



PHYSICAL CHEMISTRY 2021

## *7<sup>th</sup> Workshop*

### **SPECIFIC METHODS FOR FOOD SAFETY AND QUALITY**

*September 22<sup>nd</sup> 2021, Vinča Institute of Nuclear Sciences - National Institute of the Republic of Serbia, University of Belgrade, Belgrade, Serbia*

***PROCEEDINGS***

## **SPECIFIC METHODS FOR FOOD SAFETY AND QUALITY**

**7<sup>th</sup> WORKSHOP: SPECIFIC METHODS FOR FOOD SAFETY AND  
QUALITY**

**September 22<sup>nd</sup>, 2021, Belgrade, Serbia**

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and Applied Aspects of Physical Chemistry*

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## CONTENTS

### SESSION A:

#### *SPECIFIC METHODS IN FOOD QUALITY CONTROL*

PL A1	ELECTROANALYTICAL METHODS FOR FOOD SAFETY AND QUALITY CONTROL ASSESSMENT C. Cristea, O. Hosu, B. Feier and M. Tertis	1
IL A1	PRECISE TESTING OF PESTICIDES IN FOOD USING THE SCIEX TRIPLE QUAD™ 7500 LC-MS/MS SYSTEM- QTRAP® READY- HIGHLY SENSITIVE ANALYSIS OF MULTI-COMPOUND PANELS IN VARIOUS MATRICES FOR FOOD REGULATIONS D. McMillan, J. Stahl-Zeng, I. Moore, T. Biesenthal, J. Steed and W. Broer	6
IL A2	DEVELOPMENT OF NOVEL ANALYTICAL PLATFORMS FOR THE RAPID, POINT-OF-USE QUANTIFICATION OF MULTIPLE CONTAMINANTS IN FOOD SAMPLES G. Selvolini and G. Marrazza	10
IL A3	APPLICATION OF GCE AND FTIR METHODS FOR THE DETERMINATION OF GLIADINS FROM WHEAT FLOUR V. Gojković Cvjetković, Ž. Marjanović-Balaban, D. Rajić and D. Vujadinović	16
OP A1	ANALYSIS OF SPICE PAPRIKA POWDERS FROM SERBIAN MARKET V. Vasić, M. Radenković, M. Pavlović, J. Petrović, K. Nikolić, M. Momčilović and S. Živković	24
P A1	VISUAL DETECTION OF QUERCETIN USING GOLD NANOPARTICLES M. Nemoda, M. Pavlović, M. Stoiljković and T. Momić	28
P A2	ALUMINA-MODIFIED CARBON PASTE ELECTRODE FOR DETERMINATION OF TOTAL PHENOLIC CONTENT IN WINE T. Novaković, M. Pagnacco, P. Banković and Z. Mojović	32
P A3	REVERSED-PHASE ULTA HIGH PERFORMANCE LIQUID CHROMATOGRAPHY ANALYSIS OF TRIAZINE PESTICIDES WITH ACYCLIC AND CYCLIC SUBSTITUENTS B. Salaković, S. Kovačević, M. Karadžić Banjac, J. Anojčić, L. Jevrić, S. Podunavac-Kuzmanović, S. Gadžurić and D. Antonović	36
P A4	POLAROGRAPHY IN DETERMINATION OF RED WINE ANTIOXIDANT ACTIVITY S. Pejić, N. Đorđević, S. Gorjanović, F. Pastor, N. Todorović Vukotić, V. Tešević and S. B. Pajović	40

