Funded by the European Union

Bioaccessibility of contaminants and human health risk assessment – imperatives for mitigating the pollution in agricultural areas

Dr. Tijana Milićević, tijana.milicevic@ipb.ac.rs

Reasearch Associate Professor, University of Belgrade, Institute of Physics Belgrade

WEBINAR, 10th April 2024

Dr. Tijana Milićević

PhD in Chemistry
Research area: Environmental chemistry
Contact: tijana.milicevic@ipb.ac.rs
ORCID: https://orcid.org/0000-0003-1258-910X

Education:

•BSc, MSc and PhD in Chemistry – Faculty of Chemistry, University of Belgrade

•Specialisation in the field Environmental Law – Faculty of Law University of Belgrade

•Postdoctoral research at Institute of medical research and occupational health (IMI) in Zagreb, Croatia

Working possition: Research Associate Professor, Environmetal Physics Laboratory, Institute of Physics Belgrade, National Institute of the Republic of Serbia, University of Belgrade

Experience with sample analysis:

•Potentially toxic element and POPs analyses in soil, grape, wine, vegetables, supplements, human milk, water, PM

•Bioavailability and bioaccesibility assays (UBM and lung fluid; soil, fruits, suplements, human milk)

Relevant projects:

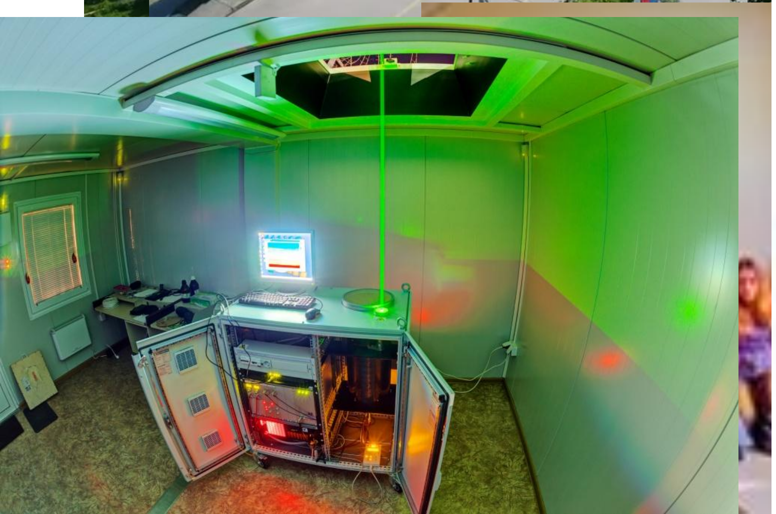
1. Bioaccessibility of toxic organochlorine pesticides and trace elements in agricultural areas in France and Serbia: state of the art to *in vitro* methodology and human health risk assessment, bilateral project with France, PI from Serbian side; 2023-2025
2. Environment pollution and human health: physico-chemical analysis, toxicity, and machine learning models (EnvironPollutHealth), Institute for Medical Research and Occupational Health, Zagreb, Croatia, EU project, 2024-
3. *„Training and research in environmental chemistry and toxicology“, Ceepus (Central European Exchange Programme for University Studies)*
4. Towards zer0 Pesticide AGRIculture: European Network for sustainability (T0P-AGRI-Network), CA21134, (COST), 2022– 2026;
5. Trace metal metabolism in plants (PLANTMETALS), CA 19116, (COST); 2020-2024;
6. Persistent organochlorine compounds in human milk and their potential effect on the level of primary DNA damage in human cells, Bilateral cooperation IMI, Croatia, 2019 – 2022;
7. Pollution state of soils and food samples in Serbia and Slovakia – bioaccessibility fraction of elements and health risk assessment, bilateral cooperation with Faculty of Agriculture in Nitra, Slovakia, 2019 – 2022.

Institute of Physics Belgrade – IPB (1961)

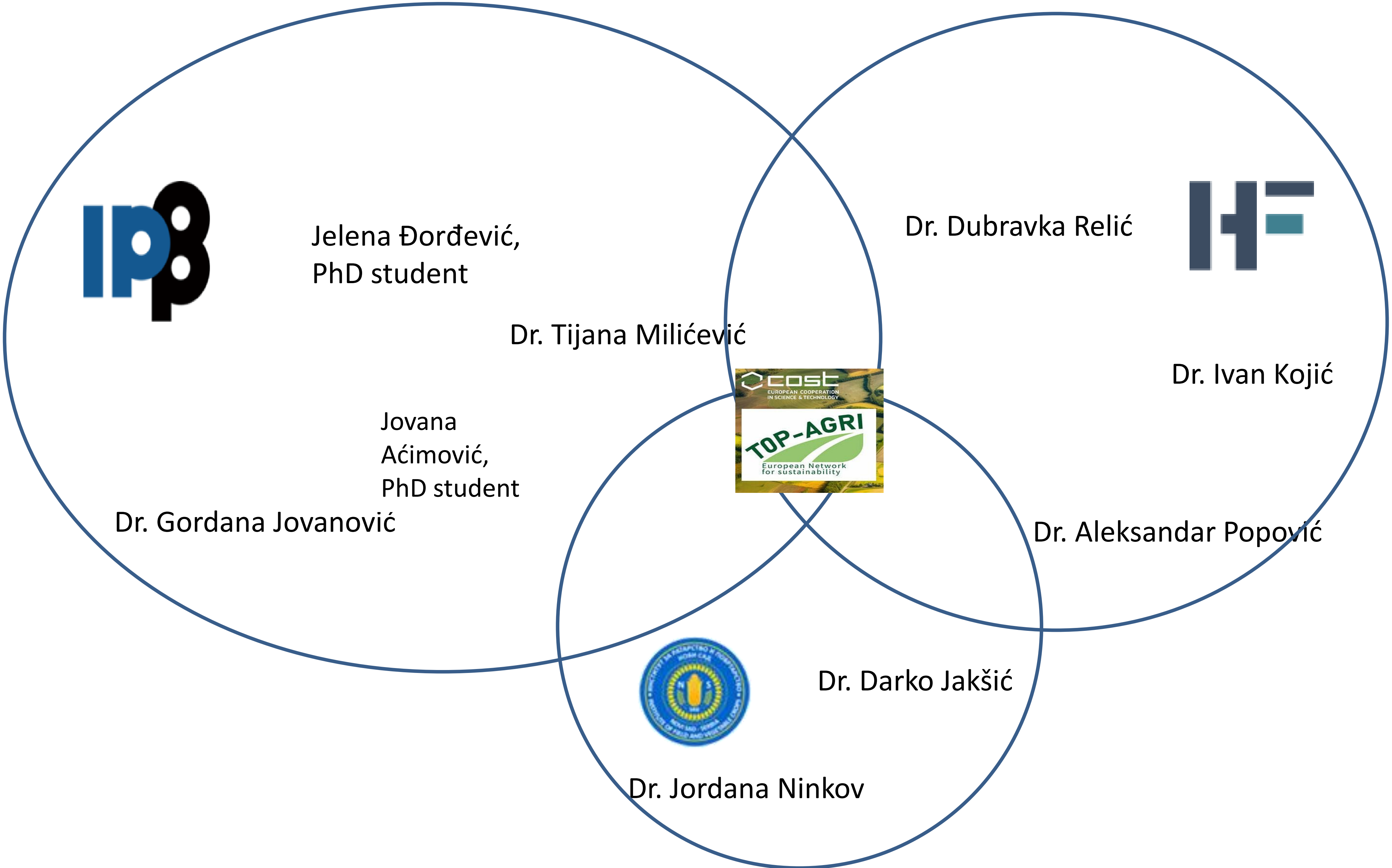
National institute of the Republic of Serbia

Evironmental Physics Laboratory

https://www.ipb.ac.rs/en/home-en/



Institute of Physics Belgrade, Faculty of Chemistry, Institute of field and vegetable crops



- Pesticides in the environment
- Pesticides and human health risk
- Bioaccessibility of pesticides
- Projects/experiments
- Pesticides in agricultural soil (Cu and organochlorines)
- Herbicides in waters and risk for irrigation of agricultural areas
- Pesticides in ecosystem

Importance of risk assessment and bioaccesibility studies in mitigating the pesticide pollution

PESTICIDE MOVEMENT IN THE ENVIRONMENT

Pesticides have the potential to move after they are first applied. Where they go and how long they may last can depend on many factors. The combination of the following factors influences pesticide movement.

PLANTS

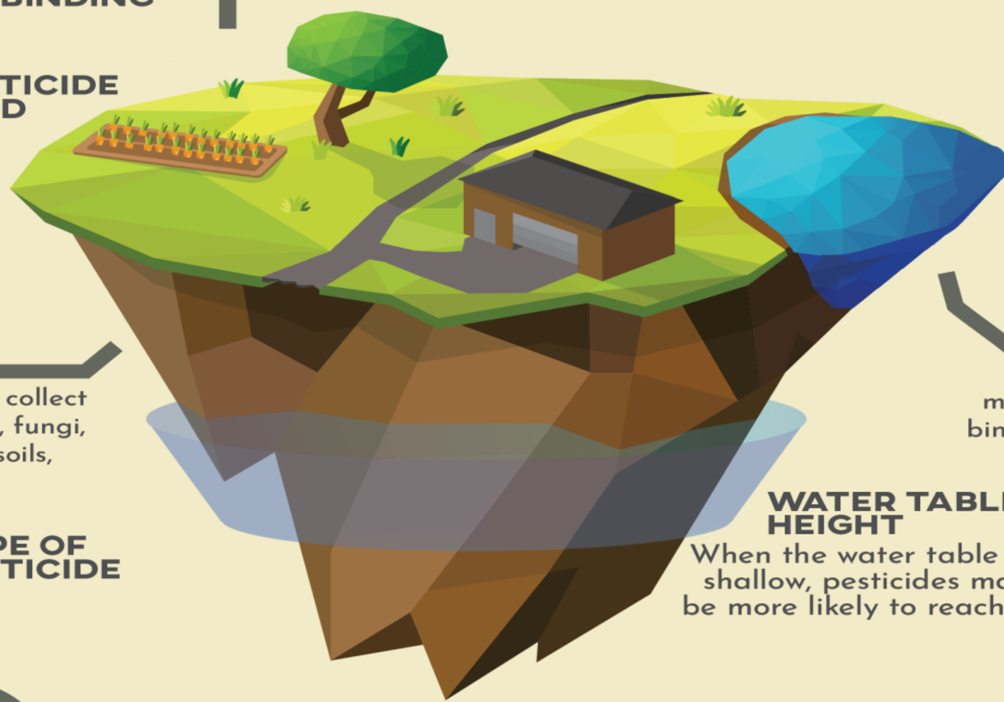
Some pesticides are not easily taken up by plants, and some plant types take up pesticides more than others.

PLANT UPTAKE

SOIL BINDING

PESTICIDE USED

PLANT TYPE



SOIL

Some soils hold onto pesticides more easily, or collect water so pesticides don't move as far. Bacteria, fungi, and other microbes vary across locations and soils, which can also affect pesticide breakdown.

