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**Multi-element survey of allotment produce and soil in the UK**

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## Multi-element survey of allotment produce and soil in the UK

### Abstract

A survey in 2004 of 12 metals was carried out in 6 rural and 6 urban allotment sites across mainland Britain. Analysis used ICP-MS in 215 samples of vegetables and 36 samples of soft fruit; and ICP-OES in 51 samples of soil. On a fresh weight basis levels (mg/kg) in produce of Cu were in the range 0.119 - 2.271. The highest levels (mg/kg) measured were Pb 0.164 in a sample of blackcurrants, Cd 0.039 in spinach, Hg 0.003 in curly kale, and As 0.025 in raspberries. The lowest concentrations for these metals were below the level of detection (LOD) in numerous samples. The majority of Pt samples were below LOD and all were under the limit of quantification (LOQ). The results of the survey showed that the concentrations of the metals in vegetables, fruit and soils were consistent with previous studies and in general at low levels.

**Keywords:** Allotment, arsenic, cadmium, copper, lead, mercury, metals, pollution, soft fruit, soil, vegetables

**Running title:** Survey of allotment produce

### Introduction

The main purpose of this survey carried out in 2004, was to determine concentrations of metals and other elements in fruits and vegetables from 6 rural and 6 urban allotment sites situated in a variety of environments in Great Britain. An allotment is a piece of land, rented by an individual from a local authority, for growing vegetables and/or flowers. Allotments can be situated on sites that have been used previously for the disposal of industrial and/or domestic waste. In this survey, urban allotments were chosen to represent those allotments that might be located on polluted land. Urban allotments are often positioned close to roads and industrial sites. For this reason, the soil as well as the fruits and vegetables grown on allotments may contain higher levels of chemical contaminants than agricultural soils and agricultural produce. The levels of potentially harmful or beneficial elements in edible crops were measured. Levels of cadmium (Cd), chromium (Cr), copper (Cu), lead (Pb), mercury (Hg), nickel (Ni), tin (Sn), titanium (Ti) and zinc (Zn) were measured in both soil and produce. In addition, the levels of arsenic (As), manganese (Mn) and platinum (Pt) were measured in allotment produce and levels of magnesium (Mg), phosphorus (P) and potassium (K) were measured in soil. Soil pH was measured, as this can affect the solubility and uptake of mineral salts. For example at Shipham, UK, levels of cadmium in the soil are very high, yet the cadmium has low solubility owing to the high pH (7.7) and high calcium carbonate and hydrous oxide content of the soils (Alloway et al., 1988).

The produce samples were chosen to represent a range of edible parts and time to harvest as well as the principal classes of vegetables namely: brassicas, roots, legumes and other. Broccoli and Brussels sprouts were also chosen because they are in the ground for a relatively long period. The

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3 mineral content of agricultural crops varies according to species, variety cultivated and season  
4 e.g. cadmium (Davis & Coker, 1980).  
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7 Some elements such as arsenic, cadmium, mercury and lead are potentially harmful to human  
8 health (MAFF 1998a,b). Levels of these were measured in soil to indicate contamination, and in  
9 produce to determine the levels that had accumulated in the plants. The presence of these  
10 elements may reflect industrial contamination or natural levels. For example, an increase in soil  
11 cadmium content may, depending on pH, result in an increased plant uptake of the metal. This  
12 has been demonstrated for soils with naturally elevated cadmium levels (Lund et al., 1981) and  
13 those contaminated by non-ferrous metal mining (Alloway et al., 1988).  
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16 Other elements such as chromium, copper, manganese and zinc are beneficial to human health at  
17 trace levels, whereas the roles of nickel and tin in human metabolism are unclear, although they  
18 are not thought harmful at low levels (Haas, 1992). Manganese-based fuel additives might be  
19 used in the future as replacements for leaded fuel and so levels in this survey could provide  
20 baseline data.  
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23 Platinum levels may represent aerial contamination due to emissions from catalytic converters in  
24 car exhausts (Anon, 1998, Fargo et al., 1998, Hees et al., 1998, Ravindra et al, 2004). Platinum  
25 was therefore included in this survey to compare its levels of contamination in rural and urban  
26 produce.  
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29 Titanium was analysed as an indicator of soil contamination. Plants do not take up titanium  
30 internally, and so the presence of titanium in plant samples can be used to indicate the presence  
31 of soil or dust on the outer surface of the plant sample. Potassium and phosphorus levels were  
32 measured principally to indicate soil fertility, being major elements required for normal plant  
33 growth.  
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36 Some previous surveys have measured levels in purchased commercially grown vegetables of the  
37 metals in the survey reported here and found them to be below statutory and guideline limits  
38 (MAFF, 1994, 1998c). The survey in this paper report levels in a wide range of home-grown  
39 allotment produce in the UK.  
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## 42 43 **Materials and methods**

