A cumulative risk assessment of pesticide residues from fruits and vegetables on the Swedish market 2014

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Methods
A chronic dietary cumulative risk assessment of pesticide residues in fruits, berries and vegetables for Swedish adults and children was performed using the Hazard Index method (HI). In this approach the calculated intake of each pesticide is divided by its Acceptable Daily Intake (ADI), to derive a hazard quotient (HQ). Thereafter all HQs are summed up to get the HI. If the HI is less than 1, no long-term health concern is expected.

Data on levels of residues were taken from the national monitoring program (1 538 samples, mainly from 2014). Mean concentrations were calculated for each commodity/pesticide combination. Concentrations were assumed to be zero if no sample was tested positive for that specific pesticide/commodity combination. In other cases, negative samples were assumed to contain residues at ≤ LOQ for that specific pesticide/commodity combination. Processing factors were taken into account for 19 pesticide/commodity combinations (e.g. imazalil and thia-bendazol in citrus and bananas). For the exposure assessment, three different scenarios were considered:

Scenario 1. Consumption of fruits and vegetables that were conventionally grown and imported (EU MS and third countries) only

Scenario 2. Consumption of fruits and vegetables that were conventionally grown in Sweden only

Scenario 3. Consumption of fruits and vegetables from organic production only

Consumption data used were from two dietary surveys resulting in an average daily consumption of raw fruits and vegetables of about 212 and 216 g per day for Swedish adults and children (4 years old). A few fruits and vegetables constituted the main part of the consumption, and the ten most consumed corresponded to 74-79 % of the total consumption (Table 1). Additionally, intake estimations were made assuming that the daily consumption of fruits and vegetables were according to the National Food Agency’s recommendations; 500 g for adults and 400 g for children (potatoes and juice excluded). The selection and consumption of different fruits and vegetables were assumed to be in the same proportions as reported in the dietary surveys, but in higher amounts. For the Swedish exposure scenario, crops like bananas and citrus fruits were excluded, and it was assumed that domestically grown fruits and vegetables were consumed in a higher amount to yield the same total fruit consumption. Likewise, in the scenario with organic crops where there was no residue data for a specific crop, the consumption data was adjusted.

Relative contribution of commodities

Results and discussion
The calculated Hazard Index (HI) was below 1 in all scenarios (Fig. 1), indicating that there is no long-term health concern. In the scenario with consumption of organic fruits and vegetables only the HI was almost negligible, ranging from 3.5*10^-4 to 0.0003, and is thus excluded from the figure. With an assumed consumption of fruits and vegetables grown in Sweden only, the HI was also low, at the most 0.075% for children eating 400 g/day according to the recommendations. With the scenario assuming that all the fruits and vegetables eaten are imported, the calculated HI was higher, 0.06 and 0.30, respectively, for adults and children with an average consumption. Assuming consumption according to the recommendation, the HI increased to 0.51 at the most (Fig. 1).

The contribution of different commodities to the HI differed depending on the scenario. In scenario 2 (Swedish conv. crops) apples, pears, cucumbers and strawberries were the main contributors (Fig. 2c and 2d). The reason is that they all have a high consumption rate, and had detectable residue levels in a high ratio of the samples and of several pesticides.

In the scenario with imported crops, apples and pears also contributed significantly, followed by bananas, citrus fruits and tomatoes (Fig. 2a and 2b). In the organic scenario, approved pesticides (spinosad and pyrethrins) were found in peppers and rucola which constituted the whole HI.

Which pesticides that contributed most to the HI also differed between the scenarios (Table 2). In the Swedish scenario, with fewer a.s. approved and detected, four pesticides constituted almost the whole HI. In imported commodities, the contribution to the HI was split between a higher number of pesticides, even if about ten had higher HQ. Dimethoate and fipronil that were detected in only one sample at a level exceeding the MRL, contributed significantly to the HI (0.5-8.6%). These could be considered risk drivers, together with those that are frequently found and have a rather low ADI (e.g. dithiocarbamates and chlorpyrifos+).

Conclusion
This cumulative risk assessment indicates that there is no long-term health concern due to the intake of pesticides residues among Swedish adults and children, even with a high consumption of fruits and vegetables, which are assumed to contribute most to the exposure. However, the intake and hazard index could be reduced if the fruits and vegetables consumed were produced conventionally in Sweden (ca 7 times) or are organically grown (ca 640-8500 times).