TYPE OF PESTICIDE

SOIL TYPE

SOIL CHEMISTRY

MICROBIAL COMMUNITY

AIR

Increasing temperature, sunlight, and rain may increase pesticide breakdown. This and other weather conditions affect the potential for pesticide movement.

ENVIRONMENTAL CONDITIONS

DROPLET SIZE

SMALL DROPLETS CARRY FURTHER BUT DISSIPATE FASTER

LARGE DROPLETS FALL FASTER BUT STAY ON TARGET BETTER

NATURAL WATER

If a pesticide does reach water, it may not move as much as you think. Some pesticides bind tightly to sediment where they settle out.

WATER TABLE HEIGHT

When the water table is shallow, pesticides may be more likely to reach it.

LAND PROFILE

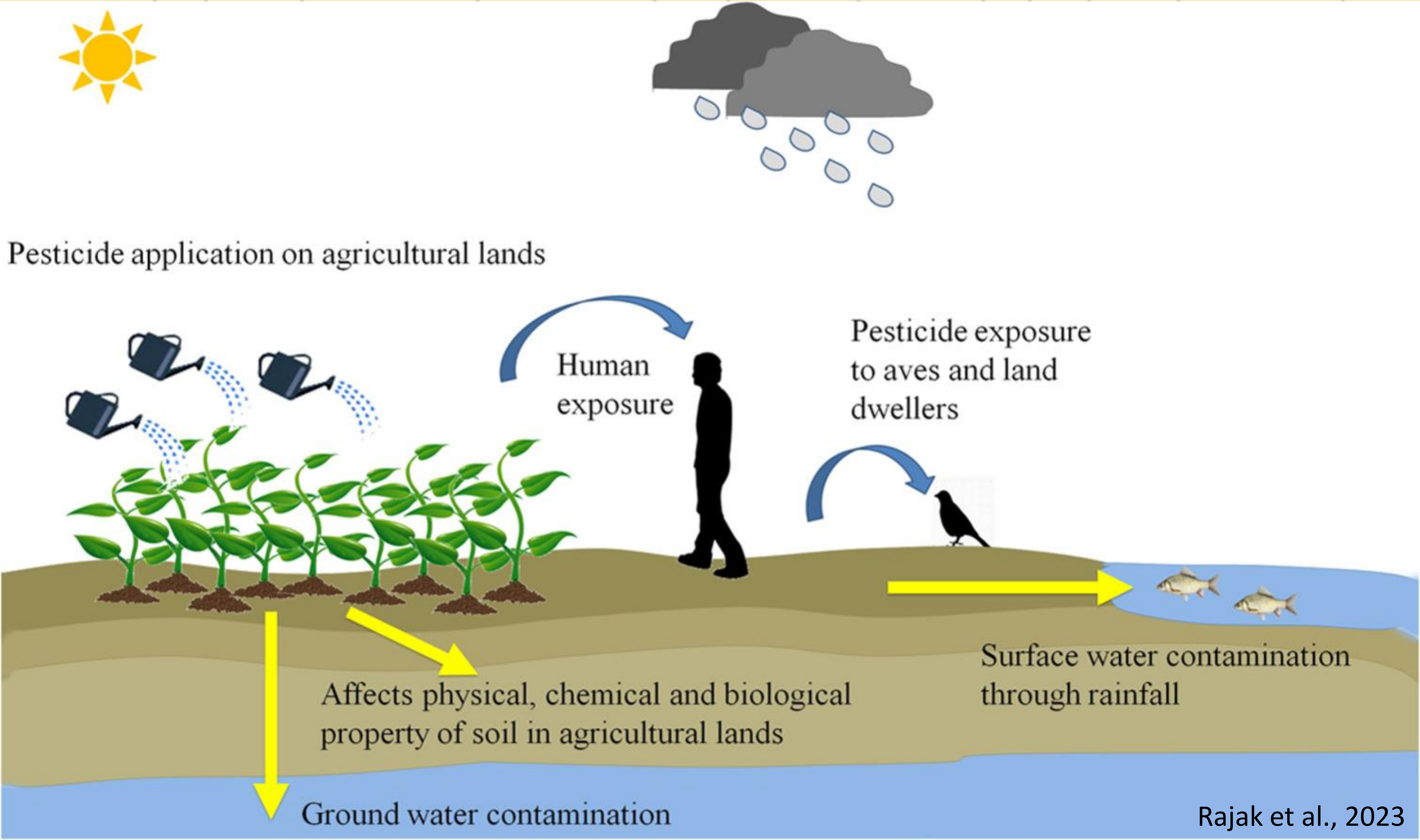
SEDIMENT BINDING

WATER MOVEMENT

For more information about pesticides or their movement in the environment, contact us M-F 8am-12pm PST at 800-858-7378.

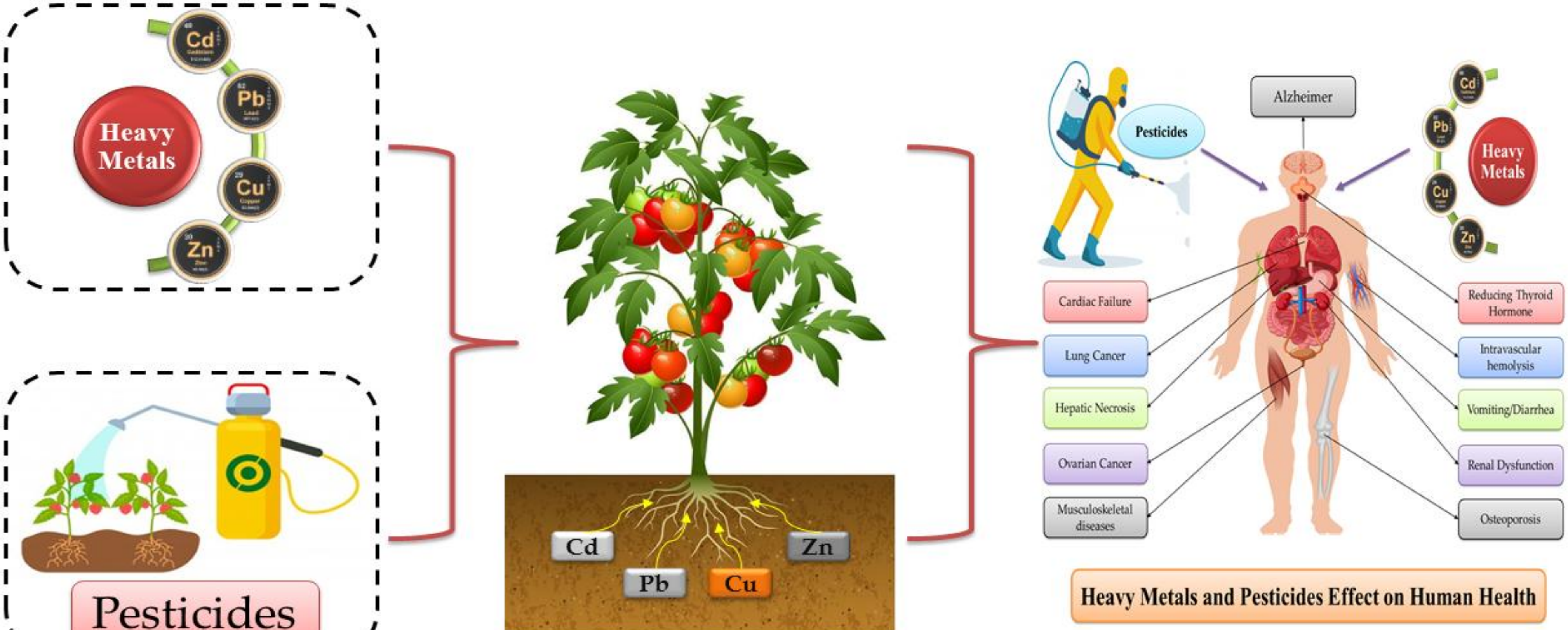
npic NATIONAL PESTICIDE INFORMATION CENTER

PESTICIDE MOVEMENT IN THE ENVIRONMENT



Rajak et al., 2023

Human health risk assessmet



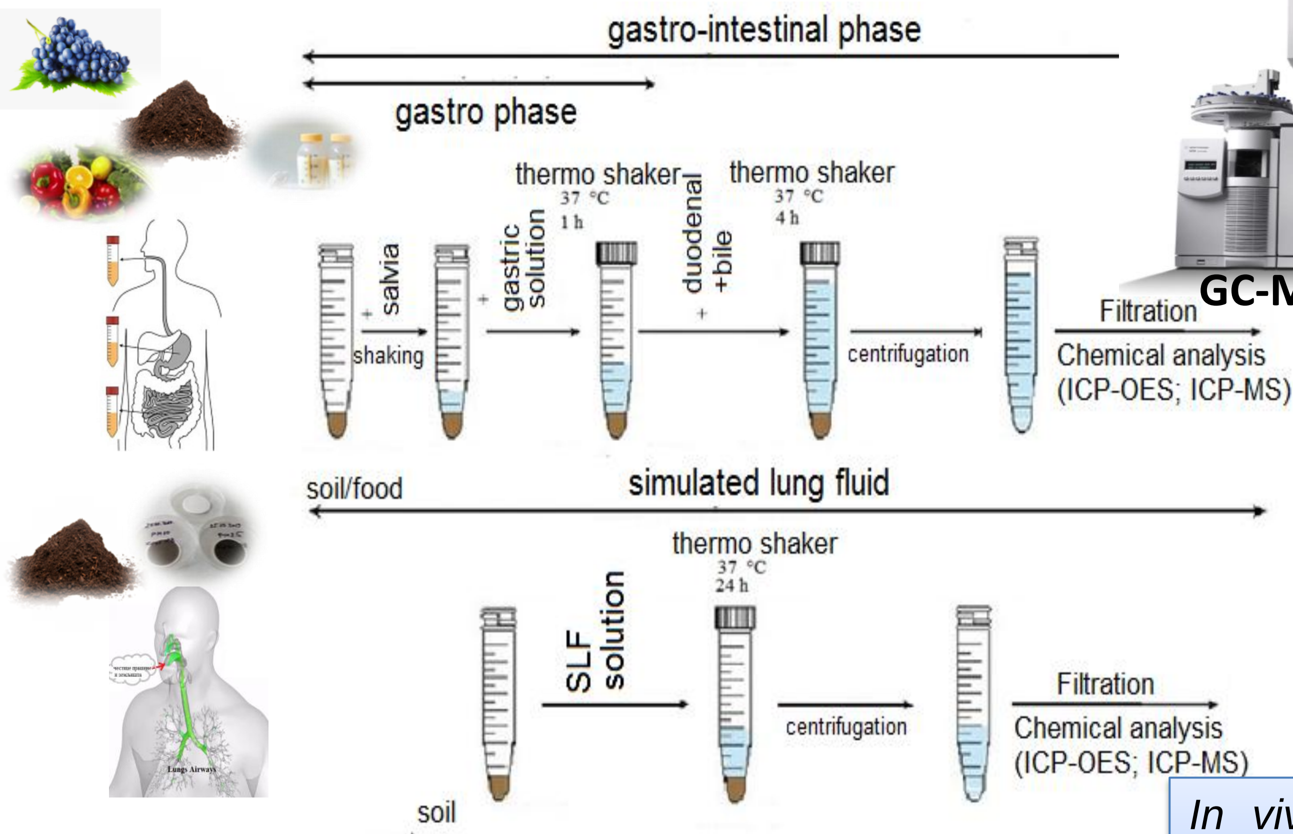
Alengebavy et al., 2021

RAIS

https://rais.ornl.gov/html

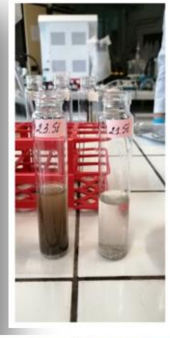
PESTICIDES BIOACCESIBILITY ASSESSMENT IN GASTROINTESTINAL TRACT AND LUNGS - *IN VITRO* TEST

BARGE



GC-MS-MS

ICP-MS
ICP-OES



In vivo validation of the unified BARGE method to assess the bioavailibility of arsenic, antimony, cadmium and lead in soils (2012) Environmental Science and Technology, 46, 6252-6260.


