Global Veterinaria 8 (5): 519-524, 2012
ISSN 1992-6197

Ochratoxin: Contamination and Toxicity (A Review)

[1]I. Gholampour Azizi, [2]K. Rahimi and [1]S. Shateri

[1]Department of Veterinary Science, Babol Branch, Islamic Azad University, Babol, Iran
[2]Department of Food Science and Technology, Young Researchers Club,
Quchan Branch, Islamic Azad University, Quchan, Iran

Abstract: It has been increased general worry about potential effect of mycotoxin on human health and animals in recent years. On some countries, authority has put control and audit for mycotoxin level. Ochratoxins produce by some fungi are to the genera of *Aspergillus* and *Penicillium* theses fungi are found in food storage places which produce mycotoxin at suitable moisture and temperature. The toxin affects kidney and liver and by going through placenta causes teratogenic and immunosuppression. Its symptom includes low appetite, weight loss, faintness, depression, high thirst and increased urination. Ochratoxin is one of the major causes of death in human and animal in the contaminated regions. These toxic fungi contaminate food products in different phases of production and processing, especially in suitable heat and moist conditions. Many countries have conducted inspection program and controlled mycotoxins for several years to promote public health. In all cases, implement many plans having the objective of reducing food product impurity by mycotoxin.

Key words: Ochratoxin · Mycotoxin · fungi

INTRODUCTION

These are three types ochratoxins includes of A, B and C in which have some chemical differences, however these differences have obvious influences as toxic potential. Ochratoxins A (OTA) is common type of ochratoxin [1]. OTA producing requires some factors like temperature, activity water (aw) and low consuming elements [2]. Feasible condition for producing OTA by *A. carbonarious,* is 20-15 centigrade 0. 95-0.98 aw [3], for *A.ochraceus* 25-30 centigrade and 0.98 aw [4] and for *Penicillium viridicatum* is 24 centigrade and 0.95-0.99 aw [5]. The most culture media has been used for biosynthesis includes sucrose extract, czapek yeast autolysate [6]. Considering acute and chronic effects of ochratoxin neuropathy and liver cyto-toxicity, it is necessary to constantly control them in food [7]. The permitted contamination limit of ochratoxin in corn is 5 ppb [8]. Forming ochratoxin A (OTA) is dependent to fungous resource, type of product, geographical condition. Its control has been evaluated by any fungous species separately. *A. ochraceus* control, is occurred on stored food, includes standard method for preventing growth of any fungus in dried foods. A general product in which *A. ochraceus* produces OTA has been stored on grains [9]. There are so many strategies for reducing OTA levels. We could reduce OTA as a part of (Hazard Analysis and Critical Control Points) HACCP on critical points on foods chain supply by: 1. Good agriculture method 2. Agriculture species resistant to fungi. 3. Correct use of fungicide. 4. Correct storing of materials. But, applying HACCP design is uncommon. When we don't take unique action successfully, OTA remains on foods and foodstuff [10].

Contamination: OTA has been generally recognized on corns. But it would be found on rice, soya, coffee, cocoa, bean, pea, ground almond and dried fruit [11]. Also it is found on corn derivatives like: flour, bread, pasta [12], beer [13], grape juice and wine [14]. Food produced from corns has some OTA, but is very low [15] *Aspergillus* and *Penicilium*, spread on corns level and develop and spread some mycotoxin during technologically procedure. The fig, raisins, ground almond, coffee are always contaminated to OTA. OTA have been recognized on the meat of animals in which consume contaminated feed [16]. Food contaminations with ochratoxin have been considered by numerous researchers: *Selouane et al*. [17]

Corresponding Author: Khadijeh Rahimi, Department of Food Science and Technology, Young Researchers Club, Quchan Branch, Islamic Azad University, Quchan, Iran.

Table 1: The percent contamination OTA in foods from different countries

Country	Sample	Contamination (%)	References
Croatia	Beans	38	[22]
Spain	wheat bread	100	[23]
	corn, oat, wheat		
Canadian	and rice-based cereals	<30	[24]
Turkey	breakfast cereals	38	[25]
Morocco	rice	26	[26]
Turkey	breakfast cereals	21.62	[27]
German	winter wheat	24.1	[28]
Portugal	Maize bread	70	[29]
Morocco	bread	48	[30]
French	Breakfast cereals	69	[31]

detected the prevalence of ochratoxin in grapes by 59% with 0.08-4 ppb concentration and reported the highest rate of OTA production by *A. niger*. The permitted contamination limit of ochratoxin in corn is 5 ppb [18]. *Abdulkadar et al*. [19] tested 106 samples of corn, nuts, spices, dried fruit and drinks for ochratoxin at Qatar supermarkets in 2004. They reported that 11 samples contained 0.20-4.91ppb ochratoxin with concentration of 0.18-6.81 ppb. In 2004-2005, ochratoxin were tested in 209 samples (spices, dried fruit, corn, wheat and barely) at Tunisian supermarket. Ochratoxin contamination was 59.8% with the mean concentration of 3.5-5.3 ng/g[20]. *Gholampour Azizi et al*. [21] in north Iran detected from 60 wheat flour samples 45 (75%) samples, from 60 rice samples 2 (5%) samples and from 54 spices samples 24 (44.4%) samples contained ochratoxin above the limit of European community regulations (5 ppb)(Table 1).

