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The influence of climate conditions on the occurrence of deoxynivalenol in maize harvested in Serbia during 2013–2015

Jovana Kos*, Elizabet Janić Hajnal, Bojana Šarić, Pavle Jovanov, Nataša Nedeljković, Ivan Milovanović, Jelena Krulj

Institute of Food Technology, University of Novi Sad, Bulevar cara Lazara 1, 21000 Novi Sad, Serbia

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ABSTRACT

The objective of this study was to investigate the influence of climate conditions on deoxynivalenol (DON) content in 1800 maize samples collected from main maize growing regions in Serbia during a period of three years.

DON concentration was determined by validated direct competitive Enzyme Linked Immunosorbent Assay (ELISA) method.

Presence of DON in maize samples from 2013, 2014 and 2015 years was detected in 2.5%, 96.0% and 15.5% of samples in the concentration range of 260.1–1388 μg/kg, 260.4–9050 μg/kg and 252.3–6280 μg/kg, respectively.

The obtained results indicate that different weather conditions recorded in examined years had a significant influence on DON occurrence in maize. Extremely rainy weather conditions in maize growing season 2014 were favourable for DON production and even 292 (48.3%) samples were unsuitable for human consumption, since DON concentrations were greater than 1750 μg/kg. However, lack of rainfall and higher air temperatures during the years 2013 and 2015 contributed to lower contamination frequency of DON.

These findings confirmed that maize should be continuously monitored in order to protect human and animal population against the risk of DON contamination. Furthermore, monitoring of DON occurrence in maize from Serbia is required in order to collect data which is needed for establishing a Serbian as well as European database.

1. Introduction

Maize is very often contaminated with fungi of *Fusarium* species which can result in mycotoxins production during maize growth, harvest, storage, transport and processing. *Fusarium* species synthesize a wide range of mycotoxins of diverse structure and chemistry which are a potential health hazard for humans and animals (D'Mello, Duffus, & Duffus, 1991; Placinta, D'Mello, & Macdonald, 1999).

One of the major *Fusarium* mycotoxin that can occur in maize and maize-based products is deoxynivalenol (DON). DON (12,13-epoxy-3α,7α,15-trihydroxytrichothec-9-one-8-one) is a polar organic compound which belongs to the type B trichothecenes, and their occurrence is mainly associated with *Fusarium graminearum* and *Fusarium culmorum*, both of which are important plant pathogens (JECFA, 2001). Although DON is among the least toxic of the trichothecenes, it is the most frequently detected one throughout the world, and its occurrence is considered to be an indicator of the possible presence of other, more toxic trichothecenes (Eriksen & Pettersson, 2004; Lombaert, 2002; Desjardins, 2006; Wu, 2007).

Based on limited data and evidence in humans and experimental animals, DON was classified in group 3 by International Agency for research on Cancer (IARC, 1993). Although DON does not show a pronounced carcinogenic effect, its presence in food chain can cause a variety of toxic effects in both humans and animals. In humans, DON may influence inhibition of protein and DNA synthesis (CAST, 2003). Furthermore, DON can have a negative impact on hematologic cells, manifesting principally as thrombocytopenia and leucopoenia (Parent-Massin, 2004; Pestka, 2007). Consumption of feed contaminated with DON by livestock has been associated with a variety of adverse health effects including feed refusal,

* Corresponding author.
E-mail address: jovana.kos@fins.uns.ac.rs (J. Kos).

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reduced weight gain, diarrhea and emesis (Kuiper-Goodman, 2002; Ma & Guo, 2008).

Since presence of DON in maize may potentially affect human and animal health and cause great economical losses, maximum residue level (MRL) have been established in numerous countries over the world. The regulation of Serbia (Serbian Regulation, 2011) on the control of DON in food was harmonized with the Regulation (European Commission, 2006) of European Union (EU) and adopted in 2011. Until then, maize intended for human consumption in Serbia had to be tested only for presence of aflatoxins and ochratoxin A. According to the new Serbian and EU Regulation, MRL for DON in unprocessed maize intended for human consumption is 1750 μg/kg. If maize is intended for animal feed, concentration of DON cannot be greater than 8000 μg/kg (Serbian Regulation, 2010; European Commission, 2006).

Occurrence of DON in maize is considered a typical agricultural issue in regions with cooler climates where weather conditions are favourable for *Fusarium graminearum* and *Fusarium culmorum* growth and DON production (JECFA, 2001; Sudakin, 2003). Previous studies on the occurrence of DON in maize, have shown that presence of this toxin is dependent on many factors, in particular climate conditions throughout the cereal growth period (Domijan et al., 2005; Jajić, Jurić, & Abramović, 2008; Pleadin et al., 2012; Van der Fels-Klerx, van Asselt, Madsen, & Olesen, 2013).

