vrednosti instrumentalnih pokazatelja boje, što upućuje na zaključak da je to optimalna boja koju je potrebno postići kod Petrovačke kobasice u tradicionalnim uslovima proizvodnje od ohlađenog mesa, nezavisno od vrste upotrebljenog omotača.

**Ključne reči:** Petrovačka kobasica, suve fermentisane kobasice, tradicionalna proizvodnja, boja.

**Napomena:** Ovaj rad nastao je kao rezultat rada na projektu broj TR31032, koji je finansiran sredstvima Ministarstva za nauku i tehnološki razvoj Republike Srbije.

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## COLOUR CHANGES OF *PETROVSKÁ KLOBÁSA* DURING DRYING AND RIPENING IN TRADITIONAL PRODUCTION

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The colour changes of four groups of dry fermented sausage *Petrovská klobása* during drying and ripening in traditional production, were studied. Sausages were produced in traditional way in rural household, according to same recipe, from pork meat and pork back fat, with addition of salt, red hot pepper powder and other natural spices. Sausages were produced using hot boned meat (A group) or cold meat (B group), and were stuffed into natural (A1 and B1) or artificial (A2 and B2) casings.

Colour and colour maintenance on the cut surface of sausages were sensory estimated, and also colour parameters ( $L^*$ - lightness,  $a^*$ - redness;  $b^*$ - yellowness) were determined using Minolta CR-400. Samples for the analyses were taken at: 2<sup>nd</sup>, 4<sup>th</sup>, 6<sup>th</sup>, 9<sup>th</sup>, 12<sup>th</sup>, 15<sup>th</sup>, 30<sup>th</sup>, 60<sup>th</sup> and 90<sup>th</sup> day of production.

Instrumentally determined colour parameters of the cut surface of sausages were in the range from 38.96 (B2) to 42.86 (B1) for lightness ( $L^*$ ), e.g. from 27.50 (B1) to 33.14 (A2) for redness ( $a^*$ ) and from 29.77 (B2) to 34.46 (A1) for yellowness ( $b^*$ ) after 2 days of production (after 1 day of smoking). Averages values of determined colour parameters were not significantly different ( $P > 0.05$ ), except for redness ( $a^*$ ), which was significantly higher ( $P < 0.01$ ) for sausages A2 than B1.

During drying and ripening lightness ( $L^*$ ) of sausages decreased. Determined lightness ( $L^*$ ) after 90 days of drying and ripening, when the sausages were ready for consumption, were in the range from 29.61 (B1) to 34.43 (A2), being significantly lower ( $P < 0.01$ ) than after 2<sup>nd</sup> day of production. Also, at the end of drying and

ripening highly significant reductions ( $P < 0.01$ ) of redness and yellowness were determined. Average values of redness ( $a^*$ ) were in the range from 18.68 (B1) to 25.72 (A2) and average values of yellowness ( $b^*$ ) were from 13.68 (B1) to 23.09 (A2). Sausages of A1 group, which were sensory evaluated with an average score of 3.75 for colour and colour maintenance had a highly significant higher ( $P < 0.01$ )  $a^*$  value and significantly higher ( $P < 0.05$ )  $b^*$  value comparing to the values determined for sausages of B1 and B2 groups after 90 days of drying and ripening. The sausages of A2 group, which were sensory evaluated with an average score of 4.00 had a highly significant ( $P < 0.01$ ) higher values for redness and yellowness and highly significant ( $P < 0.01$ ) higher lightness comparing to the values determined for sausages of B1 and B2 groups after 90 days of drying and ripening.

Both sausages B1 and B2 were sensory evaluated by maximum score (5.00) for colour and colour maintenance, also, instrumentally determined colour parameters for these samples did not differ significantly ( $P > 0.05$ ) indicating that this colour must be achieved as an optimal one for *Petrovska klobasa* produced from cold meat in traditional conditions, independently on the kind of casings.

**Key words:** Petrovska klobasa, dry fermented sausage, traditional production, colour.

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**Note:** *This study was supported by the Ministry of Science and Technological Development of the Republic of Serbia, Project No. TR31032.*

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**IV TEMATSKA OBLAST**  
***4<sup>th</sup> THEMATIC TOPICS***

**PAKOVANJE MESA I PROIZVODA OD MESA**  
***PACKAGING OF MEAT AND MEAT PRODUCTS***



## UTICAJ PAKOVANJA U MODIFIKOVANOJ ATMOSFERI NA ODRŽIVOST ČEVAPČIĆA

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U maloprodajnim objektima kao deo asortimana proizvoda od mesa zastupljeni su čevapčići koji pripadaju grupi usitnjenog oblikovanog mesa. Rok održivosti ove grupe proizvoda, koja termički nije obrađena, regulisan je Pravilnikom o kvalitetu i drugim zahtevima za proizvode od mesa (Sl. list SCG, br.33/2004) i iznosi najviše 48 sati kada se proizvodi upakovani čuvaju na temperaturi do +4°C.

Održivost čevapčića može da bude produžena pakovanjem u modifikovanoj atmosferi (MAP). Mešavina gasova sa većim sadržajem kiseonika (O<sub>2</sub>) povoljno utiče na očuvanje svetlo crvene boje kao najvažnije senzorne karakteristike svežeg mesa u maloprodaji. Čevapčići upakovani u modifikovanoj atmosferi retko su zastupljeni na tržištu Srbije.

Cilj rada bio je da se prati tok mikrobioloških, senzorskih i hemijskih promena u čevapčićima upakovanim u modifikovanoj atmosferi koja se sastojala od 60% O<sub>2</sub>, 15% CO<sub>2</sub> i 15% N<sub>2</sub>. Ispitivani uzorci su skladišteni tokom deset dana u strogo kontrolisanim uslovima pri temperaturi od +3°C. Mikrobiološka ispitivanja obuhvatala su određivanje prisustva patogenih mikroorganizama (*Salmonella vrste, koagulaza pozitivne stafilokoke, E. Coli i Listeria monocytogenes*), kao i mikroorganizama indikatora higijene i mikroorganizama kvara (ukupan broj aerobnih mezofilnih i psihrotrofnih bakterija, ukupan broj bakterija porodice Enterobacteriaceae, ukupan broj bakterija mlečne kiseline i *Bronchothrix thermosphacta*). Uzorci su mikrobiološki ispitivani svakog dana. Pomoću kvantitativno deskriptivnog testa na skali intenziteta od 1 do 5 analizirana su senzorska svojstva čevapčića (boja i miris u sirovom stanju i miris, konzistencija i ukus posle probe pečenja) 1, 4, 6. i 8. dana. Od hemijskih parametara, svakodnevno je ispitivana pH vrednost a 4. i 8. dana eksperimenta ispitivani su kiselinski stepen i peroksidni broj.

Rezultati ispitivanja su pokazali da su čevapčići upakovani u zaštitnoj atmosferi gasova bili održivi sedam dana.

**Ključne reči:** čevapčići, održivost, modifikovana atmosfera.

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## THE INFLUENCE OF MODIFIED ATMOSPHERE PACKAGING ON SHELF LIFE OF „ĆEVAPČIĆI“

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As a part of the assortment of meat products in retail stores, „ćevapčići“ which belonging to the group of minced shaped products were represented. The shelf life of this not thermally treated product was defined by Regulation on quality and other requirements for meat products (Official Gazette SCG 33/2004) and it was up to 48 hours when the packaged product were stored at temperature below +4 ° C.

Modified atmosphere packaging (MAP) could extend the shelf life of „ćevapčići“. Gas mixtures with higher level of oxygen (O<sub>2</sub>) have favourably impact on maintenance of bright red color as most important sensory characteristics of fresh meat in retail. Modified atmosphere packaging of „ćevapčići“ is rarely present on Serbian market.

The aim of this study was to attend microbiological, sensory and chemical changes of MAP packaged „ćevapčići“ in gas mixture consisting of 60% O<sub>2</sub> and 15% CO<sub>2</sub> and 15% N<sub>2</sub>. Such packaged samples were stored for 10 days at +3° C. Microbiological examination was comprised determination of pathogenic microorganisms (*Salmonella spp*, *coagulase positive staphylococci*, *E. Coli* and *Listeria monocytogenes*) as well as indicators of hygiene and spoilage (Total Viable Count, Psychrotrophic Bacteria, *Enterobacteriaceae*, Lactic Acid Bacteria and *Bronchothrix thermosphacta*). The samples were examined every day. Using quantitative-descriptive test with grading scale from one to five sensory properties of „ćevapčići“ were assessed ( color and smell in row condition and smell, consistency and tast after fried) on 1<sup>st</sup>, 4<sup>th</sup>, 6<sup>th</sup> and 8<sup>th</sup> day. Regarding the chemical parameters, every day of experiment pH value was examined and on 4<sup>th</sup> and 8<sup>th</sup> day examination included acid value and peroxid number.

Results of this experiment indicate that shelflife of „ćevapčići“ packaged in modified atmosphere was seven days.

**Key words:** „ćevapčići“, shelf life, modified atmosphere.

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## UTICAJ POLIMERSKOG KOMERCIJALNOG PAKOVANJA NA PROMENE FIZIČKO-HEMIJSKIH KARAKTERISTIKA GOTOVIH JELA

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Proizvodnja gotovih jela predstavlja segment prehrambene industrije koji je trenutno u najbržem razvoju. Postoji veliki asortiman gotovih jela na ruskom tržištu, ali sterilizovani (termički obrađeni/kuvani) proizvodi zauzimaju najveći deo ovog tržišta. Proces sterilizacije, odn. kuvanja u tehnologiji očuvanja proizvoda zahteva najviše energije (oko 40% od ukupno potrošene toplote).

Cilj ovog rada je bio smanjenje režima sterilizacije u proizvodnji gotovih obroka u polimerskim pakovanjima na bazi kompleksnog ispitivanja karakteristika kvaliteta proizvoda. Gotova jela „čufte“ i „govedina-stroganoff u sosu od pavlake sa priložima“, pre i posle sterilizacije, proizvedeni i pakovani u polimerskom pakovanju od dva dela, su odabrani kao predmet ispitivanja.

Frakcija u masi proteina, masti, pepela, ugljenih hidrata, vlage, vrednost redoks potencijala (Eh), pH, amino-amonijačni azot, sastav frakcija proteina, itd., su određivani u gotovim jelima.

Na osnovu dobijenih rezultata, utvrđeno je da su promene u hemijskom sastavu proizvoda bile neznatne i posle odabranog režima sterilizacije. Prema tome, smanjenje mase frakcije proteina je u proseku bilo 6%, a frakcije masti u masi – 3,0%.

Utvrđen je stepen destrukcije proteina u gotovim jelima zavisno od stepena usitnjavanja i prethodnog tretmana sirovine. Opšti trend smanjenja frakcije proteina rastvorljive u soli i povećanje frakcije protiena rastvorljive u vodi i alkalima je bio značajan.

Pravi izbor režima sterilizacije potvrđen je i dobijenim vrednostima amino-amonijačnog azota u gotovim jelima. Utvrđen je neznatni porast u vrednosti amino-amonijačnog azota nakon sterilizacije „čufiti“ – 7,0%, odnosno „govedine-stroganoff u sosu od pavlake sa priložima“ – 4,5%.

Intenzitet redoks potencijala u gotovim jelima u odnosu na vrednost redoks potencijala pre sterilizacije je takođe utvrđen: u gotovim jelima „čufte“, smanjenje vrednosti redoks potencijala od 0,59%, a u gotovim jelima „govedine-stroganoff u sosu od pavlake sa priložima“ – 0,45%.

Analiza fizičko-hemijskih karakteristika sterilizovanih proizvoda omogućila je određivanje najpogodnijih režima sterilizacije gotovih jela pakovanih u dvostrukim polmerskim pakovanjima, uzimajući u obzir intenzitet destruktivnih procesa, koji se dešavaju u jelima prilikom predtretmana mesnih sirovina i intenzitet termičke obrade.

**Ključne reči:** gotova jela, fizičko-hemijske karakteristike, režim sterilizacije.

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## INFLUENCE OF POLYMER CONSUMER PACKAGE ON CHANGES IN PHYSICO-CHEMICAL CHARACTERISTICS OF READY DINNER DISHES

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Production of ready dishes at the present time is one of quickly developing segments of food products market. There is a large range of ready dishes on the Russian market, but it's sterilized products that take the largest niche up to now. The process of sterilization in products preservation technology is the most energy-consuming (about 40% consumed of the total amount of the used heat).

