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Assessment of health risks from pesticide residues on cut flowers

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Plant protection products are used to protect ornamental plants, such as cut flowers, against pests. Hence, the question arises whether residues of active substances on cut flowers could have an impact on the health of florists or consumers. The Federal Institute for Risk Assessment (BfR) has evaluated published scientific literature and available data from other institutions in order to assess the potential health risks resulting from residues of plant protection products on cut flowers, which were produced within and outside the EU.

Based on the available data, the BfR concluded that cut flowers, such as those traded in Germany, are not expected to pose a risk to the health of customer. The same applies to florists, who handle cut flowers, as long as recommended occupational health and hygiene standards are complied with.

1 Subject of the assessment

The Federal Institute for Risk Assessment (BfR) has evaluated new studies about residues on cut flowers.

2 Results

The issue of residues from plant protection products on cut flowers is regularly the subject of public discussions. Of course, the detection of pesticide residues on ornamental plants and cut flowers gives rise to the question of potential health risks for customers and florists that may be associated with the exposure towards these residues. Since the use of plant protection products is part of the common horticultural practice, the detection of residues on cut flowers is not unexpected. Many plant protection products are authorised for this use in Germany, other EU countries and flower-exporting countries outside the EU.

Within the European Union, there are no legal obligations specifically addressing residues levels of plant protection products on cut flowers when placed on the market. Accordingly, no maximum residue levels have been defined. However, Regulation (EC) No 1107/2009 mandates that the potential exposure to the plant protection product must be assessed as part of the approval and authorisation procedures. In this context, exposure means the amount of an active substance to which a person is exposed to when the product is applied. The assessment is not limited to persons handling plant protection products. Thus, the exposure of workers in downstream processes and uninvolved persons residing in areas adjacent to treated areas for crop production is also evaluated.

The harmonised EU Guideline of EFSA (1) provides an overview of the basic principles for assessing exposure. As described in the guideline, the exposure assessment considers the relevant characteristics of crop groups, such as the duration and expected intensity of contact with the treated plants. This allows for the estimation of the extent to which the residues (present on the plant) can be transferred from the treated plants to the skin of a person handling these treated plants.

The amount of an active substance taken up across the skin is compared with a reference value, which was derived from experimental data – the A(O)EL (Acceptable (Operator) Exposure Level). The plant protection product is only authorised for use if the predicted exposure does not exceed the reference value. For applications of plant protection products on ornamental plants, the risk assessment also considers workers who are working with treated plants or in treated plant cultivation areas for eight hours a day. Likewise exposure by inhalation is taken into account for plant protection products that are intended for greenhouse use. Scenarios such as this can be assumed as a 'worst case' for florist staff, and thus the risk assessment also covers this group, as well as consumers, whose exposure is typically much lower.

Based on the current state of knowledge and considering recent publications, the BfR concludes that, there is no health risk for florists due to residues of plant protection products on ornamental plants. This also applies to the active substances mentioned in the latest publications, whose use in plant protection products is not approved in the EU (or whose approval has been withdrawn).

Nevertheless, the BfR considers it good occupational hygiene practice for florists to wear suitable protective gloves and comply with common hygiene rules[1] during activities with frequent plant contact, in particular those that could cause skin injuries.

3 Rationale

The statements made in BfR Opinion No. 008/2011, dated 30 June 2011, on the studies published by Barrot (2), Hagmann et al. (3), Schüürmann et al. (4), and Krüger and Krüger (5), are still valid. In addition, new publications that are subject to public debates will be discussed below.

Study data published by Tuomi et al. (6) have shown that residues of 107 separate active substances (primarily insecticides and fungicides) were present in quantifiable amounts in samples of ornamental plants. For some of these substances the measured residue levels exceeded the permitted residue concentrations for food (maximum residue levels, MRLs; according to Regulation (EC) No. 396/2005, the standard value is 0.01 mg/kg if no specific value has been specified for a substance). In the authors' opinion, this resulted from the practice of applying products directly before or even shortly after harvesting.

The BfR does not fully support this conclusion, since, apart from the timing of the application, the application conditions (e.g., application rate) as well as the physical and chemical properties of the active ingredients have an impact on residue quantities. Furthermore, no acceptable residue levels are defined for ornamentals. Thus, in absence of appropriate reference values for residues in ornamental plants, it is not possible to draw conclusions on health risks. However, as already mentioned above, exposure for downstream workers (assumed to work eight hours a day) is assessed as part of the EU approval procedure for the use of any plant protection product: the predicted exposure of workers is compared with the reference value (AOEL).