Toxicity: The ochratoxin A is the most toxicity of ochratoxin[6]. But, some know ochratoxin C is the same as toxin OTA [32]. OTA has been recognized as nephrotoxicity at first. OTA is strong nephrotoxic. It has been tested for all animals except adult ruminants [33]. It cause pig nephropathy [34], Balkan endemic nephropathy in humans [35] and chronic middle nephropathy on the north of Africa [36]. Balkan endemic nephropathy along with ochratoxin has been occurred on some southeast of Europe region [37]. The cancer research international agency, has categorized this toxin on 2B group as a carcinogen compound in human [38]. OTA has been categorized as mutagenic, teratogenic, neurotoxic, immunotoxic properties [35]. LD_{50} (lethal dose) of OTA for the young mouse is 20mg/Kg, whereas LD_{50} of OTA for duck chicken is 3.6 mg.kg [39]. LD_{50} of this toxin on pig is 6-1 mg/kg, 20-30 mg/kg for rat and 48-58 mg/kg is for mouse [40]. In these studies, OTA causes hemorrhage in all critical organs, nephritis and necrosis on liver and lymphatic tissue [35]. Daily Tolerable consuming amount has been suggested by the world health organization about 5 ng OTA/kg bw/ day. In this case it is toxin and has been found on human blood and mother milk [41]. Therefore its exposure to human has been proved. In addition, it is suggested to reduce amount of OTA on food and feed as possible by technology [35].

Prevention: For preventing fungous growth on grains, you should dry them fast and wholly and maintain them on dry place. For preventing OTA forming by *A. ochraceus*, activity of the grain by moisture would reduce to less than 0.8. The most influential method of grains storing includes; steaming, airing. Sealed storing and controlled atmosphere especially in tropical and mid tropical region in which insect damage is critical problem. Controlled atmosphere storing is based on applying atmosphere by low oxygen or high density of dioxide carbon. Using improved atmosphere to control insect helps to the control of fungus [9, 8].

Food Additive by Protection Effect Against OTA Toxin: Antioxidants could reduce mycotoxin damages in this case and have protective role. Therefore antioxidants like melatonin [42], NAC [43], ascorbic acid [44], cyaniding-3-0-B-glucopyranosida [45], retinol, α-tocopherol [46], rosmarinic acid [47], polyphenols [48], aspartame [49], l-methionine and different alkaloids [50] react by toxin effects of OTA. Be aware that α-tocopherol and poly phenols could not protect cytotoxic action of OTA on liver cells [51]. Other materials in which could reduce mycotoxin damages includes: roxazyme-G of sesame, water extract of acanthus and l-â- phenylalanine [9].

Removing Ochratoxin: There is much strategy for reducing OTA level. These methods are used for eliminating or reducing OTA level. These different technology are ranked according physical, chemical and biologically [9], microbiologically methods [52]. Ideal removing toxin method is easy and expensive and don't produce toxin compound or don't change quality parameters of material [53, 9].

Physical Method: Physical methods include division, sorting, purification; peeling, peeling procedure's aim is removing the most contaminated one. They include using absorbent materials as additive food in which absorbed through OTA, hence reduce biologic frequency [54, 9].

Chemical Method: These methods require compounds for removing OTA. We use ammonium, alkali hydrolyze, bisulfites and ozone in some procedures they has been reported as an effective compound for eliminating OTA and other mycotoxins. Although some chemical residue may remain, we don't study toxicity of the reaction products formed. In addition, there is reducing on taste and quality of cared foodstuff [54, 9].

Microbiologic Method: By the aids of microorganism for decomposing, absorb or changing OTA, to remove toxin from contaminated products or when eating mycotoxin [55]. Carboxypeptidase A could damage OTA [56]. Using a toxigenic *A. niger* strain has been suggested as carboxypeptidase source [57]. Other enzymes in which get from *A. niger* and damage OTA includes: lipase [58], enzymatic crude [59] and metalloenzyme [60]. We have one carboxypeptidase from phaffia rhodozyma in which damage more than 90% of OTA [61]. In addition to it special bacteria belongs to *Streptococcus*, *Bifidobacterium*, *Lactobacillus*, *Butyribrio*, *phenylobacterium, pleurotus*, *Saccharomyces*, *Bacillus* and *Acinetobacter* [62] and special fungus belongs to *Aspergillus*, (*A. fumigatus*, *A.* niger, *A. carbonarius*, *A. japonicus*, *A. versicolor*, *A. wentii*, *A. ochraceus)* and *Botrytis, Cladosporium, Phaffia, Penicillium, Rhizopus* (*R. stolonifer, R. oryzae*) [63] could damage more than 95% of OTA on in vivo. In any case, some of them have damage characteristic in vivo condition [64]. In industry, microbiology procedures, reduce OTA amount, includes malt, the last fermentation on beer producing [65] and malolactic fermentation on beer producing [66, 9].