The purpose of the work was the reduction of sterilization regimes in the manufacture of second dinner courses in polymer package based on the complex study of products quality characteristics. Ready dinner dishes "meatballs" and "beef-stroganoff in sour cream sauce with garnish" prior and after sterilization, manufactured in polymer two-section package were chosen as the objects of investigations.

Mass fraction of protein, fat, ash, carbohydrates, moisture, value of redox potential (Eh), pH, amino-ammonia nitrogen, fractional composition of protein were determined in ready dishes.

According to the results it was established that changes in chemical composition of the product were insignificant with the chosen sterilization regime. Thus, the decrease of mass fraction of protein was in average 6%, and of mass fraction of fat – 3.0%.

The degree of protein destruction in dinner dishes depending on the degree of comminution and pre-treatment of raw meat was found. A general trend of decrease of salt-soluble fraction of protein and increase in water-soluble and alkaline-soluble fraction of protein was marked.

The right choice of sterilization regime was confirmed by the obtained values of amino-ammonia nitrogen of ready dishes. A slight increase in the value of AAN after sterilization for "meat balls" – 7.0%, for "beef-stroganoff in sour cream sauce with garnish" – 4.5% was established.

The intensity of redox potential reduction in ready dishes in relation to the value of redox potential prior to sterilization was established: in dinner dishes "meatballs" reduction of the value of redox potential was 0.59%, and in dinner dishes "beef-stroganoff in sour cream sauce with garnish" – 0.45%.

The analysis of physico-chemical characteristics of sterilized products allowed determination of friendly regimes of sterilization for ready dinner dishes in two-section polymer package, taking into account intensity of destructive processes, occurring in dishes during pretreatment of meat raw materials and intensity of thermal treatment.

**Key words:** ready dinner dishes, physico-chemical characteristics, sterilization regime.

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## PRIMENA NANOTEHNOLOGIJE U PAKOVANJU MESA

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Koncept nanotehnologije opisan je u naučnoj javnosti 1952. godine od strane nobelovca Ričarda Fenana. Nagli rast popularnosti ove tehnologije usledio je 80-ih godina prošlog veka. Strogo gledano, nanotehnologija se bavi precizno organizovanom manipulacijom i eksperimentisanjem sa česticama nanometarske veličine, tzv. „nanočesticama“, s krajnjim ciljem proizvodnje novih struktura, materijala i mašina.

Nanotehnologija ima potencijal da donese revoluciju u sistemu bezbednosti i kvaliteta mesa. Naime, proizvođači mesa u 21. veku konstantno su pod pritiskom državnih organa koji donose sve strožije propise u pogledu bezbednosti mesa i proizvoda od mesa, ali i dozvoljenih materijala za pakovanje. S druge strane, kod potrošača intenzivno raste svest o potrebi da meso ostane sveže što je moguće duže, da je manipulacija proizvodima od mesa što lakša, kao i da se koriste ekološki materijali za pakovanje. Da bi se napravio kompromis između ovih stavova, ali i da bi opstala u jakoj konkurenciji, industrija je razvila inovacije na polju fleksibilnih materijala za pakovanje koji poboljšavaju performanse proizvoda. Osnovna ideja je da pakovanja sačinjena od nanomaterijala, za razliku od dosadašnjih pakovanja, moraju biti **aktivna i inteligentna**.

**Aktivna pakovanja** podrazumevaju oblaganje mesa ili proizvoda od mesa posebnim nanokompozitnim materijalima da bi se sprečila penetracija kiseonika, ugljen-dioksida i vodene pare u meso. Cilj je dakle da se plastika konvertuje u superbarijeru, nalik staklu ili metalu. Super barijere imaju osobinu „tortuoznog“ prolaska gasova, tj. iako je nanofilm jako tanak, blokovi nano čestica formiraju „cik-cak“ strukturu, tako da nepoželjni gasovi (kiseonik) ne mogu da uđu u pakovanje, ali lako mogu da izađu iz pakovanja (ugljen dioksid). Osnovu nanokompozita čine čestice gline koje su u obliku blokova fino dispergovane u polietilenskom, najlonskom ili polipropilenskom matriksu pakovanja. Glina je u nativnom stanju hidrofilna, a polimer hidrofoban, tako da se vrši katjonska izmena kako bi materijali bili kompatibilni. Aktivnost pakovanja postiže se i aplikacijom molekula antimikrobnih jedinjenja koja se samooslobađaju u pogoršanim (nehigijenskim) uslovima čuvanja mesa i baktericidnim delovanjem sprečavaju invaziju patogenih mikroorganizama.

**Inteligentna pakovanja** podrazumevaju implantaciju nanosenzora u sam materijal za pakovanje. Ukoliko se u mesu nađu *Escherichia coli*, *Campylobacter*, *Salmonella* vrste, *Listeria monocytogenes*, ili različiti toksični metaboliti, dolazi do kontakta između nanosenzora i patogena i potrošač na osnovu promene boje senzora, lako može da uoči neispravnost namirnice. Za ove aplikacije koriste se nanoemulzije, čestice ulja veličine od 400–800 nm koje se ireverzibilno fuzionišu sa membranama patogenih mikroorganizama, a potom ih dezintegrišu uz promenu boje.

Iako ne postoje naučni dokazi da su nanočestice štetne po zdravlje ljudi, primena nanotehnologije može biti rizična zbog nastanka kontaminenata koji se lako prenose po životnoj sredini zbog svoje male veličine. Prva ispitivanja pokazuju da se nanočestice talože u nosnoj duplji, plućima, ali i mozgu pacova, kao i da karbonske nanocevi uzrokuju oštećenje mozga kod riba. Industrija mesa, jednom je već postala sumnjičava u pogledu upotrebe GMO, pa će sigurno biti oprezna kod usvajanja proizvodnje „atomske“ modifikovanog mesa.

**Ključne reči:** nanotehnologija, meso i proizvodi od mesa, pakovanje.

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## USE OF NANOTECHNOLOGY IN MEAT PACKAGING

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The concept of nanotechnology was first described in scientific community in 1952, by Nobel laureate Richard Fennan. A giant leap in popularity of this technology occurred during late 1980-ies. Basically, nanotechnology manipulates and experiment with nano-sized particles in a highly precise and organized manner. Final aim is to develop new structures, materials and machines.

Nanotechnology has a potential to bring revolution in food safety and quality system. Namely, meat producers of the 21<sup>st</sup> century are constantly being stressed by authorities who continually lay down new food safety and packaging material regulations as well as consumers which become more and more self-aware of the importance of prolonged meat freshness, ease of handling and usage of eco-friendly packaging materials. In order to resolve these opposite approaches industry went further on development of flexible packaging materials which improve meat product performance. Basic idea was that modern nano-packaging materials unlike previous ones should be **active** and **intelligent**.

**Active packaging** implies wrapping meat or meat products by special nanocomposite materials in order to prevent penetration of oxygen, carbon dioxide or water vapor into meat. Aim is therefore to convert plastics into super barrier, like glass or metal. Super barriers possess a unique “tortuous” gas passage pattern i.e. although nanofilms are being very thin; nanoparticle blocks form “zig-zag” structure which restrict oxygen flow-in while simultaneously facilitate flow-out of carbon dioxide. Nanocomposites are basically made of clay particles which are finely dispersed within polyethylene, nylon or polypropylene matrix. Native clay is hydrophilic, while polymer is hydrophobic. In order to make these two layers compatible, cationic exchanges most occur. Activity is also acquired by using molecules of antimicrobial substances which become self-released once the foodstuff undergoes temperature abuse etc. In this manner invasion of pathogenic microorganisms is prevented.

**Intelligent packaging** denotes implantation of nanosensors within the very same packaging material. If *Escherichia coli*, *Campylobacter*, *Salmonella* spp., *Listeria monocytogenes* or different toxic metabolites are present or develop within the foodstuff, nanosensors attach to a hazard followed by color change which enables consumer to spot unsafe product. In order to accomplish this task, an oil droplets size of 400-800 nm are used, which upon contact disintegrate cell membranes.

Although there are no hard scientific evidences which render nanoparticles to be unsafe for humans, application of nanotechnology could be a risk due to occurrence of easily transferable-small sized environmental contaminants. Initial investigations showed that nanoparticles deposit in nasal cavities, lungs and brains of the rats. Carbon nanotubes can also deposit in brain of fishes. Meat industry which already became suspicious regarding usage of GMO for sure will become more cautious when it comes to production of “atomic” modified meat

**Key words:** nanotechnology, meat and meat products, packaging.

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## ODRŽIVOST SVEŽE KOBASICE U PAKOVANJU SA MODIFIKOVANOM ATMOSFEROM

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Sveže kobasice su nesalamureni proizvodi dobijeni od različitih vrsta mesa i masnog tkiva u koje se dodaju voda, kuhinjska so, aditivi, začini, ekstrakti začina i vlakna. Nakon punjenja u omotače, sveže kobasice se konzervišu hlađenjem ili smržavanjem. Upakovani proizvodi čuvaju se pri temperaturi do +4° C najviše do 48 sati, a pri temperaturi do -18° C najviše do 60 dana.

Sveže kobasice mogu da se čuvaju i u pakovanjima sa modifikovanom atmosferom gasova (MAP). Ovako upakovani proizvodi čuvaju se pri temperaturi do 4° C, dok je vreme čuvanja različito u zavisnosti od vrste mesa, sastava mesnog prata, sastava gasova, vrste pakovanja itd. Sveže kobasice u MAP pakovanju nisu uobičajene u maloprodaji na teritoriji Srbije.

Cilj ovog rada bio je da se multidisciplinarnim pristupom ispita održivost sveže kobasice u MAP pakovanju. Uzorci za ispitivanje bili su upakovani u polistirenske posude sa polietilenskom folijom. Za modifikovanu atmosferu odabrana je sledeća kombinacija gasova: 60% O<sub>2</sub>, 15% CO<sub>2</sub> i 15% N<sub>2</sub>. Održivost proizvoda procenjena je konsenzusom na osnovu rezultata mikrobioloških, senzorskih i hemijskih ispitivanja. Period ispitivanja iznosio je 8 dana.

Mikrobiološka ispitivanja obuhvatala su određivanje broja mikroorganizama indikatora higijene (ukupan broj aerobnih mezofilnih i psihrotrofnih bakterija i ukupan broj bakterija familije *Enterobacteriaceae*), mikroorganizme kvara (ukupan broj bakterija mlečne kiseline i *Brochothrix thermosphacta*) kao i određivanje prisustva patogenih mikroorganizama (*Salmonella* vrste, koagulaza pozitivne stafilokoke, *E. Coli* i *Listeria monocytogenes*). Uzorci su svakodnevno mikrobiološki ispitivani sve do 8. dana. Senzorske osobine ispitivane su pomoću kvantitativno-deskriptivnog testa na skali intenziteta od 1 do 5 (boja i miris u sirovom stanju i miris, konzistencija i ukus posle probe pečenja) 1, 4, 6. i 8. dana. Hemijska ispitivanja obuhvatala su svakodnevno merenje pH vrednosti, dok su 4. i 8. dana eksperimenta ispitivane promene lipidnog statusa (kiselinski stepen i peroksidni broj).

Rezultati ispitivanja pokazali su da su sveže kobasice upakovane u zaštitnoj atmosferi gasova bile održive 7 (sedam) dana.

**Ključne reči:** sveže kobasice, održivost, MAP.

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## SHELF-LIFE OF RAW MAP PACKAGED SAUSAGES

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Raw sausages are non-brined products composed of different meat species and fat tissue, water, common salt, additives, spices, spice extracts and fibers. Once stuffed in casings, raw sausages undergo conservation by refrigeration or freezing. Packaged products are kept at the 4°C for 48 hours i.e. at the -18°C for 60 days.

Raw sausages can also be kept in modified atmosphere packaging (MAP) at the 4°C, while the shelf-life differs in relation to meat species, stuffing composition, gas composition, packaging type etc. Raw MAP packaged sausages are not common at Serbian meat retail market.

Aim of this paper was to establish shelf-life of raw MAP packaged sausages. Samples were packaged into polystyrene trays with polyethylene foils. The following gas composition was selected for MAP packaging: 60% O<sub>2</sub>, 15% CO<sub>2</sub> and 15% N<sub>2</sub>. Shelf-life was assessed through consensus of results of microbiological, sensory and chemical studies. Experiment lasted 8 days.

