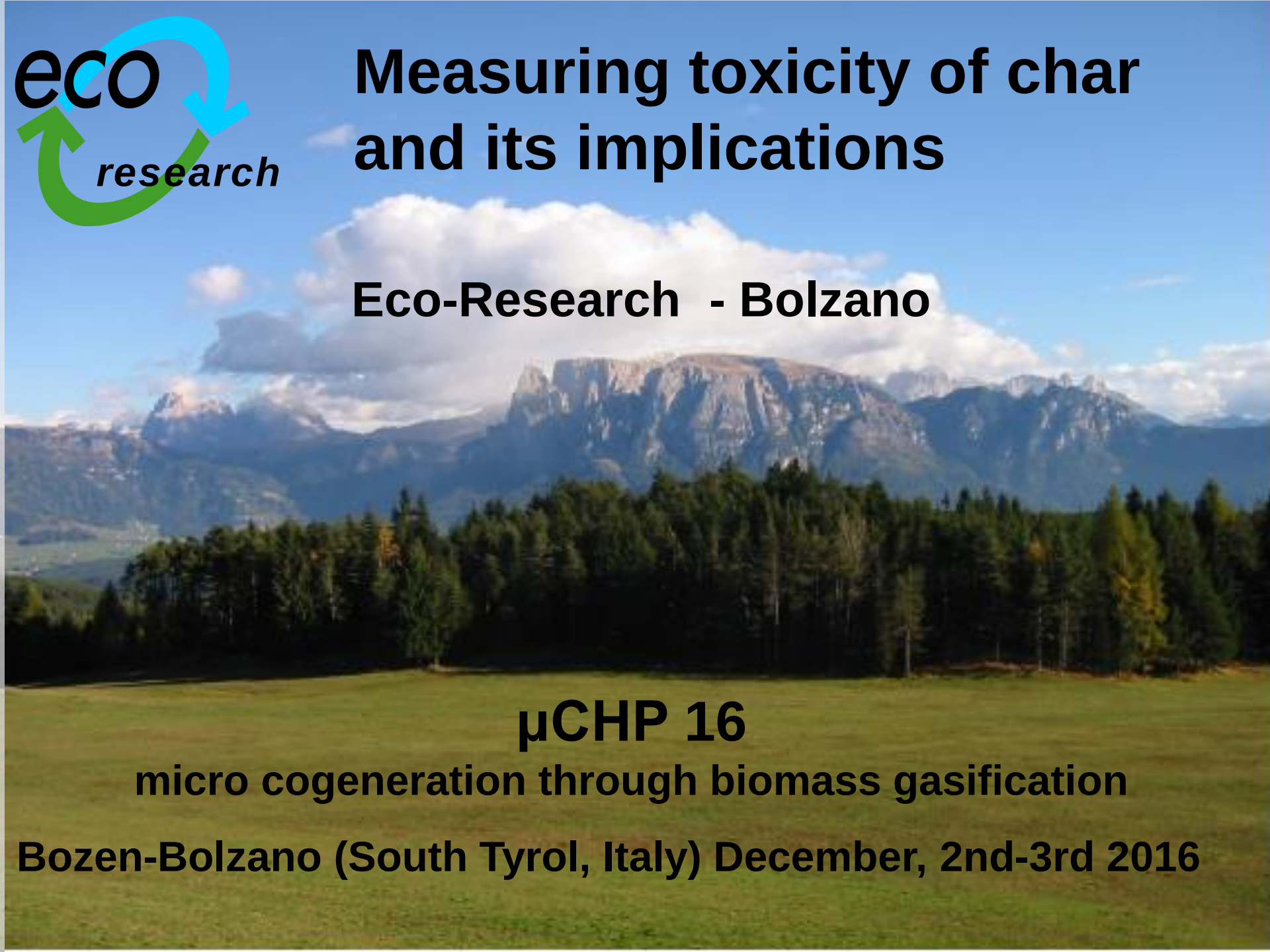


Measuring toxicity of char and its implications

Eco-Research - Bolzano

µCHP 16

micro cogeneration through biomass gasification

Bozen-Bolzano (South Tyrol, Italy) December, 2nd-3rd 2016

Gasification of biomass is a convenient solution for combined heat and power (CHP) generation systems.

