

## Contents

CHEMWATCH

(click on page numbers for links)

### ENVIRONMENTAL RESEARCH

Effects of skin region and relative lipophilicity on percutaneous absorption in the toad <i>Rhinella marina</i> .....	3
Removal of polar organic micropollutants by pilot-scale reverse osmosis drinking water treatment.....	3
Acute oral toxicity of pesticide combination (acephate 50% and imidacloprid 1.8% as active ingredients) in Sprague-Dawley rats.....	4
Neonicotinoid exposure disrupts bumblebee nest behaviour, social networks, and thermoregulation .....	5
Real-time combustion rate of wood charcoal in the heating fire basin: Direct measurement and its correlation to CO emissions .....	6

### MEDICAL RESEARCH

Investigation on drug-binding in heme pocket of CYP2C19 with UV-visible and resonance Raman spectroscopies.....	6
Integrative bioinformatics identifies postnatal lead (Pb) exposure disrupts developmental cortical plasticity.....	7
An ultrasensitive sensor based on quantitatively modified upconversion particles for trace bisphenol A detection.....	8
The Impact of Nutrition and Environmental Epigenetics on Human Health and Disease .....	8
Amyloid beta-positive subjects exhibit longitudinal network-specific reductions in spontaneous brain activity.....	9

### OCCUPATIONAL REDSEARCH

Genetic variants of filaggrin are associated with occupational dermal exposure and blood DNA alterations in hairdressers .....	10
Psychosocial and organizational determinants of safe food handling at retail and food service establishments: a systematic review and meta-analysis.....	11
Potential Hazards Not Communicated in Safety Data Sheets of Flavouring Formulations, Including Diacetyl and 2,3-Pentanedione.....	11
Risk Perceptions and Barriers to Protective Behaviour Use Among Chemical Tank Cleaners: An Exploratory Study.....	13
Insecticide toxic effects and blood biochemical alterations in occupationally exposed individuals in Punjab, Pakistan .....	13

## CONTACT US

subscribers@chemwatch.net  
tel +61 3 9572 4700  
fax +61 3 9572 4777

1227 Glen Huntly Rd  
Glen Huntly  
Victoria 3163 Australia

## Contents

**CHEMWATCH**

### PUBLIC HEALTH RESEARCH

Carcinogenic Potency of Airborne Polycyclic Aromatic Hydrocarbons in Relation to the Particle Fraction Size .....	14
A State-of-the-Science Review of Mercury Biomarkers in Human Populations Worldwide between 2000 and 2018 .....	15
Evaluation of 2-thiothiazolidine-4-carboxylic Acid, a Common Metabolite of Isothiocyanates as a Potential Biomarker of Cruciferous Vegetable Intake .....	16
Organophosphate flame-retardant metabolite concentrations and pregnancy loss among women conceiving with assisted reproductive technology .....	17
Associations of cord blood leptin and adiponectin with children's cognitive abilities .....	18

### ENVIRONMENTAL RESEARCH

#### Effects of skin region and relative lipophilicity on percutaneous absorption in the toad *Rhinella marina*

2018-12-17

Owing to the dynamic interaction between frogs' skin and the environment, xenobiotics in frog habitats are of particular concern, and knowledge of percutaneous absorption in frog skin is necessary for risk mitigation purposes. Baseline transdermal kinetics in adult aquatic and arboreal frog species have recently been reported, however, there is little information regarding absorption kinetics in adult terrestrial species. The present study investigated the *in vitro* absorption kinetics of three model chemicals - caffeine, benzoic acid, and ibuprofen - through different skin regions in the terrestrial toad *Rhinella marina*. Caffeine flux was consistently higher than that of the other two chemicals ( $p < 0.001$ ), whereas the fluxes of the moderately and highly lipophilic chemicals (benzoic acid and ibuprofen) were similar, regardless of skin region. When considering individual chemicals, caffeine demonstrated increased flux through the ventral pelvic skin compared to the ventral thoracic or dorsal skin regions. Flux did not differ between skin regions for either benzoic acid or ibuprofen. These findings have implications for management of environmental contamination in frog habitats, as many environmental xenobiotics are of moderate-to-high lipophilicity and would be expected to be equally absorbed from all skin surfaces in terrestrial toads.

Authors: Llewelyn VK, Berger L, Glass BD.

Full Source: Environmental Toxicology & Chemistry. 2018 Oct 29. doi:

10.1002/etc.4302. [Epub ahead of print]

The present study investigated the *in vitro* absorption kinetics of three model chemicals - caffeine, benzoic acid, and ibuprofen - through different skin regions in the terrestrial toad *Rhinella marina*.

#### Removal of polar organic micropollutants by pilot-scale reverse osmosis drinking water treatment

2018-12-17

The robustness of reverse osmosis (RO) against polar organic micropollutants (MPs) was investigated in pilot-scale drinking water treatment. Experiments were carried in hypoxic conditions to treat a raw anaerobic riverbank filtrate spiked with a mixture of thirty model compounds. The chemicals were selected from scientific literature data based on their relevance for the quality of freshwater systems, RO permeate and drinking water. MPs passage and the influence of permeate flux were evaluated with a typical low-pressure RO membrane and quantified by liquid chromatography coupled to high-resolution mass

spectrometry. A strong inverse correlation between size and passage of neutral hydrophilic compounds was observed. This correlation was weaker for moderately hydrophobic MPs. Anionic MPs displayed nearly no passage due to electrostatic repulsion with the negatively charged membrane surface, whereas breakthrough of small cationic MPs could be observed. The passage figures observed for the investigated set of MPs ranged from less than 1%-25%. Statistical analysis was performed to evaluate the relationship between physicochemical properties and passage. The effects of permeate flux were more pronounced for small neutral MPs, which displayed a higher passage after a pressure drop.