Microbiological studies included quantification of hygiene indicators (total viable count of mesophylic and psychrotrophic bacteria and *Enterobacteriaceae*), spoilage flora (LAB and *Brochothrix thermosphacta*) as well as detection of common food pathogens (*Salmonella* spp, coagulase positive staphylococci, *E. coli* and *Listeria monocytogenes*). Samples were successively investigated throughout 8 days. Sensory properties (color and odor of raw sausage; odor, consistency and taste after cooking) were evaluated by quantitative-descriptive test at the scale from 1 to 5. Sensory evaluation took place at 1<sup>st</sup>, 4<sup>th</sup>, 6<sup>th</sup> and 8<sup>th</sup> day of the experiment. Chemical studies included daily reading of pH value, while at the 4<sup>th</sup> and 8<sup>th</sup> day changes in lipid status (acid value and peroxide value) were evaluated.

Results of the experiment indicated that shelf-life of raw MAP packaged sausages was 7 (seven) days.

**Key words:** raw sausages, shelf-life, MAP.

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**SENZORSKE KARAKTERISTIKE NAREZAKA SUVIH  
FERMENTISANIH KOBASICA (KULEN) UPAKOVANIH U  
ATMOSFERU ZAŠTITNIH GASOVA**

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Slobodan Lilić<sup>2</sup>

U radu su predstavljene senzorske karakteristike narezaka suvih fermentisanih kobasica (kulen) upakovanih u atmosferu zaštitnih gasova. Za senzorsko ocenjivanje korišćene su numeričko deskriptivne skale sa bod sistemom od 5 ocena (5 – najbolja ocena, 1 – najlošija ocena). Gotov proizvod je narezan u tanke nareske koji su pakovani u smešu gasova (70% azota i 30% ugljen dioksida). Senzorske osobine su ocenjivane tokom 90 dana u intervalu od po mesec dana. Prvog i šezdesetog dana od proizvodnje, boja je ocenjena prosečnom ocenom 4,50, miris sa 4,67, a ukus sa 4,42. Posle 90 dana od proizvodnje, boja je ocenjena ocenom 4,08, miris sa 4,33 i ukus sa 4,42. Manje ocene za boju su dobijene usled pojave sivkaste boje na narescima. Zaključak ovih ispitivanja je da su naresci kulena održivi 60 dana od dana pakovanja.

**Ključne reči:** suva fermentisana kobasica, pakovanje, atmosfera zaštitnih gasova.

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**SENSORY CHARACTERISTICS OF DRY FERMENTED  
SAUSAGES SLICES (KULEN) PACKED IN  
MODIFIED ATMOSPHERE**

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Slobodan Lilić<sup>2</sup>

In this paper, the sensory characteristics of slices of dry fermented sausage (kulen) packed in modified atmosphere are presented. For sensory evaluation numeric-descriptive scale with 5 point system was used (5 – the highest score, 1 – the lowest score). Final product was sliced and slices were packed in the mixture of gases (70% nitrogen and 30% carbon dioxide). Sensory properties were scored during the period of 90 days in the same one month intervals. On the first and the 60th day from the production, the color was scored 4.50 points, odor 4.67 and taste 4.42. After 90 days, color was scored 4.08 points, odor 4.33 and taste 4.42. Lower average score for color was due to changes in the slice color (appearance of the grayish color). Conclusion was that slices of “kulen” were shelf stable 60 days from the packing.

**Key words:** dry fermented sausage, packing, modified atmosphere.

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**V TEMATSKA OBLAST**  
***5<sup>th</sup> THEMATIC TOPICS***

**NUTRITIVNI KVALITET MESA I PROIZVODA OD MESA**  
***NUTRITION QUALITY OF MEAT AND MEAT PRODUCTS***



## KOMPOZICIJA TRUPA I HEMIJSKI SASTAV MESA TOVNIH PILIĆA IZ INTEZIVNOG I POLUINTEZIVNOG NAČINA GAJENJA

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Sistemi gajenja živine već duži niz godina u mnogim zemljama sveta zaokupljaju pažnju i nauke i struke. Čine se brojni pokušaji da se u gajenju živine namenjene proizvodnji mesa i jaja inoviraju i ustanove nove tehnologije koje bi doprinele, pre svega, poboljšanju uslova gajenja, zaštiti životne okoline i koji bi osigurali bolji kvalitet živinskih proizvoda.

Polazeći od navedenog, cilj ovog rada bio je da se prikažu rezultati ispitivanja uticaja sistema gajenja na važnije osobine kvaliteta mesa (udeo osnovnih delova u obrađenim trupovima, udeo tkiva u važnijim osnovnim delovima i hemijski sastav mišićnog tkiva). Za istraživanje je poslužilo ukupno 400 pilića linijskog hibrida Hybro koji su gajeni na 2 različita načina (intezivan i poluintezivan). Po završetku tova i nakon klanja i primarne obrade trupova izvršena su neophodna merenja i uzeti su uzorci za analize hemijskog sastava mesa.

Rezultati ovog istraživanja pokazuju da su pilići odgajani na poluintezivan način imali nešto veći udeo bataka i grudi, tj. mesa I kategorije, kao i veći udeo mišićnog tkiva u grudima i karabatacima. Osim navedenog, sadržaj proteina u mišićnom tkivu grudi, bataka i karabataka bio je veći kod pilića iz poluintezivnog načina gajenja. S druge strane, sadržaj masti u navedenim osnovnim delovima bio je veći kod pilića iz intezivnog načina gajenja.

U celini posmatrano, rezultati ovih istraživanja pokazali su da su pilići gajeni uz korišćenje ispusta tj. na poluintezivan način u većini ispitivanih osobina postigli bolje rezultate u odnosu na piliće iz intezivnog načina gajenja.

**Ključne reči:** pilići, sistemi gajenja, kvalitet mesa.

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## CARCASS COMPOSITION AND CHEMICAL COMPOSITION OF MEAT OF FATTENING BROILERS FROM INTENSIVE AND SEMI-INTENSIVE REARING SYSTEMS

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Rakonjac Simeon<sup>1</sup>

Systems of poultry rearing have for long time been in focus of attention of scientists and experts in numerous countries. Numerous attempts have been made, in rearing of poultry intended for production of meat or eggs, to innovate or introduce new technologies which would contribute primarily to improvement of rearing conditions, protection of the environment and which would ensure better quality of poultry products.

Starting from above mentioned, objective of this paper was to present the results of the investigation of the effect of rearing system on major meat quality properties (share of main parts in treated carcasses, share of tissues in major parts and chemical composition of muscle tissue). Total of 400 chickens of hybrid Hybro, reared in 2 different systems (intensive and semi-intensive), were used in this investigation. Upon the end of fattening and after slaughtering and primary processing of carcasses, measures were taken as well as samples for analysis of the chemical composition of meat.

Results of the research show that chickens reared in semi-intensive system had slightly higher share of drumsticks and breasts, i.e. meat of I category, as well as higher share of muscle tissue in breasts and thighs. Also, protein content in muscle tissue of breasts, drumsticks and thighs was higher in chickens reared in semi-intensive system. On the other hand, content of fat in mentioned main carcass parts was higher in chickens from the intensive rearing system.

In general, research results showed that chickens reared in a system where range was used, i.e. in semi-intensive system, had better results in majority of investigated traits, compared to chickens reared in intensive system.

**Key words:** chickens, rearing system, meat quality.

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## UTICAJ MINAZELA PLUS NA PRIRAST JUNICA U TOVU

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U radu su prikazani rezultati istraživanja zeolitskog preparata Minazela Plus (ITNMS, Beograd, Srbija) na proizvodne osobine junica u tovu. Ženska telad koja nisu ostavljena za priplod, iskorišćena su za tov kao dobar izvor govedeg mesa, iako ona postižu nešto manji prirast u odnosu na muška grla. Ogled ishrane je trajao 150 dana. Obrok se sastojao od livadskog sena (kao kabastog dela obroka) i koncentrovane krmne smeše. Grla su podeljena u 2 grupe: kontrolnu (K, n = 11 grla, bez preparata Minazela Plus u obroku) i oglednu (O–I, n = 11 grla, sa 0,2% Minazela Plus u obroku). Prosečna masa ženske teladi na početku ogleda bila je 139,09 kg u obe grupe. U toku ogleda merene su telesne mase junica po grupama 31., 61., 91., 121., 150. dana i izračunati prosečni dnevni prirasti grla po grupama i oglednim periodima. Na kraju ogleda, 150. dana junice iz kontrolne grupe imale su prosečnu telesnu masu 297,91 kg, a junice iz ogledne grupe 300,00 kg. Rezultati istraživanja su pokazali da su junice, koje su u obroku dobijale Minazel Plus (0,2%), ostvarile nešto veći prosečni dnevni prirast u svim oglednim periodima, kao i u celokupnom periodu tova (1,073 kg/grlu/dan) u odnosu na junice kontrolne grupe (1,059 kg/grlu/dan), pri čemu razlike u prosečnim dnevnim prirastima između grupa nisu bile statistički značajne ( $p > 0,05$ ).

**Ključne reči:** junice, tov, prirast, Minazel Plus.

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## THE EFFECT OF MINAZEL PLUS ON GAIN OF FATTENING HEIFERS

Dosković Vladimir<sup>1\*</sup>, Radović Vera<sup>1</sup>, Đoković Radojica<sup>1</sup>

In this paper, the results of the study of zeolite preparation Minazel Plus (ITNMS, Belgrade, Serbia) on production performance of fattening heifers, are presented. Female calves which were not used in breeding, were used for fattening as good source of beef, even though they have slightly lower gain in comparison to male animals. Diet trial lasted 150 days. Diet consisted of meadow hay (as roughage part of the diet) and concentrated feed mixtures. Animals were divided into 2 groups: control (K, n = 11 animals, without Minazel Plus preparation in diet) and experimental group (O–I, n = 11 animals, with 0.2% Minazel Plus in diet). Initial average body mass of female was 139.09kg in both groups. During, body masses of heifers were recorded according to groups on 31st, 61st, 91st, 121st, 150th day, and average

daily gains per animal, per group and per trial period were calculated. At the end of the experiment, on 150th day, heifers from the control group had average body mass of 297.91 kg, and heifers from the trial group 300,00 kg. Research results showed that heifers fed diet containing Minazel Plus (0.2%) realized slightly higher daily gain during all experiment, as well as entire fattening period (1.073 kg/animal/day) compared to heifers in the control group (1.059 kg/animal/day), but differences in average daily gains between groups were not statistically significant ( $p > 0,05$ ).

**Key words:** heifers, fattening, gain, Minazel Plus.

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## ISPITIVANJE MIKROSTRUKTURE SKROBA U RAZLIČITIM TEHNOLOŠKIM TRETMANIMA

Hvylya Sergey I.<sup>1\*</sup>, Pchelkina Victoriya A.<sup>1</sup>, Burlakova Svetlana<sup>1</sup>

Široko rasprostranjena upotreba skrobova u tehnologiji proizvoda od mesa zahteva sistematsko poznavanje ove oblasti i naučni pristup njegovoj upotrebi. Glavni cilj našeg istraživanja bilo je ispitivanje mikrostrukture različitih tipova prirodnih i modifikovanih skrobova u modeliranju tehnoloških postupaka u proizvodnji proizvoda od mesa. Na ovaj način moguće je oceniti efikasnost i odabrati režime termičke obrade za potpunije poznavanje funkcionalnih svojstava skrobova.

Postojeći odnos između promene u strukturi skroba, koji je dodat u proizvod od mesa, i uslova toplotne obrade može se koristiti kao kriterijum za određivanje stepena finalizacije kobasice. U tom slučaju, skrob različitog biološkog porekla sa varijacijama u morfološkoj strukturi imaju jasno različite temperature želatiranja, i stoga, različita tehnološka svojstva. U Sve-Ruskom institutu za ispitivanje mesa izvedena su ispitivanja uticaja temperature u opsegu od 0° C do 80° C na zrnastu strukturu različitih tipova skroba.

**Ključne reči:** metod koji se bazira na mikrostrukтури, skrobovi, morfometrijska analiza, hidracija, proizvodi od mesa.

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## STUDY OF STARCH MICROSTRUCTURE IN CASE OF DIFFERENT TECHNOLOGICAL TREATMENT

Hvylya Sergey I.<sup>1\*</sup>, Pchelkina Victoriya A.<sup>1</sup>, Burlakova Svetlana<sup>1</sup>

Wide use of starches in meat products technology requires systemic knowledge in this field and scientific approach to its use. The main goal of our investigations was the study of microstructure of different types of native and modified starches in modeling of technological processes of meat products manufacture. This makes it possible to evaluate efficiency and select more advantageous regimes of thermal processing for a more complete knowledge of functional potentials of starches.

