



# **ЗБОРНИК РАДОВА**



## **XXXII Симпозијум Друштва за заштиту од зрачења Србије и Црне Горе**

**04-06. октобар 2023. године  
Будва, Црна Гора**

**ДРУШТВО ЗА ЗАШТИТУ ОД ЗРАЧЕЊА  
СРБИЈЕ И ЦРНЕ ГОРЕ**



# **ЗБОРНИК РАДОВА**

**XXXII СИМПОЗИЈУМ ДЗЗСЦГ**

**Будва, Црна Гора  
04-06. октобар 2023. године**

**Београд  
2023. године**

**RADIATION PROTECTION ASSOCIATION OF  
SERBIA AND MONTENEGRO**



**PROCEEDINGS**

**XXXII SYMPOSIUM RPASM**

**Budva, Montenegro  
4<sup>th</sup>-6<sup>th</sup> October 2023**

**Belgrade**

**2023**

ЗБОРНИК РАДОВА

XXXII СИМПОЗИЈУМ ДЗЗСЦГ

04-06.10.2023.

Издавачи:

Институт за нуклеарне науке „Винча“  
Друштво за заштиту од зрачења Србије и Црне Горе

За извршног издавача:

Проф. Др Снежана Пајовић

Уредници:

Др Милица Рајачић  
Др Ивана Вуканац

ISBN 978-86-7306-169-6

© Institut za nuklearne nauke „Vinča“

Техничка обрада:

Милош Ђалетић, Милица Рајачић

Електронско издање:

Институт за нуклеарне науке „Винча“, Мике Петровића Аласа 12-14,  
11351 Винча, Београд, Србија

Година издања:

Октобар 2023.



Овај Зборник као и сви радови у њему подлежу лиценци:

Creative Commons Attribution-NonCommercial-NoDerivatives 4.0 International License, <https://creativecommons.org/licenses/by-nc-nd/4.0/>

Ова лиценца дозвољава само преузимање и дистрибуцију дела, ако/док се правилно назначавача име аутора, без икаквих промена дела и без права комерцијалног коришћења дела.

**XXXII СИМПОЗИЈУМ ДРУШТВА  
ЗА ЗАШТИТУ ОД ЗРАЧЕЊА  
СРБИЈЕ И ЦРНЕ ГОРЕ**

Будва, 04-06.10.2023. године

**Организатори:**

**ДРУШТВО ЗА ЗАШТИТУ ОД ЗРАЧЕЊА СРБИЈЕ И ЦРНЕ ГОРЕ**

Институт за нуклеарне науке „Винча“

Лабораторија за заштиту од зрачења и заштиту животне средине „Заштита“

Центар за екотоксиколошка испитивања Подгорица д.о.о, ЦЕТИ

**Организациони одбор:**

Председник:

Ивана Вуканац

Чланови:

Милица Рајачић, Институт за нуклеарне науке „Винча“, Београд

Александра Милатовић, ЦЕТИ, Подгорица, Црна Гора

Никола Свркота, ЦЕТИ, Подгорица, Црна Гора

Ранко Зекић, ЦЕТИ, Подгорица, Црна Гора

Гордана Пантелић, Институт за нуклеарне науке „Винча“, Београд

Милош Ђалетић, Институт за нуклеарне науке „Винча“, Београд

Никола Кржановић, Институт за нуклеарне науке „Винча“, Београд

Наташа Сарап, Институт за нуклеарне науке „Винча“, Београд

Јелена Станковић Петровић, Институт за нуклеарне науке „Винча“, Београд

Ивана Коматина, Институт за нуклеарне науке „Винча“, Београд

Јелена Влаховић, Институт за нуклеарне науке „Винча“, Београд

Зорица Обрадовић, Институт за нуклеарне науке „Винча“, Београд

Игор Челиковић, Институт за нуклеарне науке „Винча“, Београд

Јелена Крнета Николић, Институт за нуклеарне науке „Винча“, Београд

Александра Самолов, Институт за нуклеарне науке „Винча“, Београд

**XXXII СИМПОЗИЈУМ ДРУШТВА  
ЗА ЗАШТИТУ ОД ЗРАЧЕЊА  
СРБИЈЕ И ЦРНЕ ГОРЕ**

Будва, 04-06.10.2023. године

**Научни одбор:**

др Владимир Удовичић, Институт за физику, Земун, Универзитет у Београду

др Војислав Станић, Институт за нуклеарне науке „Винча“, Универзитет у Београду

др Душан Мрђа, Природно математички факултет, Универзитет у Новом Саду

др Ивана Вуканац, Институт за нуклеарне науке „Винча“, Универзитет у Београду

др Игор Челиковић, Институт за нуклеарне науке „Винча“, Универзитет у Београду

др Јелена Крнета Николић, Институт за нуклеарне науке „Винча“, Универзитет у Београду

др Јелена Пајић, Институт за медицину рада Србије "Др Драгомир Карајовић",  
Београд

др Јелица Грујић, Институт за медицинска истраживања, Универзитет у Београду

др Јована Николов, Природно математички факултет, Универзитет у Новом Саду

др Маја Еремић-Савковић, Директорат за радијациону и нуклеарну сигурност и  
безбедност Србије

др Марија Јанковић, Институт за нуклеарне науке „Винча“, Универзитет у Београду

др Мирјана Ђурашевић, Институт за нуклеарне науке „Винча“, Универзитет у  
Београду

др Мирјана Раденковић, Институт за нуклеарне науке „Винча“, Универзитет у  
Београду

др Невена Здјеларевић, ЈП Нуклеарни објекти Србије, Београд

др Оливера Митровић Ајтић, Институт за медицинска истраживања, Универзитет у  
Београду

др Софија Форкапић, Природно математички факултет, Универзитет у Новом Саду

др Србољуб Станковић, Институт за нуклеарне науке „Винча“, Универзитет у  
Београду

### **Организацију су помогли:**

Институт за нуклеарне науке „Винча“, Лабораторија за заштиту од зрачења и заштиту животне средине „Заштита“

Мике Петровића Аласа 12-14

11351 Винча, Београд, Србија

<https://www.vin.bg.ac.rs/>

Центар за екотоксиколошка испитивања Подгорица д.о.о, ЦЕТИ

Булевар Шарла де Гола бр. 2

81000 Подгорица, Црна Гора

<https://mne.ceti.me/>

МОЈ ЛАБ

ул. Московска бр. 2б

81000 Подгорица, Црна Гора

<https://mojlab.me/>

ФАРМАЛАБ

Булевар Михаила Лалића бр. 8

81000 Подгорица, Црна Гора

<https://farmalab.me/>

ГЛОСАРИЈ ДОО

ул. Војисављевића бр. 76

81000 Подгорица, Црна Гора

<https://www.glosarij.me/me/pocetna>

### **Излагачи:**

Canberra Packard Central Europe GmbH.

