newfood

www.newfoodmagazine.com

Issue 1 · 2017

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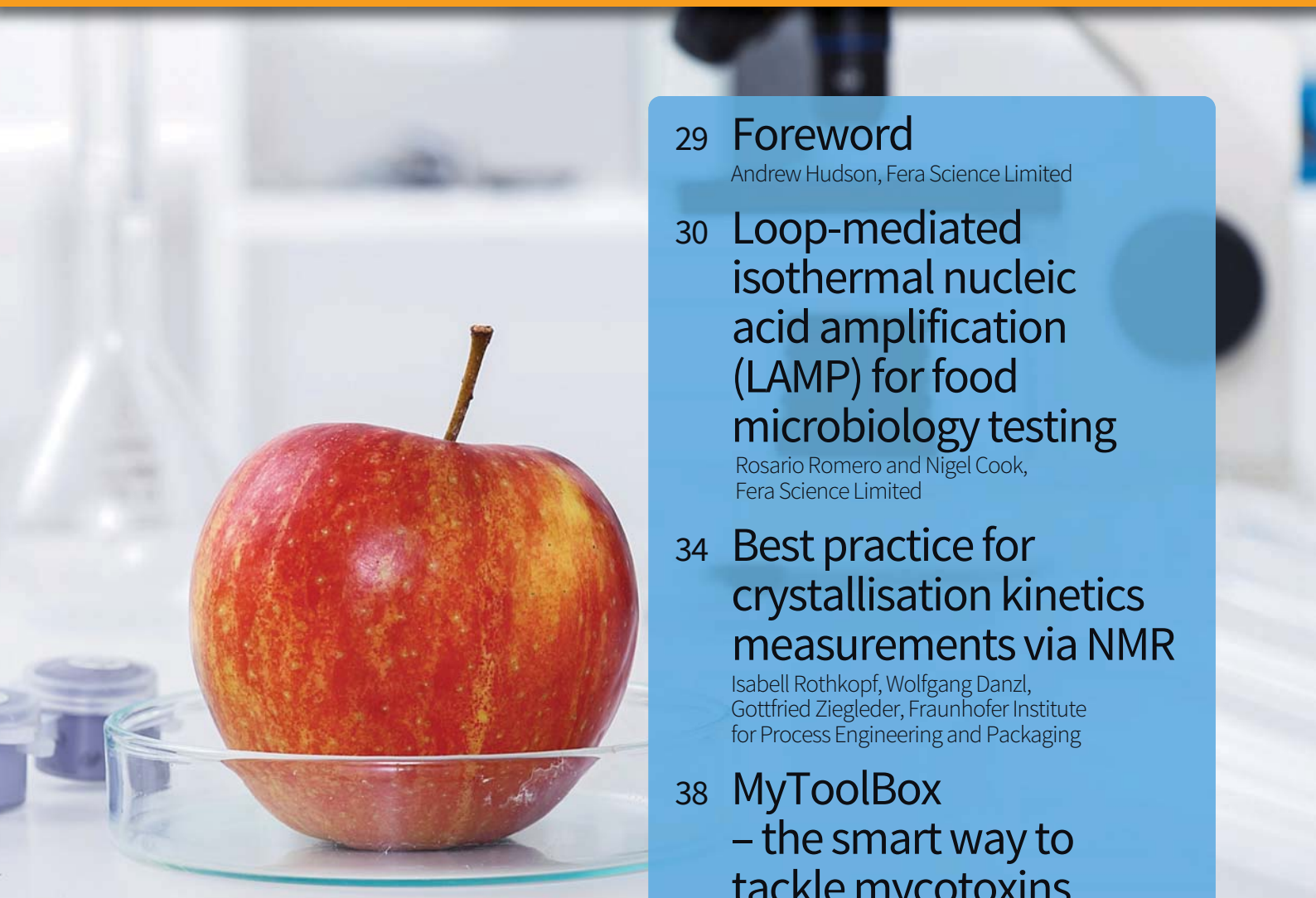

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MyToolBox – the smart way to tackle mycotoxins

There is a pressing need to mobilise and integrate the wealth of knowledge from the international mycotoxin research conducted over the past 25-30 years, in order to perform cutting-edge research to close knowledge gaps. This is the mission of MyToolBox – a four-year project, funded by the European Commission from 2016 to 2020. It facilitates a multi-actor partnership to develop novel intervention strategies aimed at achieving up to 90% reduction in crop losses due to mycotoxin contamination for major food and feed crops. Besides a field-to-fork approach, MyToolBox also considers safe use options of contaminated batches, such as the efficient production of biofuels. The distinguishing feature of MyToolBox is to provide the recommended measures to the end users along the food and feed chain in a web-based MyToolBox platform (e toolbox), focussing on small grain cereals, maize, peanuts and dried figs, applicable to agricultural conditions in the EU and China.