The existing relationship between change in the structure of starch, added to meat item, and thermal treatment conditions can be used as a criterion of the degree of sausages doneness. In this case the starches of different biological origin with variation in morphological structure have strongly differing temperature of gelatinization, and hence different technological properties. In the All-Russian Meat



Research Institute the investigations were carried out on the effects of temperature range from 0°C to 80°C on grains structure of different types of starches.

**Key words:** microstructure-based method, starches, morphometric analysis, hydration, meat products

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## UTICAJ KONZUMIRANJA MESA NA BMI KOD RAZLIČITIH GRUPA ODRASLIH LJUDI

Kočovska Marija<sup>1\*</sup>, Stojanovski Mitre<sup>1</sup>, Šambevska Katerina<sup>1</sup>, Marijana Radevska<sup>1</sup>

Debljina kod ljudi smanjuje radnu sposobnost, ima pozitivan uticaj kod uvećavanja zdravstvenih problema, kao i smanjenja životnog veka.

Indeks telesne mase (ITM) ili Body Mass Index (BMI), je pokazatelj kojim se upoređuje masa ljudi i njihova visina. Ljudi sa prekomernom masom se definišu kada je njihov BMI između 25 kg/m<sup>2</sup> i 30 kg/m<sup>2</sup>, i debeli kada je BMI veći od 30 kg/m<sup>2</sup>.

Debljina kod ljudi najčešće je prouzrokovana nesrazmernom kombinacijom hranljivih proizvoda i prekomernom ishranom, unošenje velikih količina energije, kao i nedostatak fizičke aktivnosti za njeno trošenje.

Radi ispitivanja uticaja konzumiranja mesa i mesnih prerađevina nad telesnom masom kod stanovništva, izvršena su ispitivanja 100 ispitanika, koji su zatim podeljeni u prema starosnoj strukturi, od 11 do 12 godina, od 21 do 30 godina, od 31 do 40 godina, od 41 do 50 godina, i preko 51 godinu.

Ispitivanjem je konstatovano da prosečna dnevna konzumacija mesa i mesnih prerađevina u proseku po čoveku iznosi 158 g.

Meso i mesne prerađevine konzumiraju se približno 4 dana u toku nedelje, odnosno 4,03 dana. Nedeljna konzumacija mesa u proseku po čoveku iznosi 646,6 g pri čemu je najčešće korišćeno svinjsko meso 46%, zatim pileće 38%, malo manje je zastupljeno goveđe sa 6%, kao i riba 10%.

Kao rezultat konzumiranja mesa, utvrđeno je uvećanje BMI kod 44% ispitanika. Najnepovoljniji BMI zapažen je kod starosne grupe muškaraca od 41 do 50 godina koji iznosi 28,23; zatim kod žena preko 51 godine kod kojih BMI iznosi 27,761; muškarci preko 51 godine sa BMI od 27,443 i žena od 41 do 50 godina sa BMI od 27,222.

Na osnovu izvršenih istraživanja za uticaj konzumacije mesa na BMI utvrđeno je da uvećani unos mesa, posebno svinjskog, prerađevina od mesa, kao hrane koja ima visoke energetske vrednosti, imaju značajan uticaj u uvećanju BMI.

**Ključne reči:** BMI, konzumacija svinjskog i goveđeg mesa, riba, starosne grupe ljudi.

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## IMPACT OF MEAT CONSUMPTION ON BMI IN DIFFERENT AGE GROUPS OF PEOPLE

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Obesity in humans is a condition which reduces the working capacity, have impact in increasing health problems and reduced life expectancy.

Body Mass Index (BMI) is an indicator that compares the mass of people and their height. People are defined by overweight when their BMI is between 25 kg/m<sup>2</sup> and 30 kg/m<sup>2</sup>, and obese when BMI exceeds 30 kg/m<sup>2</sup>. Obesity in humans is usually caused by a combination of inadequate nutritional products and diet, excessive intake of large amounts of energy, and lack of physical activity.

In order to examine the impact of meat and meat products consumption, on the body mass of the population, carried out tests on 100 people, which are then divided into different age groups, from 11 to 20 years, from 21 to 30 years, from 31 to 40, 41 to 50 years and over 51 years.

In tests it was found that the average daily consumption of meat and meat products is 158 grams. Meat and meat products are consumed approximately 4 days a week, or 4.03 days. Weekly consumption of meat per person has averaged 646.6 grams, and most often used is pork which is represented by 46%, followed by chicken meat 38%, beef meat is represented by 6% and fish by 10%.

As a result of this consumption of meat is marked increase in BMI in 44% of people. Worst BMI was observed among the age group of men from 41 to 50 years, which is 28.23, then in women over 51 years in whom BMI is 27.761, men over 51 years with BMI of 27, and 443 women from 41 to 50 years with a BMI of 27.222.

Based on research conducted on the impact of meat consumption on BMI may be concluded that increased intake of meat, especially pork and pork meat products which represents food that has high energy value, have a significant impact in increasing BMI.

**Key words:** BMI, consumption of meat from pigs, cattle, fish, age groups of people.

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## ISPITIVANJE FUNKCIONALNO-TEHNOLOŠKIH SVOJSTAVA SUNCOKRETOVE SAČME KAO OBEĆAVAJUĆEG PROTEINSKOG DODATKA U PROIZVODNJI KONZERVU OD MESA

Krylova Valentina B.<sup>1\*</sup>, Gustova Tatyana V.<sup>1</sup>, Khramkova Regina V.<sup>1</sup>

Nedostatak proteina u prehrambenim proizvodima izaziva potrebu za traženjem novih izvora proteina. Da bi se u potpunosti zadovoljile potrebe populacije/stanovništva za proteinom u narednih 20 godina, njegov obim proizvodnje bi trebalo da se poveća 2 do 3 puta. Uvođenje proteina biljnog porekla koji imaju visoko hranjivu vrednost i funkcionalno-tehnološka svojstva u proizvodnju konzervi od mesa omogućava povećanje stepena korišćenja resursa proteina u celosti.

Suncokret je jedna od glavnih ratarskih kultura u Rusiji. Suncokret čini oko 65–70% ukupno proizvedenog biljnog ulja u zemlji.

U ovim uslovima, od posebne važnosti je problem poboljšanja hemijskog sastava hrane koje se može postići dodavanje proteina i drugih supstanci u prehrambene proizvode.

Cilj istraživanja je bio ispitivanje hemijskog sastava i funkcionalno-tehnoloških svojstava novog, domaćeg prehrambenog aditiva – suncokretove sačme „Sanpros“.

Sadržaj udela u masi proteina, masti, pepela, ugljenih hidrata, vlage, vitamina, sposobnost formiranja gela, sposobnost emulzifikovanja masti i stabilnost emulzije su ispitivani u ovom istraživanju.

Rezultati ispitivanja su pokazali specifičnu osobinu suncokretove sačme – visoki sadržaj proteina (do 47%) i visok sadržaj ugljenih hidrata (do 28%).

Suncokretova sačma sadrži grupu vitamina B. Takođe, utvrđena je značajna količina vitamina E (do 28 mg/100 g).

Koeficijent apsorpcije vode od 1,6 do 3,0 je utvrđen u ispitivanju funkcionalno-tehnoloških svojstava.

Utvrđeni su optimalni uslovi za formiranje gela radi dobijanja emulzije protein-mast. Visoka sposobnost emulzifikacije i stabilnost emulzije u korelaciji komponenti – protein : voda : mast 1 : 2 : 2 – je utvrđena. Najstabilniji sistemi su bili emulzije protein-mast sa istopljenom svinjskom masti i biljnim uljem.

Utvrđene su dobre mogućnosti/izgledi za korišćenje suncokretove sačme kao gelova, kao i u sastavu emulzije protein-mast u proizvodnji sterilizovane (termički obrađene/kuvane) paštete.

Upotreba biljnih sirovina domaćeg porekla preko ravnoteže hemijskog sastava pružiće mogućnost smanjenja troškova proizvodnje finalnog proizvoda.

**Ključne reči:** suncokretova sačma, hemijski sastav, funkcionalne osobine.

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## INVESTIGATION OF FUNCTIONAL-TECHNOLOGICAL PROPERTIES OF SUNFLOWER MEAL AS A PROMISING PROTEIN ADDITIVE IN PRODUCTION OF CANNED PRODUCTS

Valentina B. Krylova<sup>1\*</sup>, Tatyana V. Gustova<sup>1</sup>, Regina V. Khramkova<sup>1</sup>

Protein deficiency in food products causes the necessity of search of its additional sources. To fully satisfy the requirements of population in protein in the next 20 years, its production volume should be increased 2–3–fold. The introduction of proteins of plant origin possessing high food value and functional-technological properties into canned products production process makes it possible to increase the degree of use of proteins resources on the whole.

Sunflower is one of the main cultures in Russia. Sunflower accounts for about 65-70% of the manufactured vegetable oil in the country.

Of special importance under these conditions is the problem of improvement of chemical composition of foods that can be achieved by addition of protein and other substances into them.

The purpose of the investigations was to study chemical composition and functional-technological properties of a new domestic food additive – sunflower meal “Sanpros”.

The content of mass share of protein, fat, ash, carbohydrates, moisture, vitamins, gel-forming and fat-emulsifying capacity and stability of emulsion were studied in the investigations.

The results of the investigations have shown a specific feature of sunflower meal – high protein content (up to 47%) and carbohydrates content (up to 28%).

Sunflower meal contains a set of vitamins of group B. A significant amount of vitamin E was established (up to 28 mg per 100 g).

The coefficient of water absorption from 1.6 to 3.0 was reported in the investigation of functional-technological properties.

Optimum conditions of gel formation for obtaining protein-fat emulsions were determined. High emulsifying capacity and stability of the emulsion in the correlation - protein : water: fat component 1:2:2 - was found. The most stable systems were protein-fat emulsions with melted pork fat and vegetable oil.

Good prospects for the use of sunflower meal as gels and in the composition of protein-fat emulsion in production of sterilized pâté were determined.

The use of domestic plant raw materials balanced over chemical composition will give a possibility to reduce production cost of the final product.

**Key words:** sunflower meal, chemical composition, functional properties

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## MOGUĆNOST KORIŠĆENJA REAL TIME PCR METODE ZA KVANTITATIVNU OCENU SADRŽAJA SOJE U PROIZVODIMA OD MESA

Minayev Mikhail Yu.<sup>1</sup>, Fomina Tatyana A.<sup>1</sup>

Kvantitativna ocena sadržaja soje u gotovim proizvodima od mesa neophodna je radi ocene kvaliteta proizvoda. Prema specifikacijama, zamena glavne mesne sirovine biljnim materijalom može biti od 2 do 50 vol. %. Glavni supstituenti biljnog porekla su proizvodi od soje. Prema tome, razvoj metoda za ocenu sadržaja soje u finalnom proizvodu od mesa veoma je značajan. U tu svrhu, razvijen je sistem kvantitativne ocene korišćenjem real time PCR metode za merenje koncentrata nukleinske DNK soje. Sistem je testiran na kontrolnim uzorcima kobasica gde je unapred bio poznat procenat sadržaja soje.

**Ključne reči:** pcr metoda, kvantitativna evaluacija, gotovi proizvodi od mesa, soja.

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## PROSPECTS FOR THE USE OF REAL-TIME PCR METHOD FOR QUANTITATIVE EVALUATION OF SOYA CONTENT IN MEAT PRODUCTS

Minayev Mikhail Yu.<sup>1</sup>, Fomina Tatyana A.<sup>1</sup>

Quantitative evaluation of soya content in ready to eat meat product is necessary for the assessment of quality of the manufactured product. According to specifications, the substitution of the main meat raw materials with plant material may be from 2 to 50 vol. %. The main substitutes of plant origin are soya products. Therefore, the development of promising methods of assessment of soya contents in final meat products is important. For this purpose a system of quantitative evaluation by the real time PCR method on the basis of matrix of nuclear DNA of soya was developed. The system was tested on the control samples of sausages with previously known percentage of soya content.

