

Estimation of possible exposure to Ochratoxin A via consumption of contaminated meat products

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Scientific paper

Summary

*Ochratoxin A is a toxic secondary metabolite produced by the fungi of the *Aspergillus* and *Penicillium* species. The data indicate to frequent ochratoxin A contamination of cereals and cereal products and consequently to possible contamination of meat and meat products. The aim of this study was to determine the possible level of consumer exposure to ochratoxin A through consumption of traditional meat products contaminated with this toxin. Taking into account the dietary habits and concentration of ochratoxin A in various meat products derived from raw material of treated animals the potential exposure to ochratoxin A was estimated. The results showed that the probability of exposure to ochratoxin A in a dose that is above the TWI (120 ng/kg BW per week) is very low. The data showed that through the consumption of pancetta alone 0.8% of the population could be exposed to ochratoxin A in a dose which is above the TWI value defined by the EFSA. The data for kulen, Slavonian sausage, smoked ham and smoked ribs indicated that it is unlikely for the population (average body weight 70 kg) to be exposed to ochratoxin A in doses greater than TWI if consuming contaminated meat products.*

Keywords: ochratoxin A, meat products, exposure, Tolerable Weekly Intake, ELISA

Introduction

Ochratoxin A is a mycotoxin, a secondary metabolite produced by the mold of *Aspergillus* and *Penicillium* species. Regarding the fact that research indicate to its nephrotoxic, neurotoxic, mutagenic, carcinogenic, teratogenic and immunosuppressive activity in people and animals and its wide prevalence as food and feed contaminant, ochratoxin A represents a health hazard worldwide (Krogh et al., 1979; Creppy, 2002; Walker and Larsen, 2005; Khoury and Atoui, 2010).

Penetration of ochratoxin A in human food chain can also occur due to a possible natural contamination of cereals which are a part of feed for animals intended for meat production, but also due to a possible secondary contamination of meat products during the process of their production (Markov et al., 2013). With the goal of preventing consequences on human health, the production of food and feed should be based on principles of good agricultural and manufacturing practice, i.e., the HACCP system, hazard analysis, prevention and control of critical points and removing the source in the technological production procedure. Also, it is necessary to ensure conducting of official controls to the presence of this contaminant and define its maximum allowable/recommended concentrations for different categories of food of animal origin and meat products at the same time (Peršić et al., 2013).

Earlier research in the Republic of Croatia have indicated to a more frequent contamination of feed materials with ochratoxin A (Pepeljnjak et al., 2008; Pleadin et al., 2013). The data have shown that this toxin can also be present in meat products produced from contaminated raw materials (Madsen et al., 1992; Gareis, 1996; Jørgensen, 1998; Creppy, 1999; Gareis and Scheuer, 2000). The highest ochratoxin A concentration in earlier research was determined in offal based meat products such as black pudding and liver sausage due to the highest accumulating exactly in kidney tissue and liver, which are edible tissues and represent a raw material for the production of this category of meat products (Petzinger and Weidenbach 2002; Peršić et al., 2014). Also, the published data speak on contamination of smoked and other meat products where significant levels of ochratoxin A were detected as well (Pfohl-Leszkowicz and Manderville, 2007; Dall'Asta et al., 2010; Markov et al., 2013). Industrial processes of meat product production like warming, salting, drying and storage thereby haven't shown a significant influence to decreasing ochratoxin A concentration in end meat products (Amezequeta et al., 2009).

Considering the fact that there is a long tradition in the Republic of Croatia in the production of autochthonous meat products in rural households and due to the fact that published data have indicated to a more frequent contamination with ochratoxin A precisely of the

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products from the group of fermented sausages and cured meat products (Pleadin et al., 2013), research on consumer exposure to this contaminant via consumption of these products are also significant.