But…

Char and toxicity:

Char is basically the solid material that remains after a thermal treatment (combustion, gasification,…) of a material containing carbon (eg. biomass).

Polycyclic aromatic hydrocarbons (PAHs)

are neutral, nonpolar molecules found in char and in tar deposits.

Cancer is a primary human health risk of exposure to PAHs.

WORLD HEALTH ORGANIZATION
INTERNATIONAL AGENCY FOR RESEARCH ON CANCER

IARC Monographs on the Evaluation of Carcinogenic Risks to Humans

VOLUME 92

Some Non-heterocyclic Polycyclic Aromatic Hydrocarbons and Some Related Exposures

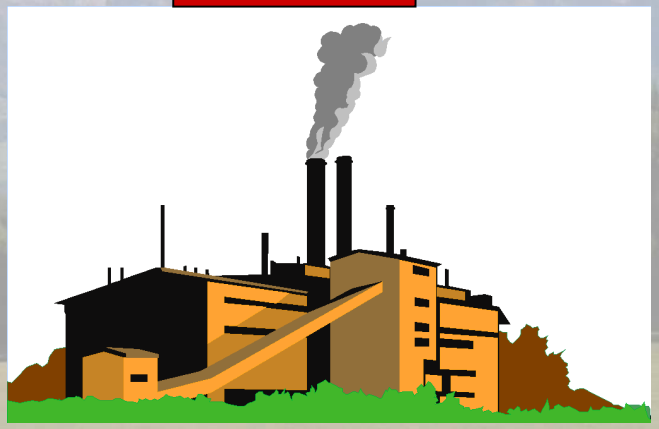
LYON, FRANCE
2010

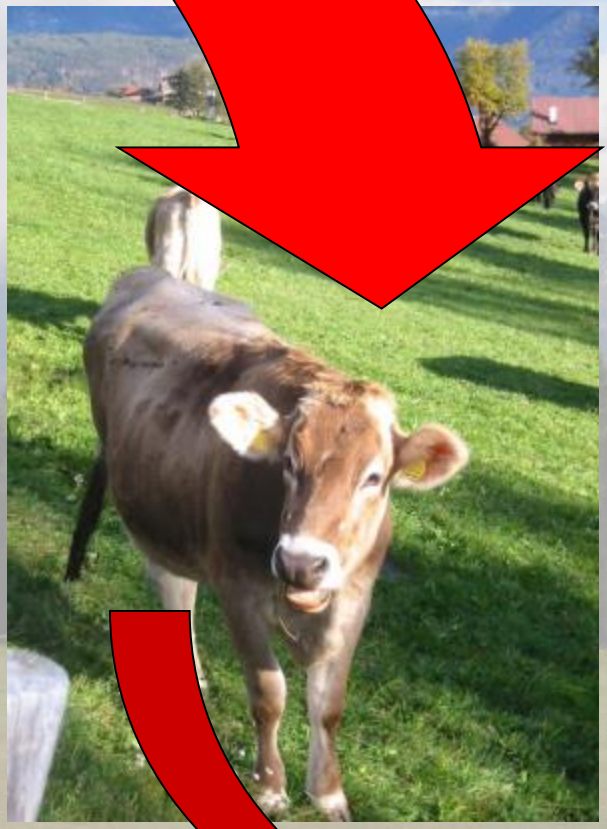
PAHs are widely detected as ambient air pollutants, primarily bound to particulate matter but also in the gas phase (especially the lower-molecular-weight PAHs). Average concentrations of individual PAHs in the ambient air of urban areas typically range from 1 to 30 ng/m^3 (excluding naphthalenes), and the more volatile PAHs are generally more abundant; however, concentrations up to several tens of nanograms per cubic metre have been reported in road tunnels or in large cities that use coal or other biomasses as residential heating fuels extensively (IPCS, 1998). Estimates of annual emissions of PAHs from anthropogenic sources in the 1990s were 8600 tonnes/year in Europe (Boström *et al.*, 2002) and 2000 tonnes/year in Canada (Government of Canada, 1994). Major sources of PAHs in ambient air (both outdoors and indoors) include residential and commercial heating with wood, coal or other biomasses (oil and gas heating produce much lower quantities of PAH), other indoor sources such as cooking and tobacco smoke, motor vehicle exhaust (especially from diesel engines), industrial emissions and forest