**Key words:** real time pcr, quantitative evaluation, ready to eat meat products, soya.

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## MOGUĆNOST PROIZVODNJE VIRŠLE SA POVEĆANIM SADRŽAJEM OMEGA-3 MASNIH KISELINA

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Omega-3 masne kiseline su esencijalne masne kiseline i neophodne su za očuvanje zdravlja. Čovekov organizam ne proizvodi ove esencijalne masne kiseline i neophodno je unositi ih putem hrane. Najbolji izvori omega-3 masnih kiselina su masnije morske ribe, morske alge, račiči, ulja dobijena iz raznih vrste oraha. Riblje ulje je najbolji izvor omega 3-masnih kiselina koje imaju važnu ulogu u očuvanju funkcije nervnog sistema, razvoja mozga, kao i u obezbeđenju pravilnog rasta i razvoja. Američka asocijacija za srce (American Heart Assotiation), preporučuje konzumiranje morske masnije ribe, najmanje dva puta nedeljno. Poznato je da u Srbiji ljudi nemaju naviku da jedu morsku ribu, a kada uključuju ribu u ishranu, to je pretežno slatkodvodna riba, koja ne sadrži n-3 masne kiseline.

Kako su u našim krajevima u ishrani najomiljeniji i najzastupljenije namirnice meso i proizvodi od mesa, koji takođe nisu bogati sa ovim esencijalnim masnim kiselinama, u industrijskim uslovima, proizveli smo viršlu, kojoj smo dodali preparat koji u sebi sadrži trigliceride i omega-3 masne kiseline. Uporedo je proizvedena viršla istog sirovinskog sastava bez dodatka omega-3 masnih kiselina. Oba proizvoda skladištili smo 40 dana na temperaturi + 4° C i pratili mikrobiološke i senzorske promene (ukupan broj mikroorganizana i patogene mikroorganizme, boju, miris ukus i konzistenciju), prvog, desetog, dvadesetog, tridesetog i četrdesetog dana od dana proizvodnje. Metodom Gasne hromatografije (GC) sa FID-a detektorom, određen je sadržaj ukupnih n-3 masnih kiselina u oba proizvoda.

Rezultati naših ispitivanja pokazuju da dodata količina preparata na bazi omega-3 masnih kiselina nema negativan uticaj na mikrobiološka i senzorska svojstva viršle u toku 40 dana skladištenja. Nasuprot tome sadržaj n-3 masnih kiselina značajno je povećan i u odnosu na kontrolni proizvod veći je za 1,2%, što je u skladu sa dodatom količinom izabranog preparata. Rezultati jasno ukazuju da se primenom odgovarajuće dobro izbalansirane tehnologije, mogu proizvesti proizvodi od mesa, koji, bar što se sadržaja omega-3 masnih kiselina, mogu u ishrani zameniti morsku ribu.

**Ključne reči:** omega-3 masne kiseline, viršla, senzorna svojstva, GC sa FID-a detektorom.

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## POSSIBILITY OF PRODUCTION OF HOT DOGS WITH INCREASED CONTENT OF OMEGA-3 FATTY ACIDS

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Omega-3 fatty acids are essential fatty acids and are necessary for preservation of health. Human organism doesn't produce these essential fatty acids and therefore they need to be introduced into organism through food. The best sources of omega-3 fatty acids are fatty sea fish, sea algae/seaweed, shrimp, oils obtained from different types of nuts, etc. Fish oil is the best source of omega-3 fatty acids which have important role in conservation of the function of the nervous system, brain development, as well as ensuring proper growth and development. American Heart Association recommends consumption of fatty sea fish at least two times per week. It is known that people in Serbia don't have the habit to eat sea fish, and when they include fish in the diet, it is usually freshwater fish, which doesn't contain omega-3 fatty acids.

Since in our country, the most popular and predominant food stuffs in our diet are meat and meat products, which are also not rich in these essential fatty acids, in industrial conditions, we were able to produce hot dog supplemented with preparation containing triglycerides and omega-3 fatty acids. At the same time, hot dogs were produced of the same raw material composition but without the addition of omega-3 fatty acids. Both products were stored for 40 days at the temperature of + 4° C, and microbiological and sensory changes were monitored (total microbial count and pathogen microorganisms, colour, smell, flavour and consistency), on the 1st, 10<sup>th</sup>, 20<sup>th</sup>, 30<sup>th</sup> and 40<sup>th</sup> day after production. By method of gas chromatography (GC) with FID detector, the content of total n-3 fatty acids in both products was determined.

Results of our research show that added amount of preparation on basis of omega-3 fatty acids has no negative/adverse effect on microbial and sensory properties of hot dogs during 40 day storage. Contrary to this, content of n-3 fatty acids increased significantly compared to the control product by 1.2 %, which corresponds to added amount of chosen preparation. Results clearly indicate that in implementation of adequate balanced technology, meat products can be obtained which can replace sea fish in the diet, at least in regard to omega-3 fatty acids.

**Key words:** omega-3 fatty acids, hot dogs, sensory properties, GC with FID detector.

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## STRATEGIJSKO UPRAVLJANJE KVALITETOM U PROIZVODNJI HRANE

Milovanović Ružica<sup>1\*</sup>

Prehrambena industrija u Republici Srbiji se suočava sa mnogobrojnim izazovima koji proizilaze iz niza činjenica, kao što su veća očekivanja u oblasti proizvodnje zdravih, bezbednih i kvalitetnih proizvoda, razvoj prehrambenih kompanija sa snažnim zaštitnim znacima, globalizaciju trgovine, razvoj gigantskih maloprodajnih lanaca i dr.

Takođe, dugoročni i aktuelni problemi ispoljeni u nedovoljnom korišćenju kapaciteta, dobrim delom zbog nedostatka odgovarajućih sirovina i kvalitetnog menadžmenta, rezultiraju neefikasnom poslovanju i nedovoljnoj konkurentnosti.

Iz tih razloga politika unapređenja kvaliteta hrane u Republici Srbiji, predstavlja uslov za konkurentno uključivanje naše zemlje u EU.

Osnovna prepreka izvoza agrarnih proizvoda jeste neusaglašenost sa propisima EU i standardima kvaliteta. Pored zahteva da prehrambeni proizvodi na tržištu budu konkurentni kvalitetom i cenom, neophodno je da budu proizvedeni po posebnim standardima o bezbednosti i zdravstvenoj ispravnosti, uz princip slobodnog protoka robe i politike zaštite zdravlja ljudi.

Sistem HACCP (Hazard Analysis and Critical Control Points) se sve više koristi kao način sveobuhvatne kontrole. Sistem verifikuje apsolutnu higijensku-sanitarnu, toksikološku i svaku drugu bezbednost proizvoda. Takođe, ekološka racionalnost postaje sastavni deo privredne prakse.

Očuvanje prirodnih resursa, racionalno korišćenje i njihovi potencijali, dobija strateški značaj.

Organska poljoprivreda se razvila kao reakcija na sve izraženiju ekološku degradaciju, pogoršanje kvaliteta hrane i sve veće ugrožavanje zdravlja ljudi. Njen cilj je proizvodnja hrane visokog kvaliteta i razvoj održive poljoprivrede uz očuvanje ekosistema.

**Ključne reči:** hrana, ekologija, kvalitet, standard, upravljanje, menadžment.

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## STRATEGIC MANAGEMENT OF QUALITY IN FOOD PRODUCTION

Milovanović Ružica<sup>1\*</sup>

Food industry in the Republic of Serbia is faced with many challenges resulting from a series of facts, such as higher expectations in the field of production of healthy, safe and high quality products, the development of food companies with strong trademarks, trade globalization, the development of giant retailers and others.

Also, long-term and current problems manifested in insufficient utilization of capacity, largely due to lack of proper raw materials and quality management, resulting in inefficient operations and lack of competitiveness.

For these reasons, policy for quality of food improvement in the Republic of Serbia, is a condition for a competitive comprehension of Serbia into the EU.

The main obstacle for export of agricultural products is non-compliance with EU regulations and quality standards. In addition to demanding that food products on the market have to be competitive in quality and price, it is necessary to be manufactured according to special standards of safety and health control, together with the principle of free movement of goods and policies to protect public health.

HACCP (Hazard Analysis and Critical Control Points) is increasingly used as a method of across the board control. The system verifies the absolute hygienic and sanitary, toxicological, and any other safety of products.

Also, ecological rationality becomes an integral part of economic practice. Conservation of natural resources, rational use and their potential, obtain the strategic importance.

Organic agriculture has developed in response to the increasing environmental degradation, deterioration of food quality and the increasing threat to human health. Its goal is production of high quality food and sustainable agriculture development with the preservation of ecosystems.

**Key words:** food, ecology, quality, standards, management.

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## PRINOS I UDEO POJEDINIH KATEGORIJA MESA PILIĆA PRI DODATKU MINERALNIH ADSORBENATA U HRANU

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U ovom radu saopšteni su rezultati primene mineralnog adsorbenta u ishrani pilića u tovu. Cilj istraživanja bio je da se utvrdi da li mineralni adsorbenti „Minazel” i „Minazel Plus” dodati u hranu, utiču na prinos i udeo pojedinih kategorija mesa pilića.

Istraživanje je obavljeno na 440 pilića za tov provenijence Cobb 500 u četiri grupe, prema nivou dodatog mineralnog adsorbenta: kontrolna grupa K (100 pilića, 0,0% mineralnog adsorbenta); ogledna grupa O-I (100 pilića, 0,5% Minazela); ogledna grupa O-II (100 pilića, 0,2% Minazela Plus) i ogledna grupa O-III (100 pilića, 0,3% Minazela Plus). Ogled ishrane trajao je 42 dana. Pilići su uzgajani u podnom sistemu držanja i hranjeni *ad libitum*.

Pošto je prinos trupova, kao i prinos i udeo pojedinih kategorija mesa obrađenih trupova pilića bitan činilac kvaliteta, praćen je uticaj tretmana ishrane na navedene osobine.

Rezultati istraživanja pokazuju da su pilići O-I grupe imali najveći prinos mesa I kategorije (919,50 g), a najmanji K-grupa (773,53 g). Najveći prinos mesa II kategorije imala je O-I grupa (141,10 g), a najmanji K-grupa (122,36 g); najveći prinos mesa III kategorije imala je O-I grupa (393,11 g), a najmanji K-grupa (260,08 g).

Razlike između grupa bile su statistički značajne ( $p < 0,05$ ) i statistički vrlo značajne ( $p < 0,01$ ).

**Ključne reči:** ishrana pilića, mineralni adsorbenti, kategorije mesa.

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## YIELD AND SHARE OF SPECIFIC CATEGORIES OF MEAT FROM CHICKEN FED A DIET SUPPLEMENTED WITH MINERAL ADSORBENTS

Vera Radović<sup>1</sup>, Filipović S.<sup>2</sup>, Okanović Đorđe<sup>2</sup>, Dosković Vladimir<sup>1\*</sup>, Karović D.<sup>3</sup>

In this research results of the application of mineral adsorbent in diet in chickens, are presented. Objective of the research was to determine do mineral adsorbents

„Minazel” and „Minazel Plus”, added into feed mixtures for chickens, have impact on the yield and share of specific poultry meat categories.

Research was carried out on 440 fattening chickens of provenience Cobb 500, divided into four groups, according to the level of added mineral adsorbent: control group K (100 chickens, no mineral adsorbent); added experimental group O-I (100 chickens, 0.5% of Minazel); experimental group O-II (100 chickens, 0.2% of Minazel Plus) and experimental group O-III (100 chickens, 0.3% of Minazel Plus). Nutrition trial lasted 42 days. Chickens were reared in the floor system and fed *ad libitum*.

Since the yield of carcasses, as well as the yield and share of specific categories of meat in processed carcasses are important factors of the quality, the effect of diet on mentioned properties was monitored.

Results of the research showed that chickens of the O-I group had the highest yield of meat of I category (919.50 g), and the lowest was recorded for chickens in K-group (773.53 g). The highest yield of II category of meat was recorded in group O-I (141.10 g), and the lowest in K-group (122.36 g); the highest yield of meat of category III was recorded in group O-I (393.11g), and the lowest in K-group (260.08 g).

Differences between groups were statistically significant ( $p < 0,05$ ) and statistically highly significant ( $p < 0,01$ ).