When the world agrees

Standards | All about ISO | Taking part | Store

Standards catalogue | Publications and products

Store › Standards catalogue › Browse by ICS › 13 › 13.080 › 13.080.30 › ISO 17924:2018

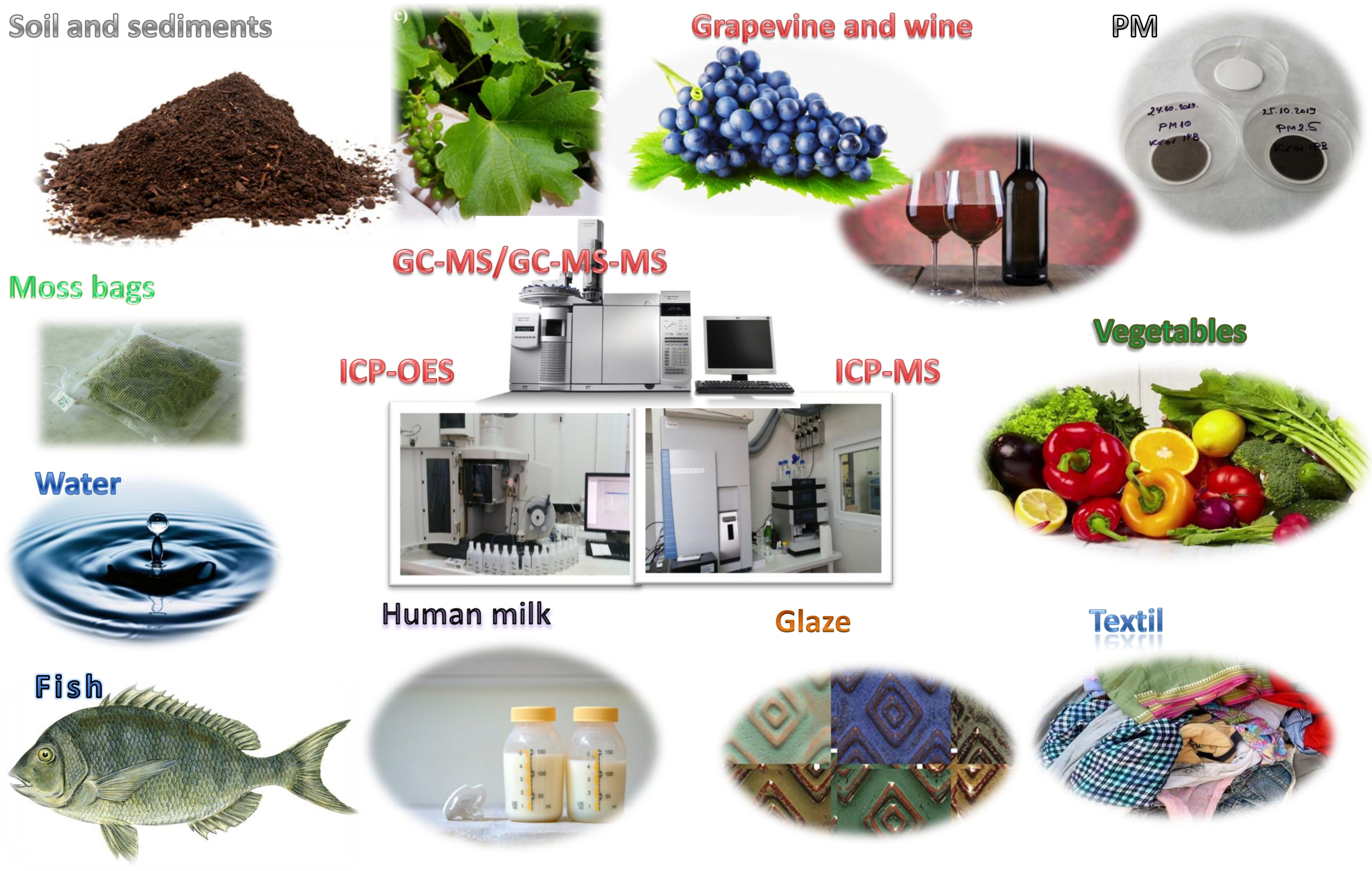
ISO 17924:2018 Preview

Soil quality -- Assessment of human exposure from ingestion of soil and soil material -- Procedure for the estimation of the human bioaccessibility/bioavailability of metals in soil

This document deals with the assessment of human exposure from ingestion of soil and soil materials. It specifies a physiologically based test procedure for the estimation of the human bioaccessibility/bioavailability of metals from contaminated soil in connection with the evaluation of the exposure related to human oral uptake.

Buy this standard

Format	Language
PDF	English
Paper	English


Soil and sediments
Grapevine and wine
PM
24.10.2019
PM10
25.10.2019
PM2.5
GC-MS/GC-MS-MS
Moss bags
Vegetables
ICP-OES
ICP-MS
Water
Human milk
Glaze
Textil
Fish

SAMPLING

➢**SOIL**

Two depths:
0-30 cm
30-60 cm

➢**GRAPEVINE**

Grapevine varieties:
*Italian riesling, Hamburg, Rhine riesling, **Smederevka**, Merlo, **Župljanka, Frankovka**, Chardoney, Muscat ottonel, Sauvignon blanc, Cabernet sauvignon, Ofelia, **Panonia, Prokupac** and **Tamjanika***

➢Copper in grapevine production

•Copper is essential for plant growth. It plays a vital role in various physiological processes (photosynthesis, respiration, antioxidant system, and hormone signal transduction)

•Cu toxicity can significantly affect grapevine quality, such as color (Fang et al., 2018).

•Bordeaux mixture [$Ca(OH)_2+CuSO_4 \cdot 5H_2O$] is one of the most used fungicides in vineyards. The excessive use of copper-containing fungicides leads to a long-term accumulation of copper in vineyard soil, resulting in copper stress (Brun et al., 2001) but also affecting the Cu enrichment in soil and humen exposure to Cu.

Meeting: The impact of climate change on the utilization of the genetic potential of grapevines, Matica Srpska 2023

Environmental Physics Laboratory
Institute of Physics Belgrade | University of Belgrade | Serbia

• Between **Cu**, other PTE can originate from agrochemicals, such as **As, Cr, Co, Pb, Ni, Zn, Mn** that as constituents of mixtures or contaminants.

• These substances may have adverse effects to:

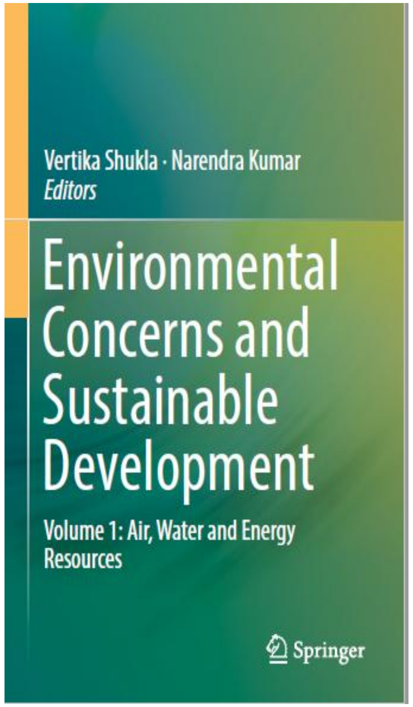
❖ **agricultural production**

❖ **environment**

❖ **human healt**

Meeting: The impact of climate change on the utilization of the genetic potential of grapevines, Matica Srpska 2023

INVESTIGATED SITES AND RESEARCH AIMS



Chapter 2

Moss Bag Biomonitoring of Airborne Pollutants as an Ecosustainable Tool for Air Protection Management: Urban and Agricultural Scenario

Mira Aničić Urošević and Tijana Milićević

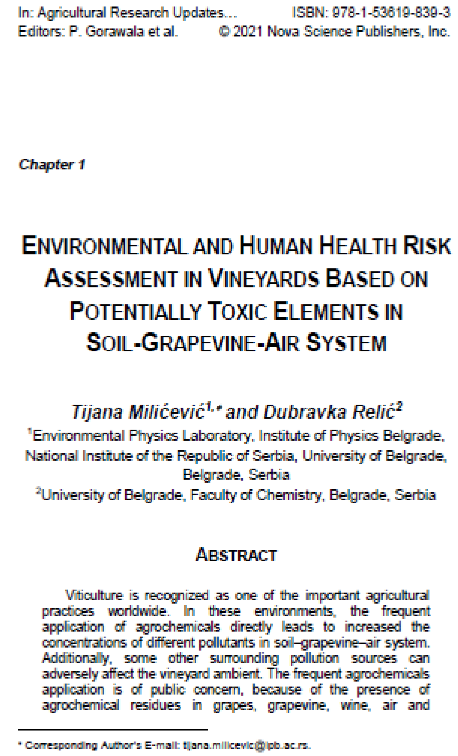
Abstract Urban and agricultural areas are highly anthropogenically devastated environments with diversely and densely distributed pollution sources. These usually highly populated and cultivated areas together represent a big part of the Earth's surface, and it is of crucial interest to monitor and control presumably high air pollution in these areas. Complex urban topography demands a high density of air quality monitoring stations while extensive and frequent agrochemical treatments in cultivated areas require repetitive measurements of pollution at the same site. The application of moss bags represents an easy-to-apply screening technique which has been used for biomonitoring of air pollutants. The technique has been mainly developed for application in areas where the naturally growing biomonitors are absent. It is successfully used for biomonitoring of potentially toxic elements including rare earth elements (PTEs) and persistent organic compounds, mostly polycyclic aromatic hydrocarbons (PAHs). In the last decade, we investigated crucial variables of the moss bag technique application (species-specific, time- and site-dependent pollutant enrichment) through a series of studies performed in the urban area of Belgrade and agricultural areas in Serbia. Starting from 2005, we have examined the moss bag technique for biomonitoring of PTEs at specifically polluted sites within the city such as crossroads, street canyons, tunnel and garages and, finally, overall city area. Thereafter, since 2015, we tested the technique application in conventional and organic vineyards. The interchangeable use of two moss species, *Sphagnum girgensohnii* (a species of the most recommended biomonitoring genus) and *Hypnum cupressiforme* (commonly available in Serbia), for performing the biomonitoring of PTEs was discussed in the studies. The results showed that the studied moss species could not be interchangeably used for airborne element assessment, except for Cr, Cu and Sb. In the urban area, 2-month bag exposure ensures accumulation of the elements and adequate replicability of the results even at air

M. Aničić Urošević (✉) · T. Milićević
Environmental Physics Laboratory, Institute of Physics Belgrade, University of Belgrade, Belgrade, Serbia
e-mail: mira.anicic@ipb.ac.rs

 29

V. Shukla, N. Kumar (eds.), *Environmental Concerns and Sustainable Development*, https://doi.org/10.1007/978-981-13-5889-0_2

mira.anicic@ipb.ac.rs



In: Agricultural Research Updates... ISBN: 978-1-53619-839-3
Editors: P. Gorawala et al. © 2021 Nova Science Publishers, Inc.