There is a long history to the identification of PAHs as human cancer hazards. In 1775 Sir Percivall Pott identified soot as the cause of scrotal cancer in chimney sweeps (Brown and Thornton, 1957), the first attribution of an occupational cancer to a specific cause. In the early 1900s laboratory scientists began the search that led to the isolation of benz[*a*]anthracene, dibenz[*a,h*]anthracene, benzo[*a*]pyrene, and other PAH compounds and the demonstration that they can induce cancer in experimental animals (Phillips, 1983).

A specific metabolite of pyrene, 1-hydroxypyrene, in urine has been suggested as a biomarker of human exposure to PAHs (Jongeneelen *et al.*, 1985; Jongeneelen, 2001).

Enrichment via food chain





The final target…

Biomass and thermal processes

only gasification?

HOME MADE DIOXINS: KNOWN AND LESS KNOWN SOURCES

Tirler W., Voto G., Donegà M., Mair K.

Eco-Research, Via Negrelli, 13, 39100 Bolzano, Italy

Introduction

Polychlorinated dibenzo-p-dioxins and polychlorinated dibenzofurans (PCDD/F) are some of the most toxic environmental contaminants. They never have been produced intentionally but are emitted in trace quantities as by-products of different industrial and thermal processes [1].

They are ubiquitously present in our environment and accumulate in body due to their highly lipophilic properties. Once there they can cause cancer and have adverse effects on the endocrine, immune and nervous system [2].

Beside well known potential sources of dioxins, like waste incineration and some processes in the chlorine industry, also domestic heating can be a considerable source of dioxins [3,4,5].

Being dioxins mainly by-products of thermal processes, we identified in angle grinding a high temperature process that can occur in craftsman's daily work. Angle grinding is routinely used to cut materials of strongly varying content. Depending on the material cut it should lead to different emission levels and thus a potential exposure to PCDD/F.

Materials and methods

Results and discussion

Depending on the material burnt significant differences in the amount of pollutants released by flue gas were observed. When household waste rich in plastics was burnt in the wood stove the emission were several order of magnitudes higher than in a state of the art incineration plant. Using household waste as fuel for wood stoves is extremely dangerous for the environment.

What is possible with a small wood stove ?

Dioxins and Benzo(a)pyrene in emission of the wood stove		
Fuel	Dioxins in ng TEQ/Nm3 (refers to oxygen 11%)	BaP in µg/Nm3
	Results are standardized to 11% oxygen	
Compressed sawdust	1,5	6
Carton	3,9	26
Waste 1	12	150
Waste 2	82	1498

Hydro Thermal Carbonization (HTC) is a thermo-chemical process for the conversion of biomass in a coal-water slurry