[1] Link to document: BGHW skin protection fact sheet for professional florists

It should also be noted here that the study did not specifically detect residues on plants but in plants or parts of plants. The plant material was homogenised before extraction. Accordingly, the values for residues as given are not suitable for use in a risk assessment for work involving skin contact with treated plants. Only the residues on the leaf surface of the ornamental plants can be transferred to the skin of workers handling treated plants. This means that only a portion of the measured residues can be transferred to the skin and hence is available for uptake. The study provides no details about the proportion of residues that could be 'wiped off' in comparison to total residue quantities. However, it is this 'wipe-off' proportion that is important for conducting a risk assessment for the non-dietary exposure for workers who are handling cut flowers (such as florists). Thus, the occupational risk assessment addresses exposure due to handling pesticide-treated plants instead of the rather atypical scenario of consumption.

The main conclusions to be drawn from this study are as follows:

- The ornamental plants investigated contain measurable (quantifiable) residues of several active substances of plant protection products. Some of these do not have (or no longer have) EU approval for use in plant protection products.
- The origin of the plants investigated cannot always be clearly established. This is particularly the case for cut flowers sourced from intermediaries.
- Due to the selected analytical approach, the residues reported are not suitable for use in a health-based risk assessment for non-dietary exposure. Nevertheless, it can be concluded that the reported residue levels do not represent unacceptable health risks.

It should also be noted that a lower number of active substances as well as significantly lower levels of residues were detected in gerberas and chrysanthemums produced exclusively within the EU as opposed to roses, which were produced both inside and outside the EU. Apart from potential differences relating to specific cultivation practices, this could also indicate differences in the use of plant protection products in different exporting countries.

A further study from Toumi et al. (7) investigated the potential skin exposure of florists. For this purpose, 20 volunteers wore cotton gloves, while working for approximately two to three hours. After work was finished, residues from active substances in plant protection products were extracted from parts of the gloves and subsequently quantified. A total number of 111 active substances were detected, most of them were fungicides or insecticides. The number of active substances per volunteer varied from 12 to 68 (median 40). Of the substances detected, 15 were present in at least 15 of the 20 samples.

As it can already be expected due to the different number of active substances found, the observations reveal differences to the preceding study, which focused on residues found in plant material (Toumi et al. (6)). It is noticeable that there is no clear correlation between the exposition determined in this study (frequencies and maximum residue levels found in the glove samples) and the residue values as determined in the preceding study from Toumi et al. (6). Accordingly, among the 15 active substances detected most frequently in gloves, there are 4 compounds that were not detected in the plant samples or were detected in less than 15% of these samples (total count = 90). Conversely, among the 3 active substances

detected most frequently in roses, only 1 was among the 15 active substances detected most frequently in gloves.

The authors do not discuss potential reasons for these discrepancies. One possible explanation, in addition to the insufficient size and representativeness of the set of samples (number of samples and/or volunteers), could be the duration of the investigation, as seasonal variations in the necessary phytosanitary measures exist. Both studies by Tuomi et al. (6 and 7) suggest that the number and quantity of active substances depend on the plant species investigated. In chrysanthemums and gerberas, both the number of substances and their quantities were significantly lower than in roses.

Taking into account the maximum measured values, Toumi et al. (7) presume that the systemic reference value of four active substances will be exceeded. Two of these active substances belonged to the group of substances most frequently detected in this study. However, all four substances were detected only in fewer than 15% of samples in the preceding study by Tuomi et al. (6) and were also not among the active substances with the highest residue values in this study. This indicates that the results from the two studies do not correlate.

One aspect viewed as critical in the study by Tuomi et al. (7) was exposure to active substances whose use in plant protection products is not approved in the EU (or whose approval has been withdrawn). In this context, it should be noted that the two non-approved substances most frequently detected in the study by Tuomi et al. (7) are indeed not approved in the EU as active substances for plant protection products but are approved as additives (insecticide adjuvants) in plant protection products or as active substances in biocides within the EU.

The latter is a substance used in products offering protection against insects (repellents, e.g. for protection against mosquitos). As a result of this approved use for protection against insects, the exposure may be attributable to the use of repellents by the study participants themselves. Taking into account the health reference values in force in the EU, a health risk resulting from exposure to the substances detected by Tuomi et al. (7) is not to be expected if the hygiene measures recommended by the authors are complied with.

When discussing the relevance of the reported results, it should be emphasised that the authors probably overestimate the systemic exposure, i.e. the quantity of active substance that is absorbed via the skin. In fact, the used uptake rate is a worst-case assumption from the corresponding EU Guideline on dermal absorption from EFSA (9). For many active substances in plant protection products, the BfR possesses data, which demonstrate that uptake rates are appreciably lower than the worst-case values given in the EU Guideline. For risk assessments, worst-case values are used if experimental data are not available. In the BfR's opinion, it is therefore doubtful that the authors' assumptions would remain valid if additional data are taken into account.

Summed up, the validity of the results obtained by Tuomi et al. (7) is limited due to the shortcomings discussed above. However, the BfR does concur with the conclusions drawn by the authors in terms of handling plants with protective gloves and the importance of hygiene measures.