The aim of this study was therefore to determine the possible level of consumer exposure to ochratoxin A through consumption of traditional meat products contaminated with this toxin. The research was conducted after the production of meat products from the raw material obtained from pigs treated with ochratoxin A and the analysis of ochratoxin A concentrations in final meat products. Estimation of exposure was conducted in comparison to TWI (tolerable weekly intake) value of 120 ng/kg body weight, determined by the EFSA (European Food Safety Authority).

Material and methods

Treatment of animals and sampling

The research was conducted on total of 10 farm raised pigs of Seghers hybrid type, body weight of about 70 kg. The animals were divided into two groups: five pigs were treated with ochratoxin A and five pigs were not treated and they represented a control group. Ochratoxin A standard (0.78 mg) was weighed into gelatin capsules filled with 100 mg lactose and was given to animals during the period of 30 days. This ochratoxin A amount equals the amount of 300 µg/kg of ochratoxin A in animal feed with the assumption that average daily intake of feed is 2.5 kg per animal. After the experiment ended, the treated animals and the control were slaughtered and the collected raw material was used in the production of meat products. The experiment on animals was conducted in accordance with current legal regulations in the Republic of Croatia.

Production and preparation of samples for analysis

After collecting raw material for the production, meat products were produced on a family farm by traditional recipes described in professional literature (Pavičić, 2004), which are often used in Croatia. A total of five kinds of traditional meat products were produced from the group of fermented sausages (kulen and Slavonian sausage) and cured meat products (pancetta, smoked ham and smoked ribs). Out of each treated and control animal two samples were produced per kind of product (a total of 50 samples). All the products were stored at -20°C until the analysis to ochratoxin A was conducted. Technological procedures of production were presented within the research by Pleadin et al. (2013). Homogenisator Grindomix GM 200 (Retsch, Germany) was used for homogenization of samples immediately before the conduction of analyses.

Chemicals and reagents

Ochratoxin A standard, of the producer Acros Organics (Geel, Belgium), was used for treating the animals and validating analytical methods. The ELISA method for quantitative determination of ochratoxin A was conducted using ELISA kit Ridascreen® Ochratoxin A 30/15 (R Biopharm, Darmstadt, Germany). The kit contains a microtitration plate with wells coated in antibodies, standard water solution of ochratoxin A (0, 50, 100, 300, 900 and 1800 ng/ml), peroxidase conjugated ochratoxin A, substrate/chromogen (tetramethylbenzidine), stop reagent (1N sulfuric acid), dilution buffer and wash buffer (10 mM phosphate buffer, pH= 7.4). All the chemicals used in the preparation of samples for the analysis of ochratoxin A were analytically pure.

Preparing samples for the analysis

Sausages: 1 g of homogenized meat product was added 0.5 mL 1 M H₃PO₄ and 3 mL ethyl acetate and it was shaken well. After centrifugation (1 min, 2000 rev/min) at room temperature (20 – 25°C), supernatant was transferred with the addition of new 3 mL of ethyl acetate. After mixing and centrifuging, ethyl acetate compounds are connected, 3 mL 0.65 M NaHCO₃ was added and left to be mixed for additional 15 minutes. After centrifuging (5 min, 2000 rev/min), 1 mL lower aqueous phase was transferred and warmed up in a water bath of 100°C during the period of 3 minutes. After cooling, 4 mL distilled water was added and aliquot part of the solution was diluted with 0.13 M NaHCO₃. 50 µL of diluted sample was used for the ELISA test.

Cured meat products: 1 g of sample was added 6 mL ethyl acetate and 0.5 mL 1 M H₃PO₄, shaken well and centrifuged at 3000 rev/min at room temperature. Then a layer of ethyl acetate was transferred by decanting and the procedure of extraction was repeated by its addition of 6 mL. After centrifuging, supernatant was incorporated to the first ethyl acetate part and 3 mL 0.26 M NaHCO₃ was added. The layers were mixed well and centrifuged, and then 0.8 mL of lower aqueous phase was transferred to a test tube and warmed up in a water bath at 100°C during the period of 5 min. The sample was slightly shaken, cooled to room temperature and diluted with 0.2 mL 0.225 M HCl and 1 mL 0.13 M NaHCO₃ and instilled into the wells of ELISA kit.