Wienersiedlung 6

2432 SCHWADORF, Austria

Phone: +43 (0)2230 3700-0

Fax: +43 (0)2230 3700-15

Web: <http://www.cpce.net/>

LKB Vertriebs doo Beograd-Palilula

Cvijičeva 115

11120 Beograd, Srbija

Tel: +381 (0)11 676 6711

Faks: +381 (0)11 675 9419

Web: [www.lkb.eu](http://www.lkb.eu)

*Овај Зборник је збирка радова саопштених на XXXII Симпозијуму Друштва за заштиту од зрачења Србије и Црне Горе који је одржан у Будви, Црна Гора, 04-06.10.2023. године. Радови су према обрађеној проблематици груписани у једанаест секција. Сви радови у Зборнику су рецензирани од стране Научног одбора, а за све приказане резултате и тврдње одговорни су сами аутори.*

*Југословенско друштво за заштиту од зрачења основано је 1963. године у Порторожу, а од 2005. носи име "Друштво за заштиту од зрачења Србије и Црне Горе". На XXXII Симпозијуму, ове године обележавамо веома значајан јубилеј - **60 година организоване заштите од зрачења на нашим просторима.***

*Од оснивања, Симпозијуми Друштва за заштиту од зрачења представљају прилику да се кроз стручни програм прикажу резултати истраживања у области заштите од зрачења, представе различите области примене извора и генератора зрачења, анализирају актуелна дешавања, размене искуства са колегама из региона, дефинишу проблеми и правци даљег унапређивања наше професионалне заједнице.*

*Поред тога, Симпозијуми друштва представљају и прилику да у мање формалном маниру сретнемо старе и упознамо нове пријатеље и колеге, обновимо старе и започнемо нове професионалне сарадње.*

*Ауторима и коауторима научних и стручних радова саопштених на XXXII Симпозијуму се захваљујемо на уложеном труду и настојању да квалитетним радовима заједно допринесемо остваривању циљева и задатака Друштва и наставимо традицију дугу импозантних 60 година.*

*Посебно се захваљујемо свима који су подржали одржавање овог Симпозијума.*

*Свим члановима Друштва, сарадницима и колегама честитамо овај значајан јубилеј!*

*Организациони одбор XXXII Симпозијума ДЗЗСЦГ*



**SOIL TO PLANT TRANSFER OF Cs-137, Sr-90, Ra-226, Pb-210 AND K-40 IN DIFFERENT AGRICULTURAL PRODUCTS IN CROATIA**

Božena SKOKO<sup>1</sup>, Gorana KARANOVIĆ<sup>1</sup>, Tomislav ILIEVSKI<sup>1</sup>, Ivana COHA<sup>1</sup>,  
Željko GRAHEK<sup>1</sup>, Katja MAGDIĆ KOŠIČEK<sup>1</sup>, Ivana SMIČIKLAS<sup>2</sup>,  
Dijana PAVIČIĆ-HAMER<sup>3</sup>, Ivana TUCAKOVIĆ<sup>1</sup>

- 1) *Ruđer Bošković Institute, Bijenička cesta 54, Zagreb, Croatia*
- 2) *University of Belgrade, Vinča Institute of Nuclear Sciences - National Institute of the Republic of Serbia, University of Belgrade, P.O. Box 552, Belgrade, Serbia*
- 3) *Ruđer Bošković Institute, G. Paliaga 5, Croatia*

**Corresponding author:** Božena SKOKO, bozena.skoko@irb.hr

**ABSTRACT**

In this study, we investigated the soil-to-plant transfer of Cs-137, Sr-90, Ra-226, Pb-210 and K-40 in different types of vegetables and fruits collected on family farms in Croatia. The difference in radionuclide distribution between different plant compartments was also investigated. Our results suggest that, in general, the transfer of selected radionuclides within studied soil/plant agricultural ecosystems is on the lower part of ranges reported by IAEA for the temperate environments. Nevertheless, for all studied radionuclides, the transfer to the fruits and vegetables peels was higher than to the pulp. Overall, observed differences in the transfer of radionuclides indicate other additional exposure pathways and mechanisms that affect radionuclide content in plants besides soil activity concentrations.

**Introduction**

The deposition of radionuclides on vegetation and soil represents the starting point of their transfer into the terrestrial environment and consequently food chains. For many radionuclides with medium and long half-lives, this initial deposition is the beginning of the long-term management and monitoring in the decades following nuclear and radiological accidents and incidents. Knowledge of radionuclide transfer pathways, their distribution in the environment and uptake by different plants and animals enable us to predict radionuclide fate, estimate potential exposure to humans and apply appropriate protective measures within the radiation protection system.

This study aimed to investigate differences in the soil-to-plant transfer of Cs-137, Sr-90, Ra-226, Pb-210 and K-40, as one of the key anthropogenic and naturally occurring radionuclides, to different crops (vegetables and fruits) collected on family farms located in different geographic Croatian regions. This research is conducted as a part of the Croatian Science Foundation project RiChFALL (Radioactivity in children food and novel methods for low-level activity determination, 2020. – 2024.).

**Materials and Methods***Samples*

In Table 1 are presented the types of fruits and vegetables analyzed in the study and their categorization according to the plant groups and plant compartment division used by IAEA [1]. When appropriate, fruits and vegetables pulp and peel were analyzed separately.

**Table 1: Type of fruits and vegetables analyzed in this study**

Plant group	Plant type	Plant compartment studied	Plant group	Plant type	Plant compartment studied
Leafy vegetables	Chard Spinach Kale Cabbage	Leaves	Tubers	Potato Sweet potato	Tuber, tuber peel
Non-leafy vegetables	Zucchini Paprika Cauliflower	Fruit without peel Fruit with peel Flowers, leaves	Fruits	Apple Mandarin orange Hazelnut	Fruit, fruit peel Fruit, fruit peel Seed
Root crops	Carrot	Root, root peel	Herbs	Rosemary Immortelle	Leaves and stems Leaves and stems

### *Sampling and sample preparation*

Soil samples were taken by auger at the same agricultural fields from which the crops were collected. Each soil sample consisted of 3-5 subsamples. The weight of collected crops ranged from several up to 10 kg (fresh mass). Crop samples were washed and where appropriate (e.g. fruit and tubers) were peeled off and cut into smaller pieces. Peeled material was kept for separate analysis. All samples were oven-dried at 80°C, milled, sieved and homogenized.

For gamma spectrometry samples were packed into cylindrical beakers (125 cm<sup>3</sup>), sealed with PVC tape and left for 3 weeks to achieve radiochemical equilibrium between <sup>226</sup>Ra and its progenies. For the <sup>90</sup>Sr determination, approximately 50 g of soil and 1 kg (fresh weight) of crop samples were dried. Dried crop samples were ashed at 600°C to remove the organic matter.

### *Measurements*

Activity concentrations of gamma emitters in soils were determined by gamma spectrometry, using the High Purity Germanium (HPGe) detector systems within a low background lead shield. For the measurements of activity concentrations in crops, the system was upgraded with active shielding (cosmic veto) to reach lower detection limits. Broad energy Germanium detector (BEGe) with a resolution of 1.95 keV at 1332 keV, and relative efficiency of 48% was used for the crop measurements. The spectra were analyzed using Genie 2000 software. Concentration activities were calculated from the 661.6 keV line for Cs-137, 1460.6 keV line for K-40, 46.5 keV for Pb-210 while Ra-226 is calculated from the lines of its progenies (Bi-214 and Pb-214). The counting time ranged from 80,000 s for soils, up to 250,000 s for crops. Efficiency calibrations were performed mathematically using Canberra's LabSOCS tool, and they were checked using gamma mix standards.

