

EDITORIAL

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Some food for thought: a short comment on Charles Benbrook's paper "How did the US EPA and IARC reach diametrically opposed conclusions on the genotoxicity of glyphosate-based herbicides?" and its implications

Henner Hollert^{1*} and Thomas Backhaus^{2*}

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Dear readers,

In this issue of *Environmental Sciences Europe*, Dr. Charles Benbrook presents a paper entitled "How did the US EPA and IARC reach diametrically opposed conclusions on the genotoxicity of glyphosate-based herbicides?" [1]. The manuscript contributes to the ongoing debate between scientists from academia, businesses and regulatory agencies on the genotoxicity (or lack thereof) of glyphosate and glyphosate-based herbicides (GBHs) and their potential to cause, or contribute to, human cancer. While the US EPA evaluates glyphosate as "not likely to be carcinogenic to humans", the International Agency for Research on Cancer (IARC) considers glyphosate and GBHs as "probably carcinogenic to humans (Group 2A)". To elucidate the data basis underlying these assessments and to tease out the reasons why the two organizations reached different conclusions, Dr. Benbrook provides a comprehensive review of the underlying studies, the different weights given to them by the US EPA and IARC and analyses the conclusions drawn.

The discussion on the (non)carcinogenicity of glyphosate and GBHs has, unfortunately, become a toxic issue in itself. Because of that and because Dr. Benbrook's paper might have clear implications for the debate, *Environmental Science Europe* decided to go beyond the normal review process. Usually, 2–4 reviews are sufficient to allow the editor to take an informed decision on the acceptance/rejection of a manuscript and to suggest improvements, if needed. However, this time, *Environmental Sciences Europe* asked for 10 anonymous reviews, which were provided by a group of renowned experts in genotoxicity and the risk assessment of pesticides in general and glyphosate in particular. The overall verdict was very positive: one reviewer suggested acceptance of the initial manuscript without further changes, six reviewers asked for minor modifications, and two reviewers requested major changes. Only one reviewer rejected the manuscript, but commented that the manuscript, after major changes and resubmission, would have the potential to move the discussion forward. On the basis of these reviews, Dr. Benbrook did a comprehensive and convincing revision of the manuscript, which you can now find published in *Environmental Sciences Europe*.

We are convinced that the article provides new insights on why different conclusions regarding the carcinogenicity of glyphosate and GBHs were reached by the US EPA

*Correspondence: Henner.Hollert@bio5.rwth-aachen.de; thomas.backhaus@gu.se

¹ Institute for Environmental Research, RWTH Aachen University, Worringer Weg 1, 52074 Aachen, Germany

² Department of Biological and Environmental Sciences, University of Gothenburg, Carl Skottsbergs Gata 22b, 40530 Gothenburg, Sweden

and IARC. It is an important contribution to the discussion on the genotoxicity of GBHs. As one reviewer put it: *“The article transparently lays out not just that the EPA and IARC came to different conclusions about the genotoxicity of glyphosate-based herbicides, but how this result occurred and its impact on the overall conclusions about its carcinogenicity. The analyses contained in this article and accompanying text enhances the understanding of the state of the science of the potential carcinogenicity of glyphosate-based herbicides and gaps in understanding that future studies may help to resolve. As such, it is an important contribution to the literature”*.

Beyond its direct contribution to the debate on the (non)carcinogenicity of glyphosate and GBHs, Benbrook’s paper as well as the broader glyphosate discussion amongst scientists and the general public provides some lessons to be learned for the assessment of pesticides and chemicals in general:

- The US EPA and IARC focussed on two different, but interlinked scenarios: (1) the exposure to (pure) glyphosate, which occurs via residues in food and feed and is therefore mainly relevant for the general public, and (2) occupational exposure, which is a multi-pathway exposure to the formulated glyphosate-based herbicide. Both scenarios are relevant.
- The different perspectives and hence conclusions from the two competent authorities emphasize that the problem formulation step of an assessment is absolutely critical (which chemicals or chemical products are actually assessed, which exposure scenarios are taken into account, which endpoints and protection goals are considered).
- In principle every assessment outcome is only valid for the particular problem at hand, which is often quite narrow and highly technical. This poses substantial challenges when results from different assessments are communicated to laypersons and/or when they are discussed in broader political contexts.
- However, in several instances even the outcome of one and the same experimental study was given different weights and reliability scores by different evaluators. This strongly supports the notion that all studies and the underlying data that are used during the (re)authorization process must be publically available for independent scrutiny. The initiative of Bayer Cropscience to make the bulk of their pesticide study results available on the internet is a welcome step in this direction [2].
- Consequently, also the initial problem formulation, assessment protocols and the resulting data analysis need to be published. That is, pesticide assessments

should implement the systematic review methodology as already promoted, for example, by the European Food Safety Authority (EFSA) [3].

- Additionally, new studies should be registered, similar to clinical trials, to ensure that negative as well as unwelcome results are equally considered during the assessment.
- The fact that glyphosate-based herbicides are more toxic than glyphosate alone strongly supports the requirement of the EU pesticide Regulation 1107/2009 to take mixture effects into consideration when assessing the potential impact of pesticides on human health (Art. 4.3(b)). However, this poses a major challenge for an open and transparent assessment, given the plethora of different GBHs with varying (often only partially known) chemical composition that are on the market in the different members states of the European Union.

Authors’ contributions

HH and TB conceptualized the manuscript. Both authors read and approved the final manuscript.

Competing interests

The authors declare that they have no competing interests. HH is Editor-in-Chief of this journal. TB has worked as a consultant and academic expert with various regulatory agencies involved in pesticide risk assessment and authorization, including the European Food Safety Authority (EFSA), the Swedish Chemicals Agency, the German Environment Agency, the European Commission and the European Parliament.

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