Authors: Albergamo V, Blankert B, Cornelissen ER, Hofs B, Knibbe WJ, van der Meer W, de Voogt P.

Full Source: Water Research. 2018 Oct 1; 148:535-545. doi: 10.1016/j.watres.2018.09.029. [Epub ahead of print]

### Acute oral toxicity of pesticide combination (acephate 50% and imidacloprid 1.8% as active ingredients) in Sprague-Dawley rats.

2018-12-17

The aim of this study was to assess the acute toxic interaction and lethal dose (LD50) of pesticide combination product (acephate 50% and imidacloprid 1.8% as active ingredients) available in the market in Sprague-Dawley female rats by oral route. A total of 10 Sprague-Dawley female rats were divided into two groups, comprising five rats in each dose group. Both groups were identified as control and test groups, respectively. Control group received sterile water as vehicle and test group received pesticide combination (acephate 50% and imidacloprid 1.8% as active ingredients) at a dose of 0 and 2000 mg/kg body weight. As per the Organisation for Economic Cooperation and Development Guideline 420, initially one animal each from both the control and test groups were dosed with 0 and 2000 mg/kg, respectively, as sighting study. Based on the results of sighting study, additionally, four animals each from both groups were dosed with the same dose to make a total of five animals in each group. Dose volume was constant as 10 mL/kg. All animals were observed daily twice for clinical signs and mortality. Body weight was recorded on day 0 and weekly thereafter during 14 days' observation period; last body weight (fasted) was recorded on day 15. All the rats of both the groups were humanely sacrificed on day 15 for gross pathology, collection of organs for histopathology, organ weighing, and morphometry. Organ weights were taken as absolute values, and relative organ weights to last fasted body weights were calculated. Pesticide

The aim of this study was to assess the acute toxic interaction and lethal dose (LD50) of pesticide combination product (acephate 50% and imidacloprid 1.8% as active ingredients) available in the market in Sprague-Dawley female rats by oral route.

combination (acephate 50% and imidacloprid 1.8% as active ingredients) treated rats showed cholinergic signs with one mortality in the test group. No significant difference was observed in body weight, relative organ weights, and organ morphometry between pesticide combination exposed and non-exposed groups. Gross pathology of the treated rats was also comparable with respect to control group. Histopathological changes in the liver, kidneys, heart, lung, adrenaline, spleen, and ovaries of test group rats were found to be comparable with control group rats. The present study demonstrated the LD50 of one of the combination products available in the market having acephate 50% and imidacloprid 1.8% as active ingredients in Sprague-Dawley female rats which is >2000 mg/kg body weight. Furthermore, gross, histopathology and histoarchitectural alterations of all the vital organs of the test group were comparable to the control.

Authors: Palkhade R, Yadav S, Mishra S, Muhamed J.

Full Source: Veterinary World. 2018 Sep;11(9):1291-1297. doi: 10.14202/vetworld.2018.1291-1297. Epub 2018 Sep 18.

### Neonicotinoid exposure disrupts bumblebee nest behaviour, social networks, and thermoregulation

2018-12-17

Neonicotinoid pesticides can negatively affect bee colonies, but the behavioural mechanisms by which these compounds impair colony growth remain unclear. In the present study, the authors investigated imidacloprid's effects on bumblebee worker behaviour within the nest, using an automated, robotic platform for continuous, multi-colony monitoring of uniquely identified workers. We find that exposure to field-realistic levels of imidacloprid impairs nursing and alters social and spatial dynamics within nests, but that these effects vary substantially with time of day. In the field, imidacloprid impairs colony thermoregulation, including the construction of an insulating wax canopy. Our results show that neonicotinoids induce widespread disruption of within-nest worker behaviour that may contribute to impaired growth, highlighting the potential of automated techniques for characterizing the multifaceted, dynamic impacts of stressors on behaviour in bee colonies.

Authors: Crall JD, Switzer CM, Oppenheimer RL, Ford Versypt AN, Dey B, Brown A, Eyster M, Guérin C, Pierce NE, Combes SA, de Bivort BL.

Full Source: Science. 2018 Nov 9;362(6415):683-686. doi: 10.1126/science.aat1598.

In the present study, the authors investigated imidacloprid's effects on bumblebee worker behaviour within the nest, using an automated, robotic platform for continuous, multi-colony monitoring of uniquely identified workers.