For the Sr-90 determination, Sr from soil samples was isolated by an ion exchanger, eluted with nitric acid and evaporated to dryness. The ashed residues of crops were dissolved in nitric acid, filtered and then evaporated to dryness. For both sample types, the precipitate was dissolved in 5M HNO<sub>3</sub> followed by strontium separation on Sr resin. After reaching radiochemical equilibrium with Y-90, Sr-90 was determined by Cherenkov counting on Quantulus GCT 6220 liquid scintillation counter (LSC) [2].

### *Transfer factor calculations*

Transfer factors (TF) were calculated using the approach described in IAEA [1] for soil-to-plant transfer of radionuclides in temperate environments. Soil activity concentrations used for TF calculations were averages of the results for the first three upper soil layers (0-5 cm, 5-10 cm, 10-20 cm).

## Results

Activity concentration was above the detection limits in 53 %, 32 %, 21 % and 100 % analysed vegetable and fruit samples, for Cs-137, Ra-226, Pb-210 and K-40, respectively. Sr-90 was above the limits of detection in all analysed samples. Differences in the transfer of radionuclides between pulp and peel fractions are shown in Figure 1 and Figure 2. In Table 2 are presented transfer factors calculated for 23 radionuclide/plant group (pulp fractions only) combinations. Where possible, calculated TF values were compared to those from different literature sources on radionuclide transfer to plants in temperate environments compiled by IAEA [1].

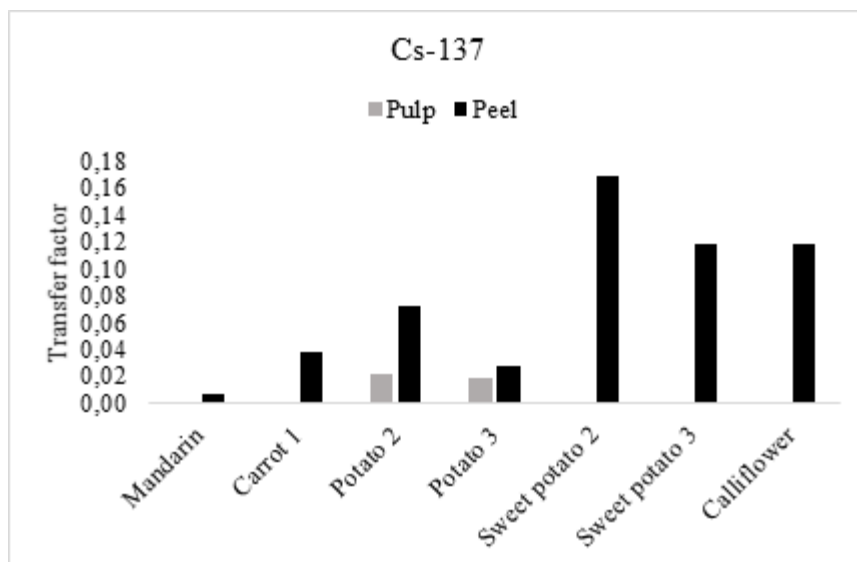


Figure 1: Comparison of Cs-137 transfer factors for pulp and peel parts of fruits and vegetables

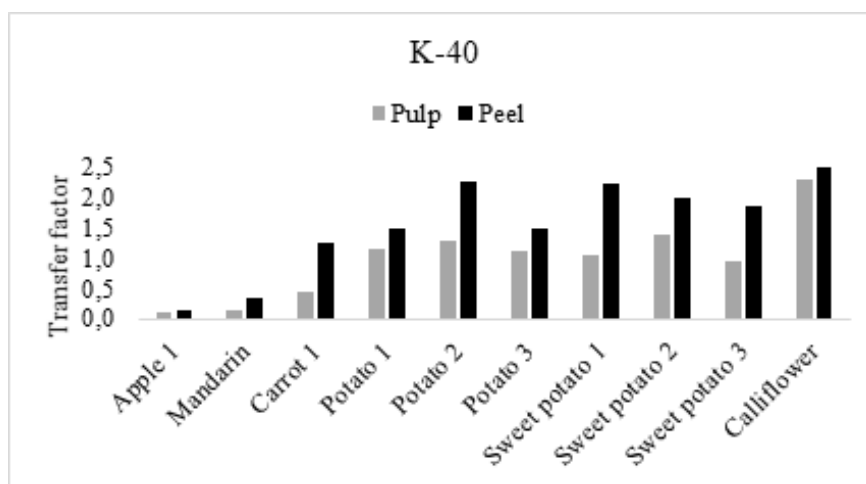


Figure 2: Comparison of K-40 transfer factors for pulp and peel parts of fruits and vegetables

**Table 2: Transfer factors (TFs) of the fruits and vegetables (pulp fractions only) analysed in this study. TF values with a number of data (N) > 1 are presented by mean, minimum (Min) and maximum (Max) values. For comparison purposes mean values of TFs compiled by IAEA [1] for the radionuclide transfer to plants in temperate environments are also presented (soil type: all soils)**

Element	Plant group	N	Our study			IAEA TRS 472	
			Mean	Min	Max	N	Mean
Cs	Leafy vegetables	2	1.09E-01	1.00E-01	1.18E-01	290	6.00E-02
	Non-leafy vegetables	2	1.75E-01	5.36E-02	2.96E-01	38	2.10E-02
	Root crops	1	5.11E-02			81	4.20E-02
	Tubers	4	1.78E-02	1.35E-02	2.17E-02	138	5.60E-02
	Fruit	1	4.26E-03			6	5.80E-03
Ra	Leafy vegetables	3	2.30E-02	9.45E-03	4.58E-02	77	9.10E-02
	Root crops	3	8.85E-02	1.99E-02	9.77E-01	60	7.00E-02
	Tubers	5	1.34E-02	7.92E-03	2.48E-02	45	1.10E-02
	Herbs	1	1.56E-02				n.d.
	Fruit	3	2.02E-03	8.38E-04	6.32E-03		n.d.
Pb	Leafy vegetables	3	1.47E-01	3.46E-02	4.16E-01	31	8.00E-02
	Herbs	2	2.17E-01	5.65E-02	3.78E-01		n.d.
K	Leafy vegetables	5	3.36E+00	1.76E+00	8.89E+00	2	1.30E+00
	Non-leafy vegetables	3	2.06E+00	1.94E+00	2.30E+00		n.d.
	Root crops	3	1.43E+00	4.52E-01	3.43E+00		n.d.
	Tubers	8	9.75E-01	4.27E-01	1.37E+00		n.d.
	Herbs	2	9.57E-01	8.78E-01	1.03E+00		n.d.
	Fruit	4	1.46E-01	7.76E-02	4.02E-01		n.d.
Sr	Leafy vegetables	3	8.44E-01	3.05E-01	1.77E+00	217	7.60E-01
	Non-leafy vegetables	3	1.46E-01	1.77E-02	5.02E-01	19	3.60E-01
	Root crops	2	6.86E-01	6.52E-01	7.20E-01	56	7.20E-01
	Tubers	4	7.10E-02	4.00E-02	1.93E-01	106	1.60E-01
	Fruit	2	1.23E-02	1.02E-02	1.49E-02	18	1.70E-02

