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SPRINT
SUSTAINABLE PLANT PROTECTION TRANSITION

This is a Public Preview of the deliverable. Because of publishing interest the full deliverable is still under embargo.

D2.3 - part 3 preview

Inventory of PPP distribution and accumulation in EPAH, including gender-mediated differences

D2.3 Manuscript draft title: Comparison of pesticide concentrations in human, animal, and environmental samples from 10 EU countries

Authors: Anne VESTED; Lingtong GAI, Vivi SCHLÜNSSEN, Abdallah ALAOUI, Florian CHRIST & colleagues

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SPRINT
SUSTAINABLE PLANT PROTECTION TRANSITION

PROJECT INFORMATION	
Project Title	Sustainable Plant Protection Transition; A global health approach
Project Acronym	SPRINT
Call Identifier	H2020-SFS-2019-2; Sustainable Food Security
Grant Agreement no.	862568
Starting Date	01-09-2020
End Date	31-08-2025
Project duration	60 months
Website address	www.sprint-h2020.eu
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REPORT INFORMATION	
Report Title	**D2.3 - part 3 preview** Inventory of PPP distribution and accumulation in EPAH, including gender-mediated differences **D2.3 Manuscript draft title**: Comparison of pesticide concentrations in human, animal, and environmental samples from 10 EU countries
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Deliverable Number	D2.3
Work Package	2
WP Leader	Vivi Schlünssen/ Abdallah Alaoui
Report Due Date	?
Report publish date	?

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Overview and highlights of the Deliverable Report D2.3

Introduction

Intensive and widespread use of pesticides raises serious environmental and human health concerns but currently data on the distribution of pesticides across Europe for humans, farm animals, and the surrounding environment are ccarce and fragmented.

With the current report we aim to provide an overview of the occurrence of pesticides and metabolites in 16 different matrices including biological samples from humans (4 matrices), farm animals (5 matrices), and environmental samples (7 matrices).

Materials and methods:

In this study 209 pesticides (active substances and transformation products) were analysed during the growing season of 2021 for 10 study sites located in Spain (ES), Portugal (PT), France (FR), Switzerland (CH), Italy (IT), Croatia (HR), Slovenia (SL), Czech Republic (CZ), The Netherlands (NL), and Denmark (DK) in samples from conventional and organic farmers, their neighbours and nearby consumers, farm animals and ecosystem.

For each CSS, 6 conventional farms and 6 organic farms were included. The goal was to include sampling from the ecosystem and farm animals on the farms and to include 24 farm residents, 24 farm neighbours and 24 consumers per study site. This was however not completely achieved for all CSS. In total 669 SPRINT participants were included; 53 females and 63 males living on organic farms, 48 females and 61 males living on conventional farms, 107 female and 101 males defined as neighbors, and 129 female and 107 males living in the areas of the farms (consumers). We analysed plasma, urine, faeces, and silicone wristband (that absorbs pesticides from the surroundings) samples from the participants (between 639 and 664 samples) and from the farm animals (cow, goat, pig, sheep, chicken, and cat) we analysed plasma, urine, faeces, silicone wristbands, and feed (66-198 samples). Environmental samples representing the fields and surroundings of the included farms included soil, earthworm, crop, water, sediment, outdoor air, and indoor dust from farmhouses (between 20 and 201 samples). All samples were taken according to an extensive sampling protocol to ensure equal sampling across the 10 study sites (Silva et al, 2021).

Pesticide concentrations of the 209 prioritized pesticides were measured by quantitative multi-methods based on LC-MS/MS and GC–MS/MS. Separate dedicated methods were used for glyphosate and AMPA determination. The limit of detection (LOD) was used as the analytical limit as well as the data analyses reporting limit. All detects above LOD were further quantified. In urine samples we measured known urinary pesticide biomarkers, for which analytical reference standards were available.
All matrices were sorted according to detection frequency of the 209 analysed pesticides, the ten most frequent pesticides per matrix were identified, and added to a compiled list of in total 70 pesticides present in a least one matrix. Six of these were specific for urine. Approval status of each of the pesticides was retrieved from the EU pesticide database (EU Pesticides database).
Median pesticide concentrations of each matrix were divided into nine log10 concentration groups (-4, -3, -2, -1, 0, 1, 2, 3, and 4) with individual colour indications (blue towards yellow) and displayed as heatmaps per matrix, sex, and participant type for humans (conventional farmers, organic farmers, neighbours, and consumers). The three lowest concentrations groups are referred to as low, the middle three as medium, and the three highest concentration groups as high. Farm animal data is presented by matrix, type of farm animal and farm type. Environmental data is presented by matrix and farm type. All frequency tables and figures were made using R Software.