### Real-time combustion rate of wood charcoal in the heating fire basin: Direct measurement and its correlation to CO emissions

2018-12-17

Previous studies of solid fuel emissions in household stoves focused more on emission measurements of the overall combustion process instead of the dynamic burning rate and its connection to the emissions. This study put forward a measurement system to monitor the dynamic fuel burning rate and emission rate directly, and explored their relationships during different combustion phases. Experiments were conducted using two types of wood charcoal consumed in a small open pan (i.e. fire basin) used commonly for space heating in rural China. The measured real-time CO emission rate (ERCO), fuel burning rate (BRF), and calculated carbon burning rate (BRC) all rose and then subsided as the combustion progressed. The relationships between ERCO and BRF and between ERCO and BRC were different for the two charcoals during a phase with rising carbon content in the combusted fuel (Phase I), likely because moisture evaporation and volatile matter release were the dominant processes and the reaction was complex during this phase. ERCO and BRF or BRC had linear relationships during a phase with stable carbon content in the combusted fuel (Phase II) for the two charcoals, which may be generalised to other solid fuels, because this phase is associated to fixed carbon dominating phase which usually exist during solid fuel combustion. The study presented a novel measurement approach to the combustion properties of solid fuels. The results implied that a complex relationship between the combustion and pollutant emissions existed in Phase I, and presented the possibility of estimating the fuel burning rate based on emission measurements in Phase II, or vice versa.

Authors: Deng M, Li J, Zhang S, Shan M, Baumgartner J, Carter E, Yang X.

Full Source: Environmental Pollution. 2018 Oct 30; 245:38-45. doi:

10.1016/j.envpol.2018.10.099. [Epub ahead of print]

This study put forward a measurement system to monitor the dynamic fuel burning rate and emission rate directly, and explored their relationships during different combustion phases.

## MEDICAL RESEARCH

### Investigation on drug-binding in heme pocket of CYP2C19 with UV-visible and resonance Raman spectroscopies

2018-12-17

Cytochrome P450 (CYP) is a class of heme-containing enzymes which mainly catalyse a monooxygenation reaction of various chemicals, and hence CYP plays a key role in the drug metabolism. Although CYP2C19

isoform is a minor hepatic CYP, it metabolises clinically important drugs such as omeprazole and S-mephenytoin. In this study, the interaction of purified CYP2C19 WT (CYP2C19) with seven drugs (phenytoin, S-mephenytoin, omeprazole, lansoprazole, cimetidine, propranolol, and warfarin) was investigated using spectroscopic methods. The binding of each drug and the induced structural change in the heme distal environment were evaluated. Ferric form of CYP2C19 was revealed to contain a six-coordinate low-spin heme with a water molecule as a sixth ligand in a distal site, and the addition of each drug caused varied minor fraction of five-coordinate heme. It was suggested that the ligated water molecule was partly moved away from the heme distal environment and that the degree of water removal was dependent on the type of drugs. The effect on the coordination was varied with the studied drugs with wide variation in the dissociation constants from 2.6  $\mu\text{M}$  for lansoprazole to 5400  $\mu\text{M}$  for warfarin. Phenytoin and S-mephenytoin showed that binding to CYP2C19 occurred in a stepwise manner and that the coordination of a water molecule was facilitated in the second binding step. In the ferrous CO-bound state,  $\nu(\text{FeCO})$  stretching mode was clearly observed at 471  $\text{cm}^{-1}$  in the absence of drugs. The Raman line was greatly up-shifted by omeprazole (487  $\text{cm}^{-1}$ ) and lansoprazole (477  $\text{cm}^{-1}$ ) but was minimally affected by propranolol, phenytoin, and S-mephenytoin. These results indicate that slight chemical modification of a drug greatly affects the heme distal environments upon binding.

Authors: Derayea SM, Tsujino H, Oyama Y, Ishikawa Y, Yamashita T, Uno T.  
Full Source: Spectrochimica Acta Part A: Molecular and Biomolecular Spectroscopy. 2018 Oct 26; 209:209-216. doi: 10.1016/j.saa.2018.10.045. [Epub ahead of print]

Given that thousands of chemicals released into the environment have the potential capacity to harm neurodevelopment, there is an urgent need to systematically evaluate their toxicity.

### Integrative bioinformatics identifies postnatal lead (Pb) exposure disrupts developmental cortical plasticity

2018-12-17

Given that thousands of chemicals released into the environment have the potential capacity to harm neurodevelopment, there is an urgent need to systematically evaluate their toxicity. Neurodevelopment is marked by critical periods of plasticity wherein neural circuits are refined by the environment to optimise behaviour and function. If chemicals perturb these critical periods, neurodevelopment can be permanently altered. Focusing on 214 human neurotoxicants, we applied an integrative bioinformatics approach using publically available data to identify dozens of neurotoxicant signatures that disrupt a transcriptional signature of a critical period for brain plasticity. This identified lead (Pb) as a

critical period neurotoxicant and we confirmed in vivo that Pb partially suppresses critical period plasticity at a time point analogous to exposure associated with autism. This work demonstrates the utility of a novel informatics approach to systematically identify neurotoxicants that disrupt childhood neurodevelopment and can be extended to assess other environmental chemicals.

Authors: Smith MR, Yevo P, Sadahiro M, Austin C, Amarasiriwardena C, Awawda M, Arora M, Dudley JT, Morishita H.

Full Source: Science Reports. 2018 Nov 6; 8(1):16388. doi: 10.1038/s41598-018-34592-4.