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46 The survey was carried out on 12 allotment sites between June and December 2004. Both rural  
47 and urban allotment sites were sampled in three geographical areas: 1. North (southern Scotland  
48 and northern England), 2. Midlands (Wales and midlands of England), 3. South (southern  
49 England). A photographic record was taken of each site and the position of each sampled plot  
50 was recorded using global satellite positioning (GPS).  
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### 53 *Produce samples*

54 Six categories of produce (soft fruits, legumes, leafy greens, Brassicas, potatoes and onions) were  
55 collected from each site. The aim was to obtain all types of produce from three plots per  
56 allotment site but if necessary produce was sampled from plots adjacent or close to the principal  
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3 sampling plots. A minimum of 200 g fresh weight was collected for each sample. Twice this  
4 amount was collected for potatoes, which were analysed both peeled and unpeeled. The number  
5 of produce samples taken totalled 251. Once collected, the fruit samples were washed with  
6 distilled water, dried using absorbent paper (Kimwipes Classic (Steel Blue), Kimberly-Clark) and  
7 then sealed in two plastic bags. The edible parts (e.g. stalks and outer leaves removed) of  
8 vegetable samples were washed then rinsed in distilled water and shaken vigorously before being  
9 homogenised into small pieces from which random samples were taken for analysis.  
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### 12 *Soil samples*

13 A sample of the soil substrate was collected from each plot from which produce was collected.  
14 Each plot soil sample comprised up to 15 sub-samples taken over the whole plot to a depth of 15  
15 cm, using a soil auger. The 51 soil samples were placed in double sealed, labelled, plastic sample  
16 bags.  
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### 19 *Analysis and quality control*

20 *Soil samples* were analysed in duplicate for As, Cd, Cr, Cu, Pb, Mg, Hg, Ni, Sn, Ti, Zn and pH by  
21 Direct Laboratory Services Ltd (now Eurofins). Following air drying to constant weight at 30 °C  
22 +/- 2 °C, each soil sample was initially ground and passed through a 2 mm sieve and were  
23 analysed for N, P and K to pass values onto the allotment holders and thus are not reported here.  
24 The pH was determined using a combined glass electrode on the suspension of 10 ml of soil in 25  
25 ml of deionised water shaken for 15 min at 20 °C. Mg was extracted from 10 ml of sieved soil by  
26 shaking with 50 ml of ammonium nitrate for 30 min at 20 °C and then determined on the extract  
27 filtered through Whatman no 2 filter paper using inductively coupled plasma optical emission  
28 spectroscopy (ICP-OES). Methodology was as indicated in MAFF (1986). The other elements  
29 were analysed following further grinding to pass through a 0.5 mm sieve.  
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34 For As analysis sample (1 g) was heated in the presence of concentrated nitric acid to destroy any  
35 organic matter present. Magnesium nitrate was added to prevent losses from volatile species. The  
36 extract was then ashed for a minimum of 16 hours at 520 °C. The ash produced was dissolved  
37 with heating in 50ml HCl and arsenic determined by hydride-generation assisted atomic  
38 fluorescence.  
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41 Hg was determined using the Advanced Mercury Analyser (Leco instruments). A sample of  
42 known weight (approximately 100mg) was placed in a sampling boat, which was introduced into  
43 a decomposition tube. By controlled heating of the decomposition furnace, the sample was first  
44 dried and then thermally decomposed. The decomposition products of the sample were passed  
45 through a gold amalgamator for the selective trapping of Hg, which was released by subsequent  
46 heating of the amalgamator and determined by cold vapour Atomic Absorption Spectrometry.  
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49 The remaining metals (Cd, Cr, Cu, Ni, Pb, Sn, Ti, and Zn) were determined by ICP-OES. 1 g of  
50 0.5 mm ground sample was heated under reflux with 15ml of aqua regia at 130°. The extract was  
51 then diluted to 50ml with 10% nitric acid and metals determined on the extract by ICP-OES.  
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54 *The produce samples* were prepared and analysed raw by CSL for As, Cd, Cr, Cu, Pb, Mn, Hg,  
55 Ni, Pt, Sn, Ti, and Zn. Millipore® (18.2 MΩ) water and high purity grade reagents were used  
56 throughout. Aliquots of each test sample (3 to 4 g) plus certified reference materials (0.5 g) were  
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3 digested under high pressure in quartz vessels using a nitric/hydrochloric (4:1) acid mixture (5  
4 ml), then diluted to 10 ml with water. Aliquots (1 ml) of sample digest and also acid matched  
5 standards were diluted with internal standard solution (4 ml) containing both indium and rhodium  
6 prior to quantification by inductively coupled plasma-mass spectrometry (ICP-MS). Reagent  
7 blanks and a reagent blank spiked with a known amount of each analyte were analysed with the  
8 test samples for recovery estimate purposes. Chromium and arsenic were measured by high  
9 resolution ICP-MS to remove severe polyatomic interferences associated with the use of  
10 hydrochloric acid (ClO and ArCl respectively).  
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14 Both laboratories are UKAS accredited to ISO 17025 for a wide range of determinations in  
15 analytical chemistry and further details of analytical and quality control procedures are discussed  
16 elsewhere (Baxter et al. 1997, Food Standards Agency 2004a,b) and are similar to those used  
17 previously for fungi and blackberry samples (Weeks et al. 2006). The limits of detection (LOD)  
18 of the elements analysed in the produce and soil are shown in Table 1. Note that in subsequent  
19 tables of results LODs were corrected for the actual weight of sample analysed.  
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### 22 *Data handling*