**SESSION B:**  
**FOOD SAFETY**

IL B1	TOXICOLOGICAL PROFILE OF MARINE TOXIN DOMOIC ACID IN HUMAN BLOOD CELLS G. Gajski, M. Gerić, A-M. Domijan and B. Žegura	44
IL B2	BACTERIAL ADHESION RATE ON FOOD CONTACT SURFACES K. Bohinc	51
IL B3	CHITOSAN-COATINGS IN EXTENDING SHELF-LIFE OF APPLES N. Mavrič, K. Bohinc, R. Vidrih, K. Godič Torkar and M. Bavcon Kralj	54
IL B4	IMPACT OF GAMMA IRRADIATION ON AFLATOXIN B1 AND OCHRATOXIN A TOXICITY A.-M. Domijan, B. Mihaljević, K. Markov, J. Pleadin and A.M. Marjanović Čermak	61
IL B5	TOXIC METALS CONTENT IN MUSCLE TISSUE OF COMMON CARP FROM LOCATIONS NEAR BELGRADE D. Jovanović, R. Marković, D. Šefer, M. Krstić, V. Stanić, D. Perić and M. Ž. Baltić	69
P B1	BIOWASTE-BASED CARBON MATERIAL FOR MALATHION REMOVAL FROM WATER A. Jocić, S. Brković and T. Lazarević-Pašti	75
P B2	VISCOSE-BASED ACTIVATED CARBON MATERIAL FOR CHLORPYRIFOS REMEDIATION V. Milanković, S. Breitenbach, C. Unterweger, C. Fürst and T. Lazarević-Pašti	79
P B3	ECO-FRIENDLY ACTIVATED CARBON AS AN ADSORBENT FOR DIMETHOATE REMOVAL FROM WATER V. Aničijević, S. Breitenbach, C. Unterweger, C. Fürst and T. Lazarević-Pašti	83
P B4	ANTIRADICAL ACTIVITY OF GRAPE SKIN EXTRACTS - THE EPR STUDY Đ. Nakarada, M. Stojanović, Z. Dajić-Stevanović and M. Mojović	87
P B5	DETERMINING OF INDIGO CARMINE (E132) IN CANDY J. Senčanski, J. Maksimović, S. Blagojević and M. Pagnacco	91
P B6	CYTOTOXIC ACTIVITY OF RED WINE ON HCT 116 AND PANC-1 CELL LINES J. Žakula, N. Đorđević, N. Todorović Vukotić, L. Korićanac, V. Kovačević and S.B. Pajović	95



P B7	GROSS ALPHA AND GROSS BETA ACTIVITY AND OSCILLATORY RESPONSE OF <i>Sardina pilchardus</i> FISH SPECIES FROM ADRIATIC SEA M. Janković, J. Maksimović, B. Janković, N. Bošković, M. Rajačić and D. Šuković	99
P B8	THE COMPARISON OF HEAVY METAL CONTENT OF <i>Sardina pilchardus</i> SPECIES COLLECTED FROM BAY AND OPEN ADRIATIC SEA A. Pesić, D. Joksimović, M. Janković, N. Sarap, J. Maksimović and M. Pagnacco	103
P B9	CYTOTOXICITY AND GENOTOXICITY OF <i>Juniperus communis</i> ESSENTIAL OIL AND POST-DISTILLATION WASTE B. Vasiljević, S. Cvetković, S. Đukanović, D. Mitić-Ćulafić, M. Jovanović and B. Nikolić	107
P B10	ASSESSMENT OF CADMIUM MOBILITY IN BIOAPATITE AMENDED SOIL: LEACHING TESTS AND AVAILABILITY TO THE TOBACCO PLANT M. Jović, J. Marković, M. Šljivić-Ivanović and I. Smičiklas	111
P B11	EFFECTS OF CHRONIC ORAL D-GALACTOSE TREATMENT ON GENERAL HEALTH STATUS IN MALE WISTAR RATS J. Martinović, I. Guševac Stojanović, M. Zarić, A. Todorović, F. Veljković, S. Pejić, Z. Stojanović, N. Mitrović, I. Grković and D. Drakulić	115
P B12	A SINGLE DOSE OF MICROPLASTIC PARTICLES INDUCES CHANGES IN ORGAN WEIGHT OF MALE WISTAR RATS Z. Stojanović, A. Todorović, J. Martinović, N. Filipović, F. Veljković and I. Guševac Stojanović	119
P B13	YELLOW GENTIAN ROOT EXTRACT AND ITS MONOTERPENE COMPOUNDS EXHIBIT ANTICANCER POTENTIAL A. Valenta Šobot, D. Drakulić, J. Savić, G. Joksić and J. Filipović Tričković	123
P B14	GENOTOXICITY TESTING OF ACACIA HONEYS OF DIFFERENT GEOGRAPHICAL ORIGIN S. Petrović, A. Bondžić, B. Nastasijević and A. Leskovac	127
P B15	CYTOGENOTOXICITY OF DEOXYNIVALENOL AND ZEARALENONE A.-M. Domijan, K. Hercog, M. Filipič, M. Sokolović, M. Gerić, G. Gajski and B. Žegura	131