Results:

Humans:

Generally, insecticides were more widely represented, and herbicides less widely represented among the top ten most frequently detected substances in human plasma, faeces, urine, and wristbands. There were no clear differences between samples from organic and conventional farmers, neighbors, and consumers, except for wristbands where it seemed four of the most frequently detected compounds were found at higher median concentrations and at higher detection frequencies in wristbands worn by conventional farmers.

No overall apparent differences between male and female median concentrations of the top ten most frequently detected compounds were seen for any of the human matrices.

The majority of compounds found among the top ten most frequently detected in human samples were of approved compound origin. However, four compounds in plasma and wristbands were of not approved origin, three in human faeces and one derivative of a non-approved compound was found among the top ten most frequently detected compounds in human urines.

Farm animals:

Generally, insecticides were more widely represented, and fungicides were less widely represented among the top ten most frequently detected substances in animal feed, urine, faeces, plasma, and wristband samples.

The majority of compounds found among the top ten most frequently detected in animal samples, were compounds with approved status. However, four were not approved in wristband and plasma, three in animal faeces, and one in urine. None of the ten most frequently detected compounds in wristbands were of non-approved origin.

Overall, slightly more compounds were detected in the samples from conventional farm animals and at higher detection frequencies compared to organic farm animal samples.

Environmental samples:

Insecticides were most widely represented among the top ten most frequently detected substances in the environmental samples except for crop and indoor dust where fungicides were more frequently detected, and outdoor air where the majority of the top ten most frequently detected compounds were herbicides. The environmental matrix with most detected compounds (60 out of 64 measured compounds) was indoor dust. Across the environmental matrices where we were able to distinguish levels and/or frequencies between organic and conventional farming system (soil, crop, earthworm, outdoor air, and indoor dust), there were tendencies towards higher levels and/or frequencies of pesticides in samples from conventional compared to the organic fields for soil, crop and earthworm samples.
The highest number compounds or derivatives of not approved compounds among the ten most frequently detected in the environmental matrices were found for water (seven out of ten) and soil samples (six out of ten), five of the ten most frequently detected compounds in indoor dust were not approved, three in sediment and earthworm, one in crop and none in outdoor air.

Results across all three compartments

For the majority of the investigated matrices, insecticides were most abundantly represented among the top ten most frequently detected compounds and although most of the top tens across the investigated matrices were approved for use in the EU, still all matrices but two (outdoor air and farm animal wristbands) had occurrences of non-approved compounds or derivatives thereof among the top ten most frequently detected compounds. Among these are compounds that are persistent in the environment and also representatives that are used as biocides rather than pesticides.

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Overall, glyphosate and main degradation product AMPA and p,p´-DDE were the most frequently detected compounds among the 16 investigated matrices. Both were detected in 9 of 16 matrices among the top ten most frequently detected compounds: two in human, three in farm animal, and four in environmental matrices.

Pesticide concentrations and frequency across the 70 investigated compounds were in general comparable to or a little higher among conventional compared to organic farming systems, but differences were not substantial, and the opposite was also found in several cases.

Conclusions:

Non-approved and to a high extent persistent compounds that have not been used for many years still represent a significant part of pesticides present in both humans, farm animal, and the environment. Insecticides were most abundantly represented among the top ten most frequently detected compounds across all investigated matrices. Pesticide frequency and levels were in general a little higher among conventional compared to organic farming systems, but the difference was not substantial. Among humans, we did not observe a gender difference for concentrations or frequencies of pesticides.
Glyphosate and p,p'-DDE were the most frequently detected compounds among the 16 investigated (both found in 9 out of 16 matrices).

Pesticides are widespread among humans, livestock, and the environment across Europe. Non-approved compounds and persistent compounds still represent a significant part of the environmental cocktails and should be accounted for in future monitoring programs and risk assessment.

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