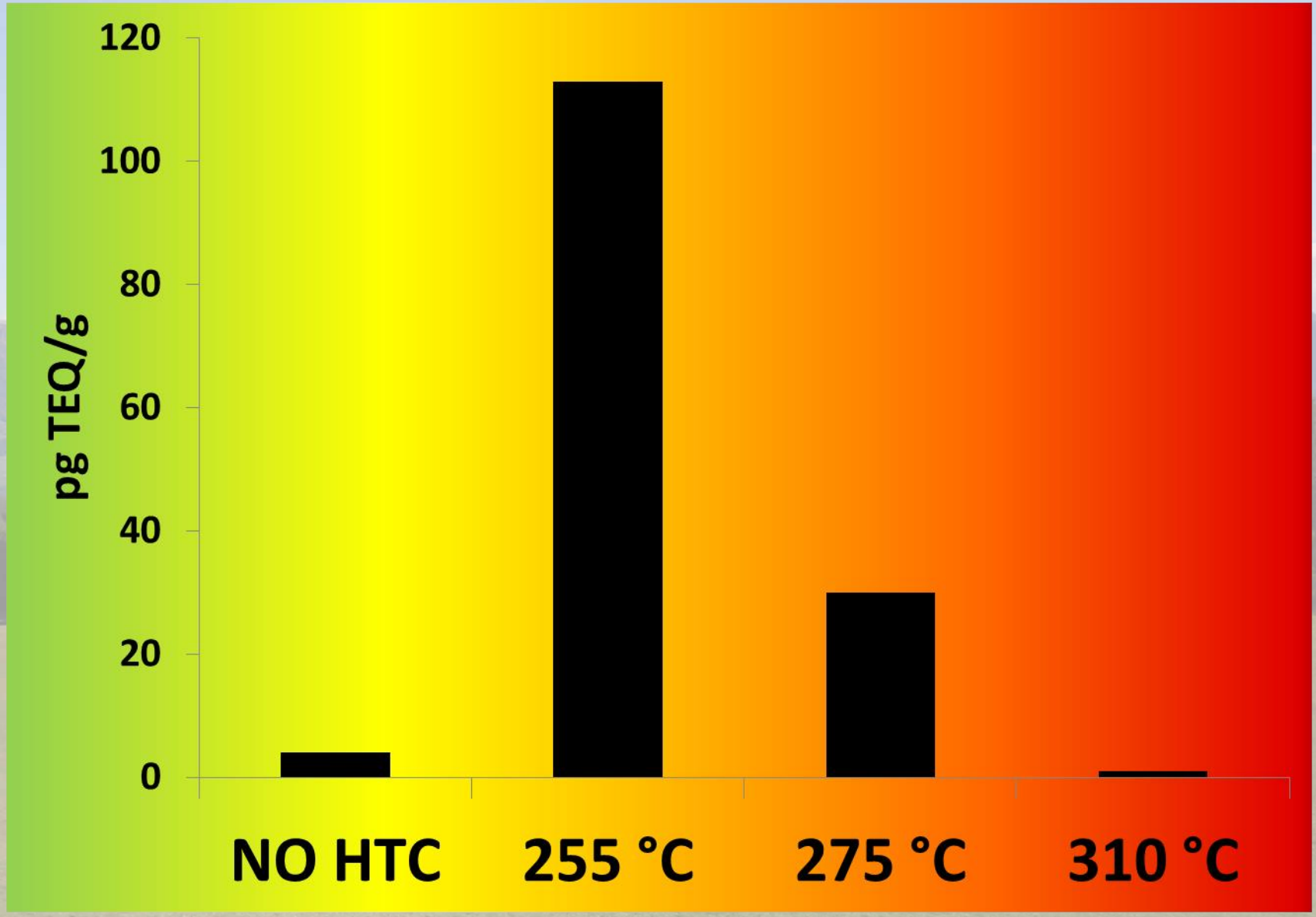
The process reflects the natural process of coal generation.

At a temperatures of 200 ° C and pressures of 20 bars, solid and wet biomass is dehydrated within hours and transformed in to bio-coal with a heating value similar to that of brown coal.

The process itself is not new. It was first described by Friedrich Bergius at the beginning of the last century when he studied naturally occurring coal formation.

In 1931 Bergius shared the Nobel Prize with Carl Bosch for their contributions to the invention and development of chemical high-pressure methods.

Sludge: before and after HTC



Examples of products of gassification:

PAHs	mg/Kg	
	Tar	Char
Acenaftene	22	23
Acenaftylene	28	11
Antracene	86	14
BaA	13	1,1
BghiP	2	0,11
BaP	17	0,08
CHR	75	1
DBahA	3	0,002
Fenantrene	50	52
Fluoranthene	38	88
Fluorene	23	1,7
IcdP	3	0,03
Naftalene	46	184
Pirene	48	26,5

Question:

Can we measure a toxicity by doing chemical analysis?