P B16	IN VITRO EVALUATION OF CHLORPYRIFOS CYTOTOXIC EFFECTS M. Čolović, A. Leskovac, A. Vujačić Nikezić and D. Krstić	135
P B17	EFFECT OF CHLORPYRIFOS-OXON ON MEMBRANE DAMAGE AND CELL VIABILITY D. Krstić, S. Petrović, A. Vujačić Nikezić and M. Čolović	139
P B18	INFLUENCE OF CAVITATION EFFECT ON STABILITY OF AFLATOXIN IN MILK V. Stanić, B.K. Adnadjević, S. Stefanović, S. Tanasković, B. Nastasijević, D. Jovanović and V. Živković	143
P B19	ANTIFUNGAL ACTIVITY OF <i>Gentiana lutea</i> EXTRACTS B. Nastasijević, M. Milutinović, V. Stanić and S. Dimitrijević-Branković	147

## **SESSION C:**

### ***FUNCTIONAL FOOD***

IL C1	BIOACCESSIBILITY OF OLIVE-DERIVED NUTRACEUTICALS DETERMINED BY NOVEL STANDARDIZED PROTOCOLS K. Radić	151
OP C1	THE ROLE OF SUSTAINABLE AGRICULTURE IN PRODUCTION OF NUTRIENT DENSE FOOD V. Dragičević, M. Stojković, M. Simić, M. Brankov, M. Šenk, M. Dodevska and M. Tolimir	157
OP C2	PHENOLIC PROFILE OF PLUM WINES AND THEIR ACTIVITY IN THE PROTECTION AGAINST FREE RADICALS U. Čakar, N. Lisov, I. Plavšić, A. Petrović, D. Krstić, I. Stanković and B. Đorđević	164
P C1	ANTIMICROBIAL AND PRO-METABOLIC PROPERTIES OF <i>Salvia officinalis</i> AQUEOUS EXTRACT J. Filipović Tričković, B. Četenović, G. Joksić, Đ. Katnić, A. Krstić and A. Valenta Šobot	168
P C2	APPLICATION OF TOMATO ( <i>S. lycopersicum</i> ) WASTE PECTINS IN BIOGENIC SYNTHESIS OF SELENIUM NANOPARTICLES N. Golub, K. Radić, D. Anić, E. Galić, T. Vinković, M. Dutour Sikirić and D. Vitali Čepo	172
P C3	ANTIBACTERIAL ACTIVITY OF AQUEOUS-ETHANOLIC EXTRACTS OF <i>Alchemilla vulgaris</i> AND <i>Frangula alnus</i> COMBINED WITH STREPTOMYCIN S. Đukanović, S. Cvetković, T. Ganić, B. Nikolić, N. Tomić, D. Kekić and D. Mitić-Ćulafić	176

P C4	MODULATION OF REDOX PARAMETERS IN RAT LIVER INDUCED BY FLAXSEED OIL A. Todorović, I. Pavlović, S. Pejić, J. Miletić Vukajlović, F. Veljković, J. Filipović Tričković, A. Valenta Šobot, J. Martinović, I. Guševac Stojanović, Z. Stojanović and D. Drakulić	<b>180</b>
P C5	COMPARISON OF EXTRACTION KINETICS OF PHENOLIC COMPOUNDS DURING SPONTANEOUS AND INOCULATED FERMENTATION CV. CABERNET SAUVIGNON N. Lisov, I. Plavšić, U. Čakar, A. Petrović and Lj. Gojković-Bukarica	<b>184</b>
P C6	ANTIBACTERIAL ACTIVITY OF RED WINE N. Đorđević, I. Novaković, N. Todorović Vukotić, V. Tešević and S. B. Pajović	<b>188</b>
P C7	N-ACETYLCYSTEINE AS REGULATOR OF THE CELLULAR HOMEOSTASIS A. Leskovac, M. Čolović, A. Bondžić and S. Petrović	<b>192</b>