n.d. no data

## Discussion and conclusions

K-40 was the only radionuclide detected in all measured samples and also the radionuclide with the highest TFs, some of them being higher than unity. However, considering that potassium is a biogenic element, high TFs of K-40 are most likely a reflection of plant homeostasis and not bioaccumulation [3]. On the other hand, Pb-210 was below the limits of detection in the majority of samples. Therefore, for this radionuclide, it was possible to calculate TFs for only seven samples: three of them being characterized by larger surface leaves (chard, spinach and kale), two with "waxy" type of leaves (rosemary and immortelle), mandarin orange peel and sweet potato peel. These results are in line with the previous studies that indicated atmospheric deposition as the primary source of Pb-210 in plants which is usually the most pronounced in plants with significant aboveground green biomass [4,5]. However, this exposure pathway might not be significant only for Pb-210, but also for Cs-137 and Ra-226. In the cauliflower sample, these two radionuclides were below the limit

of detection in its flowers, but not in cauliflower leaves that were shadowing flowers. Another exposure pathway that might have been a cause of differences in radionuclide content in cauliflower leaves and fruits is the resuspension of soil particles.

Comparison of TF values between pulp and peels of fruits and vegetables indicated uneven radionuclide distribution between these plant compartments. These differences were observed for all studied radionuclides, except for Pb-210 due to the above-mentioned low number of available data. TF values of Cs-137, Ra-226, K-40 and Sr-90 for peels were up to 12 times higher than those for the pulp fraction (on average three times). Moreover, while the activity of Cs-137 and Ra-226 was detected in approximately 20 and 50 % of pulp samples, in peel samples they were detected in 60 and 80 % of samples, respectively (Figure 1). Discrepancies in the number of data between peel and pulp TFs were not observed for K-40 and Sr-90 (Figure 2). Causes of these differences in the radionuclide content of different plant compartments might be due to the different metabolism of these radionuclides (e.g. root epidermis might serve as a barrier for some radionuclides [6] or residual soil trapped in the peel pores which usually remains even in the case of vigorous washing after sampling (and can be also related to the size and type of soil particles) [7].

The majority of TF values obtained by our study were in the same order of magnitude as mean values reported by IAEA (Table 2). On the other hand, calculated TFs for Cs in leafy and non-leafy vegetables and Pb in leafy vegetables were approximately an order of magnitude higher than the related IAEA's mean values while TF for Sr in tubers was approximately an order of magnitude lower. Overall, calculated TF values were on the lower edge of ranges reported by IAEA [1] for studied radionuclide/plant group combinations.

### Acknowledgement

This work was supported by the Croatian Science Foundation under the project IP-2019-04-1401 "Radionuclides in children's food and novel methods for low-level activity determination" (RiChFALL).

### Literature

- [1] International Atomic Energy Agency, Quantification of Radionuclide Transfer in Terrestrial and Freshwater Environments for Radiological Assessments, IAEA-TECDOC-1616, IAEA, Vienna (2009)
- [2] Grahek Z., Dulanska, S., Karanovic, G., Cocha, I., Tucakovic, I., Nodilo, M., Matel, L. (2018). Comparison of different methodologies for the <sup>90</sup>Sr determination in environmental samples. *J. Environ. Radioact.* 181, 18–31. <https://doi.org/10.1016/j.jenvrad.2017.10.0>
- [3] ICRP, 2009. Environmental Protection: Transfer Parameters for Reference Animals and Plants. ICRP Publication 114, Ann. ICRP 39(6)
- [4] Boryło A, Skwarzec B, Wiczorek J. (2022). Sources of Polonium <sup>210</sup>Po and Radio-Lead <sup>210</sup>Pb in Human Body in Poland. *Int. J. Environ. Res. Public Health.* 19(4):1984. doi 10.3390/ijerph19041984.
- [5] Persson BR, Holm E. (2011) Polonium-210 and lead-210 in the terrestrial environment: a historical review. *J. Environ. Radioact.* 102(5):420-9. doi: 10.1016/j.jenvrad.2011.01.005.

- [6] Černe, M., Smodiš, B., Štok, M., Jaćimović, R., (2018) Plant accumulation of natural radionuclides as affected by substrate contaminated with uranium-Mill Tailings. *Water. Air. Soil Pollut.* 229, 1–21. <https://doi.org/10.1007/s11270-018-4000-1>.
- [7] Sheppard, S.C., Evenden, W.G., 1992. Concentration enrichment of sparingly soluble contaminants (U, Th and Pb) by erosion and by soil adhesion to plants and skin. *Environ. Geochem. Health* 14, 121-131. <http://dx.doi.org/10.1007/BF01783487>
- [8] Černe, M., Smodiš, B., Štok, M., Jaćimović, R., (2018) Plant accumulation of natural radionuclides as affected by substrate contaminated with uranium-Mill Tailings.

**PRIJENOS Cs-137, Sr-90, Ra-226, Pb-210 I K-40 IZ TLA U BILJKU U RAZLIČITIM  
POLJOPRIVREDNIM KULTURAMA U HRVATSKOJ**

Božena SKOKO<sup>1</sup>, Gorana KARANOVIĆ<sup>1</sup>, Tomislav ILIEVSKI<sup>1</sup>, Ivana SOHA<sup>1</sup>,  
Željko GRAHEK<sup>1</sup>, Katja MAGDIĆ KOŠIČEK<sup>1</sup>, Ivana SMIČIKLAS<sup>2</sup>,  
Dijana PAVIČIĆ-HAMER<sup>3</sup>, Ivana TUCAKOVIĆ<sup>1</sup>

- 1) *Institut Ruđer Bošković, Bijenička cesta 54, Zagreb, Hrvatska,*
- 2) *Univerzitet u Beogradu, Institut za nuklearne nauke „Vinča” - Institut od nacionalnog značaja za Republiku Srbiju, Beograd, Srbija,*
- 3) *Institut Ruđer Bošković, G. Paliaga 5, Rovinj, Hrvatska*

**SAŽETAK**

U ovom smo radu istražili prijenos Cs-137, Sr-90, Ra-226, Pb-210 te K-40 iz tla u različite vrste povrća i voća sakupljenih na obiteljskim poljoprivrednim imanjima u Hrvatskoj. Istovremeno su istražene i razlike u prijenosu radionuklida u različite dijelove plodova. Rezultati ovog istraživanja ukazuju da je generalno prijenos radionuklida obuhvaćenih ovom studijom unutar raspona transfer faktora sugeriranih od strane IAEA za umjerena područja, ali na njihovom nižem dijelu. Unatoč nižem transferu, uočen je povišeni prijenos svih istraživanih radionuklida u kore plodova u odnosu na pulpu. Sveukupno, primjećene razlike u prijenosu radionuklida sugeriraju, osim sadržaja radionuklida u tlu, i druge mehanizme i puteve izlaganja radionuklidima, a koje utječu na njihove količine u biljkama.

