Comparison of cost-effective sampling and analysis plans for a wheat batch and aflatoxins in a maize batch

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Background and Objective

To date, research has been performed on the accuracy of sampling and analytical plans for mycotoxins. However, studies that have investigated the cost-effectiveness of different sampling and analytical (S&A) plans for mycotoxins in crops, varying in terms of the number of samples collected and the analytical detection method used are scarce.

The objective of this research was to find the optimal S&A plan for a batch of cereals (e.g. a truckload) given the available predefined budget.

The focus was on DON in wheat and aflatoxins in maize. DON is a pre-harvest toxin whereas aflatoxins are pre- as well as post-harvest toxins. Therefore, aflatoxins are more heterogeneously distributed within a batch than DON. We hypothesised that this difference in heterogeneity would have an effect on the most cost-effective S&A plan.

Methods

Three S&A plans were defined:

- S&A plan 1: collection of incremental samples, combination in 1 aggregate sample, analysis of aliquots in a lab with an instrumental method.
- S&A plan 2: collection of incremental samples, combination in 1 aggregate sample, analysis of aliquots in a lab with ELISA.
- S&A plan 3: collection of incremental samples, on-site analysis of all individual samples with LFDs.

The costs of the sample collection, transport, storage and the analyses were estimated based on (scarcely) available data.

The probability to correctly classify a batch below or above the predefined threshold was influenced by the heterogeneity of the mycotoxin in the batch, the number of samples collected, the number of aliquots analysed and the accuracy of the detection method. The number of batches correctly classified was used as a measure of the effectiveness of a S&A plan.

Linear programming was used to maximise the effectiveness of the S&A plan subject to a pre-defined budget.

Results

Table 1. Batches correctly classified with optimal S&A plans: DON in wheat, limit of 1250 µg/kg
(based on data on the concentrations of batches imported in the Netherlands)

	S&A plan 1 instrumental method			S&A plan 2 ELISA			S&A plan 3 on-site with LFDs	
Budget (€)	Correct (%)	N_1	NA_1	Correct (%)	N_2	NA_2	Correct (%)	N_3
200							89.7	1
600	95.4	13	1	96.9	29	3	95.7	14
800	97.1	33	1	97.5	48	4	96.5	21
1000	97.6	53	1	97.9	65	8	97.0	28
1600	98.2	103	2	98.4	123	10	97.8	48

Table 2. Batches correctly classified with optimal S&A plans: Aflatoxins in maize, limit of 5 µg/kg
(based on data on the concentrations of batches imported in the Netherlands)

	S&A plan 1 instrumental method			S&A plan 2 ELISA			S&A plan 3 on-site with LFDs	
Budget (€)	Correct (%)	N_1	NA_1	Correct (%)	N_2	NA_2	Correct (%)	N_3
200							85.5	1
600	87.4	15	1	88.6	32	1	87.4	14
800	88.8	35	1	89.6	51	3	88.0	21
1000	89.7	55	1	90.3	71	3	88.5	28
1600	91.5	105	1	91.8	130	4	89.6	48

N_1, N_2, N_3 are the number of incremental samples collected with S&A plans 1, 2 and 3 respectively.
NA_1 and NA_2 are the number of aliquots analyzed with S&A plans 1 and 2 respectively.
The number of incremental samples collected (N_3) and the number of aliquots analyzed are the same for S&A plan 3.

Conclusions

To sample and analyse for DON in a wheat batch, fewer incremental samples and therefore a lower budget was needed than for aflatoxins in maize.
For DON in wheat, on-site detection with LFDs could be a cost-effective option.
For aflatoxins in maize it was more cost-effective to combine samples collected in one aggregate sample before analysis. Therefore on-site detection would be less suitable.

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