**Key words:** chicken diet, mineral adsorbents, meat categories.

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## ISPITIVANJE STABILNOSTI BOJE PREHRAMBENIH KOLORANATA U KOBASICAMA POD UTICAJEM NATRIJUM PIROSULFITA

Semenova Anastasiya A.<sup>1\*</sup>, Nasonova Victoriya V.<sup>1</sup>, Veretov Leonid A.<sup>1</sup>

Kada se koriste kompleksni konzervansi koji sadrže natrijum-pirosulfit (E223) u kobasicama u čijoj proizvodnji su korišćeni prehrambeni koloranti, registrovana je delimična diskoloracija finalnog proizvoda. Cilj rada je bio da se ispita uticaj natrijum-pirosulfita na promene boje rastvora prehrambenih koloranata različitog porekla koji se koriste u proizvodnji kobasica. 0.2% vodeni rastvor pojedinačnih i složenih koloranata odnosno preparata sa dodatim natrijum pirosulfitom i bez njega, su podvrgnuti vizuelnoj i instrumentalnoj oceni. Na osnovu dobijenih rezultat ispitivanja karakteristika boja, L–svetlina boje, a–intenzitet crvene i b–intenzitet žute boje, izračunat je indeks stabilnosti boje pod uticajem natrijum-pirosulfita.

Prisustvo natrijum pirosulfita u vodenom rastvoru nije dovelo do promene boje koloranta karmin (E120), karamel (E150), fermentisanog pirinča, boje od krvi životinja za klanje, azorubin (E122). Rezultati su pokazali da nije preporučljivo korišćenje prehrambenih koloranata Ponceau 4 R (E 124), bilo pojedinačno ili složenim preparatima, jer rastvor sa bojom Ponceau 4R gubi intenzitet crvene boje, postaje žut ili rastvoren u crvenom rastvoru karmin boje, što je čini značajno svetlijom. To je potvrđeno i instrumentalnom ocenom.

Kada se koriste konzervansi zajedno sa natrijum-pirosulfitom u proizvodnji kobasica, preporučuje se primena koloranata na karmin bazi. Izvedeno ispitivanje je dovelo do zaključka da dodavanje natrijum pirosulfita u vodeni rastvor bilo kog preparata prehrambenih koloranta omogućava identifikovanje sintetičkog koloranta Ponceau R4, ako je prisutan, zbog pojave diskoloracije (gubitak crvene nijanse i stvaranje žute boje).

**Ključne reči:** kobasice, prehrambeni koloranti, natrijum-pirosulfit, diskoloracija.

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## STUDY OF COLOR STABILITY OF FOOD GRADE COLORANTS FOR SAUSAGE PRODUCTS UNDER THE EFFECT OF SODIUM PYROSULPHITE

Semenova Anastasiya A.<sup>1\*</sup>, Nasonova Victoriya V.<sup>1</sup>, Veretov Leonid A.<sup>1</sup>

When complex food preservatives containing sodium pyrosulphite (E223) are used in sausage products, manufactured using food colorants, a partial discoloration of final products was observed. The purpose of the work was to study the effect of sodium pyrosulphite on color changes of solutions of food grade colorants of different origin as used in manufacturing of sausage products. 0.2% aqueous solutions of individual and complex food grade colorants preparations with added sodium pyrosulphite and without it were subjected to visual and instrumental evaluation. According to the results of the study of color characteristics L-lightness, a-redness and b-yellowness, the index of color stability under the effect of sodium pyrosulphite was calculated.

The presence of sodium pyrosulphite in aqueous solution did not result in the color change of carmine colorant (E120), caramel (E150), fermented rice, color from blood of slaughter animals, azorubine (E122). The results of the studies have shown that it is not recommended to use food grade colorants Ponceau 4 R (E 124), both individually and in complex preparations, because the solution with Ponceau 4R loses its red color, becomes yellow or solved in red solution of carmine, thus making it markedly lighter. This was confirmed by instrumental evaluation.

When using preservatives with sodium pyrosulphite in manufacturing of sausage items, it is recommended to apply carmine-based colorants. The carried out studies led to the conclusion that the addition of sodium pyrosulphite into aqueous solution of any food colorant preparation allows identification of a synthetic colorant Ponceau R 4 if any is present, due to discoloration (loss of red hue and generation of yellow color).

**Key words:** sausages, food grade colorants, sodium pyrosulphite, discoloration.

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## **POTRAŽNJA I POTROŠNJA SVINJSKOG, GOVEDEG I ŽIVINSKOG MESA U TOKU SEDMICE U MAKEDONIJI**

Šambevsa Katerina<sup>1\*</sup>, Stojanovski Mitre<sup>1</sup>, Kočovska Marija<sup>1</sup>, Radevska Marijana<sup>1</sup>

Radi zadovoljavanja potreba za hranljivim materijama, čovek koristi prehrambene proizvode, među kojima dominiraju hleb i meso. Potrošnja mesa u toku jedne sedmice je različita, u zavisnosti od prehrambenih navika jedne porodice i vremena za njeno konzumiranje.

Brojnim istraživanjima potvrđeno je da je potrošnja i konzumacija mesa u toku sedmice različita. Tako, meso koje je namenjeno za suhu i termičku obradu najčešće se koristi subotom i nedeljom, dok se meso sa kostima koristi više u toku radnih dana od ponedeljka do petka.

Prema izvršenim ispitivanjima kod stanovništva u Makedoniji, konstatovano je da je u toku jedne sedmice meso na trpezi prisutno u proseku 4,14 dana. Najčešće je konzumirano svinjsko meso, koje preferiraju više od 60% ispitanih lica, zatim pileće sa 30% i na kraju goveđe meso sa 9%. Na osnovu dobijenih rezultata, utvrđeno je da je najveća potrošnja svinjskog mesa – krmenadla nedeljom i to 32,69%, zatim subotom se troši svinjska udina 21,36%, a četvrtkom najveća je potrošnja mesa sa kostima 20,19% i mlevenog mesa sa 18,26%.

Potrošnja pilećeg mesa – celo pile, najveća je nedeljom, u proseku 42,86%, četvrtkom, bataka i karabataka 26,89%, subotom krila 22,22% i pileći stek 17,09%.

Od ukupne potrošnje goveđeg mesa–udina, najviše se troši četvrtkom 27,27%, dok utorkom najveća je potražnja mesa sa kostima 24,73%, nedeljom se najviše troši goveđa krmenadla 19,44%, dok utorkom i subotom troši se mleveno meso 18,30%.

Na osnovu izvršenih istraživanja može da se konstatuje da je potrošnja mesa najveća subotom i nedeljom, sa najvećom upotrebom mesa sa suhu termičku obradu, a kao rezultat religioznih pobuna, najmanja potrošnja mesa konstatovana je petkom.

**Ključne reči:** svinjsko meso, goveda i živina, dani sedmice, potrošnja u sedmicama.

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## WEEKLY DEMAND AND CONSUMPTION OF PORK, BEEF AND POULTRY MEAT IN MACEDONIA

Šambevsa Katerina<sup>1\*</sup>, Stojanovski Mitre<sup>1</sup>, Kočovska Marija<sup>1</sup>, Radevska Marijana<sup>1</sup>

In order to meet their everyday needs for foodstuffs, people use different food products among which bread and meat are dominant. The weekly demand and consumption of meat varies depending food habits and time that families have for its preparation.

Numerous studies have confirmed that the weekly demand and the consumption of meat are different depending on the days of the week. Thus, meat intended for dry heat treatment is commonly used on Saturday and Sunday, while meat on the bone is more used during the weekdays, from Monday to Friday. According to surveys conducted among the population in Macedonia, it was concluded that in average, during a week, meat was on the table 4.14 days.

The most frequently consumed meat is pork preferred by 60% of the surveyed persons, followed by chicken with 31% and finally beef with 9%. Based on these results it was established that the weekly consumption of pork - pork chops, is the highest with 32.69%, then on Saturday, pig udine with 21.36%, and on Thursday the consumption of meat with bones is the highest with 20.19% and 18.26% minced meat. The consumption of chicken meat - whole chicken, is the highest on Sunday with 42.86%, on Thursday mainly chicken legs and drumsticks are consumed with 26.89%, and on Saturday chicken wings 22.22% and 17.09% chicken steak. From the total consumption of beef - udine are mainly consumed on Thursday with 27.27%, while on Tuesday the highest is the consumption of meat with bones with 24.73%, on Sunday the consumption of bovine chops with 19.44%, and on Tuesday and Saturday minced meat with 18.30%. Based on the conducted research it can be concluded that meat consumption is the highest on Saturday and Sunday and most meat is used in dry heat treatment, and as a result of religious motives lowest consumption of meat was found on Friday.

**Key words:** pig, cattle and poultry meat, days of week, weekly consumption.

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## SENZORSKE, LABORATORIJSKE I TEHNOLOŠKE OSOBINE MESA NERASTOVA KASTRIRANIH VAKCINACIJOM

Steinhauser L.<sup>1</sup>, Gallas L.<sup>1</sup>, Kratochvíl J.<sup>1</sup>

Hormon koji oslobađa gonadotropin (GnRF), kao vakcina, razvijen je u Australiji i Novom Zelandu od 1998. godine i koristi se za imunološku kastraciju nerastova, i njegova upotreba je u stalnom porastu zadnjih godina kako bi se iskoristila sposobnost čitave populacije muških grla sa stanovišta porasta koji je efikasniji u poređenju sa populacijom muških grla koja su fizički kastrirana. Imunološka kastracija (kastracija vakcinacijom) je komercijalno dostupna preko preparata kao što su: Improvac®, Improvest, Vivax®, Innosure®, i odobrena je u preko 50 zemalja, i trenutno je u postupku dobijanja odobrenja u SAD, odobrenje vakcinacije je u toku takođe u Kini, Japanu i Kanadi. Zemlje kao što su Velika Britanija, Danska, Španija i Australija, koriste/upućuju na klanje celu mušku populaciju, ali obično pri manjoj telesnoj masi grla pred klanje. U drugim zemljama se koriste fizički kastrirani mužjaci. Kastracija je način za smanjenje mirisa koji se pojavljuje u mesu nerastova. Miris nerastova je rezultat akumuliranja dve lipofilične supstance u masnom tkivu muških grla koja nisu kastrirana, kao i kod nekih fizički kastriranih grla i nazimica. Dva seksualna hormona koja su primarno odgovorna za miris nerastova su androstenon i skatol.

Imunološka kastracija (kastracija vakcinacijom) je metod koji omogućava proizvodnju svinja na način gde sva muška grla mogu imati koristi od testikularnih steroida koji obezbeđuju porast u poređenju sa kastriranim grlima, a zaitm budu vakcinisana u odgovarajućem periodu kako bi se eliminisali negativni efekti koje mogu imati navedeni steroidi kroz pojavu neprijatnog mirisa. Senzorne karakteristike imunološki kastriranih (kastracija vakcinacijom) muških grla su verovatno najviše analizirana i najbolje opisana tema. Poređenje senzornih odlika, nivoa androstenona i skatola kod nazimica, fizički kastriranih grla i imunološki kastriranih grla (kastracija vakcinacijom) je takođe tema mnogih istraživanja. Odeljenje za higijenu i tehnologiju mesa Veterinarskog i Farmaceutskog Univerziteta iz Brna, u saradnji sa kompanijom Pfizer je ispitalo karakteristike proizvoda od mesa napravljenih/proizvedenih od mesa nerastova koji su imunološki kastrirani.

**Ključne reči:** senzorne laboratorijske i tehnološke osobine, meso nerastova.

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## SENSORY, LABORATORY AND TECHNOLOGICAL PROPERTIES OF IMMUNOCASTRATED BOARS MEAT

Steinhauser L.<sup>1</sup>, Gallas L.<sup>1</sup>, Kratochvíl J.<sup>1</sup>

Gonadotropin releasing factor (GnRF), as vaccina was developed in Australia and New Zealand since 1998 and is used to immunocastration of male pigs and has increased in recent years to take advantage of an entire male pig's ability to grow leaner and more efficiently than physically castrated males. The immunocastration and has been available for commercial use in as

Improvac®, Improvest, Vivax®, Innosure®. and approved in over 50 countries and is currently awaiting approval in the United States, approval of the vaccination is pending in China, Japan, and Canada. A countries such as Great Britain, Denmark, Spain and Australia harvest entire males, but usually at less slaughtering weight. Other countries harvest physically castrated males. Castration is a way to reduce boar taint. Boar taint is caused primarily by the accumulation of two lipophilic substances in the fat tissue of intact male pigs and some physically castrated males and gilts. The two sex hormones that are primarily responsible for boar taint are androstenone and skatole. Immunocastration is a way to allow pigs to be produced in a manner where entire male pigs can benefit from their own testicular steroids to provide a lean growth advantage over castrated males and then be immunized at appropriate time to eliminate any detrimental effects those steroids may cause such as objectionable odors or offflavors. Sensory characteristics of immunocastrated male pigs are probably one of the most studied and best characterized topics. Comparing sensory characteristics, level of androstenone and skatole between gilts, physical castrates, immunocastrates and entire males has recently been reported. Department of meat hygiene and technology of Veterinary and pharmaceutical university Brno collaborative with Pfizer company studied characteristics of meat products made from meat of imunocastrated boars.

