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To: AgBioChatter@yahoogroups.com

Subject: Chatter: Response to Bøhn et al. "Compositional differences in soybeans on the market: glyphosate accumulates in Roundup Ready GM soybeans"

Attachments: Bohn et al - Compositional Differences in GM Soy - Comments.pdf

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All – given the misleading and unsupported claims in Bøhn et al. (2013), I am sharing this analysis with the group. Note that the links are active in the PDF version (attached).

Best,

Eric

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Compositional differences in soybeans on the market: glyphosate accumulates in Roundup Ready GM soybeans

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Overview

A recent publication by Bøhn *et al.*, 2013 makes two major claims regarding differences in composition and herbicide residues between Roundup Ready (RR) soybeans as compared to conventional and organic soybeans. Specifically, that RR soybean contains higher residue concentrations of glyphosate and its breakdown product AMPA (aminomethylphosphonic acid) and that organic soybeans have a healthier nutritional profile than other soybeans. The latter essentially rejects the widely accepted fact that genetically modified (GM) soy is substantially equivalent to non-GM soybeans.

It is important to remember that both glyphosate and AMPA residues are thoroughly evaluated prior to registration of any new use to determine if measured levels fall within currently accepted tolerances. Importantly, tolerances are only established if the dietary exposure from that use is within previously established limits. The results from Bøhn *et al.* clearly confirm that glyphosate and AMPA residues are within the tolerance. As a result, we are left with the primary conclusion that RR varieties of soy have measurable levels of glyphosate and AMPA residues. This is totally expected and normal. Therefore, the study provides no new data and falls well short of impacting the long standing safety of these crops.

Regarding compositional difference, a careful analysis of the experimental design demonstrates that the data does not support the author's conclusions. Furthermore, the observed compositional differences are small and of questionable biological significance.

Comments

Glyphosate Residue and Health Impact

Glyphosate has an excellent human health and environmental profile and a long history of safe use in more than 130 countries. In fact, all independent health assessments conducted by public authorities in Europe and internationally over the past 40 years have consistently concluded that glyphosate does not pose any unacceptable risk to human health. This has been a key factor in the acceptance of glyphosate products as among the most widely used herbicides in the world. When used according to label directions, these products do not represent a risk to human health and the environment. This is confirmed by the extensive studies as well by the first-hand experience of millions of farmers and home gardeners who have used this product. Both the glyphosate task force and Monsanto's website provides extensive information regarding glyphosate products and safety.

Tolerances are established for residues of glyphosate (including metabolites and degradates) and detailed in the Code of Federal Regulations, Title 40, Section 180. To be in compliance, measurable levels must be at or below 100 ppm for soybean, forage; 200 ppm soybean, hay; 120 ppm soybean, hulls; and 20 ppm soybean, seed. In the current study, the minimum – maximum values for AMPA and glyphosate were 0.7–10.0 mg/kg (mean concentration = 5.74) and 0.4–8.8 mg/kg (mean concentration = 3.26), respectively. These values are well below the established tolerance of 20 ppm for soybean seed.

There is nothing new or surprising to report from the results of the study. Low levels of glyphosate residue are permitted in food and are considered safe. In fact, it is not surprising to find glyphosate residues in crops to which glyphosate are applied. The authors attempt to raise concern that RR soy contains glyphosate and therefore it is unsafe when nothing in their study supports this. A recent research article by Carl Winter and Josh Katz, "Dietary Exposure to Pesticide Residues from Commodities Alleged to Contain the Highest Contamination Levels," discusses that the mere presence of residue in no way quantifies exposure. Furthermore, Winter and Katz discuss the importance of establishing toxicological significance if attempting to make claims about health. Specifically, "toxicological significance of consumer exposure to pesticides in the diet [requires] an appropriate comparison of exposure estimates with toxicological endpoints such as the reference dose (RfD) or the acceptable daily intake (ADI)." This type of analysis was not performed by Bøhn *et al.*, therefore no conclusions, inferred or otherwise, regarding glyphosate and AMPA residues levels on RR soy and safety can be reached.