## EFFECTS OF CHRONIC ORAL D-GALACTOSE TREATMENT ON GENERAL HEALTH STATUS IN MALE WISTAR RATS

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### ABSTRACT

D-galactose (d-gal) is an important physiological nutrient. According to the widely accepted aging metabolic theory d-gal at high levels can be converted into aldose and hydroperoxide, resulting in the overproduction of reactive oxygen species (ROS). Increased ROS levels may subsequently cause oxidative stress, inflammation, mitochondrial dysfunction, and apoptosis which are hallmarks of natural senescence as well as various pathological conditions. We investigated the effects of chronic oral d-gal intake (200 mg/kg and 500 mg/kg for 6 weeks) on physiological, neurological and toxicity parameters in 3 months old male Wistar rats. The obtained results indicate that body weight, food intake, serum glucose, neurological and toxicity status remained unaffected while urine proteins were significantly increased in d-gal treated rats. Although there was no effect on the general health status of the animals, our findings suggest that chronic oral d-gal administration may lead to renal dysfunction.

### INTRODUCTION

D-galactose (d-gal), a reducing sugar that occurs naturally in the body, is primarily found in foods as a structural part of lactose and to a lesser extent in legumes and some fruits and vegetables. It is crucial for human metabolism, with an established role in energy delivery (due to conversion into glucose) and galactosylation of complex molecules [1]. Its maximal recommended daily dose for healthy adults is 50 g, and most of it can be metabolized and excreted from the body within 8 h [2].

However, recent studies have demonstrated that chronic administration of d-gal leads to immune system dysregulation, sex hormone deficiencies, increased inflammatory cytokine levels, cellular apoptosis, and diminished total antioxidant capacity. Taken together, these effects mimic aging and initiate the

development of age-related diseases [3]. In animal aging studies, chronic treatment with d-gal induced oxidative brain damage and cognitive dysfunction, accompanied by several prominent features of the aging brain, such as impairment of synaptic plasticity and neurogenesis. Other organs might also be affected by d-gal treatment [3, 4, 5].

Interestingly, the majority of published studies are based on intraperitoneal or subcutaneous administration of d-gal, while data regarding the oral intake of d-gal are scarce. Only a few studies investigated the alternation of biochemical parameters provoked by oral d-gal treatment, and all of them were focused on brain tissue [6, 7]. The present research is focused on the impact of chronic d-gal treatment on general rats' health, with additional interest on several biochemical markers (glucose, proteins, blood, ketones, and pH), neurological and toxicity status.

## **EXPERIMENTAL**

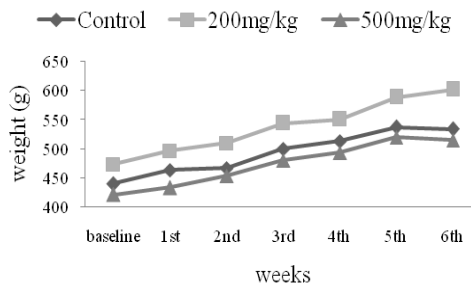
All experimental procedures complied with the Ethical Committee for the Use of Laboratory Animals of VINČA Institute of Nuclear Science – National Institute of the Republic of Serbia, University of Belgrade (protocol number 02/11) and European Communities Council Directive (2010/63/EU) guidelines. For the 6 weeks-lasting treatment, 3 months old male Wistar rats were randomly assigned to three groups: animals that drank tap water (Control, n = 4), rats receiving either 200 mg/kg (n = 4) or 500 mg/kg d-gal (n = 4) dissolved in tap water.

Body weight was monitored weekly while food intake was monitored daily to evaluate the general health. At the end of treatment, a battery of neurological and clinical toxicity tests was performed, along with the analysis of blood glucose levels and biochemical parameters in urine, using commercially available test strips (Insight Urinalysis Reagent Strips, Acon Laboratories, Inc., USA). The neurological test included scoring of following sensory - motor parameters: consciousness (0–1), respiration (0–1), spontaneous activity (0–3), forepaw outstretching (0–2), climbing (0–1), visual placing (0–1), cage grasp (0–1), gait posture (0–2), geotaxis (0–1), hearing and pacing/circling (0–1). The total score of neurological tests was expressed as the sum of average scores of all investigated parameters and graded on a scale of 0 to 15. The toxicity test included: agitation, convulsion, piloerection, sleepiness and lethargy. All toxicity parameters were valued as: – (no effect), + (mild effect), ++ (moderate effect) and +++ (major effect). In pre-treatment control testing, none of the animals exhibited any physiological deficit.