Chapter 1

ENVIRONMENTAL AND HUMAN HEALTH RISK ASSESSMENT IN VINEYARDS BASED ON POTENTIALLY TOXIC ELEMENTS IN SOIL-GRAPEVINE-AIR SYSTEM

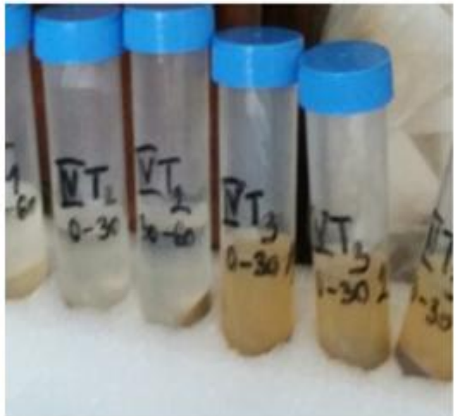
Tijana Milićević[1,] and Dubravka Relić[2]*
[1]Environmental Physics Laboratory, Institute of Physics Belgrade, National Institute of the Republic of Serbia, University of Belgrade, Belgrade, Serbia
[2]University of Belgrade, Faculty of Chemistry, Belgrade, Serbia

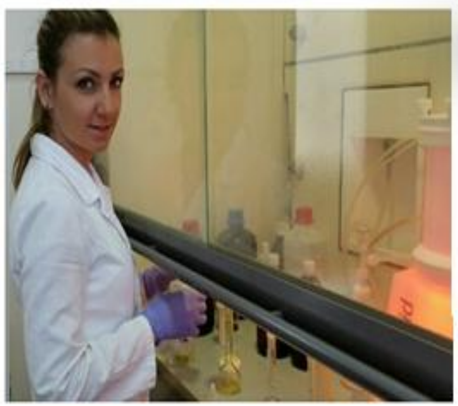
ABSTRACT

Viticulture is recognized as one of the important agricultural practices worldwide. In these environments, the frequent application of agrochemicals directly leads to increased the concentrations of different pollutants in soil–grapevine–air system. Additionally, some other surrounding pollution sources can adversely affect the vineyard ambient. The frequent agrochemicals application is of public concern, because of the presence of agrochemical residues in grapes, grapevine, wine, air and

* Corresponding Author's E-mail: tijana.milicevic@ipb.ac.rs.

➤Sample preparation and chemical analyses





ICP-OES

ICP-MS

GC-MS/GC-MS-MS

Science of the Total Environment 626 (2018) 528–545

Contents lists available at ScienceDirect

Science of the Total Environment

journal homepage: www.elsevier.com/locate/scito

ELSEVIER

Bioavailability of potentially toxic elements in soil–grapevine pulp and seed) system and environmental and health risk as

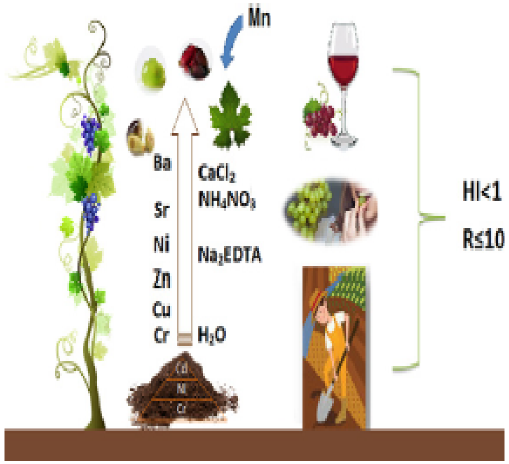
Tijana Milićević [a], Mira Aničić Urošević [a], Dubravka Relić [b,*], Gordana Vuković Sandra Škrivanj [b], Aleksandar Popović [b]

[a] Institute of Physics Belgrade, University of Belgrade, Pregrevica 118, 11080 Belgrade, Serbia
[b] University of Belgrade - Faculty of Chemistry, Studentski trg 12 – 16, Belgrade, Serbia

HIGHLIGHTS

- Bioavailability of the toxic element for grapevines and consumers was considered.
- Element concentrations were measured in soil and different grapevine parts.
- Six single extraction procedures isolated different portion of elements from soil.
- Ba was easy bioavailable; Cu and Zn were mostly accumulated in seed and leaf, respectively.
- Non-carcinogenic and carcinogenic risks were low for workers and grape consumers.

GRAPHICAL ABSTRACT



Environmental Science and Pollution Research
https://doi.org/10.1007/s11356-020-10649-8

RESEARCH ARTICLE

Check for updates

Environmental pollution influence to soil–plant–air system in organic vineyard: bioavailability, environmental, and health risk assessment

Tijana Milićević [1] · Mira Aničić Urošević [1] · Dubravka Relić [2] · Gordana Jovanović [1] · Dragica Nikolić [3] · Konstantin Vergel [4] · Aleksandar Popović [2]

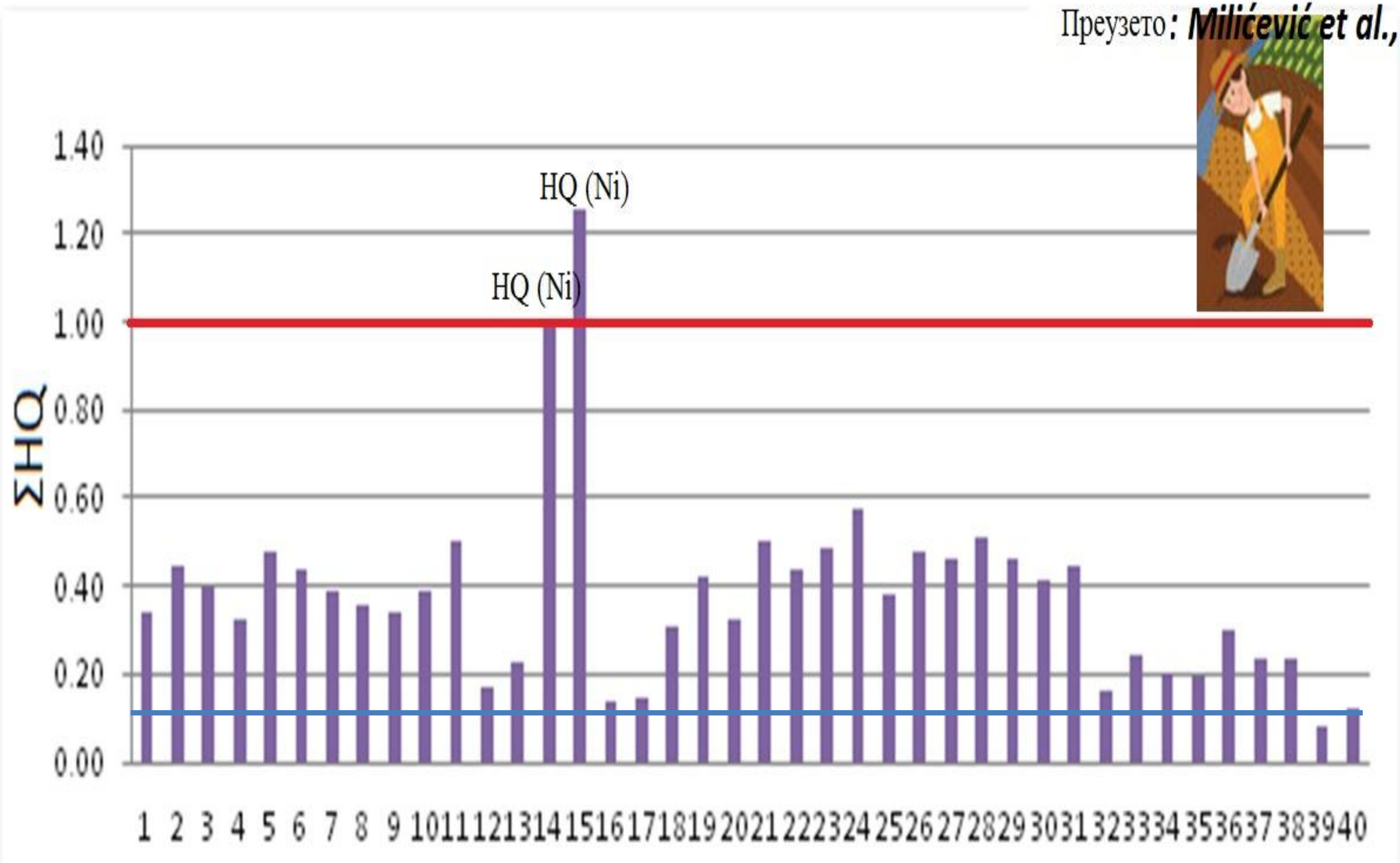
Received: 17 February 2020 / Accepted: 26 August 2020