Since in the recent years Serbia represents a leader in terms of maize production and exports in Europe and among the top ten exporters in the world, control of mycotoxins as well as DON occurrence is necessary (Maslac, 2015, pp. 1–19). Although Serbian regulations for MRL of DON in maize were harmonized with EU regulations it should be noted that monitoring program is still not prescribed. Data on the natural occurrence of DON gathered in Serbia are still insufficient since they are based on the analysis of a smaller number of maize samples. Therefore, the aim of this study was to collect more data on the matter by considering greater number of analyzed maize samples and to investigate the influence of climate conditions during maize growing season in three different years on the occurrence of DON in maize.

2. Materials and method

2.1. Samples, kits and chemicals

A total of one thousand eight hundred (n = 1800) maize samples were collected in period 2013–2015 year. Samples were collected from Northern (Autonomous Province of Vojvodina) and Central Serbia which represent the most important maize growing areas in Serbia (Fig. 1). Every year after harvest 600 maize samples were taken from Srem, Bačka and Banat regions in Vojvodina and from seven different districts (Mačvanski, Kolubarski, Podunavski, Šumadijski, Braničevski, Pomoravski and district of Belgrade city) in Central Serbia.

Sampling was performed according to EU requirements (European Commission, 2006) in order to overcome irregular mycotoxins distribution. Particular numbers of incremental samples

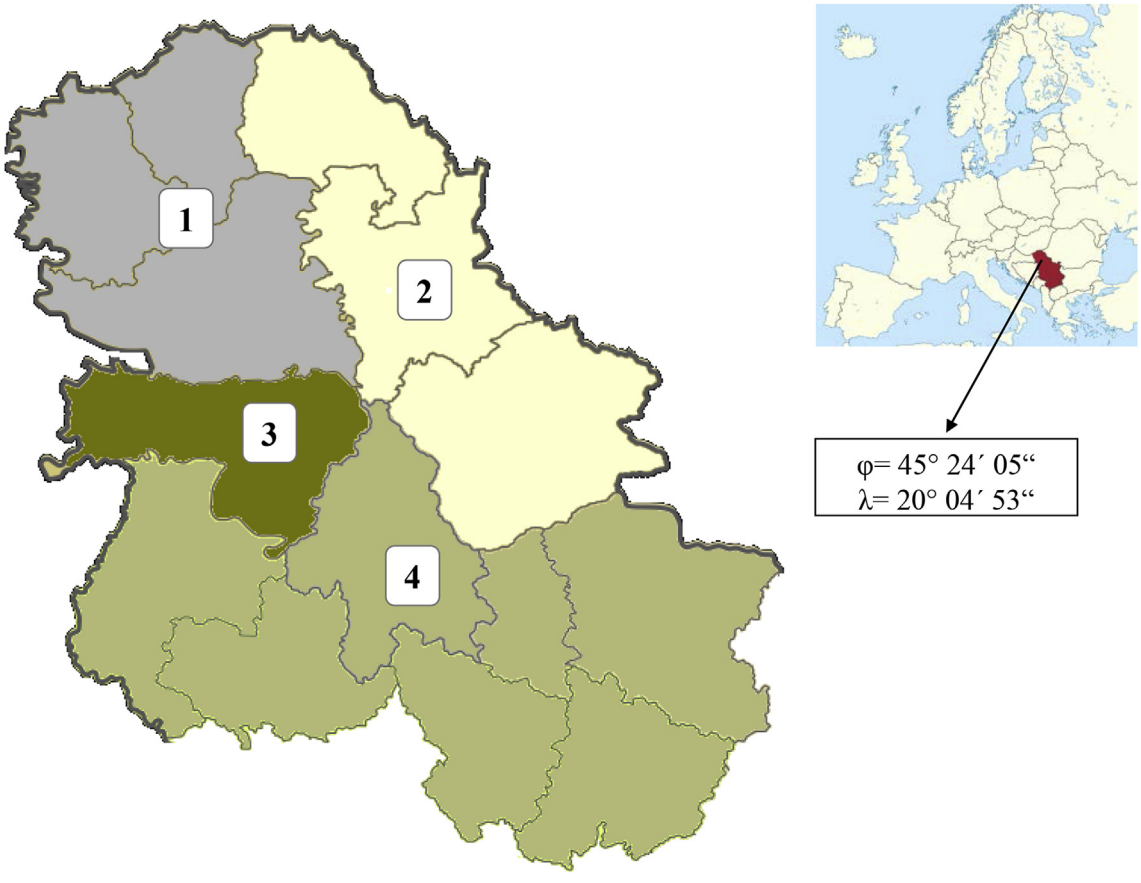

Fig. 1. Regions of maize sampling locations.