Obtained data were analyzed by One-way analysis of variance followed by Tukey's post hoc test. Results are presented as mean  $\pm$  SEM, and the *p* value less than 0.05 is considered significant.

## RESULTS AND DISCUSSION

As presented in Figure 1., all animals similarly and gradually increased body weight without statistical differences. Moreover, food intake in all groups was stable and remained within tight boundaries from the beginning until the end of the experiment (data not shown).



**Figure 1.** Body weight.

At the end of the six-week treatment, there was no significant change in glycemic levels between animals in Control and d-gal treated groups, demonstrating that d-gal does not interfere with glucose metabolism. This trend was also observed in other studies, regardless of the route of d-gal application [3, 6]. Concerning the urine parameters, oral d-gal treatments increased only urine protein levels (Table 1.), which is often a sign of renal dysfunction that occurs during aging. Indeed, recent studies indicate that renal aging could be induced by chronic d-gal treatment, initiating the disturbance of molecular and histopathological parameters [4, 5].

**Table 1.** Biochemical parameters.

Experimental group/biochemical parameters	Control	200mg/kg	500mg/kg
Serum glucose (mmol/l)	6.9	6.6	6.3
Proteins	47.5	100***	166.7***
Blood	/	/	/
Ketones	12.5	23.3	15
pH	7.25	7.5	8

Although we previously reported that oral application of d-gal compromises the memory [8], results of the current study, presented in Table 2., indicate unimpaired sensory-motor functions and non-toxic effect of d-gal. It suggests that d-gal could successfully be used for evoking alterations that correspond to mild cognitive impairment [6].

**Table 2.** Results of neurological and toxicity tests scoring.

	Control	200mg/kg	500mg/kg
Sensory - motor functions	15	15	14.75
Toxicity signs	-	-	-

## CONCLUSION

Although the results of the current study indicate unaltered general health status (unchanged body weight, food intake, glucose level, neurological markers and most of the toxicity indicators), we also report the renal dysfunction in d-gal chronically treated animals, which highlights the importance of highly controlled d-gal intake.

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## REFERENCES

- [1] A.I. Coelho, G.T. Berry, M. Estela Rubio-Gozalbo, *Curr. Opin. Clin. Nutr. Metab. Care.*, 2015, 18(4), 422–7.
- [2] E. Morava, *Mol. Genet. Metab.*, 2014, 112(4), 275–9.
- [3] M.S. de Almeida Rezende, A.J.P.O de Almeida, T.A.F Gonçalves, F. de Lourdes Assunção Araújo de Azevedo, S.H. Dantas, S. de Lima Silva, E.M. Cardoso Soares, H. Felinto Alves, T. Trajano Lima, J.F. de Souza Júnior, R. Romão Guerra, I.G. Albuquerque Araújo, I.A. de Medeiros, *PloS one*, 2021, 16(4), e0249487.
- [4] A.H. El-Far, M.A. Lebda, A.E. Noreldin, M.S. Atta, Y.H.A. Elewa, M. Elfeky, S.A. Mousa, *Int. J. Mol. Sci.*, 2020, 21(12), 4348.
- [5] C. Bo-Htay, S. Palee, N. Apaijai, S.C. Chattipakorn, N. Chattipakorn, *J. Cell. Mol. Med.*, 2018, 22(3), 1392–1410.
- [6] K. Krzysztoforska, A. Piechal, K. Blecharz-Klin, J. Pyrzanowska, I. Joniec-Maciejak, D. Mirowska-Guzel, E. Widy-Tyszkiewicz, *Behav. Brain Res.*, 2019, 368, 111896.
- [7] J. Budni, R. Pacheco, S. da Silva, M. Lima Garcez, F. Mina, T. Bellettini-Santos, J. de Medeiros, B. Constantino Voss, A. Valnier Steckert, S. da Silva Valvassori, J. Quevedo, *Behav. Brain Res.*, 2016, 302, 35–43.
- [8] M. Zarić, D. Drakulić, M. Stanojlović, N. Mitrović, I. Grković, I. Guševac, A. Horvat, J. Zlatković, *SiNAPSA Neuroscience Conference, Slovenia, 2015, Book of abstracts, MOL07 P66.*