Abstract

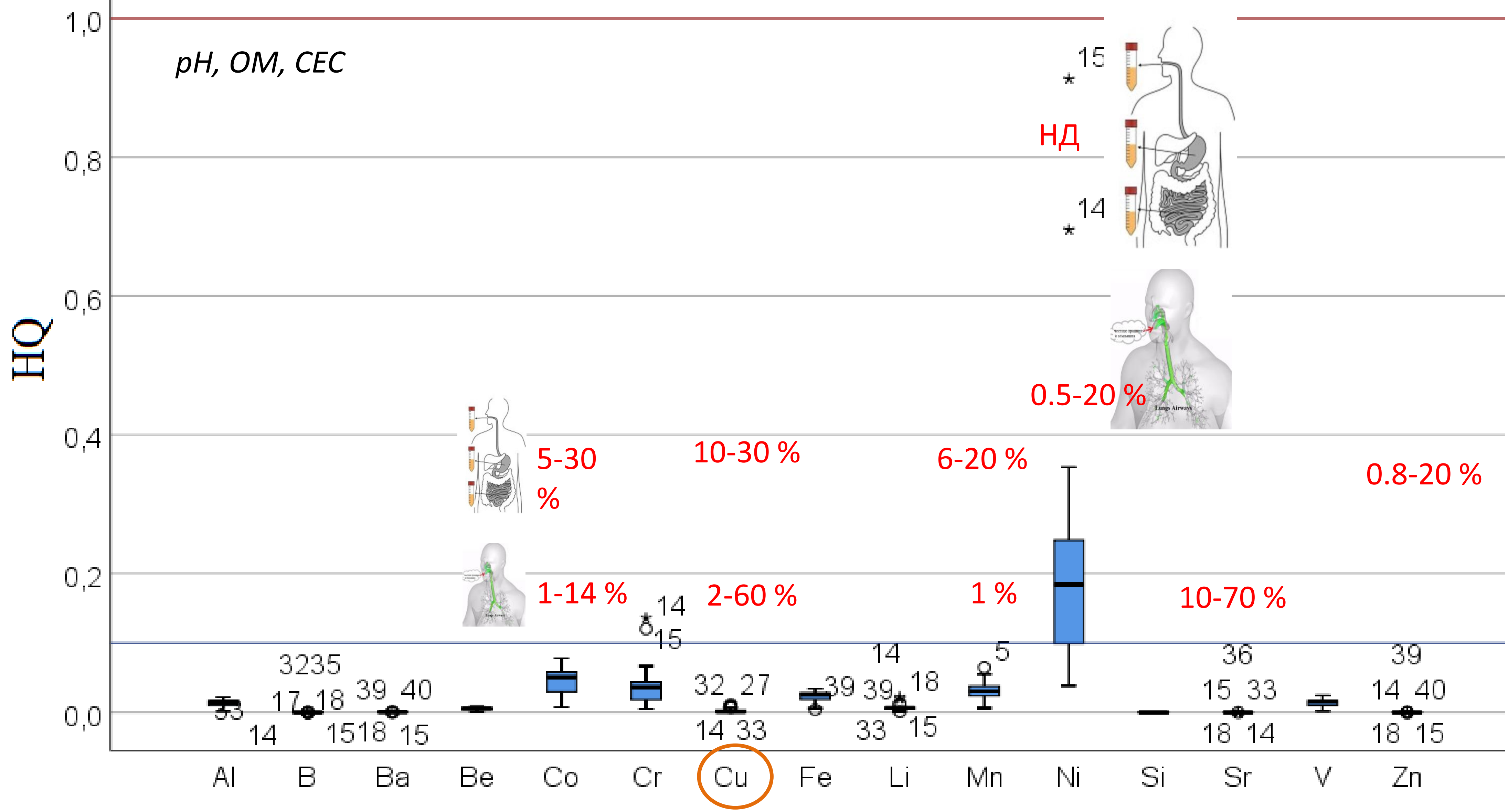
This study was performed in organic vineyard to assess integrated pollution in soil–plant–air system by potentially toxic elements (PTE). Concentrations of 26 PTE were determined in soil, grapevine, and air biomonitors (moss bags) using ICP-OES and ICP-MS. Environmental implication assessment of soil did not show pollution by PTE, except for B in samples collected in the middle of grapevine season (July). Despite low total Cd concentrations in soil, it has the highest influence on increase of environmental risk. Based on biological accumulation concentration (BAC), grapevine is not hyperaccumulator of PTE from soil. Advanced

HUMAN HEALTH RISK ASSESSMENT - SOIL (THE WORST CASE

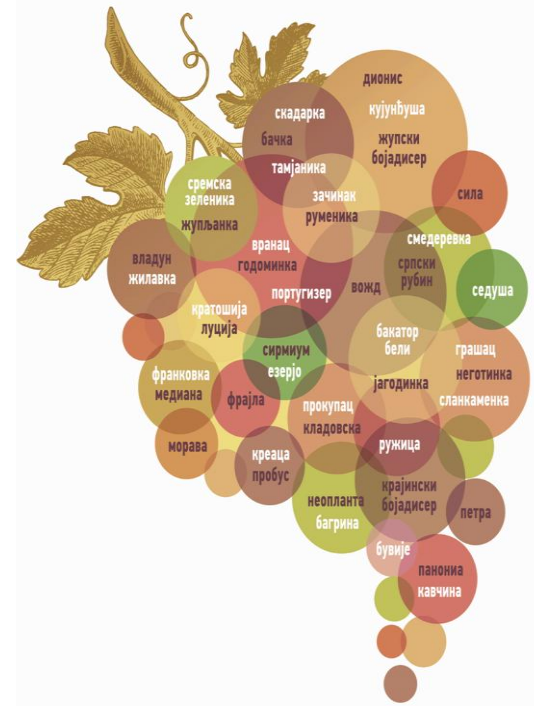
Преузето: *Milićević et al., 2023*



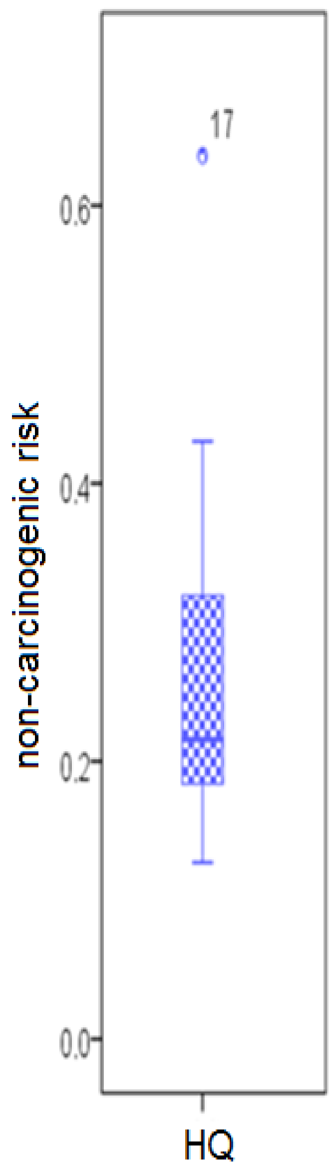
HUMAN HEALTH RISK ASSESSMENT: PTEs IN SOIL AND *IN VITRO* BIOACCESIBILITY ASSESSMENT GASTROINTESTINAL TRACT AND LUNGS

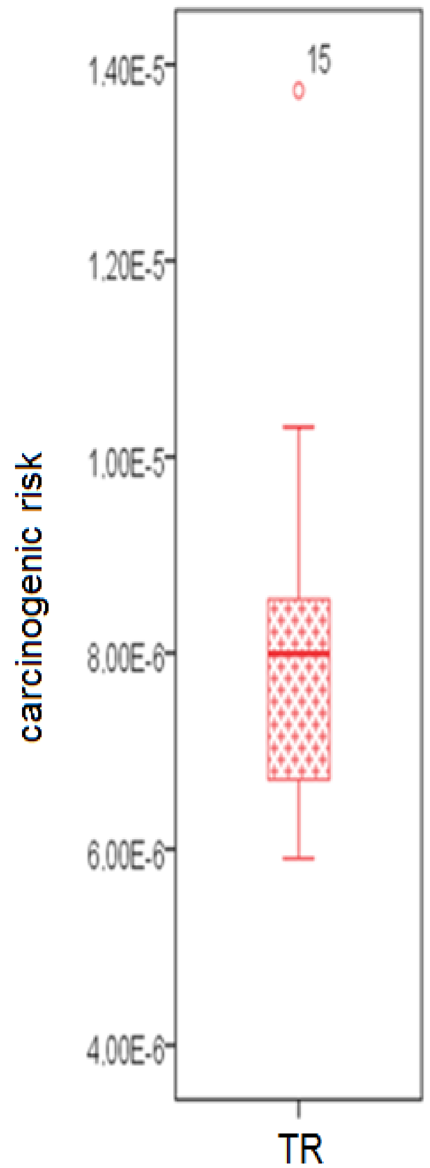



DO YOU ALSO EAT THESE WITH THAT MASK ON ?!


дионис
скадарка
кујунђуша
бачка
жупски бојадисер
тамјаника
сремска зеленика
зачинак
сила
руменика
жупљанка
смедеревка
вранац
владун
годоминка
српски рубин
жилавка
вожд
седуша
португизер
кратошија
луција
бакатор бели
сирмиум
грашац
езерјо
франковка
негостинка
медиана
јагодинка
фрајла
прокупац
сланкаменка
кладовска
морава
ружица
креаца
пробус
крајински бојадисер
неопланта
петра
багрина
бувије
панониа
кавчина