23 We have used upper bound data and unless stated otherwise, in order to include all data, where  
24 values were below the LOD, the LOD has been used to compute means and medians in tables and  
25 for graphical representations of ranges. These represent the “worst case scenario” as actual  
26 values would have been between zero and the LOD. For statistical modelling we have used zero  
27 for samples where values were below the LOD partly because of the confounding effects of  
28 different LODs for different sample sizes. For most metals the assays were very sensitive, giving  
29 small LODs, so that the results are not substantially affected by the minima used.  
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33 Statistical multi-level modelling was used to examine the extent to which levels of metals in soil  
34 were associated with levels in different types of produce. The use of multilevel models was  
35 appropriate as they account for the structures within the data of: sample within plot, within  
36 allotment site. The program MLwiN (Centre for Multilevel Modelling, University of Bristol) was  
37 used to fit the models. The effect of soil pH and the clustering effect of plots and allotment sites  
38 were built into the model. Data were initially matched at plot level and then to obtain reasonable  
39 sample sizes, the following eight categories of produce were included in the model, with  
40 unpeeled potatoes as the baseline for comparison: peeled potatoes, onions, cauliflower, cabbage,  
41 broccoli, Brussels sprouts, beans (runner, french, dwarf and green) and soft fruits (gooseberries,  
42 raspberries, redcurrants, blackcurrants and blackberries). Grapes, peas, spinach and curly kale  
43 were left out of the models as too few samples were obtained within these categories. Natural  
44 logarithms of the data values were used in the models to achieve a normal distribution of errors  
45 and homogeneity of variance.  
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## 48 **Results and discussion**

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51 The overall mean, median, maximum and minimum concentrations of metals in the fruits and  
52 vegetables sampled are summarised in Table 2, which shows that minimum levels were often  
53 below the LOD. Levels of the metals were similar to those found in the total diet study, in which  
54 samples were obtained through the usual retail outlets (Food Standards Agency 2004c). The  
55 range of levels measured is illustrated in Figure 1 in box and whisker plots. Metals are grouped  
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3 according to concentration levels and it should be noted that the scale of the y axis is different for  
4 each graph.  
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#### 7 ***Lead, cadmium, mercury and arsenic***