Determining ochratoxin A

Immunoenzymatic ELISA test was completely conducted according to the kit producer's instructions and using automated analyzer ChemWell 2910 (Awareness Technologies, Inc, USA). All samples and standards were analyzed in duplicates. After the addition of all components of the kit, the reaction was stopped by the addition of 100 µl stop solution and absorbance was measured to 450 nm. During the calculation of ochratoxin A con-

centration in meat products, the results obtained from a calibration curve were multiplied by a responding dilution factor. Conducting of ELISA method was described in detail in the research by Perši et al. (2014).

Validation of ELISA method

The limit of detection (LOD) and the limit of quantification (LOQ) were obtained by adding three, i.e., ten values of standard deviation to mean of 10 analyzed samples obtained from animals from control group. Utilization of method was determined for muscle tissue at the level of 2 µg/kg by analyzing ten enriched samples at the same level. For determining repeatability, the same steps were repeated as for determining the utilization, in the same conditions of the analysis, two more times. The within-laboratory reproducibility was determined in the same way as repeatability by changing the series of ELISA kit, reagents and laboratory devices.

Dietary habits and exposure assessment

The research on dietary habits was conducted according to the EFSA guidebook "General principles for the collection of national food consumption data in the view of a pan-European dietary survey" 2009; 7(12):1435. The research used Food Frequency Questionnaire (FFQ) in order to get the information on the consumed foodstuffs in g/day and the manual "Quantitative models of food and meals" (Senta et al., 2004) so that based on the photos of serving size (the so-called Picture book) the quantity in grams could be determined. The research was conducted on a representative sample of 1000 respondents, aged 18 – 64. While choosing the respondents, different socio-demographic parameters were taken into account in order for the sample to be representative (the ratio village-town, sex, age, regional coverage, etc.). Respondents were listing their consumptions for three days, out of which two were workdays (the interval between them was at least 2 weeks) and one day of the weekend.

A "Handbook for conducting field research" was prepared for the interviewers and it contained instructions

for them, instructions for choosing households (village, town), instructions for choosing the respondents in a household, the rules for interviewing and special instructions for the research (table – instruction for filling out). Prior to conducting a survey, coordinators of interviewers were educated and the control of interviewers was conducted in the field. The first part of the questionnaire contained questions which relate to socio-demographic parameters (region, age, sex, weight, height, employment status, marital status, education, income, etc.), whereas the second part contained a table where the respondents listed data on time and place of the consumption, foodstuff, description of the foodstuff, preparation method, consumed quantities, the frequency of consumption and different additional information (brand, home-made products, etc.). In order to conduct a validation of the questionnaire at the beginning of the research, a pilot project was made.

Taking into account the dietary habits and concentrations of ochratoxin A in different meat products obtained from the raw material of treated animals, estimation of possible exposure was made using a computer software @ Risk® - Risk Analysis Add-in for Microsoft Excel, Ver.5.0.1: Standard Edition (Palisade Corporation, 2008). Differences in average values of ochratoxin A concentrations in produced meat products were examined by variance analysis, and those with obtained p values lower than 0.05 were considered to be statistically significant. Statistical data analysis was conducted using Statistica Ver. 7 software (StatSoft Inc. Tulsa, OK, 1984-2004, USA).

