Gene expression analysis confirms Roundup causes liver and kidney damage at very low doses

A new peer-reviewed study led by Dr. Michael Antoniou at King's College London describes the effects on gene expression of a very low dose of Roundup weedkiller administered to rats over a 2-year period. The study is unique in that it is the first to look at effects of Roundup on gene expression at environmetally relevant doses. The study confirmed that levels of Roundup that may be found in drinking water can cause liver and kidney damage following long-term consumption.

Background to study

1. This experiment was a followup investigation of the long-term (2-year) toxicity study in rats of Roundup conducted by Gilles-Eric Seralini and colleagues (Seralini et al., 2014).
2. The original investigation administered a commercial Roundup formulation at 0.1ppb (parts per billion)/50ppt (parts per trillion) glyphosate via drinking water for 2 years.
3. Analysis at an anatomical (organ) and blood/urine biochemical level suggested a higher incidence of liver and kidney damage in the Roundup treatment group compared to the control. Liver and kidney pathologies were also present in the control group due to the advanced age of the animals, but at a lower frequency.

Purpose of current study

Different patterns of gene expression; i.e., which genes are turned off or on and at what level, are known to underlie health and disease status of an organ system. We wanted to investigate whether heightened liver and kidney pathology observed at an anatomical and biochemical level was reflected in the gene expression pattern. Therefore we analysed the pattern of gene expression (**"**transcriptome**"**), by comparing liver and kidney tissues from the Roundup treatment group with those of the control animals.

Findings

1. A distinct and consistant alteration in the pattern of gene expression was found in both the liver and kidneys of the Roundup treatment group.
2. A large number (over 4000) of genes were found to be either increased or decreased in expression, with many (over 1300) being similarly affected in both organs.
3. These changes in gene expression were consistent between animals and were highly statistically significant.
4. A computational (**"**bioinformatics**"**) analysis of the alterations in gene function linked these changes to numerous biochemical systems involved in regulating gene expression, respiration, and disturbances in fat metabolism.
5. The alterations in gene function were consistent with fibrosis (scarring), necrosis (areas of dead tissue), phospholipidosis (disturbed fat metabolism) and damage to mitochondria (the centres of respiration in cells).
6. These changes correlate with and thus confirm observations of pathology made at an anatomical, histological (microscopic cellular) and blood/urine biochemical level.

Conclusions

1. The glyphosate equivalent dose of Roundup administered in this study is what may be found in drinking water. It is half that permitted in drinking water in the European Union, 14,000 times lower than that permitted in drinking water in the USA and 20,000 times lower than that permitted in Australia.
2. The amount of glyphosate-equivalent Roundup consumed by the animals on a daily basis was many thousands of times below the regulatory set safety limits of glyphosate alone in all regions around the world.
3. The observed liver and kidney pathologies may have arisen from glyphosate, the adjuvants present in the Roundup formulation, or a combination of the two.
4. The mechanism by which the Roundup induced this heightened pathology is unknown, but given the extremely low dose at which these effects are observed, this could be through endocrine (hormone system) disruption.

Relevance to health

These results suggest that long-term consumption of an ultra-low, environmentally relevant dose of Roundup at a glyphosate-equivalent concentration of only 50ppt (parts per trillion) in an established laboratory animal toxicity model system can result in liver and kidney damage, with potential significant health implications for human, domesticated animals and wildlife populations.

Quote from lead author Dr Michael Antoniou:

“The findings of our study are very worrying as they confirm that a very low level of consumption of Roundup weedkiller over the long term can result in liver and kidney damage. Our results also suggest that regulators should re-consider the safety evaluation of glyphosate-based herbicides.”

The paper:

Transcriptome analysis reflects rat liver and kidney damage following chronic ultra-low dose Roundup exposure

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