8 None of the samples analysed was found to be above the corresponding regulatory limits, which  
9 are detailed in Table 3. The highest concentrations of these elements were found in individual  
10 samples of blackcurrant (0.16 mg/kg of lead), spinach (0.04 mg/kg of cadmium), and raspberries  
11 (0.03 mg/kg of arsenic). Although not a direct comparison, strawberries analysed in a Finnish  
12 study (Tahvonen et al., 1995) had a mean cadmium concentration of 0.007 mg/kg, which is  
13 similar to the overall mean concentration (Table 1) in this survey. None of the samples had a  
14 mercury concentration that was greater than the limit of detection. Table 4 summarises the results  
15 for these metals by produce, where it is important to note sampling frequency in interpretation.  
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#### 18 ***Chromium, manganese, nickel, copper and zinc***

19 None of the samples analysed were above the corresponding guideline limits for Cu or Zn. There  
20 are no guideline limits for Cr, Mn or Ni levels in vegetables or fruits; however, the levels of these  
21 metals were similar to those found in the total diet study (Food Standards Agency 2004 c) and are  
22 not considered to pose a risk to consumer safety. The highest concentrations of these metals were  
23 found in individual samples of cabbage (0.08 mg/kg of Cr) and spinach (11.65 mg/kg of Mn).  
24 This highest level of Mn was similar to the median levels in wild blackberries that we previously  
25 reported (Weeks et al, 2006) and could be associated with use of artificial fertilisers. As shown in  
26 summary Table 5, a single sample of peas had the highest levels for Ni (0.52 mg/kg), Cu (2.27  
27 mg/kg) and Zn (17.92 mg/kg).  
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#### 33 ***Titanium, platinum and tin***

34 There are no regulatory limits for titanium or platinum. The corresponding regulatory limit for tin  
35 in canned foods is 200 mg/kg. The highest concentrations of these metals were found in  
36 individual samples of spinach (0.45 mg/kg of titanium) and gooseberries (0.02 mg/kg of tin).  
37 Levels of platinum in the analysed samples were extremely low (generally below the LOD).  
38 Values for all produce are summarised for these three metals in Table 6, where, as in Tables 4  
39 and 5, more weight should be given to results from produce with more samples.  
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#### 44 ***Rural and urban site and regional variation***

45 In non-parametric (Kuskal-Wallis) statistical comparisons, produce grown on urban allotments  
46 had higher median levels of manganese ( $p=0.048$ ) but lower levels ( $p=0.004$ ) of zinc  
47 contaminants. Table 7 summarises the rural/urban variations in metal concentrations in allotment  
48 soil. There were no significant differences in levels of metals found in produce when comparing  
49 rural sites with urban sites. As the purpose of sampling from different regions was to obtain a  
50 good geographical distribution of sites, regional differences are more likely to be linked to site,  
51 however, analysis indicated ( $p\leq 0.001$ ) lower levels of Ni and Pb in the North, higher levels of As  
52 and Sn in the Midlands and higher levels of Zn in the South. This analysis, necessary because  
53 these data did not fit the assumptions necessary for parametric statistics even after  
54 transformation, does not take into account the clustering of data by allotments. Levels of  
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contamination were, however, low in produce from all areas and so the UK Food Standards Agency deemed there to be no food safety concern (FSA 2006).

### ***Variation of levels of metals in different crops***

There was both inter- and intra- produce variation in levels of metals. It is usual to find mineral content varying with crop, climate and soil (Fageria et al., 1997). Table 8 indicates for each metal those types of produce with significantly lower or higher concentration than in unpeeled potatoes, which were used as a baseline reference in the statistical model. No clear patterns emerge and neither the levels of metal in the soil nor soil pH had a detectable effect on the levels found in the produce. The majority of soil samples in the study had a pH close to neutral (median 6.90, range 5.8 to 7.8). There was a tendency for those crops with a longer growing period before harvest and permanent crops such as fruit bushes to accumulate higher levels of metals.

### **Conclusions**

The overall accumulation of heavy metals in allotment produce was relatively low and consistent with levels reported by others in commercially produced vegetables and fruit. The variation in soil pH and soil heavy metal content within the survey was small and no significant association was detected with the levels of metals present in crops.

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53 blackberries in the UK. *Food Additives and Contaminants*, 23 (2), 140-147.