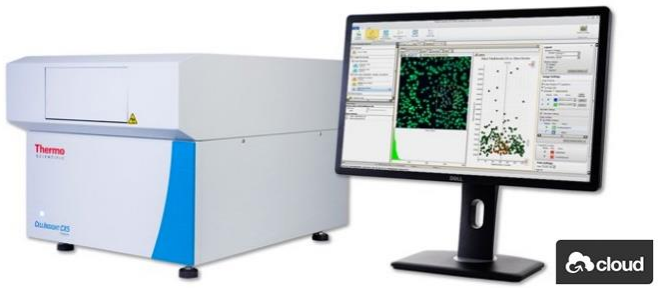
Answer:

NO !

We need a biological testing-system

IN VITRO TOXICOLOGICAL HIGH-THOUGHPUT SCREENING METHOD

RAPID MULTI-PARAMETRIC ASSESSMENT WITH THE BENEFIT OF LOW COMPOUND REQUIREMENTS



- Receptor Activation
- Cell membrane receptor binding
- GPCR internalization
- Labeled Ligand internalization
- Cell proliferation
- Cell morphology
- Cell survival signaling
- Cell migration signaling
- Organelle health
- Cell viability
- Apoptosis/necrosis
- Nuclear count
- Fluorescent protein localization
- Transcription factors
- Reporter gene expression
- Cell cycle status
- DNA replication studies
- Wound healing
- Stem cell differentiation
- Colocalization of targets
- Autophagy
- ER stress
- Nuclear-cytoplasmic translocation
- Plasma membrane translocation
- Neurite outgrowth
- Synaptogenesis
- Tube formation
- Microtubule arrangement
- Cytoskeletal reorganization
- Micronuclei formation
- Genotoxicity
- Hepatotoxicity
- Oxidative stress
- Phospholipidosis
- Choleostasis
- Calcium homeostasis
- Neurotoxicity
- Stress response
- Cell classification by biomarker
- Viral clearing
- Gene function
- Stem cell pluripotency
- Chemotaxis
- Toxicity in Whole Organisms

High-content screening (HCS) or high-content analysis (HCA) describes a set of analytical methods using automated microscopy, multi-parameter image processing, and visualization tools to extract quantitative data from cell populations. HCS typically employs fluorescence imaging of samples in a high-throughput format and reports quantitatively on parameters such as spatial distribution of targets and individual cell and organelle morphology.

MIXTURES AND TOXICITY IN-VITRO

- Toxicity of wood smoke particles in human A549 lung epithelial cells: the role of PAHs, soot and zinc.
  - Archives of Toxicology, December 2016, Volume 90, Issue 12, pp 3029–3044.

- Inhibition of the formation of benzo[a]pyrene adducts to DNA in A549 lung cells exposed to mixtures of polycyclic aromatic hydrocarbons
  - Toxicol In Vitro, September 2016, Volume 35, pp 1-10.

References:

Arch Toxicol (2016) 90:3029–3044
DOI 10.1007/s00204-016-1659-1

IN VITRO SYSTEMS

Toxicity of wood smoke particles in human A549 lung epithelial cells: the role of PAHs, soot and zinc

Marco Dilger[1] · Jürgen Orasche[2] · Ralf Zimmermann[2,3] · Hanns-Rudolf Paur[4] · Silvia Diabaté[1] · Carsten Weiss[1]

Received: 11 May 2015 / Accepted: 4 January 2016 / Published online: 2 February 2016

Toxicology in Vitro 35 (2016) 1–10

Contents lists available at ScienceDirect

Toxicology in Vitro

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

Inhibition of the formation of benzo[a]pyrene adducts to DNA in A549 lung cells exposed to mixtures of polycyclic aromatic hydrocarbons

Camille Genies [a,b,c], Amandine Jullien [a,b], Emmanuel Lefebvre [a,b,c], Morgane Revol [a,b], Anne Maitre [c], Thierry Douki [a,b,*]

[a] Univ. Grenoble Alpes, INAC, LCIB, LAN, F-38000, Grenoble, France
[b] CEA, INAC, SyMMES, LAN, F-38000, Grenoble, France
[c] Equipe EPSP Environnement et Prédiction de la Santé des Populations—laboratoire TIMC (UMR CNRS 5525), CHU de Grenoble, Université Grenoble Alpes, UFR de Médecine, Domaine de la Merci, 38706, La Tronche, France

Poster n°. 0263

In vitro assessment of toxicological profile of drugs present in wastewater obtained from Bozen water treatment plant

D. Gabbia[1], V. Pasolli[1], G. Monteleone[2], W. Tirler[2], M. Carrara[1].
[1] Department of Pharmaceutical and Pharmacological Sciences, University of Padova, Padova, Italy. [2] Ecoresearch, Bolzano, Italy.