Introduction – the mycotoxin problem

The mycotoxin contamination of crops is a major concern for stakeholders along the food and feed chain. The European Commission pointed out that 5–10% of global crop production is lost annually due to mycotoxin contamination[1]. The total costs of losses due to mycotoxin contamination, such as reduced yields; food and feed losses; increased costs for inspection and analyses; as well as others, may easily reach billions of Euros annually, as estimated by Mitchell and colleagues[2]. Mycotoxin-contaminated cereals and derived products, such as dried distillers´ grain solubles (DDGS) in animal feed, impact livestock production as well. For example, the decreased weight gain in pigs in the USA, due to including 20% DDGS contaminated with fumonisins in the feed, is estimated to result in losses of up to US$147 million annually[3].

The social impact of mycotoxin contamination is also of growing concern since recent reports suggest possible links between aflatoxin exposure and the stunting of children in Africa[4,5]. Furthermore, extreme weather events due to climate change impact the mycotoxin map worldwide[6], thus challenging existing forecasting and detection methods of mycotoxins in food and feed. Despite previous achievements, the risk of mycotoxin exposure is still high: 81% of globally collected feed samples were contaminated with at least one mycotoxin and 45% contained more than one secondary metabolite of fungi7. Furthermore, most notifications registered in the EU's Rapid Alert System for Food and Feed (RASFF) between 2004 and 2015 were related to mycotoxin contamination exceeding the maximum regulatory limits1 (see **Figure 1**, page 39). Thus, despite previous achievements in tackling mycotoxin exposure from food and feed, continuous and collaborative research is needed.

MyToolBox – the smart way to tackle mycotoxins

To tackle these issues, existing knowledge must be combined with novel findings to bridge gaps on mycotoxin reduction along the food and feed chain. By using mainstream information and communication technology (ICT), losses and waste along the food and feed chain can be prevented and traceable information to the supply chain and consumers can be provided. This is the mission of MyToolBox (www.mytoolbox.eu) (see **Figure 2**, page 39), a four year project, which is funded by the European Commission (EC) and was launched in March 2016. The project applies a multi-actor and multi-disciplinary approach throughout the food and feed chain with 40% industry participation including five end-users and three well-known institutions from China, who will collaborate closely with

farmers and stakeholders from the industry. The end-user engagement, which extends to the food and feed industry, farming communities, agronomists, manufacturers, SMEs and academia from the EU and beyond, will ensure the usability and applicability of the MyToolBox decision support system.

The overall objective of the MyToolBox project is to develop a series of integrated measures that reduce different kinds of losses that result from mycotoxin contamination. MyToolBox specifically addresses the most prevalent Fusarium mycotoxins (Deoxynivalenol [DON], T-2 toxin, HT-2 toxin, Zearalenon [ZEA] and fumonisins) in wheat, oats, maize and animal feed, ochratoxin A (OTA) in wheat and aflatoxins in maize, peanuts and dried figs. Besides a field-to-fork approach, MyToolBox also considers safe use options of mycotoxin-contaminated batches to efficiently produce biogas and bioethanol, thus considering alternative use options of otherwise wasted cereal badges. Legislative implications are also foreseen, for which advice is sought from institutions experienced in establishing regulatory limits for contaminants in foods and feeds, such as from representatives from the European Food Safety Authority (EFSA) and the EC's Directorate-General DG Santé. Eventually, a sound scientific basis for setting authorisation standards of mycotoxin detoxifying feed additives in China will complement the project's goals.