<i>Metal</i>	<i>Produce LOD (mg/kg)</i>	<i>Soil LOD (mg/kg)</i>
As	0.0005	0.02
Cd	0.0006	0.08
Cr	0.006	0.2
Cu	0.006	0.12
Hg	0.0006	0.0008
Mn	0.01	n/a
Ni	0.006	0.4
Pb	0.0006	1.0
Pt	0.0003	n/a
Sn	0.001	0.4
Ti	0.03	0.3
Zn	0.04	0.4

Note: Values shown are based on a typical sample weights of 0.4 g (fresh weight) for produce and 1.0 g (dry matter) for soil

<i>Metal</i>	<i>Mean</i>	<i>Median</i>	<i>Minimum</i>	<i>Maximum</i>
As	0.0025	0.0016	<0.0005	0.0253
Cd	0.0066	0.0052	<0.0006	0.0391
Cr	0.0081	0.0060	<0.006	0.0808
Cu	0.6092	0.5456	0.1193	2.2709
Hg	0.0007	0.0006	<0.0006	0.0027
Mn	1.5322	1.3406	0.2363	11.6533
Ni	0.0432	0.0247	<0.006	0.5224
Pb	0.0097	0.0040	<0.0006	0.1637
Pt	0.0003	0.0003	<0.0003	0.0004
Sn	0.0017	0.0010	<0.001	0.0200
Ti	0.0744	0.0512	<0.03	0.4537
Zn	3.5263	2.8986	0.6921	17.9246

**Note** that most minima were below the LOD. Where values were below the LOD, the LOD was used to compute means and medians which therefore are probable overestimates (see text). Shaded cells indicate means or medians thereby calculated as equal to the LOD.

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<i>Metal</i>	<i>Foods</i>	<i>Maximum permitted Level (mg/kg)</i>
Lead	Potatoes and onions	0.1
	Brassicas	0.3
	Small fruits and berries	0.2
Cadmium	Potatoes and onions	0.1
	Brassicas	0.2
	Small fruits and berries	0.05
Arsenic	All produce	1.0

\* Note that these limits are not applicable to allotment-grown produce.

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<i>Produce</i>	<i>No. of samples</i>	<i>As</i>			<i>Cd</i>			<i>Hg</i>			<i>Pb</i>		
		<i>Mean</i>	<i>Median</i>	<i>Max</i>	<i>Mean</i>	<i>Median</i>	<i>Max</i>	<i>Mean</i>	<i>Median</i>	<i>Max</i>	<i>Mean</i>	<i>Median</i>	<i>Max</i>
Blackberries	2	0.0017	0.0017	0.0021	0.0040	0.0040	0.0065	0.0008	0.0008	0.0010	0.0079	0.0079	0.0095
Blackcurrants	3	0.0063	0.0074	0.0093	0.0015	0.0012	0.0022	0.0014	0.0011	0.0024	0.0726	0.0396	0.1637
Broccoli	9	0.0017	0.0020	0.0037	0.0077	0.0073	0.0137	<0.0006	<0.0006	<0.0006	0.0115	0.0089	0.0271
Brussels Sprouts	10	0.0009	0.0005	0.0020	0.0099	0.0087	0.0244	0.0007	0.0006	0.0014	0.0016	0.0006	0.0057
Cabbage	34	0.0019	0.0009	0.0129	0.0048	0.0037	0.0177	0.0008	0.0006	0.0023	0.0065	0.0010	0.0868
Cauliflower	13	0.0018	0.0012	0.0057	0.0037	0.0035	0.0062	0.0006	0.0006	0.0008	0.0134	0.0091	0.0657
Curly kale	2	0.0055	0.0055	0.0068	0.0265	0.0265	0.0365	0.0026	0.0026	0.0027	0.0182	0.0182	0.0215
Dwarf beans	6	0.0007	0.0007	0.0011	0.0023	0.0020	0.0048	0.0007	0.0006	0.0008	0.0071	0.0058	0.0137
French beans	3	0.0012	0.0005	0.0026	0.0025	0.0015	0.0051	0.0007	0.0006	0.0008	0.0096	0.0015	0.0260
Gooseberries	19	0.0016	0.0015	0.0035	0.0014	0.0011	0.0052	0.0006	0.0006	0.0008	0.0078	0.0043	0.0566
Grapes	1	0.0009	0.0009	0.0009	<0.0006	<0.0006	<0.0006	<0.0006	<0.0006	<0.0006	0.0115	0.0115	0.0115
Green beans	1	0.0044	0.0044	0.0044	0.0014	0.0014	0.0014	<0.0006	<0.0006	<0.0006	0.0638	0.0638	0.0638
Onions	37	0.0037	0.0035	0.0096	0.0102	0.0084	0.0258	0.0006	0.0006	0.0008	0.0074	0.0032	0.0461
Peas	1	0.0010	0.0010	0.0010	0.0059	0.0059	0.0059	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008
Potatoes	36	0.0026	0.0023	0.0073	0.0093	0.0083	0.0244	0.0008	0.0008	0.0012	0.0133	0.0058	0.0609
Potatoes (peeled)	36	0.0014	0.0009	0.0069	0.0088	0.0080	0.0223	0.0008	0.0008	0.0008	0.0047	0.0009	0.0593
Raspberries	10	0.0101	0.0087	0.0253	0.0044	0.0045	0.0072	0.0008	0.0006	0.0017	0.0192	0.0089	0.0867
Redcurrants	1	0.0033	0.0033	0.0033	0.0032	0.0032	0.0032	<0.0006	<0.0006	<0.0006	0.0189	0.0189	0.0189
Runner beans	26	0.0018	0.0011	0.0094	0.0017	0.0015	0.0046	0.0006	0.0006	0.0008	0.0072	0.0046	0.0304
Spinach	1	0.0031	0.0031	0.0031	0.0391	0.0391	0.0391	0.0020	0.0020	0.0020	0.0286	0.0286	0.0286