**Key words:** sensory, laboratory, technical properties, board meat.

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## UČEŠĆE OSNOVNIH DELOVA U POLUTKI ZAKLANIH SVINJA DOBIVENIH UKRŠTANJEM VELIKOG JORKŠIRA I ŠVEDSKOG LANDRASA

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Kvalitet mesa kod svinja zavisi od genetskih i paragenetskih faktora, a svakako da rasa ima svoj veliki udeo u kvalitetu i prinosu mesa kod svinja. Kvalitet mesa ceni se preko udela najkvalitetnijih delova (but i kare – kremenadla).

U radu su dati klanični rezultati meleza dobivenih ukrštanjem velikog jorkšira i švedskog landrasa.

Prosečna živa masa tovnih svinja pre klanja je iznosila 92,727 kg randman klanje je 72,15 %. Posle hlađenja polutke su rasecane na industrijski način. Udeo osnovnih delova nakon rasecanja je: buta u masi polutki ispitivanih svinja iznosio je 29%, plečke 13,77%, rebara 15,88%, kremenadle 15,45 %, vrata 6,64 %, glave 5,79%, podlaktice 1,28% i potkolenice 2,32%.

Udeo najkvalitetnijih kategorija mesa kod meleza dobivenih ukrštanjem velikog jorkšira i švedskog landrasa (but i kremenadla) u ukupnoj masi polutki iznosi 44,88%.

**Ključne reči:** rasa, but, kremenadla, plečka, rebara, podlaktica, glava, potkolenica.

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## SHARE OF MAIN CARCASS PARTS OBTAINED FROM PIG CROSSES - LARGE WHITE SWINE AND SWEDISH LANDRACE

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Quality of pig meat depends on genetic and paragenetic factors, where breed is important factor in quality and yield of meat. The quality of meat is assessed based on share of the carcass parts of the highest quality (leg and chop).

In this paper slaughter results obtained from crosses of Large White and Swedish Landrace are presented.

Average body mass of fattening pigs pre-slaughter was 92.727 kg, slaughter yield 72.15 %. After cooling, carcass sides were cut according to the industrial meth-

od. Shares of main carcass parts after cutting were following: leg in the mass of investigated pigs was 29%, shoulder 13.77%, ribs 15.88%, chop 15.45 %, neck 6.64 %, head 5.79%, forearm 1.28% and shin 2.32%.

Share of the meat categories of the highest quality, obtained from pig crosses Large White and Swedish Landrace (leg and chop) in total weight of carcass side was 44.88%.

**Key words:** basic parts, leg, chop, shoulder, ribs, forearm, head, shin.

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## ISPITIVANJE MEHANIZAMA INTERAKCIJE VITAMINSKO- -MINERALNIH KOMPLEKSA U OBOGAĆENIM PROIZVODIMA OD MESA

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Obezbeđivanje vitamina i minerala je trenutno goruće pitanje i veoma je važno da njihov unos bude u okviru normativa i da nema odstupanja ni u smeru viška ni nedostatka. Unos vitamina i minerala koji su sadržani u „modernim“ prehrambenim proizvodima često neće biti dovoljan da zadovolji potrebe našeg organizama. U vezi s tim, mnogi autori predlažu metode obogaćivanja sirovina i prehrambenih proizvoda, kao i hrane za životinje vitaminsko-mineralnim kompleksima.

Uloga vitamina i minerala je od esencijalne važnosti za održavanje vitalnih aktivnosti ljudskog organizma. Oni su biokatalizatori hemijskih reakcija, koje se dešavaju u izgradnji i konstantnom obnavljanju živih struktura organizma, i učestvuju u regulaciji metabolizma. Međutim, malo pažnje se posvećuje ispitivanju hemijskih interakcija vitamina i minerala u sirovinama, kao i u gotovim proizvodima.

Stoga, predmet ispitivanja je bilo obogaćivanje sirovina za izradu proizvoda od mesa i ispitivanje uticaja minerala i vitamina, odnosno njihove interakcije u ispitivanom materijalu i gotovim proizvodima.

Kao rezultat ispitivanja, analiziran je međusobni uticaj vitamina i minerala, sa stanovišta sinergističkih i antagonističkih interakcija, na primeru različitog modela sistema mlevenog mesa.

**Ključne reči:** vitamini, minerali, sinergizam, antagonizam, interakcija.

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## STUDY OF MECHANISMS OF INTERACTION OF VITAMIN- -MINERAL COMPLEX IN ENRICHED MEAT PRODUCTS

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Presently, the vitamin and mineral supply is a burning issue, it is extremely important that their consumption is within the norm and that it does not deviate to the excess or deficiency. The consumption of both vitamins and minerals contained in “modern” food products often will not completely provide the requirements of our organism. In connection with this, many authors propose the methods of enrichment

of raw materials and food products, and also of mixtured feeds with vitamin-mineral complexes.

The role of vitamins and minerals in provision of vital activities of human organism is essential. They are biocatalysts of chemical reactions, occurring in building and constant renovation of live structures of the organism, and also participate in metabolism regulation. However, little attention was paid to the study of chemical interaction of vitamins and minerals both in raw materials, and in final products.

Therefore, the topical issue is the enrichment of meat raw materials and the study of the effects of minerals and vitamins interaction both in the studied material, and in final products.

As a result of the investigations a mutual influence of vitamins and minerals was studied, from the point of view of synergistic and antagonistic interactions, on the example of different model ground meat systems.

**Key words:** vitamins, minerals, synergism, antagonism, interaction.

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## MOGUĆNOST UPOTREBE NOJEVOG MESA U HRANI ZA DECU I DIJETETSKIM PROIZVODIMA

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Samo ekološke, bezbedne sirovine visoke hranljive i biološke vrednosti se mogu koristiti u proizvodima od mesa za decu i dijetetskim proizvodima. U uslovi- ma kada postoji nestašica govedine i svinjetine u Rusiji, uzgoj i prerada egzotičnih vrsta ptica, kao što su nojevi, postaju široko rasprostranjeni. Zbog toga je neophodno da se ispita meso noja. U cilju davanja preporuka za korišćenje nojevog mesa u hrani za decu, ispitana je njegova hranljiva i biološka vrednost, bezbednost, strukturno- mehaničke karakteristike mesa i sporednih proizvoda, i upoređeni sa tradicionalnim vrstama mesa koje se koriste kao sirovine, i koje su u širokoj upotrebi u proizvodnji hrane za decu – govedina i svinjetina.

Visoka biološka vrednost i bezbednost nojevog mesa i sporednih proizvoda su utvrđeni, te se može dati preporuka za njihovo korišćenje kao sirovine u proizvodnji hrane za decu i dijetetskih proizvoda. Za bolje poznavanje posebnih svojstava no- jevog mesa i sporednih proizvoda, urađena je analiza mikrostrukture mišićnog tkiva mesa (zadnja četvrt trupa) i sporednih proizvoda (jetra i srce), u poređenju sa orga- nima svinja i goveda. Ispitivanje je izvedeno prema opšte prihvaćenim metodama histoloških ispitivanja.

U cilju određivanja funkcionalnih svojstava nojevog mesa, ispitivani su pH, sposobnost vezivanja vode i strukturalno-mehaničke i karakteristike boje.

Prema tome, kompleksna istraživanja su nam pomogla da utvrdimo da nojevo meso i sporedni proizvodi, u pogledu njihove hranljive i biološke vrednosti, funkcio- nalno-tehnoloških i histoloških karakteristika, nisu lošiji od glavnih vrsta mesa koje se koriste kao sirovine, a u pogledu bezbednosti, ispunjavali su zahteve za meso kao sirovinu koja se koristi u proizvodnji hrane za decu mlađeg uzrasta, od 6 meseci, i mogu se preporučiti za proizvodnju hrane za decu, dijetetske i funkcionalne proiz- vode.

**Ključne reči:** noj, sporedni proizvodi, hrana za decu, hranljiva vrednost, bez- bednost, tehnološke i karkateristike mikrostrukture.

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## **PROSPECTS FOR THE USE OF OSTRICH MEAT IN FOODS FOR CHILDREN AND DIETETIC PRODUCTS**

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Only ecologically safe raw materials of high nutritional and biological value should be used in meat products for children and dietetic products. Presently, since there are shortages of beef and pork in Russia, farming and processing of an exotic bird such as ostrich becomes widespread. Therefore, it is necessary to study the ostrich meat. In order to give recommendations for the use of ostrich meat in children nutrition products, the nutritional and biological value, safety, structural-mechanical characteristics of meat and by-products were studied and compared with traditional types of meat used as raw materials, widely used in foods for children – beef and pork.

High biological value and safety of ostrich meat and by-products were established and therefore it can be recommended as raw material in production of foods for children and dietetic products. For better knowledge of specific features of ostrich meat and by-products the analysis of the microstructure of muscle tissue of meat (hind quarter of carcass) and by-products (liver and heart), compared to the organs of pigs and cattle, was carried out. The study was conducted according to commonly used methods of histological investigations.

In order to determine the functional properties of ostrich meat, pH, water binding capacity and structural-mechanical and color characteristics were studied.

Thus, complex investigations helped establish that ostrich meat and by-products, in regard to the nutritional and biological value, functional-technological and histological characteristics, are not inferior to main types of meat used as raw materials, and in regard to the safety, complied with the requirements for meat as raw material used in food products for children of early age, beginning from 6 months, and can be recommended for the production of foods for children, dietetic and functional products.

**Key words:** ostrich, by-products, foods for children, nutritional value, safety, technological and microstructure characteristics.

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## PROIZVODNJA I POTROŠNJA MESA U REPUBLICI MAKEDONIJI

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Meso i proizvodi od mesa učestvuju u ishrani kao jedan od najvažnijih njenih činilaca. Prema svojim biohemijskim i fiziološkim osobinama, meso ima važno mesto u ljudskoj ishrani. Njegovo prisustvo u ishrani je od ključne važnosti.

Zbog toga je stalna potreba svakog društva povećanje proizvodnje mesa čime se omogućava snabdevanje tržišta proizvodima i poboljšanje ekonomske situacije proizvođača, s druge strane. Naravno, obezbeđivanje visoke produktivnosti, ekonomičnosti i rentabilnosti proizvođača takođe mora biti uzeto u obzir. Na ovaj način, proizvodi će biti dostupni svim kategorijama potrošača, čak i onih sa manjim prihodima.

**Ključne reči:** proizvodnja, potrošnja, meso, Makedonija.

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## PRODUCTION AND CONSUMPTION OF MEAT IN REPUBLIC OF MACEDONIA

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Meat and meat products participate as one of the most important items in human nutrition. According to its biochemical and physiological traits, meat has a significant place in the diet. Its presence in diet is an essential need.

That is why permanent need of every society is to increase the meat production enabling the supply to the market with this product and improving the economic position of producers, on the other hand. Of course, providing high productivity, economy and profitability of producers should be taken into consideration. In this way, cheaper products available for every category of consumers, including even those categories with lower income, should be obtained.

**Key words:** production, consumption, meat, Macedonia.

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## ULOGA PERCEPCIJE I STAVOVA POTROŠAČA PRI KUPOVINI MESA I PROIZVODA OD MESA

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Proces koji utiče na to da potrošač prihvati određeni proizvod od mesa ili meso je multidimenzionalan. Nije uvek jednostavno uspostaviti vezu između fiziološke percepcije i reakcije potrošača. Odgovor potrošača, kada je hrana u pitanju, nije baziran samo na senzorskim osobinama proizvoda i njegovom fizičkom statusu, već je povezan i sa drugim faktorima kao što su: prethodna informisanost, prošlo iskustvo potrošača kao i njegovi stavovi i verovanja.

Danas su potrošači mnogo zahtevniji u pogledu kvaliteta i bezbednosti hrane, deklarisanja proizvoda, opredeljenosti proizvođača da primenjuju odgovarajuće standarde u proizvodnji hrane.

U radu su razmatrane razne metode dobijanja informacija o percepciji potrošača, stavovima, verovanjima i očekivanjima koji utiču na kupovinu i konzumiranje mesa i proizvoda od mesa.