### An ultrasensitive sensor based on quantitatively modified upconversion particles for trace bisphenol A detection

2018-12-17

Bisphenol A (BPA) is one of the endocrine-disrupting chemicals which might cause reproductive and endocrine system diseases, and poses a serious threat to the ecosystem and human health. In this study, the authors report an ultrasensitive sensor for trace BPA detection employing fluorescence resonance energy transfer (FRET) between modified upconversion nanoparticles (UCNPs) and tetramethylrhodamine. To circumvent the problems of low luminous efficiency of FRET and low sensitivity of sensor, the upconversion nanoparticles with very strong fluorescence efficiency were prepared and quantitatively modified. Results showed that the concentrations of amino groups and streptavidin were 43 nmol/mg and 6.12 µg/mg on the surface of the UCNPs, respectively. Under the optimal detection conditions, the peak intensity of UCNPs at 547 nm was linear with the logarithm of the BPA concentration with the detection limit of 0.05 ng/mL. Without complicated pre-processing, the recoveries were in general between 91.0 and 115.0% in tap water, river water, and disposable paper cup water. Therefore, the proposed sensor is suitable for effective sensing of trace BPA in water samples.

Authors: Li Q, Bai J, Ren S, Wang J, Gao Y, Li S, Peng Y, Ning B, Gao Z.

Full Source: Analytical and Bioanalytical Chemistry. 2018 Nov 3. doi: 10.1007/s00216-018-1425-8. [Epub ahead of print]

### The Impact of Nutrition and Environmental Epigenetics on Human Health and Disease

2018-12-17

Environmental epigenetics describes how environmental factors affect cellular epigenetics and, hence, human health. Epigenetic marks alter

In this study, the authors report an ultrasensitive sensor for trace BPA detection employing fluorescence resonance energy transfer (FRET) between modified upconversion nanoparticles (UCNPs) and tetramethylrhodamine.

the spatial conformation of chromatin to regulate gene expression. Environmental factors with epigenetic effects include behaviours, nutrition, and chemicals and industrial pollutants. Epigenetic mechanisms are also implicated during development in utero and at the cellular level, so environmental exposures may harm the foetus by impairing the epigenome of the developing organism to modify disease risk later in life. By contrast, bioactive food components may trigger protective epigenetic modifications throughout life, with early life nutrition being particularly important. Beyond their genetics, the overall health status of an individual may be regarded as an integration of many environmental signals starting at gestation and acting through epigenetic modifications. This review explores how the environment affects the epigenome in health and disease, with a particular focus on cancer. Understanding the molecular effects of behaviour, nutrients, and pollutants might be relevant for developing preventative strategies and personalised health programs. Furthermore, by restoring cellular differentiation, epigenetic drugs could represent a potential strategy for the treatment of many diseases including cancer.

Author: Tiffon C.

Full Source: International Journal of Molecular Science. 2018 Nov 1;19(11). pii: E3425. doi: 10.3390/ijms19113425.

### Amyloid beta-positive subjects exhibit longitudinal network-specific reductions in spontaneous brain activity

2018-12-17

Amyloid beta ( $A\beta$ ) deposition and cognitive decline are key features of Alzheimer's disease. The relationship between  $A\beta$  status and changes in neuronal function over time, however, remains unclear. This study evaluated the effect of baseline  $A\beta$  status on reference region spontaneous brain activity (SBA-rr) using resting-state functional magnetic resonance imaging and fluorodeoxyglucose positron emission tomography in patients with mild cognitive impairment. Patients (N= 62, [43  $A\beta$ -positive]) from the Alzheimer's Disease Neuroimaging Initiative were divided into  $A\beta$ -positive and  $A\beta$ -negative groups via prespecified cerebrospinal fluid  $A\beta_{42}$  or  $^{18}F$ -florbetapir positron emission tomography standardised uptake value ratio cut-offs measured at baseline. The authors analysed interaction of biomarker-confirmed  $A\beta$  status with SBA-rr change over a 2-year period using mixed-effects modelling. SBA-rr differences between  $A\beta$ -positive and  $A\beta$ -negative subjects increased significantly over time within subsystems of the default and visual networks. Changes exhibit an interaction with memory performance over time but were

This study evaluated the effect of baseline  $A\beta$  status on reference region spontaneous brain activity (SBA-rr) using resting-state functional magnetic resonance imaging and fluorodeoxyglucose positron emission tomography in patients with mild cognitive impairment.

independent of glucose metabolism. Results reinforce the value of resting-state functional magnetic resonance imaging in evaluating Alzheimer's disease progression and suggest spontaneous neuronal activity changes are concomitant with cognitive decline.

Authors: Avants BB, Hutchison RM, Mikulskis A, Salinas-Valenzuela C, Hargreaves R, Beaver J, Chiao P; Alzheimer's Disease Neuroimaging Initiative.

Full Source: Neurobiological Aging. 2018 Oct 11;74: 191-201. doi: 10.1016/j.neurobiolaging.2018.10.002. [Epub ahead of print]

## OCCUPATIONAL REDSEARCH

### Genetic variants of flaggrin are associated with occupational dermal exposure and blood DNA alterations in hairdressers