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**Note** Where values were below the LOD, the LOD was used to compute means and medians which therefore are probable slight overestimates (see text). Shaded cells indicate means or medians thereby calculated as equal to the LOD.

<i>Produce</i>	<i>No. of samples</i>	<i>Cr</i>			<i>Cu</i>			<i>Mn</i>			<i>Ni</i>			<i>Zn</i>		
		<i>Mean</i>	<i>Median</i>	<i>Max</i>	<i>Mean</i>	<i>Median</i>	<i>Max</i>	<i>Mean</i>	<i>Median</i>	<i>Max</i>	<i>Mean</i>	<i>Median</i>	<i>Max</i>	<i>Mean</i>	<i>Median</i>	<i>Max</i>
Blackberries	2	0.0107	0.0107	0.0113	0.8264	0.8264	0.9527	2.2611	2.2611	3.1774	0.0466	0.0466	0.0778	2.1525	2.1525	2.1678
Blackcurrants	3	0.0136	0.0072	0.0277	0.9677	0.8576	1.2581	1.4710	1.5221	1.6192	0.0778	0.0473	0.1451	3.0052	3.1693	3.7798
Broccoli	9	0.0069	0.006	0.0107	0.6688	0.6149	0.8604	2.1933	2.2311	3.0931	0.0669	0.0555	0.1797	9.0588	8.6071	12.8027
Brussels Sprouts	10	0.0095	0.006	0.0381	0.6516	0.6283	0.8047	2.6595	2.6763	3.1737	0.0732	0.0598	0.1673	6.4515	6.1703	9.6206
Cabbage	34	0.0104	0.006	0.0808	0.3272	0.3005	0.7299	1.3203	1.2652	2.4153	0.0379	0.0250	0.1988	3.3552	3.0239	14.2421
Cauliflower	13	0.0067	0.006	0.0093	0.3963	0.4026	0.5727	1.4764	1.3668	1.9996	0.0209	0.0184	0.0553	4.7850	4.7594	8.8250
Curly kale	2	0.0137	0.0137	0.0190	0.6416	0.6416	0.7785	3.3958	3.3958	3.8675	0.0626	0.0626	0.1018	6.0348	6.0348	9.4480
Dwarf beans	6	0.0073	0.0070	0.0099	0.6245	0.6075	0.8684	2.1835	2.0117	3.7799	0.1343	0.0967	0.3526	3.9694	3.8338	5.5080
French beans	3	0.0111	0.006	0.0212	0.5038	0.5303	0.5748	1.7390	1.8494	1.9116	0.0817	0.0821	0.0830	3.6595	3.0865	4.9831
Gooseberries	19	0.0075	0.006	0.0117	0.4692	0.4303	0.7909	1.1636	1.1371	2.7409	0.0285	0.0278	0.0474	1.2500	1.1974	1.7532
Grapes	1	0.0112	0.0112	0.0112	0.5721	0.5721	0.5721	0.2463	0.2463	0.2463	0.0106	0.0106	0.0106	0.8491	0.8491	0.8491
Green beans	1	<0.006	<0.006	<0.006	0.4542	0.4542	0.4542	0.9068	0.9068	0.9068	0.0325	0.0325	0.0325	3.3112	3.3112	3.3112
Onions	37	0.0066	0.006	0.0174	0.4077	0.3724	0.7705	1.2278	1.1114	2.0885	0.0193	0.0134	0.0701	3.3135	2.8274	10.3716
Peas	1	0.0080	0.0080	0.0080	2.2709	2.2709	2.2709	3.1820	3.1820	3.1820	0.5224	0.5224	0.5224	17.9246	17.9246	17.9246
Potatoes	36	0.0082	0.0080	0.0192	0.9020	0.8461	1.5663	1.1900	1.1692	1.9857	0.0211	0.0162	0.0774	2.8308	2.7105	6.8063
Potatoes (peeled)	36	0.0078	0.0080	0.0165	0.9050	0.8864	1.6054	1.2214	1.1894	1.8704	0.0186	0.0143	0.0828	2.8379	2.6314	5.8020
Raspberries	10	0.0094	0.0064	0.0261	0.9745	0.9538	1.4999	2.0924	2.0459	3.4286	0.1088	0.0930	0.2044	3.7840	3.7120	4.9332
Redcurrants	1	0.0123	0.0123	0.0123	0.9111	0.9111	0.9111	1.4799	1.4799	1.4799	0.0552	0.0552	0.0552	3.3329	3.3329	3.3329
Runner beans	26	0.0067	0.0060	0.0162	0.3305	0.2974	0.6021	1.8224	1.7864	3.4905	0.0774	0.0407	0.4448	3.2108	2.9283	5.5275
Spinach	1	0.0137	0.0137	0.0137	1.3921	1.3921	1.3921	11.6533	11.6533	11.6533	0.0358	0.0358	0.0358	5.4313	5.4313	5.4313