## САДРЖАЈ

### ОПШТИ ПРОБЛЕМИ ЗАШТИТЕ ОД ЗРАЧЕЊА GENERAL PROBLEMS OF RADIATION PROTECTION ..... 1

OPRAVDANOST, OPTIMIZACIJA I REFERENTNI NIVOI U SITUACIJAMA POSTOJEĆEG IZLAGANJA ..... 2

JUSTIFICATION, OPTIMIZATION AND REFERENCE LEVELS IN EXISTING EXPOSURE SITUATIONS ..... 8

METROPOEM PROJEKAT – METROLOGIJA ZA HARMONIZACIJU MERENJA ZAGADJIVAČA ŽIVOTNE SREDINE U EVROPI ..... 9

METROPOEM – METROLOGY FOR THE HARMONISATION OF MEASUREMENTS OF ENVIRONMENTAL POLLUTANTS IN EUROPE ..... 14

### РАДИОЕКОЛОГИЈА И ИЗЛАГАЊЕ СТАНОВНИШТВА RADIOECOLOGY AND POPULATION EXPOSURE ..... 15

RADIOLOŠKA KARAKTERIZACIJA POLJOPRIVREDNOG ZEMLJIŠTA NA TERITORIJI VOJVODINE ..... 16

RADIOLOGICAL CHARACTERIZATION OF AGRICULTURAL SOIL IN THE TERRITORY OF VOJVODINA ..... 23

MONITORING RADIOAKTIVNOSTI I PROCENA RADIJACIONOG RIZIKA U OKOLINI TERMOELEKTRANA U REPUBLICI SRBIJI U 2021. I 2022. GODINI ..... 24

RADIOACTIVITY MONITORING AND RADIATION RISK ASSESSMENT IN THE SURROUNDINGS OF THERMAL POWER PLANTS IN THE REPUBLIC OF SERBIA IN 2021 AND 2022 ..... 29

GRAMON BAZA PODATAKA: DESETOGODIŠNJA MERENJA SPECIFIČNE AKTIVNOSTI BERILIJUMA-7 U VAZDUHU ..... 30

GRAMON DATABASE: TEN YEARS OF BERYLLIUM-7 SPECIFIC ACTIVITY MEASUREMENTS ..... 35

ISPITIVANJE SADRŽAJA RADIONUKLIDA U VODI I SEDIMENTU, REKA SAVA ..... 36

RADIONUCLIDES IN WATER AND SEDIMENT, SAVA RIVER ..... 41

RADIOLOŠKA ANALIZA NEKIH VRSTA LEKOVITOG BILJA SA PODRUČJA GUČEVA I PROCENA GODIŠNJE EFEKTIVNE DOZE USLED INGESTIJE ..... 42

RADIOLOGICAL ANALYSIS OF SOME TYPES OF MEDICINAL PLANTS FROM THE GUČEVO AREA AND ESTIMATION OF ANNUAL EFFECTIVE DOSE DUE TO INGESTATION ..... 48

PRIMENA JONOIZMENJIVAČKIH SMOLA ZA GAMA SPEKTROMETRIJSKO ODREĐIVANJE RADIJUMA U VODI ..... 49

APPLICATION OF ION EXCHANGE RESINS FOR GAMMA SPECTROMETRIC DETERMINATION OF RADIUM IN WATER ..... 55

ODREĐIVANJE VEŠTAČKIH I PRIRODNIH RADIONUKLIDA U UZORKU ZEMLJIŠTA U SVRHU INTERKOMPARACIJE IAEA-TERC-2022-02 ..... 56

DETERMINATION OF GAMMA-EMITTING ANTHROPOGENIC AND NATURAL RADIONUCLIDES IN SOIL SAMPLE FOR THE PURPOSE OF PROFICIENCY TEST IAEA-TERC-2022-02 ALMERA ..... 61

RASPODELA KONCENTRACIJA AKTIVNOSTI PRIRODNIH RADIONUKLIDA U UZORCIMA ŽIVOTNE SREDINE KAO POSLEDICA RADA TERMOELEKTRANE “KOLUBARA” U PERIODU 2010 – 2022. GODINE ..... 62

THE ACTIVITY CONCENTRATION DISTRIBUTIONS OF NATURALLY OCCURRING RADIONUCLIDES IN THE ENVIRONMENTAL SAMPLES AS A RESULT OF THE OPERATION OF THE “KOLUBARA” COAL-FIRED POWER PLANT IN THE PERIOD OF 2010 – 2022. .... 70

