RISK ASSESSMENT FOLLOWING THE HYPOTHETICAL IMPORT OF DIOXIN-CONTAMINATED FEED

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In early June 1999, it was made public that one or several Belgium fat-processing companies had traded fats that were contaminated with high levels of dioxin. This subsequently led to one of the biggest food scandals in Europe with Belgian products being taken off the markets for several months in Europe and overseas. As animal feed and feed compounds are traded freely within the European Union (EU), contaminated feed or feed compounds potentially could have reached other member countries.

In order to provide scientific evidence of the risk related to the import of contaminated feed or feed compounds, risk analysis methods can be used. Risk analysis is the method of choice when assessing the necessary level of protection regarding food-related risks in international trade. To use a systematic approach is particularly desirable in an emergency situation where decisions have to be made under time pressure. Such a situation existed after the declaration on June 4 in all EU member states with potential imports from Belgium. Under these circumstances, the objective of the risk assessment was to quantify the potential effect of import of contaminated fat on, for example, pork production and pork consumers. As an example, input figures from Denmark were used in the simulation.

Material and Methods

The assessment regarding the risk posed by dioxin-contaminated feed and feed compounds to a pig population and the related pork consumers was based on three elements: 1) Tracing back of imported fat and feed, 2) exposure assessment, and 3) consequence assessment.

Ad 1) All feed mills and registered feed importers were asked by the Danish Plant Directorate to provide information on type and amount of feed and feed compounds, specifically fat, received from international contractors and sub-contractors between January and June 1999.

Ad 2) The first step in developing the risk model was to draft a graphical model representing the flow of contaminated material from the plant(s) of origin to an importing country. The model was developed by an interdisciplinary team with expertise in feed trade, pig feeding, toxicology, epidemiology and risk assessment. This graphical model was used as the basis for a quantitative assessment. Quantitative input was obtained from the literature and from individual experts. The structure of the risk model was translated into a spreadsheet using @RISK (Version 3.5.2, Palisade Corp., Newfield, NY). The

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output of the model consisted of the number of exposed pig farms, the number of exposed pigs and consumers, concentration of dioxin in exposed pork and the consequences for the consumers in terms of dioxin toxicity. The primary input of the exposure model was the amount of contaminated material that could have been imported and the dioxin concentration in this material. The trace back conducted for Denmark did not reveal any evidence for imports originating from Belgium neither via direct nor indirect transport routes. With an input of contaminated material of zero, the output of the risk simulation model will obviously also be zero. In order to be able to illustrate the model, a hypothetical scenario was developed: One truck (20-25 t) of contaminated material was assumed to have been imported. As the most likely situation, it was assumed that a portion of highly contaminated material from Belgium would have been blended with non-contaminated material by an intermediate trader thus resulting in a 10-100-fold dilution in the concentration of dioxin. The initial concentration of dioxin in fat from Belgium was derived from a figure provided by the EU[1] reporting an initial concentrations in chicken feed of 781 International Toxicity Equivalents (I-TEQ) ng/kg. From these inputs and using information on fat concentration in pig feed and amount of feed fed per week, the exposure per week was calculated. Subsequently, the number of exposed pigs could be estimated as well as the concentration of dioxin in pork by adding the background dioxin level which was taken from the literature[2]. The daily intake of pork was Denmark-specific and the fat content of pork products was a rough estimate based on the relative frequency of consumption of certain products and their fat content The simulation was run 5000 times and summary statistics of these runs were calculated. Sensitivity analysis was conducted to identify influential input variables.

Ad 3) The consequence for human health was assessed qualitatively based on data from the literature on acute and chronic toxicity of dioxin.

Results

Note that the trace back of imported feed did not provide any evidence of contaminated feed having reached Denmark. The following results are therefore based on a hypothetical scenario to illustrate the performance of the model.

Under the hypothetical import scenario, in 95% of the simulation iterations, an amount of feed for slaughter pigs of <550 t with a dioxin concentration of <30 I-TEQ ng/kg was obtained. This would have been distributed among approx. 200 farms and up to 20,000 pigs would have been exposed for between 1 and 4 weeks. The weighted average contamination in exposed pigs was 10-30 I-TEQ ng/kg fat. The probability of consuming pork from an exposed pig given the hypothetical import scenario was low ($p \approx 0.002$). Because the exposed pigs were only a small proportion of all pigs produced, the average concentration of dioxin in pork was not visibly different from background levels. Similarly, the average daily intake of dioxin from pork among all consumers was not significantly increased as compared to the background exposure. When assuming standard servings of 100 g each, the contaminated pork would most likely have resulted in approx. 6 Mio. contaminated servings (most likely value). The exposure from one contaminated standard serving was most likely around 60 I-TEQ pg but could in 5% of the simulation runs be >600 I-TEQ pg.

Sensitivity analysis was used to identify most influential variables for selected outcomes. The dioxin concentration in fat of exposed pigs was mostly determined by the dilution factor, a factor that was based on assumptions in this hypothetical scenario. The background concentration – a rather uncertain variable derived from one publication with small sample size – was influential both for background levels as well as for the situation with additional exposure from contaminated feed. An even stronger influence was related to the fat content of pork products, another very rough estimate. The weight of a carcass and the amount of contaminated imported fat were influential on the number of contaminated standard servings.

If considering the risk for a person consuming a standard serving of pork from an exposed pig, in approximately 70% of runs, the exposure was <200 pg, but higher values were also possible. These exposures were calculated per 100 g wet weight of pork. During cooking fat is accumulated in the frying pan and is often not consumed. In fatty products, this can be up to 70% of the original fat content[3]. The estimated daily dietary intake of dioxin in Denmark was reported to be 2.44 I-TEQ pg/kg body weight (bw)[4]. Using these background figures, the exposure from one serving of contaminated pork is probably within the daily variability of exposure for an adult, but could be high for a child. The U.S. Department of Health and Human Services[5] states an acute oral minimal risk level of 0.2 ng/kg bw/day for immunosuppressant effects. Thus, the exposure from one contaminated standard serving in this simulation was likely to be below the acute toxic value for adults and children. However, if contaminated meals were consumed repeatedly over a short time period, the concentration could accumulate to a critical level. Also, each additional exposure contributes to the body burden and therefore increases the risk of chronic adverse effects such as effects on reproduction, immunity, and cancer risk.

Discussion

In this paper, a risk model is presented as developed during a relatively short time period (14 days). Some rough assumptions had to be made under time pressure. The goal was to reduce the complexity to a workable level of detail and yet to obtain realistic and valid estimates. This example of a risk simulation model is presented to demonstrate that it is possible to obtain quantitative information within a short time period. Risk assessment offers a framework to organize these data to provide quantitative and transparent decision support based on the best available information.

This model was validated very roughly by comparing intermediate outputs (e.g. estimated dioxin concentration in pig feed) with data from Belgium. This provided an indication that the model was providing reasonable results (data nor shown). However, in order to improve the simulation model, it would be useful to obtain better estimates of the relative frequency of fat content in pork and pork products as well as figures on background dioxin concentration in pork.

References

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