**Ključne reči:** odgovori potrošača, percepcija, stavovi, očekivanja.

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## THE ROLE OF CONSUMERS' PERCEPTION AND ATTITUDE IN PURCHASING OF MEAT AND MEAT PRODUCTS

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The process influencing the consumer to accept certain meat product or meat is multi-dimensional. It is not always simple to establish the connection between the physiological perception and reaction of the consumer. Response of the consumer, in case of food, is not only based on sensory properties of the product and its physical status, but it is also associated with other factors, such as: previous knowledge, previous experience as well as consumer attitudes and believes.

Consumers today are much more demanding in terms of food quality and safety, product labeling, determination of producers to implement certain standards in food production, etc.

In this paper, different methods for acquiring the information on consumer perception and expectations which influence the purchasing and consumption of meat and meat products, are studied and discussed.

**Key words:** consumer response, perception, attitudes, expectations.

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## SADRŽAJ CINKA U *m. semimembranosus*, JETRI I BUBREZIMA DESET RAZLIČITIH GENOTIPOVA SVINJA ODGAJANIH U VOJVODINI

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U ovom radu utvrđen je sadržaj ukupnog pepela i sadržaj cinka (Zn) u mesu *m. semimembranosus*, jetri i bubrežima svinja ( $n = 69$ ), deset različitih genotipova [veliki jorkšir, landras, veliki jorkšir  $\times$  landras, landras  $\times$  veliki jorkšir, durok  $\times$  (veliki jorkšir  $\times$  landras), durok  $\times$  (landras  $\times$  veliki jorkšir), (durok  $\times$  pietren)  $\times$  (veliki jorkšir  $\times$  landras), (durok  $\times$  pietren)  $\times$  (landras  $\times$  veliki jorkšir), (hempšir  $\times$  pietren)  $\times$  (veliki jorkšir  $\times$  landras), (hempšir  $\times$  pietren)  $\times$  (landras  $\times$  veliki jorkšir)], odgajenih u Vojvodini. Prosečna starost svinja pre klanja bila je 6 meseci, dok je prosečna telesna masa bila  $104,9 \pm 5,45$  kg. Sadržaj ukupnog pepela određen je standardnom ISO metodom. Sadržaj Zn određen je atomskom apsorpcionom spektrofotometrijom (AAS), nakon suvog spaljivanja homogenizovanih uzoraka. Između različitih genotipova svinja nisu utvrđene značajne razlike ( $P > 0,05$ ) u sadržaju ukupnog pepela i u sadržaju Zn, ni za jedno ispitano tkivo. Sa druge strane, u jetri je utvrđen visoko značajno ( $P < 0,001$ ) veći sadržaj Zn u poređenju sa sadržajima Zn u mesu (*m. semimembranosus*) i u bubregu. Sadržaj ukupnog pepela u mesu nalazio se u intervalu od 0,98 [genotip svinja: (hempšir  $\times$  pietren)  $\times$  (veliki jorkšir  $\times$  landras)] do 1,08 g/100 g [genotipi svinja: landras  $\times$  veliki jorkšir, durok  $\times$  (veliki jorkšir  $\times$  landras), (hempšir  $\times$  pietren)  $\times$  (veliki jorkšir  $\times$  landras), (hempšir  $\times$  pietren)  $\times$  (landras  $\times$  veliki jorkšir)], odnosno prosečno je iznosio 1,04 g/100 g, zatim u jetri u intervalu od 1,38 [genotipi svinja: durok  $\times$  (veliki jorkšir  $\times$  landras), (durok  $\times$  pietren)  $\times$  (landras  $\times$  veliki jorkšir)] do 1,50 g/100 g [genotipi svinja: durok  $\times$  (veliki jorkšir  $\times$  landras), durok  $\times$  (landras  $\times$  veliki jorkšir)], odnosno prosečno je iznosio 1,43 g/100 g i u bubrežima u intervalu od 1,11 g/kg (genotip svinja: veliki jorkšir  $\times$  landras) do 1,37 g/100 g (genotip svinja: veliki jorkšir), odnosno prosečno je iznosio 1,20 g/100 g. Sadržaj Zn u mesu nalazio se u intervalu od 2,30 (genotip svinja: veliki jorkšir  $\times$  landras) do 3,29 mg/100 g (genotip svinja: landras  $\times$  veliki jorkšir), odnosno prosečno je iznosio 2,70 mg/100 g, zatim u jetri u intervalu od 6,32 [genotip svinja: (hempšir  $\times$  pietren)  $\times$  (veliki jorkšir  $\times$  landras)] do 15,99 mg/100 g (genotip svinja: landras), odnosno prosečno je iznosio 9,82 mg/100 g i u bubrežima u intervalu od 2,15 (genotip svinja: landras) do 4,10 mg/100 g [genotip svinja: durok  $\times$  (landras  $\times$  veliki jorkšir)], odnosno prosečno je iznosio 2,99 mg/100 g. Utvrđeni sadržaji Zn u sva tri ispitana tkiva svinja odgajenih u Vojvodini odgovaraju sadržajima Zn utvrđenim u istim tkivima svinja odgajenih u drugim zemljama. Konzumiranjem 100 g jetre zadovoljava se minimalno 42,1%, odnosno maksimalno 106,6% (prosečno 65,4%), preporučenog dnevnog unosa za Zn, dok se konzumiranjem 100 g bubrega ili 100 g mišićnog tkiva zadovoljava maksimalno 27,3%, odnosno 21,9% preporučenog dnevnog unosa za Zn.

**Ključne reči:** svinje, cink, *m. semimembranosus*, jetra, bubreg.

**Napomena:** Ovo istraživanje je finansirano od strane Ministarstva za nauku i tehnološki razvoj Republike Srbije, projekat TR – 31032.

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## ZINC CONTENTS IN *m. semimembranosus*, LIVERS AND KIDNEYS FROM TEN DIFFERENT GENETIC LINES OF PIGS PRODUCED IN VOJVODINA

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The contents of total ash and zinc (Zn) were determined in the *m. semimembranosus*, livers and kidneys of sixty-nine pigs from ten different genetic lines [Large White; Landrace; Large White x Landrace; Landrace x Large White; Duroc x (Large White x Landrace); Duroc x (Landrace x Large White); (Duroc x Pietrain) x (Large White x Landrace); (Duroc x Pietrain) x (Landrace x Large White); (Hampshire x Pietrain) x (Large White x Landrace); (Hampshire x Pietrain) x (Landrace x Large White)], raised in Vojvodina. The pigs were slaughtered at an average live weight of  $104.9 \pm 5.45$  kg, and were about 6 months old. The total ash content was determined according to the ISO method. Zinc content was determined by the flame atomic absorption spectrometry (AAS) after mineralization by dry ashing. The differences in total ash and zinc content between different genetic lines of pigs were not significant ( $P > 0.05$ ) in all three of analyzed tissues. On the other hand, Zn content in liver was highly significantly higher ( $P < 0.001$ ) comparing to Zn content in meat (*m. semimembranosus*) and kidney tissue. Total ash content in meat was in the range from 0.98 [genetic line: (Hampshire x Pietrain) x (Large White x Landrace)] to 1.08 g/100 g [genetic line: Landrace x Large White; Duroc x (Large White x Landrace), (Hampshire x Pietrain) x (Large White x Landrace), (Hampshire x Pietrain) x (Landrace x Large White)], i.e. on average 1.04 g/100 g. In liver total ash content ranged from 1.38 [genetic line: Duroc x (Large White x Landrace), (Duroc x Pietrain) x (Landrace x Large White)] to 1.50 g/100 g [genetic line: Duroc x (Large White x Landrace), Duroc x (Landrace x Large White)], with an average of 1.43 g/100 g; and in kidneys ash content ranged from 1.11 g/kg (genetic line: Large White x Landrace) to 1.37 g/100 g (genetic line: Large White), with an average of 1.20 g/100 g. Zinc content in meat was in the range 2.30 - 3.29 mg/100 g in genetic line Large White x Landrace and genetic line Landrace x Large White, respectively. Average Zn content in meat was 2.70 mg/100 g. Further, Zn content in liver ranged from 6.32 [genetic line: (Hampshire x Pietrain) x (Large White x Landrace)] to 15.99 mg/100 g (genetic

line: Landrace), with an average of 9.82 mg/100 g, and finally, in kidneys Zn content ranged from 2.15 mg/100g (genetic line: Landrace) to 4.10 mg/100 g [genetic line: Duroc x (Landrace x Large White)], with an average of 2.99 mg/100 g. The Zn contents obtained in the Vojvodian pork meat, liver and kidneys are in agreement with Zn contents in same tissues of pigs from other countries. The consumption of 100 g of liver contributes minimally 42.1% and maximally 106.6% (on average 65.4%) of the Reference Daily Intake (RDI) value for Zn, while consumption of 100 g of kidneys or meat contributes maximally 27.3% and 21.9%, respectively, of RDI value for Zn.

**Key words:** pigs, zinc, *m. semimembranosus*, liver, kidney.

**Note:** *The research was financed by the Ministry of Science and Technological Development, the Republic of Serbia, project TR – 31032.*

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## IDENTIFIKACIJA TERMIČKOG STANJA MESNE SIROVINE KORIŠĆENJEM MULTI-SENZORNOG METODA

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Organizacija efikasnog sistema bezbednosti i kvaliteta proizvoda je preduslov za uspešan rad prehrambene industrije u uslovima tržišne ekonomije. Rešavanje ovih problema je direktno povezano sa razvojem novih pristupa u oceni kvaliteta mesa kao sirovine korišćenjem modernih analitičkih metoda, koje su u skladu sa naprednim naučnim saznanjima i tehnologijom.

Jedna od svojstvenih karakteristika kvaliteta hrane je aroma/ukus koji se formira kroz kompleks različitih slabo isparljivih supstanci relativno male molekulske mase. Analiza takvih informacija je bila moguća zbog pojave nove klase analitičkih mernih sistema, čiju osnovu čine nanokristalni senzori koji omogućavaju sprovođenje molekularne identifikacije supstanci pojedinačno ili u smeši bez esencijalnog uništavanja analita.

U ovom radu je predstavljena mogućnost primene elektronskog nosa „VOCmeter“ za identifikaciju termičkih uslova/stanja mesne sirovine. Utvrđeno je da tokom dužeg perioda čuvanja/skladištenja različitih tipova mesa na minus 18° C, dolazi do promena profila i oblasti „vizuelnih izdanja“ arome. Na osnovu podataka dobijenih multi-senzornom analizom, obrađenih metodom najvažnijih komponenti, razvijeni su kalibracioni obrasci, koji omogućavaju razlikovanje ohlađenog od odmrznutog materijala. U radu su predstavljeni rezultati komparativne analize multi-senzorne i biohemijske metode ispitivanja dinamike promena isparljivih komponenti, koje formiraju aromu mesnih sirovina, tokom skladištenja na -18°C. Rezultati su potvrdili mogućnost korišćenja sistema za identifikaciju ponovno odmrznutih sirovina. Prednosti ove metode su u jendostavnosti i brzom izvršenju analize.

**Ključne reči:** meso, elektronski nos, identifikacija mesne sirovine podvrgnute tretmanu na niskoj temperaturi.

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## IDENTIFICATION OF THERMAL STATE OF MEAT RAW MATERIALS BY MULTI-SENSORY METHOD

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The organization of effective system of safety and quality assurance of the manufactured products is the pre-condition of successful activities of a food plant under market economy. Solution of these problems is directly associated with the development of new approaches to quality evaluation of meat raw materials using modern analytical methods, corresponding to advanced level of science and technology.

One of the inherent characteristics of food quality is the aroma which is formed by a complex of various lightly volatile substances with relatively small molecular mass. The analysis of such information was possible owing to the appearance of a new class of analytical measuring systems, the basis of which are nanocrystalline sensors allowing conducting of the molecular identification of the substances individually and in a complex mixture without essential destruction of the analyte.

The presented paper shows the applicability of electronic nose „VOCmeter„ for the identification of thermal condition of meat raw materials. It was found that during long-term storage of different meat species at minus 18° C, the profiles and areas of „visual printings“ of aroma are changing. On the basis of the data of multi-sensory analysis, treated by the method of principal components, the calibration plots have been developed, allowing differentiation of chilled and defrosted materials. The paper presents the results of comparative analysis of multi-sensory and biochemical methods of investigations of dynamics in changes of volatile components, forming the aroma of meat raw materials, during storage at –18° C. The results have confirmed a possibility of use of the system for determination of redefrosted raw materials. The advantages of this method are simplicity and quick performance of the analysis.

**Key words:** meat, electronic nose, identification of meat raw materials, subjected to low temperature treatment.

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