Results and discussion

Within validation framework of analytical method for determining ochratoxin A, utilization, repeatability and within-laboratory reproducibility parameters were determined for muscle tissue as the main ingredient of meat products. Utilization of the method was 64.94% (CV = 24.9%), whereas variation coefficients (CV) for repeatability and within-laboratory reproducibility were 24.62%, i.e., 25.2%. The obtained validation results indicate to the fact that the applied method can be used for quantitative

Table 1. Limit of detection, limit of quantification and amount of ochratoxin A (µg/kg) determined in meat products

Meat product ^a	LOD ^b (µg/kg)	LOQ ^c (µg/kg)	Amount of ochratoxin A in samples Mean ±σ ^d (µg/kg)
Kulen	0.83	1.50	5.17±0.93
Slavonian sausage	0.84	1.07	6.68±0.85
Pancetta	0.30	0.37	6.29±0.64
Smoked ham	0.32	0.40	4.59±0.61
Smoked ribs	0.33	0.46	5.71±0.69

a Ten products of each type b Limit of detection c Limit of quantification d Standard deviation

determination of ochratoxin A in meat products.

Table 1. presents the values of the limit of detection (LOD), the limit of quantification (LOQ) and the amounts of ochratoxin A determined in different meat products produced from the raw material of treated animals

The highest concentration of ochratoxin A in meat products obtained from the raw material of treated animals was determined in Slavonian sausage ($6.68 \pm 0.85 \mu\text{g}/\text{kg}$), whereas the lowest concentration ($4.59 \pm 0.61 \mu\text{g}/\text{kg}$) was found in smoked ham. Ochratoxin A concentration in other meat products ranged from $5.17 \mu\text{g}/\text{kg}$ to $6.29 \mu\text{g}/\text{kg}$. The previous research conducted on homemade dry sausages of the Slavonian sausage type, which were

A (Domijan, 2005; Pepeljnjak et al., 2008), it is important to determine a possible exposure of people to ochratoxin A via consumption of meat products. At the same time it is important to emphasize the fact that in the production of these products offal are not used (kidney, liver). In earlier research offal was determined to cumulate the remains of ochratoxin A at the highest levels, significantly higher in comparison to muscle and fatty tissue (Perši et al, 2014), so generally they represent the most significant source of contamination in meat product.

For the estimation of possible exposure to ochratoxin A, average intake of meat products was determined by

Table 2. Average intake of different types of meat products (g/day) in Croatia (Croatian Food Agency, 2011-2012)

	Meat product (g/day)				
	Kulen	Slavonian sausage	Pancetta	Smoked ham	Smoked ribs
Mean	53,1	27,3	33,4	26,2	58,5
SD	76,4	26,4	34,4	36,3	50,1
Median	30,8	18,0	25,0	16,0	46,5
Mode	36,0	12,0	36,0	18,0	100,0
Min	1,4	1,4	0,2	0,8	4,5
Max	400,0	96,0	200,0	214,0	160,0

collected on the market in the Republic of Croatia (Frece et al., 2010) showed that the concentration of ochratoxin A in this kind of sausage can range from 1.0 to $4.7 \mu\text{g}/\text{kg}$. The results obtained for Slavonian sausage in this research are in accordance with the research by Frece et al. (2010). The research by Dall'Asta et al. (2010) conducted on pigs treated with ochratoxin A during the period of 40 days at a dose of 0.68 mg a day showed that ochratoxin A can be detected in samples of smoked ham. The range of concentrations was from 1.25 to $5.65 \mu\text{g}/\text{kg}$, which is similar to concentrations for the same product obtained in this research ($4.59 \mu\text{g}/\text{kg}$). There are no published professional data for other products included in this research which can be explained by a regional character of the prepared products, especially kulen as a traditional meat product in Croatia.

Ochratoxin A can enter a human food chain in several ways. Cereals and cereal products are a suitable substrate for mold development, consequently for mycotoxin development, so ochratoxin A as well. As cereals represent an important component in human nutrition and are also used for animal feed, a direct intake of ochratoxin A is possible via contaminated cereals, but also via meat and meat products obtained from the animals fed on contaminated feed material (Petzinger and Weidenbach, 2002). As there is a tradition of preparation and consumption of traditional meat products in the Republic of Croatia and earlier research have shown a frequent contamination of cereals and feed material with ochratoxin

the Food Frequency Questionnaire (FFQ) and the results for different meat products are shown in Table 2.