**Note** Where values were below the LOD, the LOD was used to compute means and medians which therefore are probable slight overestimates (see text). Shaded cells indicate means or medians thereby calculated as equal to the LOD.

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<i>Produce</i>	<i>No. of samples</i>	<i>Pt</i>			<i>Sn</i>			<i>Ti</i>		
		<i>Mean</i>	<i>Median</i>	<i>Maximum</i>	<i>Mean</i>	<i>Median</i>	<i>Maximum</i>	<i>Mean</i>	<i>Median</i>	<i>Maximum</i>
Blackberries	2	<0.0003	<0.0003	<0.0003	0.0025	0.0025	0.0030	0.0621	0.0621	0.0641
Blackcurrants	3	<0.0003	<0.0003	<0.0003	0.0073	0.0050	0.0157	0.1664	0.1175	0.2786
Broccoli	9	<0.0003	<0.0003	<0.0003	0.0014	0.001	0.0028	0.1237	0.1337	0.1728
Brussels Sprouts	10	<0.0003	<0.0003	<0.0003	0.0016	0.001	0.0071	0.1707	0.1375	0.4395
Cabbage	34	0.0003	0.0003	0.0004	0.0016	0.001	0.0043	0.0919	0.0737	0.2859
Cauliflower	13	0.0003	0.0003	0.0004	0.0014	0.001	0.0033	0.0877	0.0720	0.1992
Curly kale	2	<0.0003	<0.0003	<0.0003	0.0021	0.0021	0.0024	0.2475	0.2475	0.3141
Dwarf beans	6	0.0003	0.0003	0.0004	0.0023	0.0015	0.0064	0.0635	0.0562	0.1121
French beans	3	0.0003	0.0003	0.0004	0.0016	0.0011	0.0026	0.0529	0.0474	0.0864
Gooseberries	19	<0.0003	<0.0003	<0.0003	0.0031	0.0012	0.0200	0.0348	0.0283	0.0895
Grapes	1	<0.0003	<0.0003	<0.0003	0.0020	0.0020	0.0020	0.0501	0.0501	0.0501
Green beans	1	<0.0003	<0.0003	<0.0003	0.0054	0.0054	0.0054	0.0678	0.0678	0.0678
Onions	37	0.0003	0.0003	0.0004	0.0013	0.001	0.0081	0.0584	0.0469	0.2309
Peas	1	0.0004	0.0004	0.0004	0.0017	0.0017	0.0017	0.0437	0.0437	0.0437
Potatoes	36	0.0004	0.0004	0.0004	0.0012	0.001	0.0042	0.0623	0.0330	0.2401
Potatoes (peeled)	36	0.0004	0.0004	0.0004	0.0012	0.001	0.0036	0.0434	0.0330	0.2420
Raspberries	10	<0.0003	<0.0003	<0.0003	0.0033	0.0026	0.0077	0.0985	0.0776	0.1687
Redcurrants	1	<0.0003	<0.0003	<0.0003	0.0023	0.0023	0.0023	0.1200	0.1200	0.1200
Runner beans	26	0.0003	0.0003	0.0004	0.0016	0.001	0.0041	0.0613	0.0394	0.2164
Spinach	1	<0.0003	<0.0003	<0.0003	0.0021	0.0021	0.0021	0.4537	0.4537	0.4537