2018-12-17

Hairdressers are exposed to high levels of chemicals, including possible carcinogens. For dermal exposure, the skin protects against the uptake of chemicals and the protein flaggrin (encoded by FLG) has a key role in skin barrier function. This study investigated if variants of FLG previously linked to impaired skin barrier function, i.e. null mutations and copy number variation (CNV) alleles (CNV10), are associated with cancer-related DNA changes. Blood and questionnaire data were collected from hairdressers (n = 295) and controls (n = 92). Exposure to aromatic amines was measured as haemoglobin adducts by gas chromatography tandem mass spectrometry. DNA from peripheral blood was used to test for FLG null mutations and CNV (10, 11, or 12 repeats), telomere length, and methylation of selected cancer-related genes. Hairdressers had a lower frequency of FLG null mutations (4.1 vs. 7.6%, P = 0.18) and CNV10 (43.2 vs. 56%, P = 0.0032) than controls. In hairdressers, CNV10 carriers had a decreased risk of high ortho-toluidine adducts in blood compared with non-carriers (odds ratio, OR = 0.49, 95% CI = 0.30-0.81). Further, telomere length was shorter for carriers of any FLG null allele ( $\beta = -0.18$ , 95% CI = -0.31 to -0.044) and CNV10 carriers ( $\beta = -0.054$ , 95% CI = -0.11 to -0.00051, linear regression adjusted for age, passive smoking, residence, and education) compared to non-carriers. Carriers of any FLG null allele showed higher methylation of the cyclin-dependent kinase inhibitor 2A gene CDKN2A (OR = 6.26, CI = 1.13-34.7), but not of the other genes analysed. These associations were not found among the controls. This study showed that the frequency of FLG CNV10 was lower among

This study investigated if variants of FLG previously linked to impaired skin barrier function, are associated with cancer-related DNA changes.

hairdressers than controls, which may indicate a healthy worker selection. Moreover, FLG null and CNV10 were associated with cancer-related DNA changes in hairdressers, which may influence their risk of cancer.

Authors: Liljedahl ER, Wahlberg K, Lidén C, Albin M, Broberg K.

Full Source: Science of the Total Environment. 2018 Oct 27; 653:45-54. doi: 10.1016/j.scitotenv.2018.10.328. [Epub ahead of print]

### Psychosocial and organizational determinants of safe food handling at retail and food service establishments: a systematic review and meta-analysis

2018-12-17

Various psychosocial and organisational factors have been investigated as determinants of food handlers' food safety behaviours. A systematic review and meta-analysis of studies in this area was conducted to identify and synthesise the key behavioural determinants. Standard systematic review steps were followed:

- comprehensive search strategy; relevance screening; article characterisation;
- risk of bias assessment; data extraction; and random-effects meta-analysis.

Sixty-two relevant studies were identified, and knowledge was the most commonly investigated behavioural determinant (n =51). Increased knowledge was consistently associated with safe food handling behaviours across both correlation ( $r = 0.30$ ; 95% confidence interval [CI]: 0.12, 0.46; n =24 studies;  $I^2 = 98\%$ ) and odds ratio (OR) measures (adjusted OR=1.85; 95% CI: 1.27, 2.70; n =3;  $I^2 = 0\%$ ). Seven other behavioural determinant categories were also consistently associated with various food safety behaviour outcomes. In contrast, no association was found between food handler experience and behaviour. The findings can inform the development of targeted training initiatives for food handlers.

Authors: Young I, Thaivalappil A, Waddell L, Meldrum R, Greig J.

Full Source: International Journal of Environmental Health Research. 2018 Nov 8:1-16. doi: 10.1080/09603123.2018.1544611. [Epub ahead of print]

### Potential Hazards Not Communicated in Safety Data Sheets of Flavouring Formulations, Including Diacetyl and 2,3-Pentanedione

2018-12-17

Workers using flavouring formulations containing diacetyl and 2,3-pentanedione may be at risk of inhalational exposure, as these volatile

Various psychosocial and organisational factors have been investigated as determinants of food handlers' food safety behaviours.

## Technical

### CHEMWATCH

hazardous chemicals are emitted from the bulk material, especially at elevated temperatures. However, flavouring formulations that contain diacetyl and 2,3-pentanedione might not list these ingredients because they are generally recognised as safe to ingest, may be part of a proprietary mixture deemed a trade secret, or may not be required to be listed if they are present at <1% composition. The objective of this study was to investigate whether potential inhalational hazards present in flavouring samples were reported as chemical ingredients on their corresponding safety data sheets (SDSs). A convenience sample of 26 bulk liquid flavourings obtained from two coffee roasting and packaging facilities in the USA was analysed for 20 volatile organic chemicals present in the headspaces of vials containing flavouring liquids using gas chromatography-mass spectrometry. Flavouring samples were included in the study if headspace analysis results and SDSs were available. Flavouring samples included hazelnut, French vanilla, amaretto, chocolate, and caramel as well as some flavouring mixtures containing added fruit flavours such as cherry and raspberry. The presence of a chemical in the flavouring formulation was then compared to the ingredient list on the SDSs. All the flavouring SDSs contained trade secret designations. None of the SDSs listed diacetyl or 2,3-pentanedione. Headspace analyte concentrations revealed that diacetyl was present in 21 of 26 samples (81%) with a maximum concentration of  $5.84 \times 10^4 \mu\text{g m}^{-3}$  in flavour 18 (caramel). 2,3-Pentanedione was present in 15 flavours (58%) with a maximum concentration of  $3.79 \times 10^5 \mu\text{g m}^{-3}$  in flavour 24 (oatmeal cookies). A majority of the flavourings tested had diacetyl, 2,3-pentanedione, or both as volatile constituents in the headspace. These chemicals were not listed on the SDSs, but inclusion of diacetyl and 2,3-pentanedione on SDSs would serve to protect downstream users from unrecognised exposure and potential respiratory disease. The headspace technique presented here is a viable tool to rapidly screen for volatile hazardous chemicals that may be present in flavouring formulations. Facilities that use flavourings should be aware that constituents in flavourings may present a potential inhalational hazard even if not identified as such by the SDS. A precautionary approach is warranted when working with flavourings, including exposure monitoring and effective exposure control strategies such as containment and local exhaust ventilation.