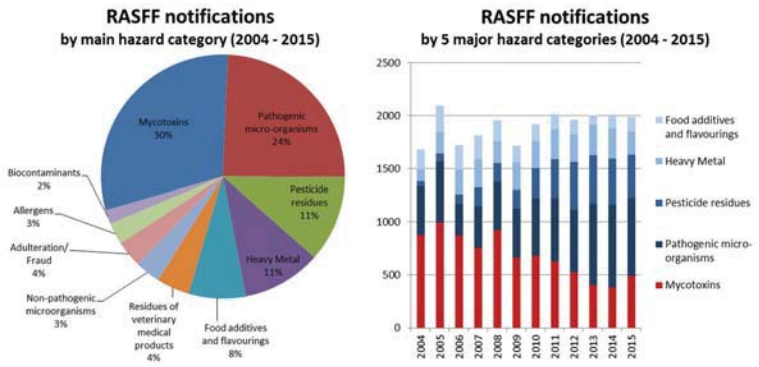

Figure 1: RASFF notifications from 2004 – 2015 (left) and RASFF notifications of five main hazards from 2004 – 2015 (right)

Expected impacts along the food and feed chain

The pre- and post-harvest measures should lead to significant economic and food safety benefits and improvements in mycotoxin management along the food and feed chains, leading to a reduction of contamination incidents and more transparent communication in the supply chains. Furthermore, farmers and other stakeholders along the food and feed chain will benefit financially by saving resources (e.g. fertilisers, seeds, etc.) and by lowering the risk of rejection of their products due to unexpected contamination. As such, mycotoxin-related border rejections noted by RASFF are expected to decrease further. Overall, the integrated measures are expected to lead to a 20-90% reduction of mycotoxin contamination in food and feed, thus contributing to improved consumer trust in imported food and feed.

The pre-harvest measure focus on in-field strategies – to determine the most promising available novel cultural biocontrol strategies targeting the *Fusarium* inoculum within crop debris, *Brassica* biofumigation[9,10], as well as accelerated biodegradation[11] with an extract or competitive fungi[12] – are being explored. To increase the climate change resilience of EU-maize farmers and thus reduce susceptibility of maize to aflatoxin contamination, MyToolBox is testing two measures: (1) The selection of appropriate genotypes of maize with various traits, and (2) The application of atoxigenic *Aspergillus* strains to out-compete toxigenic *Aspergillus* strains in the field. In addition available forecasting models regarding DON contamination in wheat and maize are being validated, combined and extended to cover the most important wheat and maize growing areas in Europe.

Post-harvest strategies span from the sorting of crops, over storage and further processing; up to alternative uses of contaminated batches. In order to achieve significant improvements in the sorting of dried figs (and dramatically improve the work environment) MyToolBox is developing a non-invasive system for the real-time sorting of contaminated dried figs, based on visible and near infrared (NIR) spectral imaging and appropriate algorithms. Innovative pre-milling and milling strategies are combined and up-scaled to provide more accurate separation of grain tissues that have characterised (different) mycotoxin contamination levels. Milling strategies, such as debranning and micronisation, are efficient, but individual tissues of the grains are often inhomogeneous and not well confined. The synergistic potential of debranning, micronisation and dry- or wet-turbo separation will minimise the mycotoxin concentration in raw materials and the final wheat products destined for the consumer. Within MyToolBox the fate of mycotoxins, as well as their modified forms and co-occurrences in naturally contaminated raw materials (with simultaneous co-occurrence of different mycotoxins), will be monitored during thermal food processing at an industrial scale with Barilla (Parma, Italy), one of the