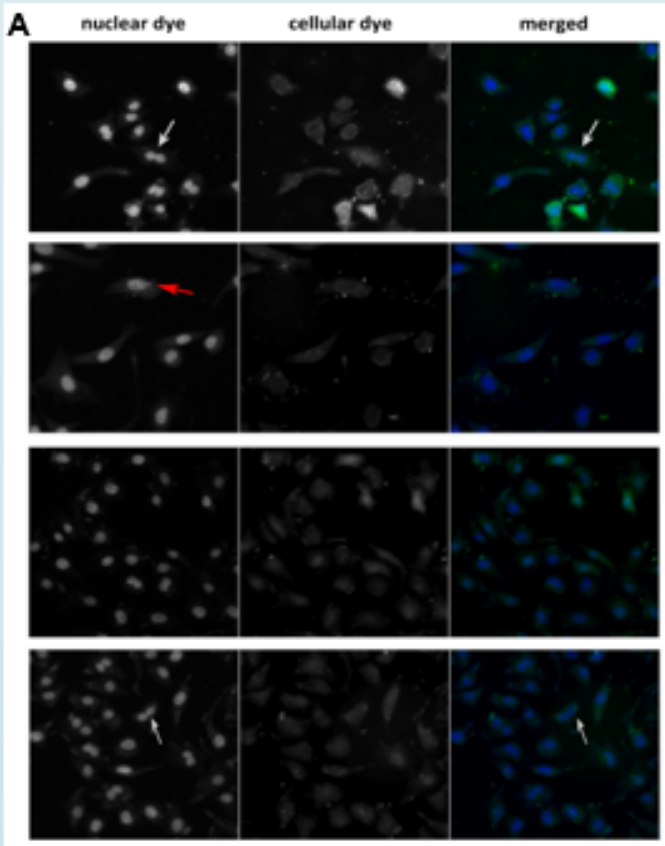
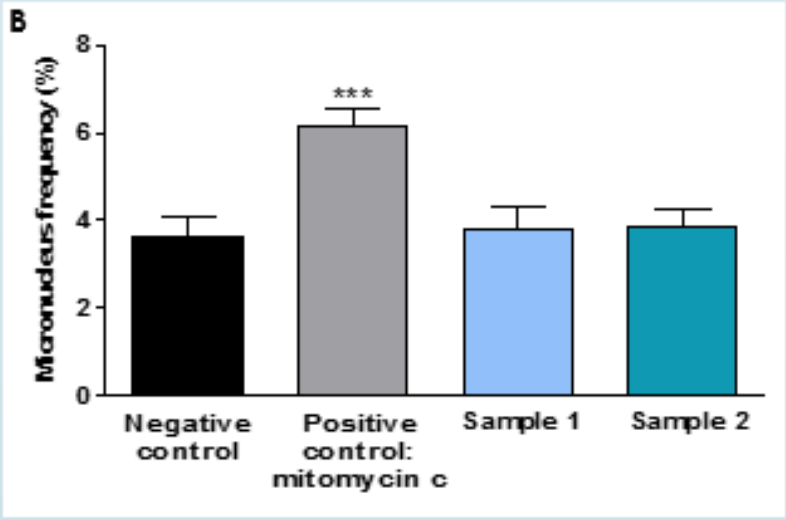


Fig. 5 Micronucleus frequency assay for testing genotoxic potential. (A) Images obtained with Cellomics Scan, Thermo Fisher of negative control, mitomycin C, sample 1 and 2, in order from top to bottom. Grey arrow: nucleus, red arrow: micronucleus. (B) Micronucleus frequency (%), Medium and mitomycin C were used as negative and positive control, respectively.




Thank you for your attention