

Arsenic speciation in fruit and vegetables grown in the UK

Area of research interest: [Chemical hazards in food and feed](#)

Project code: FS241003

Conducted by: University of Aberdeen

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Background

During growth, fruit and vegetables take up metal contaminants from the surrounding soil area. The metal contaminants may include; arsenic, cadmium, lead, copper and zinc. Arsenic, cadmium and lead have no known beneficial health effects, while copper and zinc can act as nutrients and are essential for health. However, all may be harmful if excessive amounts are consumed.

The European Food Safety Authority has previously concluded that dietary exposure to arsenic, cadmium and lead should be reduced. Additionally, the Joint Food and Agriculture Organisation and the World Health Organisation Expert Committee on Food Additives agree that it is not possible to set a tolerable lead intake and therefore minimisation of exposure to lead from all sources is desirable. We consider that exposure to arsenic, cadmium and lead should be reduced to as low as reasonably practicable.

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Research Approach

The project aimed to:

- Establish the levels of total and inorganic arsenic in UK grown fruits and vegetables
- Investigate the levels of cadmium, lead, copper and zinc in UK grown fruits and vegetables
- Measure the gradation or distribution of all these metals in selected fruits and vegetables, from 'skin to core' using laser ablation mass spectrometry.

Samples of locally grown fruit and vegetable produce were sampled in South West England and analysed to determine the levels of arsenic, cadmium, lead, copper and zinc.

In two, geologically stable, arsenic enriched regions of South West England, 630 basket products from local farm shops, greengrocers, pick your own, supermarkets and farmers markets and 174 samples of field produce and associated soil samples were collected and analysed to determine the levels of arsenic, cadmium, lead, copper and zinc. To ensure that seasonality of crop production and climate was taken into account, the samples were collected and analysed from late autumn 2010 through to late summer 2011. Samples included fruits and vegetables that are normally washed and peeled in the home to enable a comparison of the levels of arsenic, cadmium, lead, copper and zinc in unpeeled and peeled produce; levels in the skins and flesh of baked potatoes were determined in 20 samples.

For reference purposes, 190 samples of basket produce were sampled from a region of North East Scotland known to contain comparatively low levels of arsenic in the soil, and analysed for

total arsenic, cadmium, lead, copper, and zinc.

All produce and soil analyses were carried out using inductively coupled plasma mass spectrometry (ICP-MS). A subset of 247 samples of basket and field produce were also analysed for inorganic arsenic using high performance liquid chromatography (HPLC) linked to a HPLC-ICP-MS.

To establish the gradation or distribution of arsenic, cadmium and lead from the 'skin to core' in peelable produce e.g. apple, beetroot, carrot, parsnip and potato, 25 samples were analysed using laser ablation (LA) ICP-MS.

The results from this research study have been sent to the European Food Safety Authority for collation with data from other member states.

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Results

The results confirm that:

- Basket produce from South West England had a higher concentration of total arsenic and copper, compared to basket produce from North East Scotland.
- Levels of cadmium, lead and zinc in the same produce were found to be generally equivalent.
- Vegetables categorised as open leaf e.g. kale, chard, lettuce, greens and spinach had the highest concentrations of total arsenic and cadmium (possibly due to soil contamination on the leaves).
- Levels of total arsenic in potatoes, swedes and carrots were lower when peeled. However, there was no notable difference between the levels of total arsenic found in peeled and unpeeled apples, beetroots, courgettes, cucumbers, parsnips and squashes.
- Levels of cadmium and lead in potatoes and swedes were lower when peeled.
- Levels of copper in carrots and swedes were found to be lower when peeled.
- Levels of zinc in courgettes were found to be lower when peeled.
- On average 98.5% of the total arsenic from basket and field produce collected in South West England was present in the inorganic form.
- The level of total arsenic, cadmium, lead, copper and zinc found in the skin of baked potatoes sampled from South West England was found to be higher in the potato skin compared to the flesh. The level of total arsenic in potato skin was on average 75 times greater than that found in potato flesh.

Correlation between the levels of total arsenic found in the soil and in the produce was most evident in potatoes. This relationship varied for other produce and for some did not exist. For 'below ground produce' e.g. potatoes, the levels of soil arsenic may be a determining factor in the levels of arsenic found in produce, whereas for 'above ground produce' e.g. apples, this may not always be the case.

No strong correlations were found between soil cadmium levels and levels found in produce. There were good correlations between the levels of copper found in the soil and levels found in peeled potatoes and peeled root vegetables. For lead, there was a correlation between peeled and unpeeled root vegetables and soil lead levels. For zinc, there were only correlations between soil zinc levels and the levels found in peeled root vegetables and cabbage.

Laser ablation results indicated that:

- Total arsenic was elevated in the skin of beetroot and potato, typically within 2mm of the surface.
- Cadmium and lead were elevated in the skin of beetroots, carrots and potatoes, with levels decreasing to those generally found in the flesh, 2mm from the skin surface.
- There was no indication of total arsenic elevation in the skin of carrots, apples and parsnips.
- There was no indication of cadmium or lead elevation in the skin of apples and parsnips.

The levels of metals reported in this study do not increase concern about risk to human health and do not support any changes to our advice to consumers, therefore our current advice on how to wash and peel fruits and vegetables remains the same.

We are considering whether to expand this study to investigate the level and distribution of these and other metals in UK grown fruits, vegetables and cereals.

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Published Papers

1. Norton, G., Deacon, C., Mestrot, A., Feldmann, J., Jenkins, P., Baskaran, C. & Meharg, A.A. (2013) Arsenic speciation and localization in horticultural produce grown in a historically impacted mining region, *Environmental Science and Technology*, 6164–6172, doi: 10.1021/es400720r

Research report

England, Northern Ireland and Wales

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