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Memo

TO
Laura Shumow
Executive Director
American Spice Trade Association
1101 17th Street, NW Suite 700
Washington, DC 20036 USA

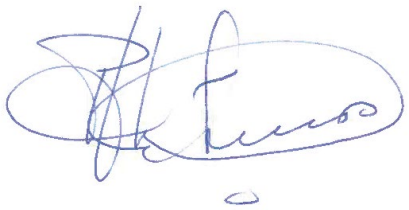
FROM
Dr. Ir. P. Römkens

Dear Laura,

Please find attached the summary of the presentation we presented at the meeting last October.

This summary can be shared freely since it does not contain any confidential information.

With kind regards, also on behalf of René Rietra



Dr. Ir. P. Römkens

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DATE
1 November 2023

SUBJECT
ASTA Meeting Notes

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Lead in soils and crops: sources and management options

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Date: November 1st, 2023

In this short report we summarize the main statements related to the presentation at the ASTA meeting on October 18th in Washington. For question regarding specific issues please contact Dr Paul Römkens (paul.romkens@wur.nl) or Dr René Rietra (rene.rietra@wur.nl)

This report does not contain confidential information and can be shared freely.

1. Lead in soils: reason for concern?

Lead in crops can contribute to the exposure and intake of lead by humans and especially children. Based on current assessments (slide 4), current exposure levels of children are in the same order or higher than recommended intake levels as proposed by EFSA. This means that even at low levels, the total intake of lead via food, water, air, dust, or other sources should be reduced whenever possible.

Food is a relevant source for lead (slide 5), and for children intake via grain and grain-based products as well as fruit and fruit products are relevant sources for lead. For adults, beverages and vegetables are relatively more important even though lead in food is less of a problem for adults.

The sources for lead that lead to the total exposure (slide 6) are complex and depend on a wide range of factors including age, soil lead levels, presence of lead pipes for water, food and feeding habits. A study in Rotterdam revealed that an increase of soil lead with 100 mg/kg increase blood levels of Pb by 12%. At present however, the reduction of lead in fuel and, as a result, city dust and soils, has resulted in a decrease of the average blood Pb levels in children.

Due to the fact that lead uptake by crops is limited, intake of lead in case of children is more controlled by intake of soil (average 72% of the total exposure to lead) than intake of vegetables and fruit (27%).

The necessity to reduce intake of lead has resulted in various sets of standards for food and food products. Recently the EU Regulation on lead was revised (EU 2021/1317) and now includes specific guidelines for various types of herbs as well (in the range from 0.6 to 2.0 mg/kg based on dry dried plant material). Recently the WHO introduced standards that are in line with the ones in EU2021/2017 (0.2 – 3.0 mg/kg; slide 9). The standards set by EU and WHO however are markedly higher than some of the proposed standards in the USA which are set at the lowest level of standard in the EU Directive for baby food (0.01 – 0.02 mg/kg fresh weight).

For herbs, most issues related to quality in 2023 are related to either plant protection chemicals (pesticides) and presence of Salmonella rather than the presence of lead (slide 10).

2. Lead in crops: origin

Despite the specific nature of herbs, levels of herbs in general tend to be in the same order or magnitude as those found in other crops (slide 11). Only various types of root and bark type spices tend to have higher levels of lead (slide 9).

For many crops however it has been documented that the actual uptake via roots is relatively small and levels of lead in (or on) crops are controlled partly by the deposition of dust (in dry conditions) or soil particles (in wet conditions). When grown under the same conditions (soil, crop type), crops grown in areas with high traffic density or presence of dust contained up to 10 times higher concentrations of lead compared to the same crops grown in reference areas (slide 13). This was confirmed by a very clear relationship between lead concentrations in the air and those in crops (slide 14). The role of dust therein seems especially relevant in parts of Africa and Asia during wintertime when dust concentrations are high compared to other areas (slide 14). The clear impact of soil particles on levels of lead was confirmed as well in a study using labelled lead and cadmium. For the above ground biomass, most of the lead in the crops was air-borne lead and only for carrot uptake from soil was the most relevant pathway (slide 15). This in contrast to cadmium which is largely taken up from soils via root action.