**Note** Where values were below the LOD, the LOD was used to compute means and medians which therefore are probable slight overestimates (see text). Shaded cells indicate means or medians thereby calculated as equal to the LOD.

	<i>pH</i>	<i>As</i>	<i>Cd</i>	<i>Cr</i>	<i>Cu</i>	<i>Hg</i>	<i>Ni</i>	<i>Pb</i>	<i>Sn</i>	<i>Ti</i>	<i>Zn</i>
Rural	6.90	11.47	0.83	35.63	40.90	0.83	32.99	152.19	12.05	232.00	194.70
Urban	7.04	13.15	1.11	28.88	86.25	1.79	29.10	464.72	13.56	295.09	338.90
ALL	6.97	12.33	0.97	32.19	64.02	1.32	31.01	311.52	12.82	264.56	268.20
Soil LOD (mg/kg)	0.02	0.08	0.2	0.12	0.0008	n/a	0.4	1	n/a	0.4	0.3



<i>Metal</i>	<i>Whole potatoes</i>	<i>peeled potatoes</i>	<i>onions</i>	<i>cauliflower</i>	<i>cabbage</i>	<i>broccoli</i>	<i>Brussels sprouts</i>	<i>legumes</i>	<i>soft fruit</i>
As	-6.068(0.397)	-0.686(0.227)**		-0.989(0.327)**		-0.839(0.365)*	-2.355(0.431)***	-0.770(0.227)***	
Cd	-0.019(0.007)	-0.006(0.001)***		-0.006(0.001)***	-0.005(0.001)***			-0.008(0.001)***	-0.007(0.001)***
Cr	-9.568(0.464)						+1.293(0.586)*		+2.423(0.407)***
Cu	-0.036(0.169)		-0.783(0.074)***	-0.733(0.108)***	-1.059(0.076)***	-0.259(0.119)*	-0.334(0.074)*		-0.409(0.103)***
Hg	-8.957(0.128)						+0.848(0.284)**		+0.525(0.195)**
Mn	+0.114(0.249)			+0.251(0.108)*		+0.604(0.120)***	+0.865(0.144)***	+0.425(0.074)***	
Ni	-5.065(0.712)					+2.271(0.567)***	+1.414(0.650)*	+1.978(0.349)***	+1.354(0.456)**
Pb	-3.907(0.764)	-1.733(0.283)***			-1.579(0.291)***		-4.528(0.574)***		
Sn	-8.358(0.366)							+0.718(0.323)*	+1.858(0.382)***
Ti	-2.348(1.074)		-1.066(0.450)*				+1.505(0.765)*		
Zn	+0.990(0.245)			+0.540(0.084)***		+1.127(0.138)***	+0.531(0.165)***	+0.196(0.085)***	-0.430(0.117)***

\* P < 0.05, \*\* P < 0.01, \*\*\* P < 0.001