The data have shown that, for the listed meat products, the highest average intake refers to smoked ribs and kulen, and it is $58.5 \text{ g}/\text{day}$, i.e., $53.1 \text{ g}/\text{day}$.

There are two possible approaches for the risk assessment: qualitative and quantitative (FAO/WHO, 1995; CAC, 1999). Qualitative risk assessment represents a descriptive or categorical treatment of information, whereas quantitative approach represents a mathematical analysis of numerical data. Quantitative risk assessment has advantages especially when information and data are needed but, in the lack of that or some time limit, qualitative risk assessment is the only option. Quantitative risk assessment can further be divided into two categories: deterministic and stochastic, i.e., point-estimate and probabilistic risk assessment. The basic difference between them is in input data for risk assessment. The approach that takes into account an individual datum like average value is point-estimate (deterministic), whereas probabilistic (stochastic) considers all available data and uses probability distribution in relation to individual values in describing parameters which contribute the risk. Risk distribution, i.e., risk scale, whether on an individual or on population also result from it. Therefore risk characterization includes variability and uncertainty (Lammerding and Fazil, 2000). Based on the experimental data obtained above, the estimation of exposure point-estimate

Table 3. Ochratoxin A weekly intake assessed according to the type of sample produced from treated animals, average body weight of men and women and calculated with the Croatian Food Agency survey data.

Meat product	Mean concentration ($\mu\text{g}/\text{kg}$)	Daily consumption (g)		Weekly intake (ng/kg BW / week)	
Kulen	5,17	average	53,1	average	27,45
		maximum	400,0	maximally	206,80
Slavonian sausage	6,68	average	27,3	average	18,24
		maximum	96,0	maximally	64,13
Pancetta	6,29	average	33,3	average	20,95
		maximum	200,0	maximally	125,80
Smoked ham	4,59	average	26,2	average	12,03
		maximum	214,0	maximally	98,23
Smoked ribs	5,71	average	58,5	average	33,40
		maximum	160,0	maximally	91,36

was made by a deterministic approach (Brera et al., 2011) which included individual average concentrations of ochratoxin A in products made from raw material of contaminated animals and the data of the research by CFA (Croatian Food Agency) on dietary habits and consumption of certain foodstuffs (CAF, 2011-2012), then by taking into account weight of the consumers of 70 kg (EFSA Scientific Committee, 2012). TWI (tolerable weekly intake) values of ochratoxin A were obtained expressed in nanograms per kilo of body weight and week and compared to TWI reference values of EFSA (EFSA, 2006).

By comparing the obtained results with the reference value of 120 ng/kg of body weight/week (EFSA, 2006), it follows that a weekly exposure of the Croatian population of both sexes would be far below the allowable limit in consumption of any kind of the researched meat products obtained from the raw material of treated animals. If, in assessing exposure, maximum values of consumption of each individual researched product would be taken into account, the consumption of kulen and pancetta would represent the risk.

If data on average intake of individual types of meat products are shown in triangular distribution and ochratoxin A concentration in the same types of meat products produced from the raw material of treated animals in normal distribution using Monte Carlo simulation (10000 iterations), a probability curve of the possibility of ochratoxin A exposure can be obtained for each researched meat product (Figure 1.). The abscissa represents expressed iterations, and the intakes of ochratoxin A from individual meat products converted to daily intake for a person weighing 70 kg considering the average daily consumption of products are shown on the ordinate.

