Mycotoxins in spices and culinary herbs from Italy and Tunisia

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ABSTRACT
Spices and aromatic herbs can be contaminated with mycotoxins, since of their preharvest, postharvest, and storage conditions. In this study, 112 samples of different spices and aromatic herbs were evaluated for their mycotoxins content by HPLC-MS/MS in order to highlight their possible risk linked with human use. The results showed that mycotoxins were occasionally detected only in samples of coriander, laurel, mint, rosemary, and verbena. In both geographical origins a different contamination was detected. Among the investigated mycotoxins, AFB2, AFG1, AFG2, T2 and HT2 were detected, whereas none of the samples contained AFB1 and FB1. The co-occurrence of two toxins were observed for some samples of rosemary and verbena. This study indicates that it is essential minimize the toxins in agriculture, industry, and food-product manufacturing for the consumer health protection.
1. Introduction

Spices and herbs, widely used for improving aroma and taste, are also applied in medicine, pharmacology, and cosmetology due to their antioxidant properties and nutritional benefits (Peter 2012). Because of their preharvest, postharvest, and storage conditions, they can be contaminated with organic and inorganic pollutants (Cicero et al. 2017; Di Bella et al. 2018; Di Bella et al. 2019), and mycotoxins (Wan Ainiza et al. 2015). Mycotoxins are natural secondary chemical metabolites produced by different toxigenic fungi strains such as Aspergillus and Fusarium (Cammilleri et al. 2019).

Aflatoxins are the most common mycotoxins in spices (Ozbey and Kabak 2012). Depending on their fluorescence characteristics, they are identified as AFB1, AFB2, AFG1 and AFG2. Aflatoxins have carcinogenic, mutagenic, teratogenic and immunosuppressive activity (Reinholds et al. 2017). The pyramid of toxicity, carcinogenicity, and mutagenicity of different aflatoxins is in the order AFB1 > AFG1 > AFB2 > AFG2 (Afshar et al. 2013). Fumonisin B1 (FB1) is a mycotoxin produced by Fusarium spp. Moulds and it has a wide range of toxic effects. In human exposure to FB1 is linked with higher incidence of primary cancers. It been established that FB1 has a neurodegenerative potential (Costanzo et al. 2015). T-2 toxin (T2) is a representative mycotoxin of a large group of mycotoxins called trichothecenes. T2 is associated with a human disease called “alimentary toxic aleukia”. Moreover, it is affecting the immune system and causing among other things apoptosis of proliferating cells as well as inhibition of protein synthesis (Marin et al. 2013).

The European Food Safety Authority (EFSA) published a tolerable daily intake (TDI) of 100 ng/kg body weight for the sum of HT2 and T2 (EFSA 2011), while indicative levels ranging from 15 to 2000 μg/kg for cereals and some products made with cereals were established in Recommendation 2013/165/EU from the European Commission (Commission Recommendation 2013). With regard to Aflatoxins, the legal limit in the European Union (EU) for AFB1 and the total aflatoxins (the sum of AFB1, AFB2, AFG1 and AFG2) in dried spices/herbs are set to 5 μg·kg⁻¹ and 10 μg·kg⁻¹ (EC 2010).

To analyze mycotoxins in foods several methods have been applied, mainly, HPLC-MS/MS and UPLC-FLD (Gentile et al. 2016; Campone et al. 2018).

The purpose of this study was to evaluate the level of some mycotoxins contamination in common herbs and spices and to highlight their risk assessment.

2. Results and discussions

Mycotoxins content found in samples from Tunisia and Sicily is summarized in Table 1S. The results showed that the samples investigated were not exempt of mycotoxins, but they are found only occasionally. The 7% of analyzed samples were contaminated by AFB2 (67% of Tunisian rosemary and 80% of Italian rosemary samples, with mean value of 5.38 ± 1.72 ng·g⁻¹ and 6.62 ± 2.77 ng·g⁻¹, respectively), 2% by AFG1 (22% of Tunisian laurel samples, with mean value of 3.35 ± 0.85 ng·g⁻¹), 12% by AFG2 (83% of Tunisian rosemary, 44% of Italian laurel and 80% of Italian rosemary samples, with mean value of 100.4 ± 15.6 ng·g⁻¹, 15.2 ± 4.2 ng·g⁻¹ and 57.2 ± 6.4 ng·g⁻¹, respectively), 9% by T2 (60% of Tunisian coriander, 80% of Tunisian verbena and 43% of Italian mint samples, with mean value of 0.73 ± 0.15 ng·g⁻¹, 73.08 ± 0.168 A. G. POTORTÈ ET AL.
99 ng·g⁻¹ and 2.22 ± 0.27 ng·g⁻¹, respectively), 1% by HT2 (20% of Tunisian verbena samples, with value of 5.31 ng·g⁻¹) and none of the samples contained AFB1 and FB1. Also, as can be seen in Table 1S, all samples of Sicilian rosemary that are contaminated by AFB2 showed the co-occurrence of AFG2 too; the same can be observed for Tunisian rosemary except for one sample. Only one Tunisian verbena sample showed the co-occurrence of T2 and HT2 toxins. The co-occurrence assessment is relevant for human health because their synergetic toxic action is known (Di Stefano et al. 2014; Di Stefano et al. 2015; Di Sanzo et al. 2018).

Sicilian and Tunisian rosemary samples shown the highest AFG2 concentration. T2 toxin was detected just Tunisian coriander and verbena, whereas for Sicilian samples it was detected just in mint samples. HT2 was detected just in Tunisian verbena. Our research has come to light a low contamination by mycotoxins of this commodity, confirming the results of previous works from different countries (Romagnoli et al. 2007). This can be due probably to the essential oils content having a wide spectrum of fungicidal activity. In our study, the total AF concentration reached up in Tunisian laurel and rosemary was 3.35 ng·g⁻¹ and 105.78 ng·g⁻¹ respectively, whereas for Sicilian samples the concentration detected was lower 15.2 ng·g⁻¹ and 63.86 ng·g⁻¹ respectively. Thus, this levels (except for Tunisian laurel) are higher than limit by European Union (EC 2010).

3. Experimental

See Supplementary materials for: Chemicals, Samples preparation, Instrumentation, analytical conditions and Validation method.

4. Conclusions

This study showed that mycotoxins were occasionally detected in spices and culinary herbs under analysis although coriander, laurel, mint, rosemary, and verbena tend to have a risk of mycotoxins contamination and, in particular, both Tunisian and Italian rosemary showed a more important contamination. Thus, generally, this study results suggested that analyzed samples are not a risk for consumers, except for same samples of laurel and rosemary. The absence of mycotoxin contamination in other spices and herbs indicates that they are likely not to be a good substrate for fungal growth or may result from inhibition of fungal proliferation and mycotoxin production by their essential oils and aromatic substances. Farm-management and food-storage functions are essential at decreasing food-processing times, and these efforts can prevent or minimize the toxin in agriculture, industry, and food-product manufacturing to promote human health.

Disclosure statement

No potential conflict of interest was reported by the authors.
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