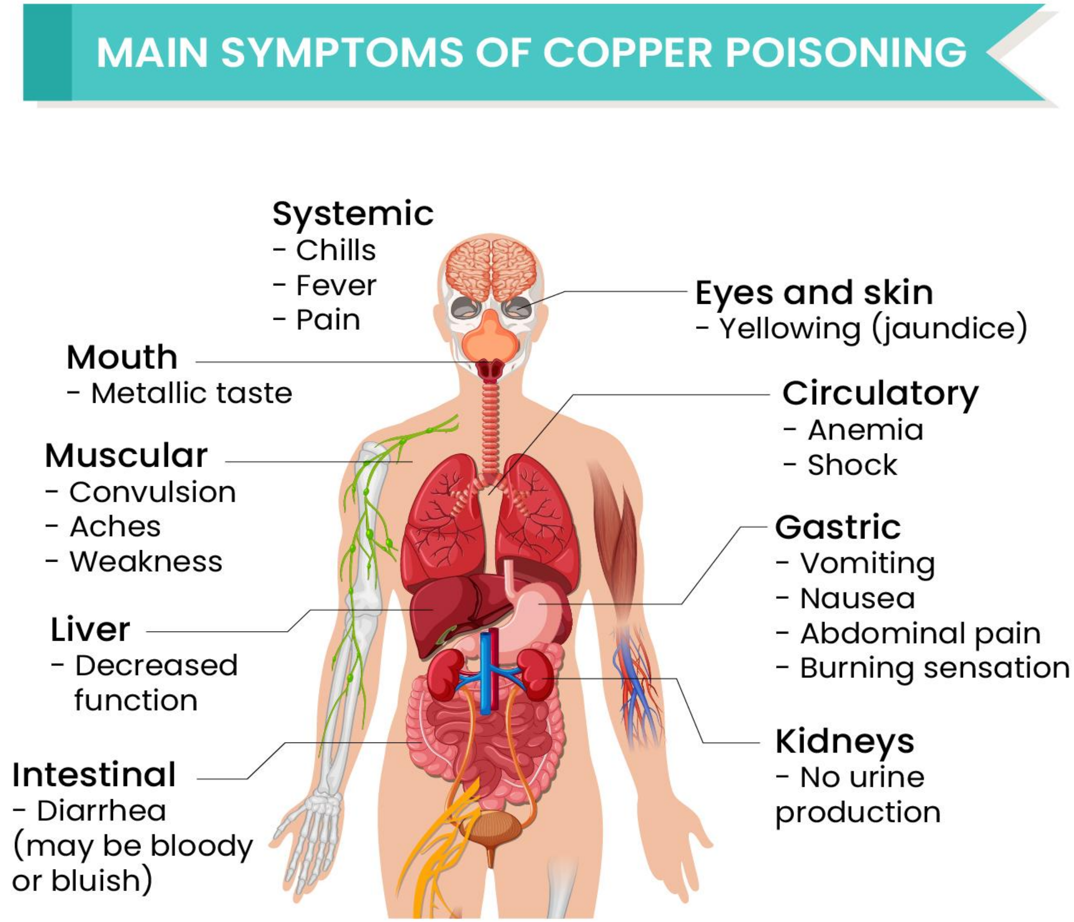
CONSUMERS – HUMAN HEALTH RISK





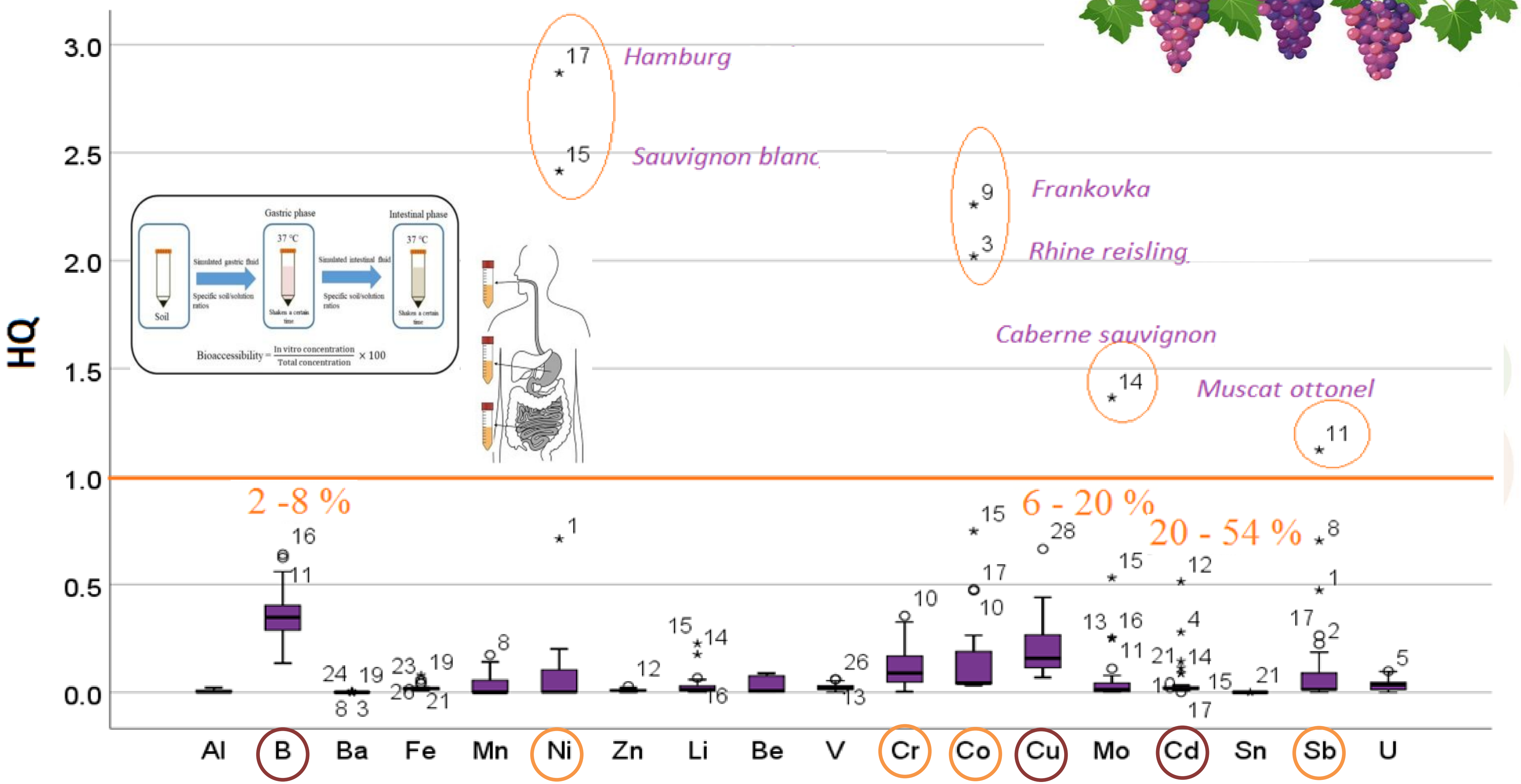
TR ≤ 10^{-6} = Negligible risk
TR: 10^{-6} to 10^{-4} = Acceptable risk
TR ≥ 10^{-4} = High risk

HI < 0,1 Negligible risk
1 ≥ HI/HQ ≥ 0.1 = Low risk
HI/HQ > 1 = High risk

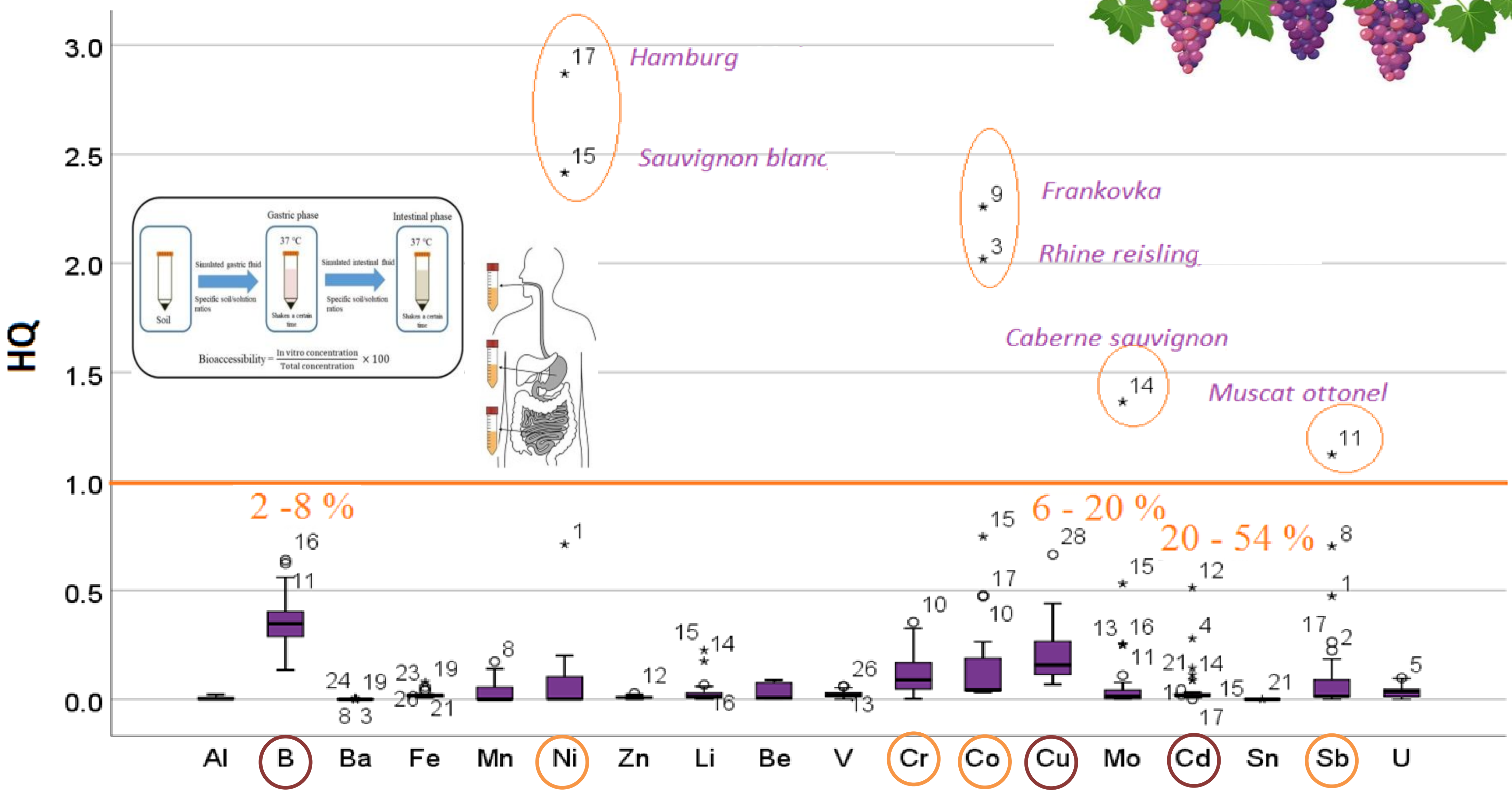


(S.b.)

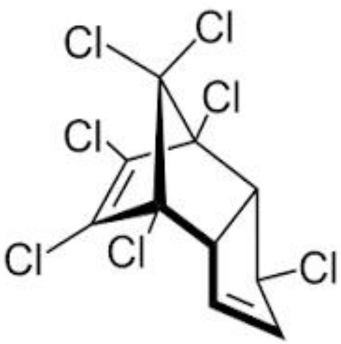
CONSUMERS - HUMAN HEALTH RISK ASSESSMNT

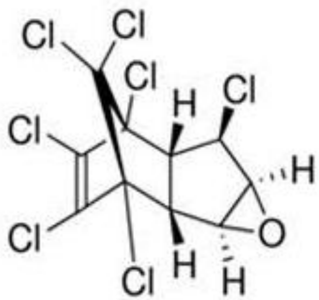


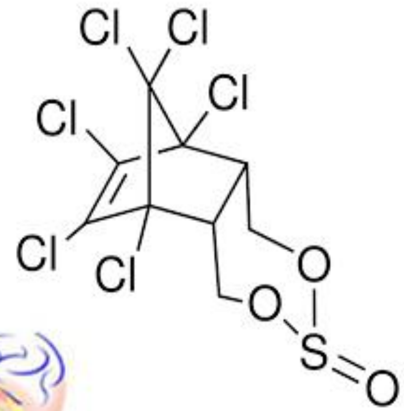
CONSUMERS - HUMAN HEALTH RISK ASSESSMNT



PESTICIDES IN AGRICULTURAL SOIL (WILD LANDFILDS)

