Effect of selected food components on effectiveness of dietary exposure mitigation to chemical contaminants

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Overview

- Strategies involve the use of food components able to reduce the effects of contaminants

- Accurate data

- Case Studies
  - Arsenic
  - Acrylamide
  - AGEs
Accuracy of measurements

- “What is there that is not poison? All things are poison and nothing is without poison. Solely the dose determines that a thing is not a poison”

*Paracelsus*
• Need of accurate measurements, comparable, overtime at national and international level.
• Metrology as the pillar of reliable analytical data.

Coelho et al., Experimental approaches for the estimation of uncertainty in analysis of trace inorganic contaminants in foodstuffs by ICP-MS Food Chemistry 2013, 141:604–611
Eatwell: the concept

Nutrients + Environmental contaminants + Processing contaminants

Nutrients + Environmental Contaminants

Complement

Percursors

Mitigation strategies
First Case Study
Toxicity Arsenic end points

Cardiovascular disorders

Diabetes mellitus

Skin, kidney, lungs, bladder, liver

Immunosuppressive properties

Neurological deficits
Selenium

Heart
Hypertension
Atherosclerosis
Myocardial infarction

Brain
Alzheimer
Parkinson

Liver and Pancreas
Diabetes

Lungs
Asthma

Reproductive systems
Male and female infertility
Arsenic and Selenium

It has been proposed that interactions between selenium and arsenic in the body may affect their kinetics and toxicity. Both elements are methylated in the body through the one-carbon metabolism suggesting a possible pathway for a potential interaction.

Rego et al., Amino acid contents and toxically relevant arsenic of rice varieties consumed in Portugal - Measurement – 2017 accepted
Krohn et al., A high-selenium lentil dietary intervention in Bangladesh to counteract arsenic toxicity: study protocol for a randomized controlled trial
Selenium and Arsenic Interaction

Studies with Bangladeshi women suggest a positive association between urinary methylarsonic acid (MMA) and trimethyl selenonium ion (TMSε) (main forms of selenium excreted in urine).

Genes involved in the methylation of selenium and arsenic may interact on associations with urinary methylarsonic acid.
Second Case Study
Dietary Acrylamide

• Acrylamide is a by-product of the cooking process and is formed when reducing sugars (glucose or fructose) react with the amino acid asparagine during the Maillard reaction

![Chemical structure of acrylamide]

• Acrylamide is a multi-organ carcinogen in both male and female rodent models

• Based on the evidence of acrylamide carcinogenicity in animals, the International Agency for Research on Cancer has classified acrylamide as a group 2A carcinogen for humans

• EU Regulation 2017/2158 - mitigation measures and benchmark levels for the reduction of the presence of acrylamide in food

Virk-Baker et al, 2014
Acrylamide Mitigation

Input

**Potatoes**
- Deprivation of sulfur
- Application of nitrogen fertilizers

**Cereals**
- Application of sulfur

Farm

**Potatoes**
- Select low-sugar walks

**Cereals**
- Select varieties with low asparagine content
  - Select mixtures of wheat and chickpeas

**Coffee**
- Selection of Arabica coffee species

Processing and consumer

**Potatoes**
- Addition of amino acids
  - Application of alemcric extract in frying oil
  - Addition of antioxidants
    - PH change

**Cereals**
- Replace the baking soda with sodium bicarbonate
  - Addition of glycine
  - Addition of spices, bamboo leaves, tea polyphenols

**Coffee**
- Blends with higher percentage of Arabica coffee
Third Case Study
AGEs

- Advanced glycation endproducts (AGEs) form by Maillard-reactions after initial binding of aldehydes with amines or amides in heated foods or in living organisms
  - proteins to form high-molecular weight AGEs
  - small molecules to form low-molecular weight AGEs

- AGEs in the body have been associated with several age-related diseases
- Higher AGE intake was associated with higher free plasma and urinary AGE levels

Jean L.J.M. Scheijen et al, 2018
AGEs Mitigation

- Reduction of cooking temperature and time
- Application of polyphenols
- Use of acidic ingredients

Gengjun Chen et al., 2018
Future directions

➢ Further research is needed to elucidate sources of exposure and factors that may influence arsenic and AGEs or Acrylamide exposure in pregnant women and children.

➢ Laboratory research and real world applications need to become more closely tied particularly on mitigation strategies.

➢ Human studies on gut microbiome at low arsenic and maillard products intake still in infancy.
Thanks for your attention

Determination of Acrylamide in Portuguese Bread by UPLC-MS/MS: Metrological and Chemometric tools

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Amino acid contents and toxically relevant arsenic of rice varieties consumed in Portugal

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