The obtained results have shown that the possibility of exposure to ochratoxin A in a dose above TWI (120 ng/kg BW a week) is very low. The data for kulen, Slavonian

sausage, smoked ham and smoked ribs indicate to a low probability for the population (of average body weight 70 kg) to be exposed to ochratoxin A in doses higher than TWI if they consume contaminated products. As opposed to these products, the data for pancetta have shown that there is a possibility that 0.8% of population to be exposed to ochratoxin A in a dose higher than TWI while consuming that product. The difference in exposure between individual types of meat products can be explained by different average intake of individual products, as well as by a statistically significant difference in concentration of ochratoxin A in those products ($p < 0.05$).

The research which relate to estimation of human exposure to ochratoxin A were published for different groups of food (Bakker, 2002; Milićević et al., 2012; Durate et al., 2012), but data for meat products are insufficient. The study conducted in the Netherlands (RIVM, 2003) covered some groups of foodstuffs for which the contamination with ochratoxin A is characteristic. The data have shown that meat contributes to total intake of ochratoxin A with 8% and that that contribution along with the consumption of cereals, coffee and red wine amounts 79% out of total intake of ochratoxin A. Another study which estimates the possible human exposure to this mycotoxin through meat analysis (Milićević et al., 2012) showed that the meat of pigs and poultry doesn't represent hazard for human health. The research in Italy (Toscana, 2007) conducted on samples of smoked hams showed that the concentration of ochratoxin A in samples of dried ham can amount up to 7.28 $\mu\text{g}/\text{kg}$, with the incidence of contaminated samples of 50%. Not one of those studies included the estimation of exposure to ochratoxin A through dietary habits, but they are the results interpreted in accordance with the incidence of contamination and the concentration of ochratoxin A determined in certain groups of food or food products.