Authors: LeBouf RF, Hawley B, Cummings KJ.

Full Source: *Annals in Work Exposure & Health*. 2018 Nov 8. doi: 10.1093/annweh/wxy093. [Epub ahead of print]

### Risk Perceptions and Barriers to Protective Behaviour Use Among Chemical Tank Cleaners: An Exploratory Study

2018-12-17

Chemical tank cleaners' occupational diseases and injuries are largely unknown due to a lack of monitoring and limited research. Their potential exposure to highly corrosive chemicals-including sodium hypochlorite, sodium hydroxide, and ferric chloride-suggests that tank cleaners represent an at-risk occupational group. This pilot study explored tank cleaners' risk perceptions and barriers to using personal protective equipment and other protective behaviours in their workplace. Data sources included a survey (n = 29) and interviews (n = 9) with sodium hypochlorite tank cleaners in the United States. Although sodium hypochlorite may become reactive under high temperatures, 12 questionnaire respondents indicated not being concerned about high temperatures within the tank, and 15 were not concerned about exposure via ingestion. Analyses of survey and interview results provide evidence of inadequate training among tank cleaners, their lack of understanding of basic chemical properties and routes of exposure, and limited access to and an incomplete understanding of how to properly use personal protective equipment, particularly respiratory protection. These findings can inform researchers, educators, and safety engineers in developing future studies, interventions, and training to improve tank cleaners' health and safety.

Authors: Persaud E, LePrevost C.

Full Source: Journal of Primary Prevention. 2018 Nov 8. doi: 10.1007/s10935-018-0527-6. [Epub ahead of print]

This pilot study explored tank cleaners' risk perceptions and barriers to using personal protective equipment and other protective behaviours in their workplace.

### Insecticide toxic effects and blood biochemical alterations in occupationally exposed individuals in Punjab, Pakistan

2018-12-17

Biomonitoring of people exposed to hazardous materials provides opportunities for early identification of several diseases, particularly in those individuals who are constantly exposed to pesticides, such as pesticide operators and workers in pesticide manufacturing industry. However, data on this hot topic are limited in Pakistan. In this study, insecticide toxic effects and biochemical alterations (i.e., damage in DNA and enzyme activity) were studied in blood samples of occupationally exposed individuals from Punjab, Pakistan. Eight out of twenty-seven blood samples (29.6%) of the pesticide operators were found positive in five insecticides, with the maximum concentration found for chlorpyrifos-

## Technical

### CHEMWATCH

methyl (0.039 µg/mL). Eleven out of twenty-seven blood samples (40.7%) of the pesticide industry workers were found positive in eight insecticides, with the maximum concentration found for endosulfan (0.051 µg/mL). Comet tail length was  $16.88 \pm 4.57$  µm in pesticide industry workers and  $16.33 \pm 3.78$  µm in pesticide operators, which were significantly higher ( $P < 0.01$ ) than that recorded in the control group ( $4.84 \pm 2.21$  µm). Values of serum cholinesterase (SChE) concentration were slightly lower ( $P > 0.05$ ) in exposed individuals, whereas values of alanine aminotransferase (ALT), aspartate aminotransferase (AST), and alkaline phosphatase (ALP) concentration were significantly higher ( $P < 0.01$ ) in exposed individuals compared with control group. Exposure duration and total insecticide concentration in blood samples were positively associated with comet tail length, ALT activity, AST activity, and ALP activity, but negatively with SChE. DNA damage was higher in smokers vs. non-smokers. Also, a positive association was found between comet tail length and number of cigarettes per day. Overall, occupational exposure to insecticides can pose serious health risks to pesticide operators and workers in pesticide manufacturing industry, highlighting the necessity of personal protection in those groups for preventing exposure and resultant health disorders. Authors: Hayat K, Afzal M, Aqueel MA, Ali S, Saeed MF, Qureshi AK, Ullah MI, Khan QM, Naseem MT, Ashfaq U, Damalas CA. Full Source: Science of the Total Environment. 2018 Nov 13; 655:102-111. doi: 10.1016/j.scitotenv.2018.11.175. [Epub ahead of print]

## PUBLIC HEALTH RESEARCH

### Carcinogenic Potency of Airborne Polycyclic Aromatic Hydrocarbons in Relation to the Particle Fraction Size

2018-12-17

Polycyclic aromatic hydrocarbons (PAHs) that are bound to particulate matter can have adverse effects on human health. Particle size plays an important role in assessing health risks. The aim of this study was to compare concentrations of PAHs bound to particle fractions PM<sub>10</sub>, PM<sub>2.5</sub>, and PM<sub>1</sub>, as well as to estimate their carcinogenic potency and relative contributions of the individual PAHs to the carcinogenic potency in relation to the size of the particle. Measurements of ten PAHs were carried out in 2014 at an urban location in the northern part of Zagreb, Croatia. 24-h samples of the PM<sub>10</sub>, PM<sub>2.5</sub>, and PM<sub>1</sub> particle fraction were collected over forty days per season. Carcinogenic potency of PAHs was estimated by calculating benzo(a)pyrene equivalent concentrations while using three different toxic equivalence factor (TEF) schemes. The