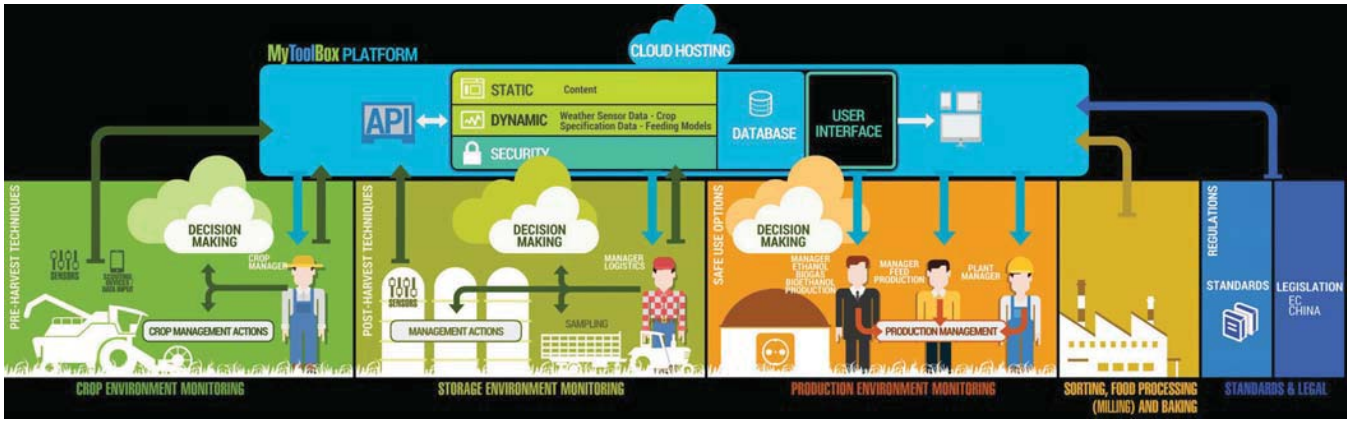

Figure 2: Overview of the MyToolBox project approach (©IRIS)

industrial partners. These efforts fulfill the need to obtain further data on the fate of modified mycotoxins, as defined by EFSA in 2014[13], during food and feed processing.

The outcome of the MyToolBox studies shall also positively contribute to the current food vs. fuel debate, due to our intention to utilise mycotoxin contaminated batches to produce biofuels on the one hand, and high quality DDGS on the other. In DDGS, a major protein source in feeding stuffs derived from bioethanol production, the mycotoxin concentration can be increased by a factor of three compared to the starting maize[14]. To reduce the mycotoxin contamination of DDGS, the MyToolBox industry partners Südzucker (Mannheim, Germany) and BIOMIN (Getzersdorf, Austria), in cooperation with BOKU/IFA-Tulln, will study the effects of specific mycotoxin-degrading microorganism strains[15] and novel enzymes[16] on the reduction of DON and fumonisins in DDGS.

The EU-China partnership within MyToolBox aims to contribute to the standard setting for authorisation of mycotoxin-detoxifying feed additives in China, wherein current EU guidelines for the registration shall serve as examples for possible adaptions of Chinese legislation. This shall include standardised procedures to verify the safety and *in vivo* efficacy of detoxifying feed additives. Currently in China, up to 24% of complete feed for pigs have exceeded the maximum limits of deoxynivalenol set by the Chinese authorities[17]. Since approximately half of the world´s total pig population is farmed in China, such legislation is expected to also improve the efficiency of Chinese pork-meat production.

Finally, the web-based MyToolBox platform will represent a one-stop-shop for farmers and other decision makers in the food and feed supply chain. Consisting of information and advisory modules, as well as management tools and technologies, such individuals will be equipped with systematic, cost effective and affordable approaches for the effective monitoring and reduction of mycotoxin contamination in crops, food and feed.

This will lead to the increased trust of consumers in the high quality of EU food and feed, which will strengthen the economic position of the EU food producers.

Conclusion

The MyToolBox project does not only pursue a field-to-fork approach to reduce mycotoxins in wheat, oats, maize, peanuts and dried figs, but also considers safe use options of mycotoxin contaminated batches. This will increase the availability of high quality food and feed in the EU as well as in China. Various agricultural strategies used thus far have not been able to efficiently reduce the impact of fungal infection, let alone take account of climate change related issues or other analytical challenges. The current situation pursues a novel and integrated multi-actor approach involving all actors in the food and feed chain, including the end-users. Consequently, the MyToolBox approach combines a series of integrated pre- and post-harvest measures, which could enable a 20-90% reduction in loss of crops due to fungal and mycotoxin contamination, depending on the type of commodity and intervention.

Acknowledgements

The authors are grateful to all partners' contributions, in particular Simon Edwards from Harper Adams University, Michele Suman from Barilla, Naresh Magan and Angel Medina Vaya from Cranfield University, Ine van der Fels-Klerx from RIKILT Wageningen University & Research, Vittorio Rossi from HORTA S.R.L., John Gilbert from FoodLife International, Edurne Gaston Estanga from IRIS and Michaela Pichler from ICC.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 678012.

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Monique de Nijs is a scientist and project manager on mycotoxins and plant toxins at RIKILT Wageningen University & Research, with a background in food chemistry, microbiology and risk assessment of mycotoxins. As the Co-Coordinator of the MyToolBox project she adds over 16 years of experience in the field of food safety analysis to the project.

Birgit Poschmaier is the Project Manager of MyToolBox, with experience in safeguards management in World Bank financed projects. As a PhD student at the BOKU she will take a closer look at the social and economic impacts of integrated mitigation and reduction strategies against mycotoxin contamination.

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