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The crucial role of proper sampling in food and feed safety assessment

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The general principles for safety and nutritional evaluation of foods and feed and potential health risks associated with hazardous compounds have been developed by FAO and WHO[1] and further elaborated in the EU funded project Safe Foods, where specific attention was given to a coherent scientific analysis of health and environmental risk-benefits and impacts on economics, social and ethical aspects[2]. Nevertheless, the crucial role that sampling has in foods/feed safety assessment has never been explicitly recognized. High quality sampling should always be applied to ensure the use of adequate and representative samples as test materials for all the steps of food/feed safety assessment: hazard identification, toxicological and nutritional characterization of identified hazards, as well as estimation of quantitative and reliable exposure levels of foods/feed or related compounds of concern for humans and animals[3]. The different types of substances under study which are present in food/feed matrices and commodities, raw or semi- processed, pose both general and specific challenges to the development of appropriate sampling strategies and analytical detection methods. Although it is well recognized that both sampling and analytical errors affect the reliability of any final risk estimation, traditionally much more attention has been devoted to the development and improvement of analytical methods, as compared to the development of appropriate sampling plans. But the reality is that analytical results are of low or no value, no matter the quality of the method used, if the sampling process is not representative of the entire field-to-aliquot pathway.

The Theory of Sampling (TOS) has developed over the last six decades a complete theory of heterogeneity, sampling procedures and sampling equipment assessment, the importance of which was first recognized in the mining and geological sectors, but since transgressed nearly all boundaries between science, technology and industry[4,5]. Over the course of the last 10-15 years the universality of TOS principles has been proven thoroughly, demonstrating that all sampling processes, irrespective of the nature of their target lots, need to be structurally correct (unbiased) in order to ensure a sufficient degree of accuracy and precision[6]. This is true also when assessing foods and feed safety, including food/feed contaminants, additives, naturally occurring toxins/ anti-nutrients, or contaminating micro-organisms, and whole foods/feed derived from genetically modified plants/animals.

More specifically, TOS allows estimating the variability remaining after all sources of sampling bias have been removed, i.e. the variability intrinsic to the specific material under investigation for both stationary as well as dynamic lots. From a food and feed safety perspective, this constitutes the level of unavoidable risk associated with any given survey. No other sampling framework allows objective quantification of the risk as a direct function of the specific heterogeneity properties of the test material. On the contrary: all other sampling frameworks rely on *specific* distributional assumptions, do *not* characterize heterogeneity patterns stemming from the specific properties of the test material, and do *not* include an estimation of the risk associated with sampling surveys[7]. For these reasons we consider that only TOS provides a complete framework to ensure accuracy and precision of all sampling steps involved in any given scenario, starting from the primary sampling all the way to the subsequent secondary sampling steps involved in the field-to-fork continuum necessary to monitor foods and feed safety[3].

Therefore we propose to explicitly recognize the central role of sampling in foods and feed safety assessment and to integrate TOS in the well-established FAO/WHO risk assessment approach in order to guarantee a transparent and correct frame for the safety assessment of foods and feed and the many steps of the subsequent decision making process. A key example of successful implementation of this approach regarding GMO detection and quantification was published recently[8,9,10].

References

1. FAO and WHO, *Food Safety Risk Analysis, a guide for national food safety authorities*. Geneva: World Health Organization (2006).
2. A. König, H. A. Kuiper, H.J.P. Marvin, P.E. Boon, L. Busk, F. Cnudde, S. Cope, H.V. Davies, M. Dreyer, L.J. Frewer, M. Kaiser, G.A. Kleter, I. Knudsen, G. Pascal, A. Prandini, O. Renn, M.R. Smith, B.W. Traill, H. Van der Voet, H. Van Trijp, E. Vos and M.T.A. Wentholt, in: Safe Foods - towards a New Risk Analysis Framework for Food Safety. Special Issue Food Control 21 (2010).
3. H. A. Kuiper and C. Paoletti, Food and feed safety assessment: proper sampling is imperative. *J. AOAC Int*. 98 (2015).
4. P. Gy, Sampling for Analytical Purposes. Wiley. ISBN 0-471-97956-2 (1998).
5. K.H. Esbensen and P. Minkkinen, Special Issue: 50 years of Pierre Gy's Theory of Sampling. Proceedings: First World Conference on Sampling and Blending (WCSB1). Tutorials on Sampling: Theory and Practise. Chemometrics and Intelligent Laboratory Systems 74, 236 (2004).
6. DS 3077- Horizontal Standard: Representative Sampling. www.ds.dk
7. C. Paoletti and K.H. Esbensen, Distributional assumptions in food and feed commodities – development of fit-for-purpose sampling protocols. *J. AOAC Int*. 98 (2015).
8. K.H. Esbensen, C. Paoletti and P. Minkkinen, Representative sampling of large kernel lots I. Theory of sampling and variographic analysis. *Trends in Analytical Chemistry* (TrAC) 32, 154-164 (2012).
9. P. Minkkinen, K.H. Esbensen and C. Paoletti, Representative sampling of large kernel lots II. Application to soybean sampling for GMO control. *Trends in Analytical Chemistry* (TrAC) 32, 165-177 (2012).

10. K.H. Esbensen, C. Paoletti and P. Minkkinen, Representative sampling of large kernel lots III. General considerations on sampling heterogeneous foods. *Trends in Analytical Chemistry* (TrAC) 32, 178-184 (2012).