Adding Realism to Occupational Exposure Assessment of Pesticides using Probabilistic Modelling. A case study on Aggregate Exposure to Pyrethroids.

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Abstract (under 300 words)

Pyrethroid usage has risen due to restrictions on other insecticides, prompting interest in biomonitoring data as exposure indicators. Occupational exposure, particularly in Plant Protection Product (PPP) applications, is a focus. Regulatory agencies, like the European Food Safety Authority (EFSA), use tools such as OPEX to assess non-dietary exposure, employing worst-case scenarios for increased protection.

This research explores OPEX's suitability for realistic exposure estimations via probabilistic modeling and Monte Carlo simulations. This study uses data from is part of the EU PARC project estimating aggregated pyrethroid exposure. This study uses workflows for operators and workers, integrating tasks and applying Monte Carlo simulations for exposure estimation variability. Probability distributions replace default values, addressing real-world uncertainties.

The intention is to present a conceptual model for three occupational exposure scenarios, highlighting variability in task roles and exposure routes. Monte Carlo simulations offer full probability distributions, aiding sensitivity and uncertainty analyses. The study plans to compare aggregated exposure, including dietary exposure, with some preliminary results. The ongoing project aims to refine default values via a probabilistic assessment strategy.

To conclude, there is a need for aggregate exposure models considering shared neurotoxicity among pyrethroids. The proposed approach, based on the regulatory OPEX tool, facilitates comparisons between regulatory and aggregate assessments. Pyrethroids are chosen due to their proximity to concerning dietary exposure levels. The study's innovative approach aims to refine occupational exposure assessments, identify aggregate exposure risks, and enhance pesticide risk evaluation in occupational settings, contributing valuable insights for future studies.

Abstract (under 300 words each section)

1. Introduction

Pyrethroids, a broadly used class of insecticides, have been the subject of emerging interest; their use has been increased due to restrictions for other insecticides. Human biomonitoring data on their metabolites as biomarkers of exposure integrating all routes and sources, indicate exposure levels close to the respective thresholds for potential effects on human health [1]. The occupational exposure to pesticide active substances used in Plant Protection Products (PPPs) concern operators, those applying the PPP, and agricultural workers, who enter into the crop after the PPP application. Regulatory agencies, such as the European Food Safety Authority (EFSA) in the EU, have developed exposure models for conducting regulatory assessments. In particular, EFSA has developed and recently updated the guidance [2] and the accompanying tool OPEX

(https://r4eu.efsa.europa.eu/app/opex); a systematic framework specifically designed for assessing non-dietary exposure to pesticides. As expected for a tool for regulatory assessment, the scenarios and default values tailored for the assumptions and parameters represent a combination of mainly worst-case situations, to ensure a high level of protection.

The present study explores the suitability of the OPEX tool for conducting non-regulatory realistic aggregate exposure estimations for pyrethroids, through the incorporation of probabilistic modelling using Monte Carlo simulations. This statistical technique addresses the real variability by transforming the values used as parameters/assumptions into distributions, acknowledging the inherent variability and the uncertainty of real-world occupational assessments.

This research uses as background information/data generated within projects funded by EFSA and is part of a case study under the EU funded PARC project to estimate the aggregated exposure to pyrethroids using a combination of prospective and retrospective approaches.

2. Materials and Methods

The first step for the EFSA OPEX tool application, is the identification and prioritization of the different tasks described in the EFSA OPEX tool that are relevant for approved uses of pyrethroids in PPPs. Two workflows, one for operators and one for workers, have been considered. The workflows integrate the different tasks that the same person may conduct as part of their daily work. As a next step, both workflows will be integrated in a third one representing those cases with the same person playing both roles. Each workflow includes realistic scenarios indicating the time and frequency of each task, while the inhalation and/or dermal exposure associated to each task is estimated using the algorithms proposed in the EFSA guidance, but instead of using the proposed default values, the parameters and assumptions are replaced by probability distributions integrated in Monte Carlo simulations to cover the variability in the expected individual exposure.

The selection of the probability distribution is based on the reassessment of the information collected in the frame of EFSA PPR Procurement Projects [3, 4], supported by expert knowledge elicitation. The development is iterative, and a module for sensitivity analysis associated to the Crystal Ball® Monte Carlo tool supports the analysis of the results of each iteration indicating the priorities for refining and recalibration.

In order to further estimate the aggregate exposure of adults, being exposed to PPPs as operators and/or agricultural workers but also as consumers, the dietary exposure to pyrethroids will also be considered; Prospective estimations based on the EU monitoring programme on pesticide residues in food published by EFSA will be conducted. The aggregate exposure estimated will be compared with retrospective exposure estimations based on relevant human biomonitoring data from HBM4EU.

3. Results and Discussion

The conceptual model describes three occupational exposure scenarios, one for each workflow, PPP operators, agricultural workers, and combined operator-worker tasks, addressing variability in the role of each task (duration and frequency) and the variability in the potential for dermal and inhalation exposure. The results focus on the use of pyrethroids in PPPs, but the conceptual model can be extended to other pesticides, in particular insecticides and spray applications.

The implementation of the conceptual model using Monte Carlo simulations provides full probability distributions and the opportunity for conducting sensitivity analysis for identifying the main contributors to the overall variability, as well as to support the uncertainty analysis. As professionals are also exposed through the diet, both exposure routes will be aggregated, and the

overall risk from the aggregated and combined exposure to pyrethroids authorized in the EU as PPP will be estimated.

This is an ongoing activity, and for the upcoming conference, our focus is to present the conceptual model for assessing the non-dietary exposure, and the proposals for refining the currently considered default values via a probabilistic assessment strategy. The preliminary results, including a discussion of the respective dietary exposure will be presents as well.

The comments and discussions following the presentation of the conceptual model and preliminary results at the conference, as well as the proposed next steps, will be considered for the further development of the proposed approach.

4. Conclusions

Our study focusses on the area of aggregated exposure to pyrethroid PPPs and the associated concerns for human health. The EFSA OPEX tool, used for the non-dietary exposure assessment, conducted for regulatory purposes independently for each pyrethroid and for each intended PPP use, is a conservative by design approach. Considering that different pyrethroids share common neurotoxicity mode of action, and that operators and workers may be involved in agricultural tasks for different crops and be exposed to several pyrethroids, models providing aggregate exposure from different occupational workflows are required. The workflows are associated to the specific use patterns of PPP, named Good Agricultural Practices, defined during the authorization process. Our proposal, using as basis the regulatory EFSA OPEX tool, would facilitate comparison of regulatory and aggregate assessments. Pyrethroids have been selected for the case study as the dietary exposure of EU adults is close to the levels of concern, and therefore it is urgent to conduct aggregate exposure estimations to identify potential risks related to the aggregated exposure from different routes and sources.

To conclude, the results of the present approach will serve as a case study for future studies aiming not only to refine the occupational exposure assessments to pesticides when the realistic conditions of use/exposure are known, but also to identify cases of concern when aggregate exposure is considered and strengthen the foundations of risk evaluation in pesticide exposed occupational settings. The proposed innovative approach will contribute by improving the information provided by exposure estimates better and in better understanding the potential variability and uncertainties associated with the assessed parameters.

5. References

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