The aim of this study was to compare concentrations of PAHs bound to particle fractions PM<sub>10</sub>, PM<sub>2.5</sub>, and PM<sub>1</sub>, as well as to estimate their carcinogenic potency and relative contributions of the individual PAHs to the carcinogenic potency in relation to the size of the particle.

total carcinogenic potency (TCP) and percentage contributions differed significantly depending on the TEF scheme used. The lowest PAH mass concentrations and TCPs were in summer and the highest in winter. The contributions of individual PAHs to the sum of PAH mass concentrations remained similar in all fractions and seasons, while in fractions PM<sub>10</sub> 2.5 and PM<sub>2.5</sub> 1 they varied significantly. Road traffic represented the important source of PAHs in all fractions and throughout all seasons. Other sources (wood and biomass burning, petroleum combustion) were also present, especially during winter as a consequence of household heating. The highest contribution to the TCP came from benzo(a) pyrene, dibenzo(ah)anthracene, indeno(1,2,3,cd)pyrene, and benzo(b) fluoranthene (together between 87% and 96%) in all fractions and seasons. In all cases, BaP showed the highest contribution to the TCP regardless relatively low contributions to the mass of total PAHs and it can be considered as a good representative for assessing the carcinogenicity of the PAH mixture. When comparing the TCP of PAHs in PM<sub>10</sub> and PM<sub>2.5</sub> fractions, it was found that about 21–26% of carcinogenic potency of the PAH mixture belonged to the PM<sub>2.5</sub> fraction. Comparison of TCP in PM<sub>2.5</sub> and PM<sub>1</sub> showed that about 86% of carcinogenic potency belonged to the PM<sub>1</sub> fraction, regardless of the TEF scheme used.

Authors: Pehneć G, Jakovljević I.

Full Source: International Journal of Environmental Research & Public Health. 2018 Nov 7;15(11). pii: E2485. doi: 10.3390/ijerph15112485.

### A State-of-the-Science Review of Mercury Biomarkers in Human Populations Worldwide between 2000 and 2018

2018-12-17

The Minamata Convention on Mercury provided a mandate for action against global mercury pollution. However, the knowledge of mercury exposures is limited because there are many regions and subpopulations with little or no data. This study aimed to increase worldwide understanding of human exposures to mercury by collecting, collating, and analysing mercury concentrations in biomarker samples reported in the published scientific literature. A systematic search of the peer-reviewed scientific literature was performed using three databases. A priori search strategy, eligibility criteria, and data extraction steps were used to identify relevant studies. 424,858 mercury biomarker measurements were collected from 335,991 individuals represented in 312 articles from 75 countries. General background populations with insignificant exposures have blood, hair, and urine mercury levels. The authors identified four populations of concern: a) Arctic populations who consume fish and

This study aimed to increase worldwide understanding of human exposures to mercury by collecting, collating, and analysing mercury concentrations in biomarker samples reported in the published scientific literature.

marine mammals; b) tropical riverine communities (especially Amazonian) who consume fish and, in some cases, may be exposed to mining; c) coastal and/or small-island communities who substantially depend on seafood; and d) individuals who either work or reside among artisanal and small-scale gold mining sites. This review suggests that all populations worldwide are exposed to some amount of mercury and that there is great variability in exposures within and across countries and regions. There remain many geographic regions and subpopulations with limited data, thus hindering evidence-based decision making. This type of information is critical in helping understand exposures, particularly in light of certain stipulations in the Minamata Convention on Mercury. <https://doi.org/10.1289/EHP3904>.

Authors: Basu N, Horvat M, Evers DC, Zastenskaya I, Weihe P, Tempowski J. Full Source: Environmental Health Perspectives. 2018 Oct;126(10):106001. doi: 10.1289/EHP3904.

### Evaluation of 2-thiothiazolidine-4-carboxylic Acid, a Common Metabolite of Isothiocyanates as a Potential Biomarker of Cruciferous Vegetable Intake

2018-12-17

Cruciferous vegetable consumption is associated with favourable health outcomes. Bioactive compounds arising in these, especially isothiocyanates, exert effects that contribute to prevention of disease, in large part through attenuation of inflammation and oxidative stress. However, much about isothiocyanate metabolites and their role as biomarkers of crucifer intake remain unknown. The authors tested the utility and limitations of 2-thiothiazolidine-4-carboxylic acid (TTCA) as a urinary biomarker of broccoli beverage intake in a randomised crossover clinical trial where 50 participants consumed either a glucoraphanin-rich (GRR) or sulforaphane-rich (SFR) beverage. Compared to run-in and wash-out periods, the authors observed significantly higher urinary TTCA after broccoli beverage consumption. Measurements also showed that TTCA was present in beverage powders and in all tested cruciferous vegetables. GRR resulted in excretion of 87% of the ingested TTCA while SFR resulted in excretion of 176%. Elevated urinary TTCA was observed in rats administered 100µmol/kg SFN. Unlike SFN, TTCA did not activate Nrf2-mediated cytoprotective signalling. Collectively, TTCA appears to be common isothiocyanate-derived metabolite that has the capacity

Cruciferous vegetable consumption is associated with favourable health outcomes.

to be utilised as a biomarker of cruciferous vegetables which would be beneficial for objective and quantitative tracking of intake in studies.