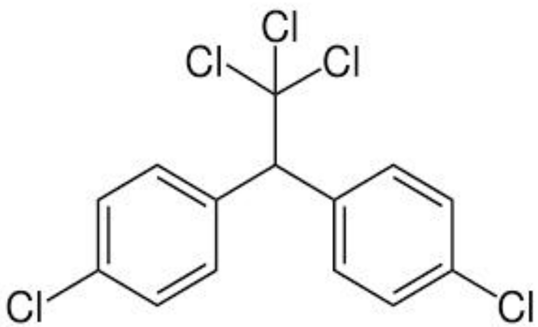


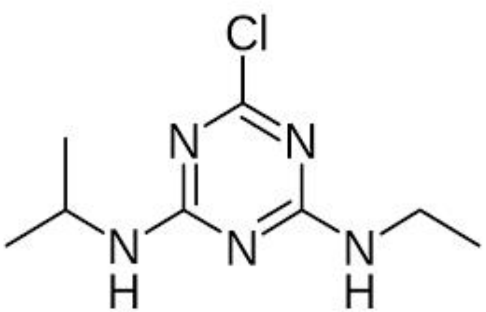


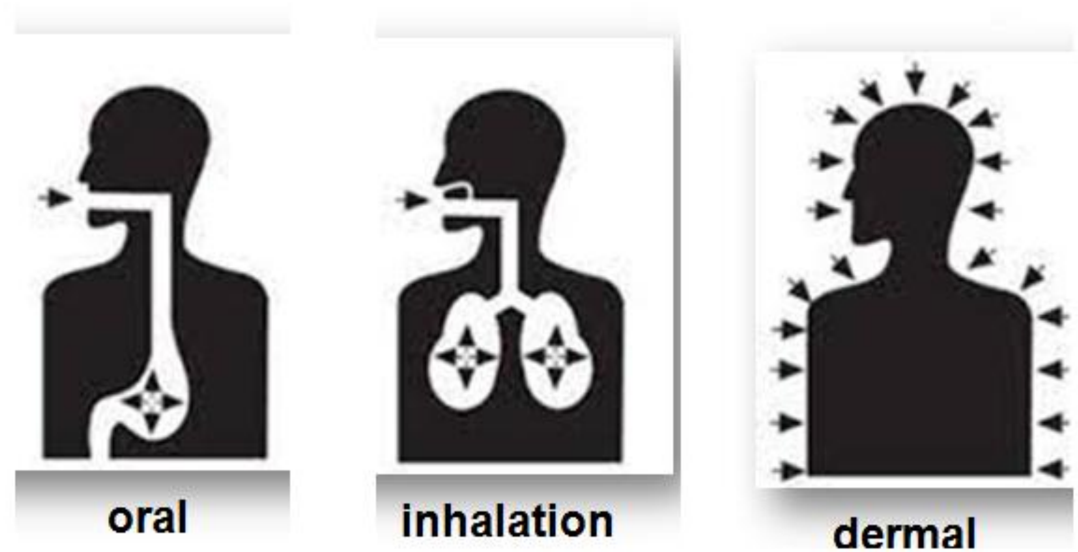


THQ=1.46E-05 THQ=0.1-1

R=2.48E-08 R=1E-05





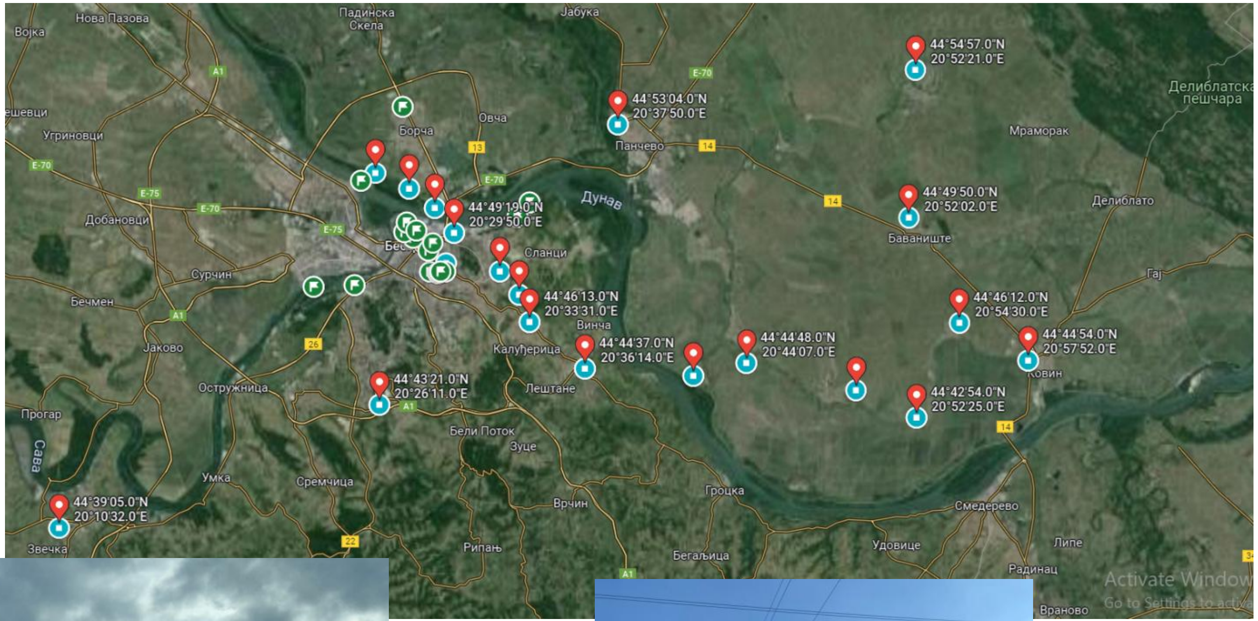


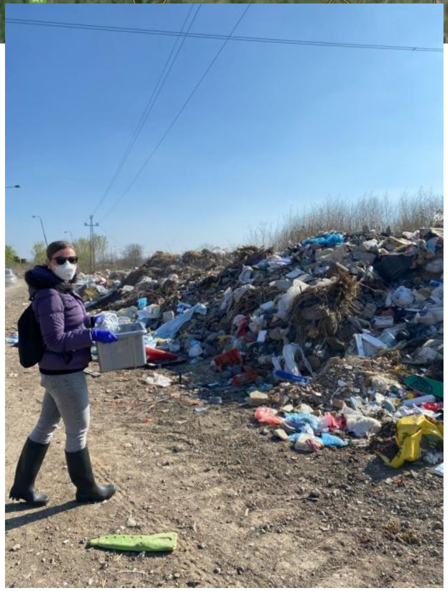
1.74E-08 1.25E-12 7.36E-09

WILD LANDFILDS IN AGRICULTURAL AREAS IN SERBIA

18 locations in Central part of Serbia- Serbian agricultural areas (per location 3-5 samples):

Pesticides, PCB, PTEs, PAHs



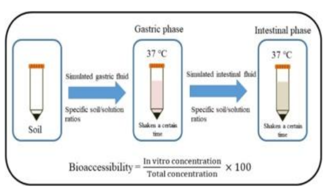


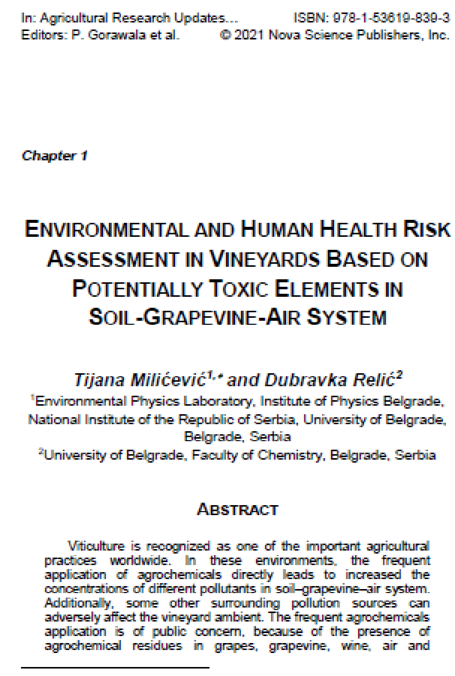
PROJECTS

L'Oreal-UNESCO For Woman in Science

„IT MAKES S(CI)ENSE“

♲ Bilateral project “Bioaccessibility of toxic organochlorine pesticides and trace elements in agricultural areas in France and Serbia: state of the art to *in vitro* methodology and human health risk assessment” with France (337-00-93/2023-05/10; the grant period is 2023-2024).





In: Agricultural Research Updates... ISBN: 978-1-53619-839-3
Editors: P. Gorawala et al. © 2021 Nova Science Publishers, Inc.

Chapter 1

Environmental and Human Health Risk Assessment in Vineyards Based on Potentially Toxic Elements in Soil-Grapevine-Air System

Tijana Milićević[1,] and Dubravka Relić[2]*

[1]Environmental Physics Laboratory, Institute of Physics Belgrade, National Institute of the Republic of Serbia, University of Belgrade, Belgrade, Serbia

[2]University of Belgrade, Faculty of Chemistry, Belgrade, Serbia

Abstract

Viticulture is recognized as one of the important agricultural practices worldwide. In these environments, the frequent application of agrochemicals directly leads to increased the concentrations of different pollutants in soil–grapevine–air system. Additionally, some other surrounding pollution sources can adversely affect the vineyard ambient. The frequent agrochemicals application is of public concern, because of the presence of agrochemical residues in grapes, grapevine, wine, air and

* Corresponding Author's E-mail: tijana.milicevic@ipb.ac.rs.

➢HERBICIDES IN WATER FOR IRRIGATION OF AGRICULTURAL AREAS

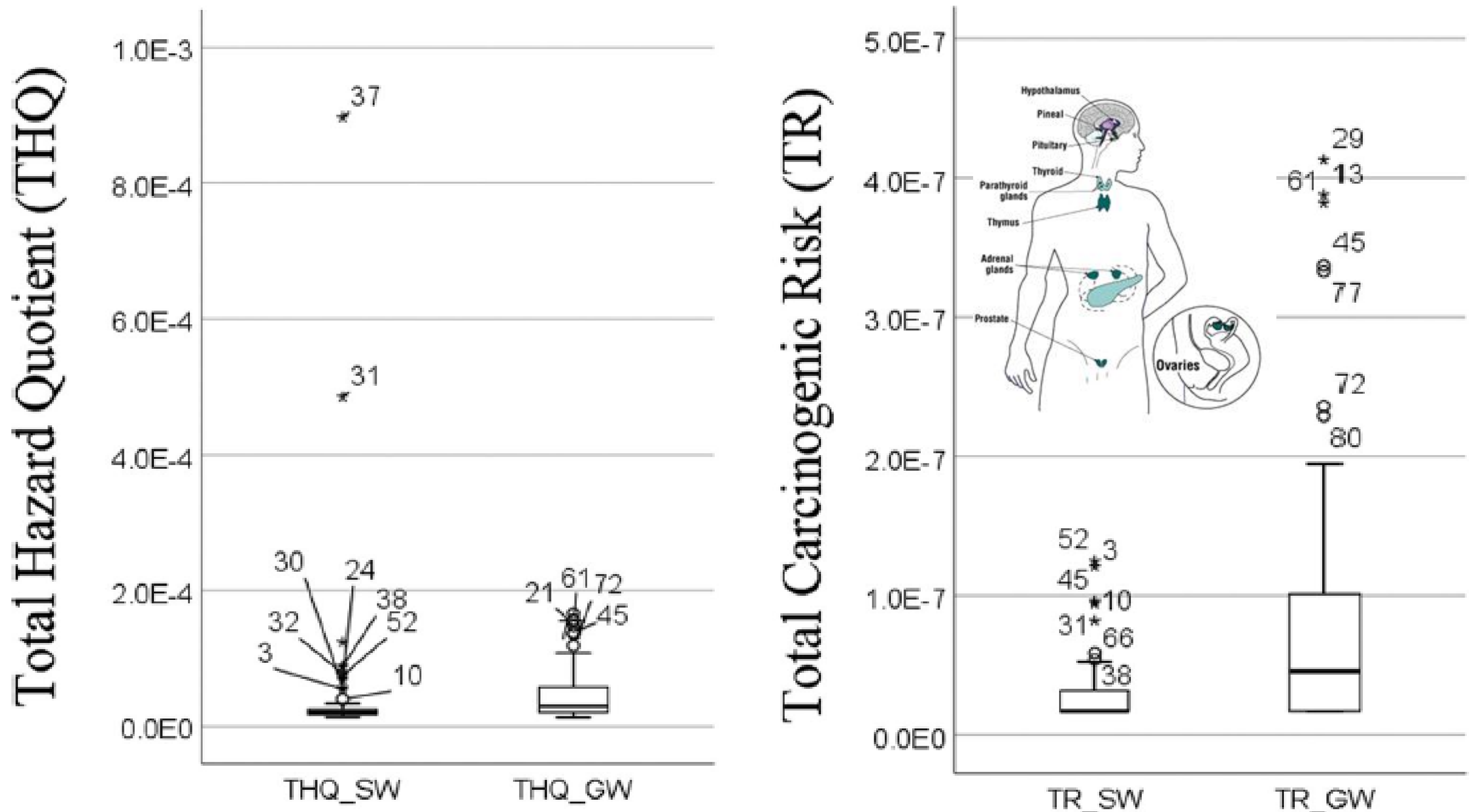
Environmental Science and Pollution Research (2023) 30:106330–106341
https://doi.org/10.1007/s11356-023-29561-y