RADIOLOGICAL CHARACTERIZATION OF ALKALI ACTIVATED MATERIALS CONTAINING WOOD AND FLY ASH ..... 71



RADIOLOŠKA KARAKTERIZACIJA ALKALNO AKTIVNIH MATERIJALA KOJI SADRŽE DRVENI I LETEĆI PEPEO .....	79
POTENCIJALNI ODNOS IZMEĐU KONCENTRACIJE TRICIJUMA U KIŠNICI I REKAMA.....	80
RELATIONSHIP BETWEEN TRITIUM CONCENTRATIONS IN PRECIPITATION AND RIVERS.....	85
ANALIZA TRENDA PROMENE UKUPNE ALFA I UKUPNE BETA AKTIVNOSTI U POLJOPRIVREDNOM EKOSISTEMU.....	86
ANALYSIS OF TREND OF THE GROSS ALPHA AND GROSS BETA ACTIVITY IN THE AGRICULTURAL ECOSYSTEM.....	92
AKUMULACIJA RADIONUKLIDA IZ ZEMLJIŠTA U PLODOVIMA LEŠNIKA .....	93
ACCUMULATION OF RADIONUCLIDES FROM SOIL IN HAZELNUT FRUITS.....	102
REZULTATI MERENJA PRIVATNE MERNE STANICE U POŽAREVCU ZA KONTINUALNO MERENJE AMBIJENTALNOG EKVIVALENTA DOZE ZA 2021. I 2022. GODINU.....	103
MEASUREMENT RESULTS OF PRIVATE MEASURING STATION IN POŽAREVAC FOR CONTINUOUS MEASUREMENT OF AMBIENT DOSE EQUIVALENT FOR 2021 AND 2022 .....	109
ISPITIVANJE KONCENTRACIJE RADIONUKLIDA U SEDIMENTU PODMORJA CRNE GORE .....	110
CONCENTRATION OF RADIONUCLIDES IN THE SUBMARINE SEDIMENT OF MONTENEGRO	115
SADRŽAJ RADIONUKLIDA I DOZA INGESTIJOM ZA ČAJEVE SPRAVLJENE OD LEKOVITOG BILJA SA TERITORIJE REPUBLIKE SRBIJE.....	116
RADIONUCLIDE CONTENT AND INGESTION DOSE FOR TEA MADE FROM MEDICINAL HERBES FROM THE THERITORY OF REPUBLIC OF SERBIA .....	121
ANALIZA FRAKTALNE PRIRODE SPECIFIČNE AKTIVNOSTI BERILIJUMA-7 U PRIZEMNOM SLOJU ATMOSFERE MERENE U BEOGRADU, SRBIJA (1991-2022) .....	122
ANALYSIS OF THE FRACTAL NATURE OF THE SPECIFIC ACTIVITY OF BERYLLIUM-7 IN THE NEAR-SURFACE LAYER OF THE ATMOSPHERE MEASURED IN BELGRADE, SERBIA (1991–2022) .....	127
FLY-ASH FOR USAGE IN THE BUILDING MATERIAL INDUSTRY .....	128
UPOTREBA LETEĆEG PEPELA U INDUSTRIJI GRAĐEVINSKOG MATERIJALA .....	136
IZBOR REFERENTNOG DATUMA ZA PREZENTOVANJE AKTIVNOSTI RADIONUKLIDA U VREMENSKI KOMPOZITNIM UZORCIMA.....	137
SELECTION OF REFERENCE DATE FOR PRESENTATION OF RADIONUCLIDE ACTIVITY IN TIME-COMPOSITE SAMPLES.....	142
SADRŽAJ RADIONUKLIDA I TEŠKIH METALA U OTPADNOM TALOGU OD PREČIŠĆAVANJA RASTVORA ZA ELEKTROLIZU CINKA U “ZORKI” ŠABAC .....	143
CONTENT OF RADIONUCLIDES AND HEAVY METALS IN THE WASTE PRECIPITATE FROM THE PURIFICATION OF THE SOLUTION FOR THE ELECTROLYSIS OF ZINC IN "ZORKA" ŠABAC .....	152
SOIL TO PLANT TRANSFER OF CS-137, SR-90, RA-226, PB-210 AND K-40 IN DIFFERENT AGRICULTURAL PRODUCTS IN CROATIA.....	153
PRIJENOS CS-137, SR-90, RA-226, PB-210 I K-40 IZ TLA U BILJKU U RAZLIČITIM POLJOPRIVREDNIM KULTURAMA U HRVATSKOJ .....	159
<b>РАДОН RADON.....</b>	<b>160</b>
MERENJE RADIOAKTIVNOSTI I EKSHALACIJE RADONA IZ KONCENTRATA ARSENA KORIŠĆENOG U INDUSTRIJI CINKA „ZORKA” ŠABAC .....	161
MEASUREMENTS OF RADIOACTIVITY AND RADON EXHALATION FROM THE ARSENIC CONCENTRATE USED IN THE ZINC INDUSTRY "ZORKA" ŠABAC .....	171
RADON U SREDNJIM ŠKOLAMA U CRNOJ GORI.....	172

RADON IN SECONDARY SCHOOLS IN MONTENEGRO.....	177
RAZVOJ METODOLOGIJE ZA BRZU DIJAGNOSTIKU POVIŠENIH NIVOVA RADONA I ANALIZU GEOLOŠKIH FAKTORA U RADONOM UGROŽENIM PODRUČJIMA .....	178
DEVELOPMENT OF METHODOLOGY FOR RAPID DIAGNOSTIC OF ELEVATED RADON LEVELS AND ANALYSIS OF GEOLOGICAL FACTORS IN RADON PRIORITY AREAS.....	185
MERENJE KONCENTRACIJE RADONA U ZATVORENOM PROSTORU – PRIKAZ JEDNOG SLUČAJA.....	186
INDOOR RADON CONCENTRATION MEASUREMENT - CASE STUDY .....	195
TRACERADON PROJEKAT – PREGLED NAJVAŽNIJIH REZULTATA.....	196
TRACERADON PROJECT – AN OVERVIEW OF SCIENTIFIC ACHIEVEMENTS .....	205
MONITORING KONCENTRACIJE RADONA U RADNOM PROSTORU, LABORATORIJA PMF-A U KOSOVSKOJ MITROVICI .....	206
MONITORING OF RADON CONCENTRATION IN THE WORKPLACE, LABORATORY OF FACULTY IN KOSOVSKA MITROVICA.....	211
ISPITIVANJE KONCENTRACIJE AKTIVNOSTI RADONA SA VODOIZVORIŠTA U CRNOJ GORI	212
INVESTIGATION OF RADON ACTIVITY CONCENTRATION FROM WATER SOURCES IN MONTENEGRO .....	218
<b>METODE DETEKCIJE I MERNA INSTRUMENTACIJA DETECTION METHODS AND MEASUREMENT INSTRUMENTATION.....</b>	<b>219</b>
PONOVLJIVOST ODREĐIVANJA AKTIVNOSTI RADIONUKLIDA CS-137 IZ CILINDRIČNOG RADIOAKTIVNOG IZVORA.....	220
REPEATABILITY OF CS-137 RADIONUCLIDE ACTIVITY DETERMINATION FROM CYLINDRICAL RADIOACTIVE SOURCE .....	224
VARIJACIJE FONA HPGE DETEKTORA .....	225
BACKGROUND VARIATIONS OF HPGE DETECTORS .....	231
INTERNA KONTROLA KVALITETA HPGE GAMASPEKTROMETRIJSKOG SISTEMA.....	232
INTERNAL QUALITY CONTROL OF HPGE GAMMA SPECTROMETRY SYSTEM.....	237
ODREĐIVANJE SADRŽAJA PRIRODNIH RADIONUKLIDA U UZORCIMA MINERALNIH ĐUBRIVA.....	238
DETERMINATION OF THE CONTENT OF NATURAL RADIONUCLIDES IN SAMPLES OF MINERAL FERTILIZERS.....	244
GODIŠNJA KONTROLA DETEKTORA INSPECTOR 1000 I RADEYE PRD .....	245
ANNUAL CONTROL OF INSPECTOR 1000 AND RADEYE PRD DETECTORS.....	251
UPOTREBA FRAM SOFTVERA U ANALIZI GAMA SPEKTARA NUKLEARNIH MATERIJALA ....	252
FRAM SOFTVER .....	252
THE USE OF FRAM SOFTWARE IN THE ANALYSIS OF GAMMA SPECTRA OF NUCLEAR MATERIALS .....	258
REZULTATI ISPITIVANJA SONDE S1 SA KOMPENZACIONIM FILTEROM ZA MERENJE AMBIJENTALNOG EKVIVALENTA DOZE ZA UREĐAJ DMRZ-M15 .....	259
TEST RESULTS OF PROBE S1 WITH COMPENSATION FILTER FOR MEASURING THE AMBIENT EQUIVALENT DOSE USED WITH DMRZ-M15 SURVEY METER.....	264
MERNA NESIGURNOST AMBIJENTALNIH FOTONSKIH DOZIMETARA U IMPULSNOM REŽIMU RADA SA POSEBNIM OSVRTOM NA UTICAJ OSETLJIVOSTI DETEKCIJE I VREMENA MERENJA .....	265