A key question then is whether lead deposited on plants can be removed. A small part of the lead deposited on plants can be taken into the interior of the leaf after partial dissolution of the lead particles (slide 16). This part cannot be removed via washing. The small amount of lead that is take up by roots usually is stored in the root itself and transport to above ground biomass is limited (slide 17)

Even though levels in plants are related to soil lead, there is no clear relation between soil lead and levels of lead in crops (slide 18). This is because splash from soil is not a uniform process and depends on variation in weather, soil type and crop type. However, the clear impact of soil as such as a source of plant lead was confirmed both by the amounts of aluminum and lead in crops. Aluminum is not or only in minor quantities taken up by plants and levels of aluminum are largely dependent on the splash of soil particles. The clear relation between lead and aluminum in crops (slide 19) proves that lead is controlled largely by soil as well. This means that soil quality as such can be used as a first indicator of the potential quality of crops. Recently information on soil lead has become more available both at country level (in this case EU level) as well as at regional of city level (slide 20).

Several studies also have provided more insight in the impact of soil quality on levels of lead in crops. It was shown for example that this impact (in this case splash) decreases markedly with the height of the crop (slide 21) with a clear decrease of the impact of splash at 1m above the surface. This implies that low growing crops (such as various herbs and spices) can be categorized as high risk in view of the potential effect of splash.
Research on the effect of distance to the source of lead (in this case road traffic) also revealed that the effect on crop quality was noticeable at a greater distance (up to 66 meter) from the source that the effect on soil itself (up to 20 meter). This is partly because most particles will be deposited closer to the source whereas finer particles that will stick to crops can be distributed further away (slide 22). This was also shown in a comparison of dust from the street itself and that collected from the crops (slide 23); chemically these particles were comparable but the dust on the crops was characterized by a smaller average particle density. Clearly the reduction of lead in fuel has greatly reduced this impact of traffic on lead concentrations in crops and a recent study revealed that the area of impact was reduced to 5 to 10 meters from the source. Some crops were not affected by the emission of traffic at alle (slide 24)

Since lead in food can be relevant even at low concentrations, it is relevant to assess to what extent it can be removed. Recent research on crops grown in polluted soils (New York) showed that a large part of lead can be removed, in winter more so than in summer (which again showed the impact of weather on lead in crops; slide25). The efficiency of washing also sometime decreases at lower levels of lead. This again shows that high concentrations of lead in plants are more related to soil particles and/or dust compared to low levels of lead that are controlled more by uptake.

For crops grown in allotments (polluted soils) between 71-97% of the original concentration of lead was removed after washing (slide 26) and, in this case it was shown also that most of the lead was from soil splash and not from deposition of dust. This contribution (dust vs soil splash vs uptake) can vary

depending on weather conditions, crop type and height as well as presence of sources of lead in the air (rural vs urban or industrial environment).

3. Lead in crops: how to control?

Levels of lead in crops are controlled by three major pathways (slide 27):

1. Uptake from soil by the roots and transfer into above ground biomass
2. Splash from soil affecting plant materials growing on the soil
3. Deposition of dust from the air originating from a range of sources (traffic/industry/general dust)

To control levels of lead it is therefore imperative to evaluate the main source or sources for a specific location. Various sources can be used ranging from soil maps of the area or local investigations to road maps showing traffic intensity or presence of industry.

However, the effectiveness to reduce lead levels in crops depends on the source and pathway. Deposition from the air can be effectively reduced by using covers (greenhouses or plastic cover) but this cannot reduce lead in the soil itself. However, in most cases, a cover will also reduce the direct impact of soil splash if irrigation is performed carefully.
Control of concentrations in soil to reduce the effect of splash is often costly (removal of soil) or not very effective (chemical soil management to reduce availability) since soil splash still can cause soil particles to stick to the plants. In that case the use of a mulch can help to reduce splash but this measure in turn does not reduce dust.
The solution therefor always must be based on a careful assessment of local conditions: what is main cause of the pollution? From this appropriate measures or combination of measures can be taken (slide 28). Recently some examples were included in the updated Code of Practice of WHO (slide 29).

4. Take home messages

- Air quality often main cause for lead pollution (Temmerman et al 2012)
- Knowledge of nearby sources (traffic, industry) relevant
- Washing has effect (Temmerman et al 2012, Aksoy et al 1999; Egendorf et al., 2022)
- Uptake from soil is limited (and crop specific): soil cleanup is costly and possibly not effective (enough)
- Cover crops if possible and if air quality is poor
- Avoid impact of dust or splash (soil) in case of rain by covering (mulch) soil
- Use existing information e.g., soil maps
- In case of soil pollution:
    - Use layer of clean soil to cover soil and avoid splash
- Soil cleanup for lead is difficult/costly/not necessarily effective, so if nothing else, relocate production site
- Better harmonization legal framework essential!
- Agree on risk assessment protocol!