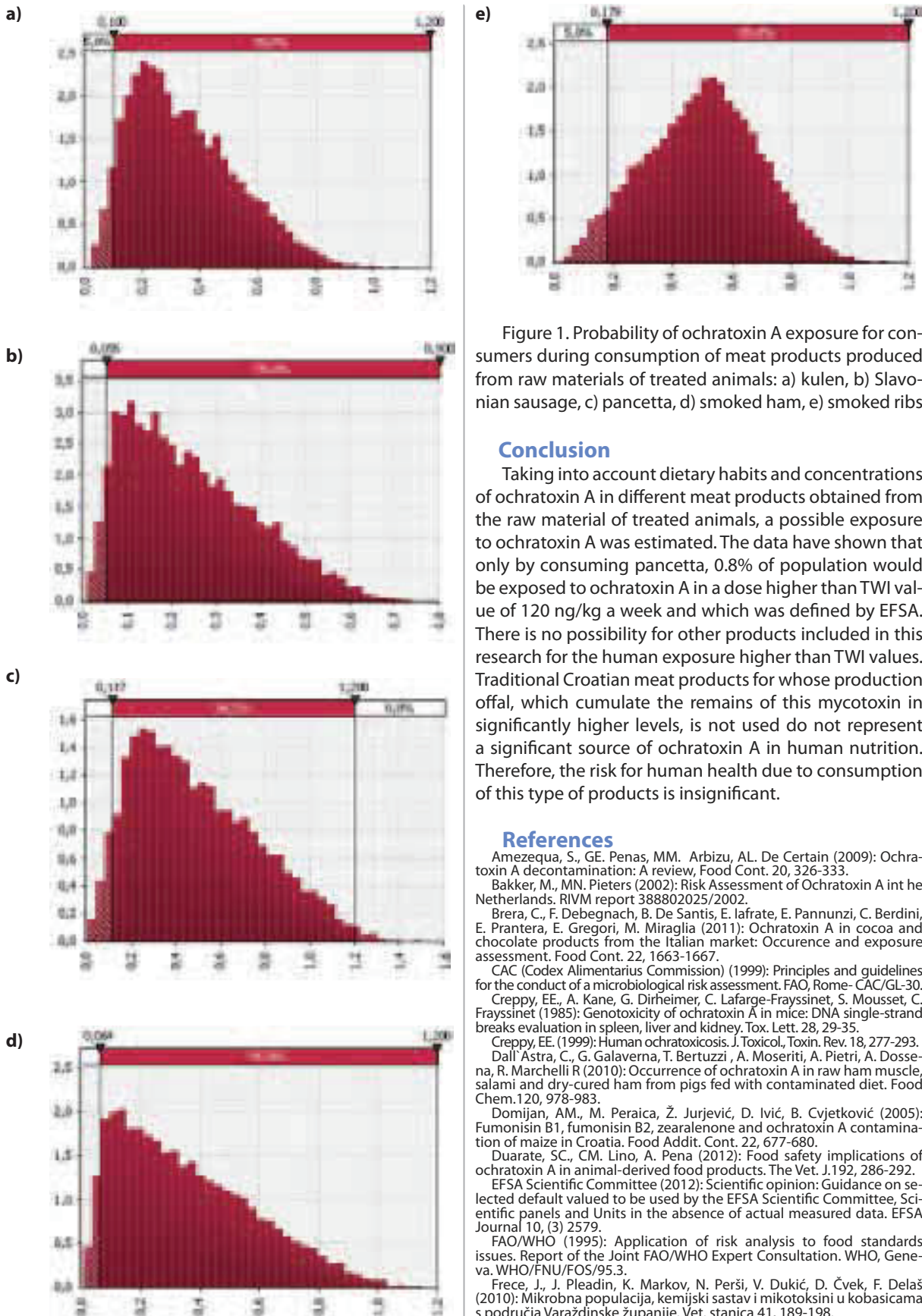


Figure 1. Probability of ochratoxin A exposure for consumers during consumption of meat products produced from raw materials of treated animals: a) kulen, b) Slavonian sausage, c) pancetta, d) smoked ham, e) smoked ribs

Conclusion

Taking into account dietary habits and concentrations of ochratoxin A in different meat products obtained from the raw material of treated animals, a possible exposure to ochratoxin A was estimated. The data have shown that only by consuming pancetta, 0.8% of population would be exposed to ochratoxin A in a dose higher than TWI value of 120 ng/kg a week and which was defined by EFSA. There is no possibility for other products included in this research for the human exposure higher than TWI values. Traditional Croatian meat products for whose production offal, which cumulate the remains of this mycotoxin in significantly higher levels, is not used do not represent a significant source of ochratoxin A in human nutrition. Therefore, the risk for human health due to consumption of this type of products is insignificant.

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Einschätzung der möglichen Ausgesetzttheit dem Ochratoxin A durch die Konsumation der Fleischprodukte

Zusammenfassung

Ochratoxin A ist der sekundäre toxische Metabolit, den die Schimmelsorten *Aspergillus* und *Penicillium* erzeugen. Die Angaben weisen auf eine häufige Ochratoxin A - Kontamination der Getreide und der Getreideerzeugnisse hin, und demzufolge eine mögliche Kontamination von Fleisch und Fleischerzeugnissen. Das Ziel dieser Untersuchung war, das mögliche Niveau der Ausgesetzttheit der Konsumenten dem Ochratoxin A durch die Konsumation der traditionellen Fleischerzeugnisse, kontaminiert mit diesem Toxin, festzustellen. In Betracht ziehend die Ernährungsgewohnheiten und die Ochratoxinkonzentrationen in verschiedenen Fleischerzeugnissen stammend aus den Rohstoffen von trätieren Tieren, wurde die Möglichkeit der Ausgesetzttheit dem Ochratoxin A eingeschätzt. Die Resultate haben gezeigt, dass die mögliche Ausgesetzttheit dem Ochratoxin A in der Dose über TWI (120 ng/kg TM wöchentlich) niedrig ist. Die Resultate haben gezeigt, dass nur durch die Konsumation von „panceta“ (Speck) 0,8 % der Population dem Ochratoxin A ausgesetzt ist, in der Dose die über TWI Werte von 120 ng/g TM wöchentlich liegt, was seitens EFSA definiert wurde. Die Angaben für „Kulen“ (Dauerwurst aus Schweinefleisch von bester Qualität), slawonische Würste, Schinken und geräucherte Rippen weisen darauf hin, dass es eine geringe Möglichkeit gibt, für die Bevölkerung (durchschnittliche Körpermasse 70 kg) für die Ausgesetzttheit dem Ochratoxin A in Dosen größer als TWI, wenn sie kontaminierte Erzeugnisse konsumiert.