MEASUREMENT UNCERTAINTY OF AMBIENT PHOTON DOSIMETERS IN PULSE MODE OPERATION WITH SPECIAL EMPHASIS TO THE INFLUENCE OF DETECTION SENSITIVITY AND MEASUREMENT TIME .....	271
PRIPREMA RADIOAKTIVNIH STANDARDA ZA KALIBRACIJU GAMA SPEKTROMETARA .....	272
PREPARATION OF RADIOACTIVE STANDARDS FOR CALIBRATION OF GAMMA SPECTROMETER .....	279
ODREĐIVANJE SR-89 I SR-90 ČERENKOVLJEVIM BROJENJEM.....	280
DETERMINATION OF SR-89 AND SR-90 BY CHERENKOV COUNTING.....	286
ANALIZA FLUKSA I DOZNIH EFEKATA TERESTRIJALNOG SKYSHINE ZRAČENJA .....	287
ANALYSIS OF FLUX AND DOSE EFFECTS OF TERRESTRIAL SKYSHINE RADIATION .....	292
KALIBRACIJA LSC DETEKTORA U OKVIRU RAZVOJA METODE ZA MERENJE URANIJUMA U PODZEMNIM VODAMA .....	293
CALIBRATION OF LSC DETECTOR FOR THE DEVELOPMENT OF METHOD FOR MEASURING URANIUM IN GROUNDWATER.....	297
<b>ЗАШТИТА ОД ЗРАЧЕЊА У МЕДИЦИНИ RADIATION PROTECTION IN MEDICINE.....</b>	<b>298</b>
ANALIZA RASEJANJA ZRAČENJA OD ZAUSTAVLJAČA SNOPI KOD LINEARNIH MEDICINSKIH AKCELERATORA .....	299
ANALYSIS OF RADIATION SCATTERING FROM BEAM STOPPERS AT LINEAR MEDICAL ACCELERATORS.....	305
UNAPREĐENJE ZAŠTITE MEDICINSKOG OSOBLJA KOJE UČESTVUJE U FLUOROSKOPSKI VOĐENIM INTERVENTNIM PROCEDURAMA UVOĐENJEM POLUAUTOMATSKOG SISTEMA UPRAVLJANJA VISEĆIM ZAŠTITNIM EKRAKOM.....	306
IMPROVING THE PROTECTION OF MEDICAL STAFF PARTICIPATING IN FLUOROSCOPICALLY GUIDED INTERVENTIONAL PROCEDURES BY INTRODUCING A SEMI-AUTOMATIC SYSTEM FOR MANAGING A CEILING-SUSPENDED PROTECTIVE SCREEN.....	312
NOVI PRISTUP U KONSTRUKCIJI ZAŠTITE U BRAHITERAPIJI-BRAHITERAPIJSKA KOMORA	313
A NEW APPROACH IN THE CONSTRUCTION OF PROTECTION IN BRACHYTHERAPY – BRACHYTHERAPY CHAMBER.....	320
EKSPERIMENTALNI MODEL ZA PROCENU MOGUĆEG RADIOPROTEKTIVNOG EFEKTA BILJNOG EKSTRAKTA .....	321
EXPERIMENTAL MODEL FOR ASSESSING THE POSSIBLE RADIOPROTECTIVE EFFECT OF PLANT EXTRACT .....	327
CT PROTOKOL I VRIJEDNOSTI DOZA ZA PREGLED UROGRAFIJE.....	328
CT PROTOCOL AND DOSE VALUES FOR UROGRAPHY EXAMINATION.....	334
STANJE RENDGEN-APARATA U DIJAGNOSTIČKOJ RADIOLOGIJI U CRNOJ GORI.....	335
THE CONDITION OF X-RAY MACHINES IN DIAGNOSTIC RADIOLOGY IN MONTENEGRO .....	341
VALIDACIJA ITLC METODE ZA ODREĐIVANJE SADRŽAJA RADIOHEMIJSKE NEČISTOĆE C U <sup>99m</sup> Tc-MIBI INJEKCIJI .....	342
VALIDATION OF AN ITLC METHOD FOR THE DETERMINATION OF RADIOCHEMICAL IMPURITIES C IN <sup>99m</sup> Tc-MIBI INJECTION.....	349
METODA ISPITIVANJA FIZIOLOŠKE RASPODELE <sup>99m</sup> Tc-DPD.....	350
METHOD FOR INVESTIGATION OF PHYSIOLOGICAL DISTRIBUTION OF <sup>99m</sup> Tc DPD .....	355
AUTOMATIZACIJA PROCESA PROIZVODNJE RADIOFARMACEUTIKA U CILJU SMANJENJA DOZE ZRAČENJA OPERATERA.....	356

AUTOMATION OF THE PRODUCTION OF RADIOPHARMACEUTICAL WITH THE AIM TO REDUCE THE OPERATOR'S RADIATION DOSE .....	360
<b>ДОЗИМЕТРИЈА DOSIMETRY .....</b>	<b>361</b>
USPOSTAVLJANJE ETALONSKOG POLJA ZA MALE VREDNOSTI JAČINE DOZNOG EKVIVALENTA.....	362
ESTABLISHING CALIBRATION FIELD FOR SMALL VALUES OF DOSE EQUIVALENT RATE....	368
EVALUATION OF DIAGNOSTIC RADIOLOGY DETECTOR PERFORMANCE IN REFERENCE MAMMOGRAPHY RADIATION FIELDS .....	369
EVALUACIJA PERFORMANSI DETEKTORA ZA DIJAGNOSTIČKU RADIOLOGIJU U REFERENTNIM POLJIMA ZRAČENJA ZA MAMMOGRAFIJU .....	375
PROVERA RADIOTERAPIJSKIH USTANOVA SRBIJE OD 2019. DO 2022. GODINE POŠTANSKOM DOZIMETRIJOM U VELIČINI APSORBOVANA DOZA U VODI.....	376
POSTAL DOSIMETRY AUDIT OF RADIOTHERAPY CENTERS IN SERBIA FOR THE PERIOD FROM 2019. TO 2022. IN TERMS OF ABSORBED DOSE TO WATER .....	381
THE INFLUENCE OF COMPRESSION PADDLE POSITIONING ON HVL MEASUREMENTS IN MAMMOGRAPHY .....	382
UTICAJ POZICIJE KOMPRESIJE PAPUČICE NA HVL MERENJA U MAMMOGRAFIJI .....	386
PRIMENA TL DOZIMETARA ZA ISPITIVANJE TAČNOSTI ISPORUČENE DOZE U OZRAČIVAČU KRVU .....	387
APPLICATION OF TL DOSIMETERS FOR TESTING THE ACCURACY OF DELIVERED DOSE IN BLOOD IRRADIATOR.....	393
<b>БИОЛОШКИ ЕФЕКТИ ЈОНИЗУЈУЋИХ ЗРАЧЕЊА BIOLOGICAL EFFECTS OF IONIZING RADIATION .....</b>	<b>394</b>
SINTEZA LUTECIJUMA(III) KOMPLEKSA SA POLIAZAMAKROCIKLIČNIM LIGANDOM .....	395
SYNTHESIS OF LUTETIUM(III) COMPLEX WITH A POLYAZAMACROCYCLIC LIGAND.....	400
ANTIOKSIDATIVNI I RADIOPROTEKTIVNI EFEKAT FLAVONOIDA NA UČESTALOST MIKRONUKLEUSA U HUMANIM LIMFOCITIMA .....	401
ANTIOXIDATIVE AND RADIOPROTECTIVE EFFECT OF FLAVONOIDS ON FREQUENCY OF MICRONUCLEI IN HUMAN LYMPHOCYTES.....	405
PROMENE GENETIČKOG MATERIJALA U LIMFOCITIMA PERIFERNE KRVU IZLOŽENIH U VANREDNOM DOGAĐAJU NA GRANIČNOM PRELAZU BEZDAN.....	406
CYTOGENETIC CHANGES IN PERIPHERAL BLOOD LYMPHOCYTES OF THE EXPOSED PERSONS IN THE EMERGENCY EVENT AT THE BORDER CROSSING BEZDAN .....	410
ANALIZA ZDRAVSTVENOG STANJA RADNIKA NA CARINSKOM PRELAZU AKCIDENTALNO IZLOŽENIH RADIOAKTIVNOM ZRAČENJU .....	411
ANALYSIS OF THE HEALTH CONDITION AFTER THE EMERGENCY EVENT AT BEZDAN BORDER CROSSING .....	416
THE EFFECT OF HONEY ON MALONDIALDEHYDE LEVEL IN PLASMA EXPOSED TO A THERAPEUTIC DOSE OF RADIATION.....	417
DELOVANJE MEDA NA NIVO MALONDIALDEHIDA U PLAZMI IZLOŽENOJ TERAPIJSKOJ DOZI ZRAČENJA.....	423
OKSIDATIVNI STATUS KOD PACIJENATA OBOLELIH OD DOBRO DIFERENTOVANIH KARCINOMA ŠTITASTE ŽLEZDE NAKON TERAPIJE <sup>131</sup> I.....	424
OXIDATIVE STATUS IN PATIENTS SUFFERED FROM WELL DIFFERENTIATED THYROID CARCINOMA AFTER <sup>131</sup> I THERAPY.....	429