In a third study, Tuomi et al. (8) analysed urine samples of florists. Samples were collected over a period of 24 hours on three different dates at which an especially high workload was to be expected (i.e., Valentine's Day, Mother's Day, All Saints' Day). In the florists' group, 70 relevant substances (56 active substances and 14 metabolites) were detected in quantifiable concentrations, compared with 41 in the control group. For both groups residues had been detected in almost all samples, but the number and concentrations differed significantly.

Residues of active substances that did not have (or no longer had) EU authorisation for use in plant protection products at the point in time of the study were found in urine samples from both groups. The median value for the number of active substances detected was eight for the florist group and four for the control group. However, it is not clear whether the active substance and corresponding metabolites were counted separately or together.

The data provided possibly indicate a higher exposure to pesticide residues for florists, as is expected in this profession. In addition, the most frequently detected active substances were different in both groups. The authors attribute this fact to the different predominant routes of exposure for both groups (dietary uptake or non-dietary exposure). Unfortunately, the authors present only fragmentary data on the active substances and metabolites identified in the control group.

The absence of a comparative presentation of the data for both groups makes an objective assessment difficult. Thus, the conclusions drawn by the authors are not entirely comprehensible. A comparative analysis of the results from the test and control group is not possible (e.g. a determination of a baseline exposure level derived from the data from the control group, which would allow to draw conclusions whether and to which extent residue levels in urine samples of florists increased).

In the florist group, a total of 14 out of 70 active substances or their metabolites were detected in at least one sample of each sampling date. However, these are usually individual detection events, i.e. these active substances were only detected in a small proportion of test subjects. This indicates that generalised conclusions on exposure must be drawn cautiously, as it appears that factors, which are not apparent from the available data, have an impact on exposure.

This is further substantiated by the fact that only two active substances were detected in more than half of the samples, while the vast majority of the substances were detected in only a few samples (63 substances found 10 or less samples [out of 42]; 49 substances found in 5 or less samples [out of 42]). Moreover, several substances were only found in samples taken on one out of three sampling dates. While the authors do not further discuss this observation, it can nonetheless be taken as a further evidence for seasonal variations in terms of requirements for phytosanitary measures. Or it may simply result from different customer preferences in terms of the species of cut flowers that are purchased on different occasions.

One essential shortcoming of the three studies conducted by Tuomi et al. is that the data on residues in plant material, on the occupational exposure of individuals and on biomonitoring (urine) were collected independently at different time points. Seasonal variations in plant protection practice or the sale of individual types of cut flowers can be expected to result in

changing exposure of florists. Only 7 of the 13 active substances that were found in at least 80% of the glove samples in the study by Tuomi et al. (7) were detected in the subsequent biomonitoring (urine) study. On the contrary, the substance, which was detected most frequently in the biomonitoring (urine) study, was hardly found in samples from both preceding experiments.

In addition to seasonal differences, systemic exposure might be influenced by physiological and biochemical properties of active substances (e.g., rates of uptake, degradation and excretion) as well as the varying exposure to residues in foodstuff. Considering that all studies were conducted independently and essential data from the control group is not presented in the publication, the authors' general conclusion that residues in urine samples of florists are solely a consequence of occupational exposure is not fully comprehensible. Nevertheless, the conclusion could be probably valid for a subset of substances, which were only found in the samples from the florists' group. Consequently, the BfR concurs with the conclusion that the differences observed between the control group and the florists' group could be a result of occupational exposure.

Finally, the limitations of the study are acknowledged by the authors: in their concluding remarks it is repeatedly noted that the study results suggest that efforts to increase public awareness for potential health risks are required in order to improve working habits, in particular the use of protective garment and compliance to hygiene measures.

In this context, it should be noted that the competent German occupational insurance associations clearly emphasise the importance of hygiene measures and the use of protective garment for skin protection (e.g. gloves). As a general rule, the conditions defined during the risk assessment for plant protection product as part of the authorization procedure must be met in order to ensure the safe handling of treated plants. The exposure study by Tuomi et al. (7) leads to a similar conclusion; simple precautionary measures such as wearing protective gloves are sufficient to reduce exposure to pesticide residues and help to prevent health risks. This underlines the appropriateness of the occupational safety measures recommended by the professional associations. Accordingly, the BfR endorses these recommendations.

A recent review of the communications received by the BfR as the central register for poisoning cases and adverse health events shows that in recent years no incidents involving florists handling contaminated cut flowers have been documented by medical practitioners in Germany.

About the BfR

The German Federal Institute for Risk Assessment (BfR) is a scientifically independent institution within the portfolio of the Federal Ministry of Food and Agriculture (BMEL) in Germany. The BfR advises the Federal Government and the States ('Laender') on questions of food, chemical and product safety. The BfR conducts its own research on topics that are closely linked to its assessment tasks.