In the absence of analysis, Bøhn *et al.* attempt to correlate glyphosate residue to negative health impact by citing a select set of negative reports while ignoring the vast body of literature expounding the safety of glyphosate. In fact, most of the studies cited have been refuted by experts for various reasons including unrealistic exposure scenarios, improper experimental design, and the lack of proper controls. For example, the authors cite Paganelli *et al.* (2010) which showed that glyphosate increased retinoic acid activity in frog embryos which can disrupt early development. The European Commission called for a review of this publication and concluded that the study "had been performed under highly artificial conditions, extremely different from what can be expected in agricultural circumstances, and that it is hardly possible to predict adverse effect on mammals on this basis." In Monsanto's response we discuss how high concentrations and unrealistic routes of exposure were tested in experiments with frog and chicken embryos. These experiments are not predictive of birth defects or any other effects in humans or wildlife, and are contradicted by an extensive worldwide human health, safety and environmental database on glyphosate. Furthermore, there is no evidence that glyphosate is associated with craniofacial malformations or any other specific malformations in humans.

Another example is the study by Seralini *et al.* suggesting that glyphosate ingestion leads to higher death rates and incidence of tumors. However, this study was widely refuted and was recently retracted by the editor of Food and Chemical Toxicology (Monsanto's Response Materials).

Compositional Differences

A major claim put forth by Bøhn *et al.*, is that, based on compositional differences, organic soybeans have a healthier nutritional profile than other soybeans. This conclusion is not supported by the current literature. A recent clinical report from the American Academy of Pediatrics concluded "[the] current evidence does not support any meaningful nutritional benefits or deficits from eating organic compared with conventionally grown foods, and there are no well-powered human studies that directly demonstrate health benefits or disease protection as a result of consuming an organic diet." Likewise, a systematic review of the literature by Smith-Spangler *et al.*, concluded that "[t]he published literature lacks strong evidence that organic foods are significantly more nutritious than conventional foods."

While it is true that agricultural practices can have a huge impact on compositional differences, the current study is confounded by the use of different locations and varieties. This makes it impossible to assess the effects of the different agricultural practices on seed composition. Specifically, it is firmly established that varietal differences contribute to compositional variability. Bøhn *et al.* examined a total of 31 soybean samples harvested as batches (no field design reported) separated into three groups; GM (n=10, total of 8 unique varieties), conventional (n=11, 4 unique varieties) and organic (n=10, 9 unique varieties). There is overlap in only one variety (Legend 2375) which is present three times in the conventional group and once in the organic. Varietal differences in soybeans have significant effects on seed composition, and with only a single overlapping variety between the conventional and organic groups, and no overlap of between the GM and conventional group, it is not possible to discriminate between variability introduced from genetic or agronomic sources.

Furthermore, geographic locations contribute to compositional variability and the samples were harvested across a region encompassing a 200 km radius. Location differences can have significant impacts on seed composition, even across short distances. Therefore, the study cannot assess the effect of agricultural practices as the soybean varieties are obtained from different locations and it is not possible to assign which factors introduced variability into the seed composition.

The authors acknowledge that variation in composition will result as "different varieties of soy (different genetic backgrounds) from different fields (environments) grown using different agricultural practices were analysed." In an attempt to rationalize that their approach is still valid, the authors state that "13 samples out of the 31 had at least one sibling (same variety) to compare both within and across the region". This however is invalid as the geographical location is still a confounding factor. In addition, the data does not support strong genotype x environment interactions, it simply indicates location effects.

The authors refer to the Organisation for Economic Cooperation and Development (OECD) as a source of recommended feed and food nutrients (though primarily to criticize the fact that pesticide residues are not included). However, the selection of analytes provided represents only a limited assessment of the nutritional profile as key OECD analytes such as raffinose, stachyose, isoflavones, trypsin inhibitors, and lectin are not assessed. Furthermore, the analysis is on individual samples with the exception of sugars and fiber, which have an n = 1 based on pooled samples for each group.

Finally, all observed differences (Table 2) are characterized by small magnitudes. For example, the protein difference between GM and organic is 4.9%. This difference is small particularly with respect to the extensive compositional variability associated with soybean. Furthermore, given the correlation between protein and yield, this difference may reflect a decreased yield in the organic soybean. However, because we cannot assign causes to the differences observed in the study we cannot attribute any potential yield decrease to agricultural practice. In fact, it is difficult to resolve how any conclusions can be made based in the current study. For example, the one-way ANOVA for the nutritional composition assessment is questionable. Largely due to the limited and small sample size (n=10 GM, n=10 conventional, n=11 organic) which do not represent true replicates because they were obtained under different agronomic and geographical conditions from an observational study, not a controlled experiment. Additionally, it is not mentioned if the ANOVA assumptions were checked and verified (normality, homogeneity of variance, etc.), and the significant differences that are indicated appear to be very small in magnitude raising the question of biological significance.

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