Authors: Palliyaguru DL, Salvatore SR, Schopfer FJ, Cheng X, Zhou J, Kensler TW, Wendell SG.

Full Source: Molecular Nutrition & Food Research. 2018 Nov 8:e1801029.

doi: 10.1002/mnfr.201801029. [Epub ahead of print]

### Organophosphate flame-retardant metabolite concentrations and pregnancy loss among women conceiving with assisted reproductive technology

2018-12-17

In the present study, the authors evaluated whether urinary concentrations of organophosphate flame retardant (PFR) metabolites are associated with pregnancy loss among women conceiving with assisted reproductive technology (ART). The study was a prospective preconception cohort of subfertile women. At the Academic hospital fertility centre in Boston, Massachusetts. A total of 155 women conceiving 179 pregnancies with ART. Mean exposure to each of five PFR metabolites was estimated by averaging the specific-gravity adjusted natural log concentrations from two urine samples collected during the ART cycle of conception. Adjusted risk ratios (RRs) and 95% confidence intervals (CIs) for biochemical and total pregnancy loss (all losses <20 weeks' gestation) by quartiles of PFR metabolite concentrations were estimated using a repeated measures log-binomial model, accounting for multiple pregnancies per woman. Of the 179 pregnancies, 31% ended in pregnancy loss (12% in biochemical loss). Among the three metabolites with high detection frequency [bis(1,3-dichloro-2-propyl) phosphate (BDCIPP), diphenyl phosphate (DPHP), and isopropylphenyl phenyl phosphate (ip-PPP)], an increased risk of biochemical loss was observed for women with DPHP concentrations in the fourth vs. first quartile (RR 1.64; 95% CI 0.61-4.39). Also found was an elevated risk of biochemical pregnancy loss among women in the highest quartile of the molar sum of urinary PFR metabolites compared with the lowest (RR 1.89; 95% CI 0.64-5.58). Urinary concentrations of ip-PPP and BDCIPP were not associated with either outcome. Among subfertile women, urinary DPHP metabolite concentrations measured during the ART cycle of conception may be associated with early pregnancy loss. Although this study is uniquely designed to investigate early markers of pregnancy success and maintenance, the small sample size likely contributed to imprecision. Given their increasing use as replacement chemicals for traditional flame retardants, exposure to PFRs may increase, and more studies

In the present study, the authors evaluated whether urinary concentrations of organophosphate flame retardant (PFR) metabolites are associated with pregnancy loss among women conceiving with assisted reproductive technology (ART).

will be needed to investigate their potential to impact pregnancy and reproduction.

Authors: Messerlian C, Williams PL, Mínguez-Alarcón L, Carignan CC, Ford JB, Butt CM, Meeker JD, Stapleton HM, Souter I, Hauser R; EARTH Study Team.

Full Source: *Fertility & Sterility*. 2018 Nov;110(6):1137-1144.e1. doi: 10.1016/j.fertnstert.2018.06.045.

### Associations of cord blood leptin and adiponectin with children's cognitive abilities

2018-12-17

Adipocytokines may play a role in foetal programming of neurodevelopment. In this study, the authors aimed to investigate the associations between cord blood adipocytokine concentrations and children's intelligence test scores. Data from two ongoing pregnancy cohorts in North America were used: The Maternal-Infant Research on Environmental Chemicals (MIREC, n=429) and Health Outcomes and Measures of the Environment (HOME, n=183) Studies. Umbilical cord blood adipocytokine concentrations were measured using enzyme-linked immunosorbent assays. Children's Intelligence Quotient (IQ) was tested and its components using the Wechsler Preschool and Primary Scales of Intelligence-III or Wechsler Intelligence Scale for Children-IV. Linear regression and linear mixed models were used to estimate associations between log<sub>2</sub>-transformed adipocytokine concentrations and children's IQ after adjusting for sociodemographic, perinatal, and child factors. After adjusting for covariates, cord blood adiponectin was positively associated with children's full-scale IQ scores at age 3 years in the MIREC Study ( $\beta = 1.4$ , 95% confidence interval [CI]: 0.2, 2.5) and at ages 5 and 8 years in the HOME Study ( $\beta = 1.7$ , CI: -0.1, 3.5). Adiponectin was positively associated with performance IQ in both studies (MIREC:  $\beta = 2.0$ , CI: 0.7, 3.3; HOME:  $\beta = 2.2$ , CI: 0.5, 3.9). Adiponectin was positively associated with working memory composite scores at age 8 in the HOME Study ( $\beta = 3.1$ , CI: 1.0, 5.2). Leptin was not associated with children's IQ in either study. Cord blood adiponectin was associated with higher full-scale and performance IQ and working memory composite scores in children. Future studies are needed to explore the mechanisms underlying these associations.

Authors: Li N, Arbuckle TE, Muckle G, Lanphear BP, Boivin M, Chen A, Dodds L, Fraser WD, Ouellet E, Séguin JR, Velez MP, Yolton K, Braun JM.

Full Source: *Psychoneuroendocrinology*. 2019 Jan; 99:257-264. doi: 10.1016/j.psyneuen.2018.10.021. Epub 2018 Oct 25.

In this study, the authors aimed to investigate the associations between cord blood adipocytokine concentrations and children's intelligence test scores.