RESEARCH ARTICLE

Human health risk assessment based on direct and indirect exposure to endocrine disrupting herbicides in drinking, ground, and surface water in Croatia

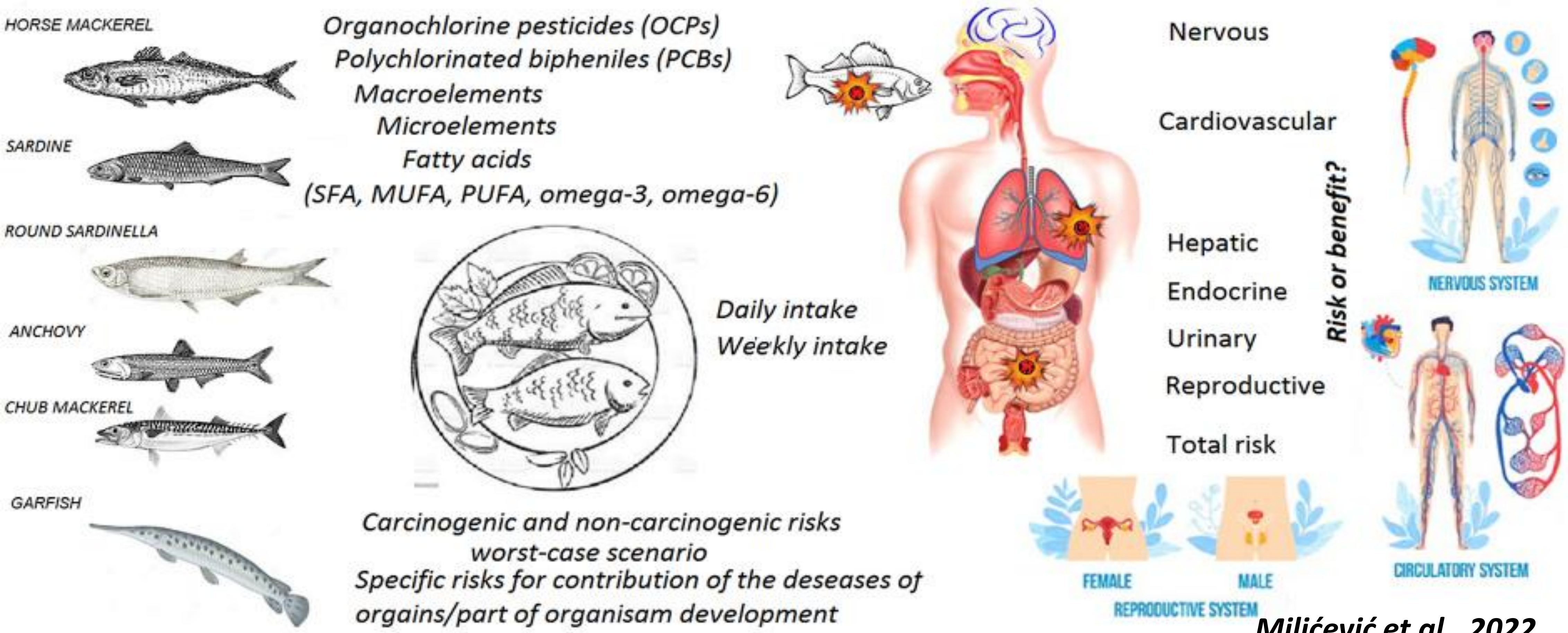
Gordana Mendaš[1] · Tijana Milićević[2] · Sanja Fingler[1] · Vlasta Drevenkar[1] · Snježana Herceg Romanić[1] · Aleksandar Popović[3] · Dubravka Relić[3]

Fig. 3 Box and whiskers of total hazard quintet of each herbicide (THQ) and total carcinogenic risk (TR) for indirect consumption, posed by herbicides in water used for irrigation of fruits and vegetables, taking into account their consumption (SW—surface water, GW—ground water); Middle line of box plots represent the median, top and bottom represent the first and the third quartiles and whiskers represent maximum and minimum values; "o" represents outliers and "*" represents extremes



➢PESTICIDES IN ECOSYSTEM - FISH

1. To assess the health risk for fish consumers based on the PCBs, OCPs and toxic and carcinogenic elements in investigated samples (Risk Assessment Information System - adapted for the specific local conditions) – **total risk (worst case scenario) and specific risks.**
2. Based on toxic and carcinogenic elements, organic compounds (POPs) and essential fatty acids (EFA), benefit-risk (BR) was assessed to investigate the safety and benefits of the fish consumption.



Milićević et al., 2022

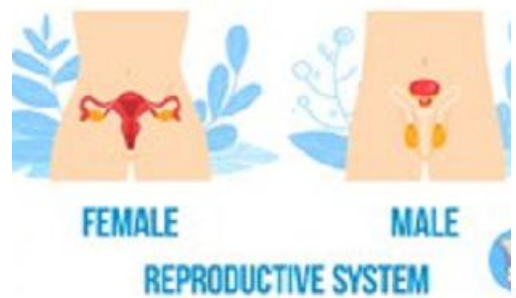
Specific risk assessment

CARDIOVASCULAR

Cr, Fe, As, Se, Cd

Mn, Ni, Cu, As

α-HCH, γ-HCH, HCB, p'p'-DDT, PCB-105, PCB-114, PCB-118, PCB-156, PCB-157, PCB-167, PCB-189, Cd



Ni, Zn, As, Cd

HEPATIC

α-HCH, γ-HCH, HCB, p'p'-DDT, Fe, Cu, Se

α-HCH, Cd

Integrated Risk Information System (IRIS) classification and other literature sources (US EPA - IRIS, 2020; Kabata-Pendias and Mukherjee, 2007; ***Milićević et al., 2022***)

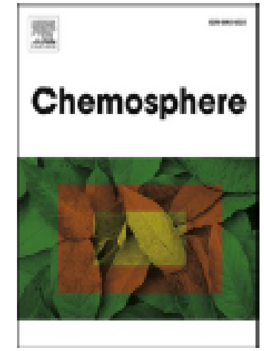
➢Benefit-risk analysis

Chemosphere 287 (2022) 132068

Contents lists available at ScienceDirect

Chemosphere

journal homepage: www.elsevier.com/locate/chemosphere



Human health risks and benefits assessment based on OCPs, PCBs, toxic elements and fatty acids in the pelagic fish species from the Adriatic Sea

Tijana Milićević [a,*], Snježana Herceg Romanić [b], Aleksandar Popović [c], Bosiljka Mustać [d], Jasna Đinović-Stojanović [e], Gordana Jovanović [a,f], Dubravka Relić [c]

[a] *Environmental Physics Laboratory, Institute of Physics Belgrade, National Institute of the Republic of Serbia, University of Belgrade, Pregrevica 118, 11080, Belgrade, Serbia*

[b] *Institute for Medical Research and Occupational Health, Ksaverska Cesta 2, PO Box 291, 10001, Zagreb, Croatia*

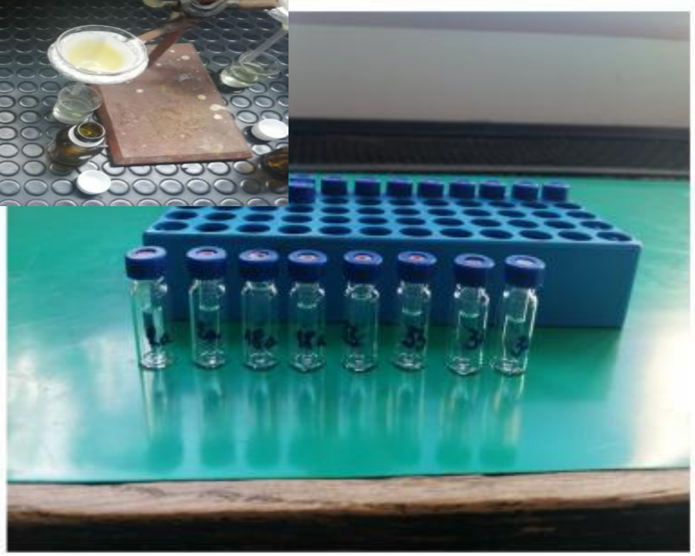
[c] *University of Belgrade - Faculty of Chemistry, Studentski Trg 12-16, 11000, Belgrade, Serbia*

[d] *Department of Ecology, Agronomy and Aquaculture, University of Zadar, Trg Kneza Višeslava 9, 23000, Zadar, Croatia*

[e] *Institute of Meat Hygiene and Technology, Kaćanskog 13, 11000, Belgrade, Serbia*

[f] *Singidunum University, Danijelova 32, 11000, Belgrade, Serbia*

➢PESTICIDES IN HUMAN MILK SAMPLES



imi

Environmental Physics Laboratory
Institute of Physics Belgrade | University of Belgrade | Serbia

IPB

EnvironPollutHealth

Funded by the European Union
NextGenerationEU

Environment pollution and human health: physico-chemical analysis, toxicity, and machine learning models

European Union – Next Generation EU
Program Contract of 8 Dec 2023, Class: 643-02/23-01/00016, Reg. no. 533-03-23-0006

https://projekti.imi.hr/environpolluthealth/?page_id=176&lang=en

- ❖ Easier identification the priorities "toward zero pollution" in agricultural areas;
- ❖ Human health risk as pecuration measure for management in agricultural areas and mitigation the pollution;
- ❖ Significatnt reports for producers, decision makers and consumers;
- ❖ More realistic human health risk assessment, validation and sertification of in vitro methodology at the international level;
- ❖ Associations of scientists and experts at the international level for easier implementationa of the solution and implementation of Green Agenda (The European Green Deal).

COST European Cooperation in Science & Technology

TOP-AGRI European Network for sustainability

Funded by the European Union

Environmental Physics Laboratory
Institute of Physics Belgrade | University of Belgrade | Serbia

Thank you for your attention!

E-mail: tijana.milicevic@ipb.ac.rs