Schlüsselwörter: Ochratoxin A, Fleischerzeugnisse, Ausgesetzttheit, Tolerable Weekly Intake, ELISA

Evaluación de posible exposición a ocratoxina A por la consumación de productos cárnicos contaminados

Resumen

Ocratoxina A es el metabolito secundario tóxico producido por los hongos de géneros *Aspergillus* y *Penicillium*. Los datos indican la contaminación frecuente de los cereales y productos cereales y consiguientemente posible contaminación de carne y productos cárnicos por ocratoxina A. El objetivo de este estudio fue determinar el nivel posible de exposición de consumidores a la ocratoxina A por la consumación de productos cárnicos tradicionales contaminados por esta toxina. Tomando en cuenta las costumbres alimentarias y la concentración de la ocratoxina A en varios productos cárnicos provenientes de carne cruda de los animales medicados, se ha estimado la exposición potencial a ocratoxina A. Los resultados mostraron que la probabilidad de la exposición a ocratoxina A en la dosis por encima de TWI/IST (120 ng/kg del PC por la semana) es muy baja. Los datos muestran que con tan solo consumir panceta 0.8% de la población podría estar expuesta a ocratoxina A en la dosis por encima del valor de la TWI/IST de 120 ng/kg por la semana del PC definida por JECFA. Los datos sobre kulen, salchicha de Eslovenia, jamón ahumado y costilla ahumada indican que es poco probable que la población (con el PC promedio de 70 kg) sea expuesta a ocratoxina A en las dosis por encima de TWI/IST si consume los productos contaminados.

Palabras claves: ocratoxina A, productos cárnicos, exposición, Tolerable Weekly Intake/Ingesta Semanal Tolerable, ELISA

Valutazione della possibile esposizione all'ocratoxina A mediante la consumazione di prodotti della carne contaminati

Riassunto

L'ocratoxina A è un metabolita tossico secondario prodotto da specie dei generi delle muffe *Aspergillus* e *Penicillium*. I dati mostrano la frequente contaminazione dei cereali e dei prodotti del frumento e, di conseguenza, la possibile contaminazione delle carni e dei prodotti della carne. Questa ricerca è stata condotta con lo scopo di accertare il possibile livello di esposizione dei consumatori all'ocratoxina A mediante la consumazione dei prodotti della carne tradizionali contaminati da questa tossina. La possibile esposizione all'ocratoxina A è stata valutata prendendo in considerazione le abitudini alimentari e la concentrazione di ocratoxina A in vari prodotti della carne ottenuti da materie prime degli animali trattati. I risultati ottenuti hanno dimostrato che la probabilità di esposizione all'ocratoxina A in una dose superiore a TWI (120 ng/kg TM la settimana) è molto bassa. I dati hanno dimostrato che soltanto la consumazione della pancetta ha esposto lo 0,8% della popolazione all'ocratoxina A in una dose superiore a 120 ng/kg TM la settimana (in base ai dati EFSA). I dati sul salame kulen, la salsiccia della Slavonia, il prosciutto cotto e le costine di maiale affumicate, invece, hanno evidenziato una bassa probabilità che la popolazione (composta d'individui con massa corporea di 70 kg), una volta consumati i prodotti contaminati, possa essere esposta all'ocratoxina A in una dose superiore a TWI.

Parole chiave: ocratoxina A, prodotti della carne, esposizione, Tolerable Weekly Intake, ELISA