**РАДИОАКТИВНИ ОТПАД И ДЕКОНТАМИНАЦИЈА RADIOACTIVE WASTE AND DECONTAMINATION.....430**

BEZBEDNO UPRAVLJANJE ZATVORENIM IZVORIMA JONIZUJUĆEG ZRAČENJA: MOGUĆI PRISTUPI, RUKOVANJE, KONDICIONIRANJE I SKLADIŠTENJE .....	431
SAFE MANAGEMENT OF SEALED RADIOACTIVE SOURCES: POSSIBLE APPROACHES, HANDLING, CONDITIONING AND STORAGE .....	438
EFIKASNOST I KAPACITET SORPCIJE JONA $BA^{2+}$ ZEOLITOM 4A I PRIRODNIM KLINOPTILOLITOM I UTICAJ KOMPETICIJE SA JONIMA $SR^{2+}$ .....	439
EFFICIENCY AND CAPACITY OF $BA^{2+}$ IONS SORPTION BY ZEOLITE 4A AND NATURAL KLINOPTILOLITE AND INFLUENCE OF COMPETING $SR^{2+}$ IONS.....	444
PREGLED POTENCIJALNIH PRIMENA OTPADNOG STAKLA EKRANA U MALTER-MATRIKSU ZA IMOBILIZACIJU TEČNOG RADIOAKTIVNOG OTPADA .....	445
OVERVIEW OF POTENTIAL APPLICATIONS OF SCREEN WASTE GLASS IN MORTAR-MATRIX FOR LIQUID RADIOACTIVE WASTE IMMOBILIZATION .....	451
ПРОБНИ РАД ПОСТРОЈЕЊА ЗА ПРЕРАДУ РАДИОАКТИВНОГ ОТПАДА БЕЗ РАДИОАКТИВНИХ И НУКЛЕАРНИХ МАТЕРИЈАЛА .....	452
TRIAL OPERATION OF THE RADIOACTIVE WASTE PROCESSING FACILITY WITHOUT RADIOACTIVE AND NUCLEAR MATERIALS .....	460
UPRAVLJANJE RADIOAKTIVNIM OTPADOM INSTITUTA ZA ONKOLOGIJU I RADIOLOGIJU SRBIJE .....	461
RADIOACTIVE WASTE MANAGEMENT OF THE INSTITUTE FOR ONCOLOGY AND RADIOLOGY OF SERBIA .....	468

**РЕГУЛАТИВА, ЕДУКАЦИЈА И ЈАВНО ИНФОРМИСАЊЕ REGULATION, EDUCATION AND PUBLIC INFORMATION.....469**

PRIMENA KAZNENIH MERA U INSPEKCIJSKOM NADZORU .....	470
APPLICATION OF PENALTIES IN INSPECTION OVERSIGHT .....	476
TERMINOLOGIJA U OBLASTI RADIJACIONE I NUKLEARNE SIGURNOSTI I BEZBEDNOSTI – IZAZOVI.....	477
TERMINOLOGY IN THE FIELD OF RADIATION AND NUCLEAR SAFETY AND SECURITY – CHALLENGES .....	482
BEZBEDNOSNI IZAZOVI USLED POJAVE FALSIFIKOVANIH, LAŽNIH I SUMNJIVIH PREDMETA U LANCU NUKLEARNOG SNABDEVANJA .....	483
SECURITY CHALLENGES DUE TO THE APPEARANCE OF COUNTERFEIT, FAKE AND SUSPICIOUS ITEMS IN THE NUCLEAR SUPPLY CHAIN.....	488
UNAPREĐENJE REGULATORNOG OKVIRA U OBLASTI PRIMENE IZVORA ZRAČENJA U MEDICINI.....	489
IMPROVEMENT OF THE REGULATORY FRAMEWORK IN THE FIELD OF APPLICATION OF RADIATION SOURCES IN MEDICINE.....	495
GENERALNA PREVENCIJA ILEGALNE TRGOVINE RADIOAKTIVNIH MATERIJALA .....	496
GENERAL PREVENTION OF RADIOACTIVE MATERIALS ILLICIT TRAFFICKING.....	508

**НЕЈОНИЗУЈУЋА ЗРАЧЕЊА NON-IONIZING RADIATION .....509**

UTICAJ EVOLUCIJE MOBILNIH TEHNOLOGIJA NA IZLAGANJE LJUDI EM POLJIMA.....	510
THE INFLUENCE OF THE EVOLUTION OF MOBILE TECHNOLOGIES ON THE EXPOSURE OF PEOPLE TO EM FIELDS.....	518
ФОТОТЕРАПИЈА ЗА НЕОНАТАЛНУ ХИПЕРБИЛИРУБИНЕМИЈУ .....	519
PHOTOTHERAPY FOR NEONATAL HYPERBILIRUBINEMIA .....	525