THE RISK ASSESSMENT OF CONTAMINANTS OR RESIDUES IN ANIMAL FEED USING TRANSFER FACTORS

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In recent years increasing attention has been paid to the risk posed to animal feed by chemical contamination. Cases concerning the contamination of milk, eggs and other animal products by potentially hazardous chemicals have sparked massive interest. Assessments of the risk to consumers posed by chemical contaminants or residues in animal feed have often been hampered by a lack of knowledge about how contaminants and residues behave when consumed by livestock.

Transfer database

In assessing consumer risk, the transfer of contaminants or chemical residues from animal feed to animal products is predominantly an unknown factor. To gain a better understanding of this transfer we performed a meta-analysis of public literature. The relevant data on the transfer of various groups of chemicals from animal feed to products of animal origin were gathered and recorded in a database. In total, over 200 records were entered into the database, each of which held information on the transfer of contaminants and residues. In our database, the quantitative transfer of a given chemical was recorded as its ‘transfer factor’. This was defined as the ratio of the concentration of a chemical in animal products to the concentration of the chemical in animal feed. In total, more than 2,500 individual transfer factors were entered in the database.

Database-derived transfer factors

Besides the use of chemical specific transfer factors, the database was also used to assess the relative vulnerability of animal matrices to contamination by chemical compounds. In addition, statistical analyses were performed for various classes of chemicals. In the absence of compound-specific information, this provided the basis for a probabilistic assessment of the carry-over of substances.

The overall results of these analyses are given per matrix in the table below. As shown, fat and edible offal appear to have the highest transfer factors, whereas eggs, milk and meat tend to have lower transfer factors. Separate, similar statistical sub-analyses have been performed for various classes of chemicals.

The risk assessment of contaminants in animal feed: case study on nickel

To illustrate the value of the database, we envisaged a case study in which a raw material in animal feed may have been contaminated by nickel. The raw material in question was fat and its inclusion rate in dairy cattle feed was 6%.

As we had no actual information about nickel transfer from feed to edible products, or about the relative susceptibility of animal tissues to nickel retention, a worst-case scenario was used. We assumed complete absorption and retention of nickel by livestock animals and complete transfer to one of the edible commodities. To give the worst-case approach a little nuance, we assumed a steady state after feeding for about one week (> five times the plasma half-life). This would mean that only the cumulative nickel intake for one week would add to the ultimate residue levels in edible commodities.
Using these assumptions, the following presumed worst-case transfer factors were derived for dairy-cattle products: milk: 0.8; meat: 0.6; liver: 20; kidney: 74; fat: 20.

We used these figures as the basis for the risk assessment. In our case the feed’s contamination level was expected to be at most 1.5 mg/kg feed (dry weight).

For a human-health risk assessment, a Tolerable Daily Intake (TDI) for nickel of 0.05 mg nickel per kg body weight per day (or 3 mg/person/day, assuming a body weight of 60 kg) can be used, as proposed by the Dutch National Institute of Public Health and the Environment (RIVM, 2000).

Finally, we used the consumption pattern as assumed in the health-risk assessment for the residues of veterinary medicinal products (i.e. daily consumption of 1.5 kg of milk and milk products, 100 g eggs and egg products, 300 g meat, 50 g fat, 100 g liver and 50 g kidney).

On the basis of these figures and the presumed worst-case assumptions, consumption of the commodities would lead to intakes amounting to the following percentages of the TDI:

milk: 60%; meat: 9%; liver: 100%; kidney: 185%; fat: 50% of the TDI.

These results indicate that in our worst-case approach it is possible that intakes (whether or not incidental) in excess of the TDI may occur. To verify this conclusion, information from the database on the nickel transfer factors was used to refine the risk assessment. This resulted in the following worst-case percentages:

milk: 2%; meat: 89%; liver: 55%; kidney: 28% of the TDI; insufficient data were available for fat.

Unexpected risk areas

Compared to the results of the worst-case approach, the database-derived information indicates that meat rather than edible offal may be the major source of nickel residue intake by consumers. In fact, database-derived information indicates that the consumer intake via meat would be about 10 times higher than that anticipated in the worst-case assessment. By contrast, it appears that the intake via milk would be much lower than that assumed by the worst-case assessment. Even the combined intake of milk and tissue commodities is unlikely to cause an exposure in excess of the TDI.

When the worst-case scenario was compared to the database-derived transfer, we found that the database-derived factors offer a more accurate risk assessment. Where no information on the specific contaminant is available in the database, transfer factors may be calculated using data on compounds within the same chemical class or with comparable physico-chemical properties. A more accurate risk assessment may be possible using, for instance, the overall 90 percentile of the transfer factors for the representative chemical class for each of the animal products. Using the transfer database enables a better understanding of the transfer of feed contaminants and residues to animal products and results in a more realistic risk assessment.

Added value of the database

- The use of database-derived transfer factors enables more realistic risk assessment
- Even if little information is available, scientifically founded transfer factors can be derived using the data for comparable chemicals (in terms of either chemical group or physico-chemical properties)
- In cases where contaminated feed products are found, those products of animal origin most susceptible to contamination can be identified
- Rapid risk management decision-making and/or intervention is possible using the transfer database

Animal Product	**r**						
	Average	**SD**	**Median**	**P90**	**P95**	**Maximum**	**Minimum**
Eggs	0.29	0.61	0.037	0.98	1.6	5.5	0.000030
Milk	0.12	0.22	0.020	0.38	0.56	2.2	0.00000011
Meat	0.20	1.4	0.013	0.26	0.50	31	0.0000025
Offal	1.4	6.0	0.12	3.0	5.0	126	0.000038
Fat	4.7	14	0.16	14	18	180	0.000000

Transfer of chemicals from feed to animal products: data for all chemicals together