Reducing Ochratoxin Amount Method: As if mould resides on damaged part of ground almond and corns, it should be protected against mechanical damage and insects attack. Using chemical compound like switch prevent producing mycotoxin. For example, fungicide for grapes, against fungus colonization and producing ochratoxin are influential. Fungicide should be applied by special alertness. Because some of them like carbendazim, reducing fungus micro flora, produce OTA. On in vitro, epiphytic yeast activity for biological control of *A. carbonarius* and *A. niger* has been proved on grapes. For avoiding fungi attack and producing OTA, plant moisture and drought stress should be reduced [9, 67, 68]. When the moisture of plant is feasible, you should withdraw. In this case, mechanical damage reduces. As far as possible, only gather rape fruit on basket and plate without contamination. You should omit damaged and contaminated to the soil crop. Corp moisture is reduced fewer than 10% very soon. It has been proved, on coffee drying by the light of sun is cheaper than mechanical drying. Hence, the amount of OTA contamination is higher. Some food diet like coffee and cocoa before drying, have has fermentation phases. This is effective for reducing mould and growth of fungus. Therefore, workers and device should be clean and environment condition, be controlled for avoiding contamination. Peeled corns like cocoa coffee and some corns in which have peeling phases, should be done on correct environment condition and been proved this phases is very sensitive to OTA [9, 69, 68]. Prevention through pre withdrawal management is the best method for controlling mycotoxin contamination. On after withdrawal phases, by storing, process and even by applying mechanical separation or chemical non activation, you could control it. Environment condition are very important on storing phases and it has been suggested stored product be dried and their aw be under 0.70 and temperature is about 20 centigrade and without packing, should be put on 2-3 centigrade. On producing phases on factory, clean condition is maintained. You should apply all export and transformation condition to other countries. After withdrawal, by fungicides like Azoxystrobin, Switch and Scala on beer, it has shown good result against OTA. Treatment by potassium sorbet or propionate calcium prevents OTA contamination. Using antioxidant like vanillic acid, 4-hydroxybenzoic acid and essential oil, extracted from plants like *Thmus vulgaris*, *Aframomum danielli* of OTA growth and synthesis are effective. Using caseinate potassium or activated coal on OTA toxin removing on beers effective about 82%. But theses damage beer quality [8, 9, 68].

CONCLUSION

Ochratoxin contamination causes serious public health problem. Therefore, keeping toxins in low levels in foodstuff is of great importance. To reach this goal, foodstuff should be kept away from probable contamination. There are various methods to control mycotoxins at stores by reducing moisture and preventing them from damage. As there is no reduction in the level of mycotoxin after cooking, it would be feasible to pass some regulations to decrease mycotoxigenic moulds in food. There should be some standards for suitable storage of food and feed; because, these products may get contaminated which endanger human health; therefore, it is crucial to pass some regulations to reduce mould contamination.

REFERENCES

1. Pohland, A.E., S. Nesheim and L. Friedman, 1992. Ochratoxin A, a review. Pure Appl. Chem., 64: 1029-1046.
2. Ringot, D., A. Chango, Y.J. Schneider and Y. Larondelle, 2006. Toxicokinetics and toxicodynamics of ochratoxin A, an update. Chem. Bio. Interac., 159: 18-46.
3. Mitchell, D., R. Parra, D. Aldred and N. Magan, 2004. Water and temperature relations of growth and ochratoxin A production by *Aspergillus carbonarius* strains from grapes in Europe and Israel. J. Appl. Microbiol., 97: 439-445.
4. Ramos, A.J., N. Labernia, S. Marin, V. Sanchís and N. Magan, 1998. Effect of water activity and temperature on growth and ochratoxin production by three strains of *Aspergillus ochraceus* on a barley extract medium and on barley grains. Int. J. Food Microbiol., 44: 133-140.
5. Northolt, M.D., H.P. Vanegmond and W.E. Paulsch, 1979. Ochratoxin A production by some fungal species in relation to water activity and temperature. J. Food Prot., 42: 485-490.
6. Xiao, H., S. Madhyastha, R.R. Marquardt, S. Li, J.K. Vodela, A.A. Frohlich and B.W. Kemppainen, 1996. Toxicity of ochratoxin A, Its opened lactone form and several of its analogs: Structure-activity relationships. Toxicol. Appl. Pharmacol., 137: 182-192.
7. Kumar, V., M.S. Basu and T.P. Rajendran, 2008. Mycotoxin research and mycoflora in some commercially important agricultural commodities. Crop Protection, 27: 891-905.
8. Shrif, S.O., E.E. Salama and M.A. Abdel-Wahhab, 2008. Mycotoxins and child health: The need for health risk assessment. Int. J. Hyg. Environ. Health. doi: 10.1016/j.ijheh.2008.08.002.
9. Amezqueta, S., E. Gonzalez-Penas, M. Murillo-Arbizu and A.L. De Cerain, 2009. Ochratoxin A decontamination: Food Control, 20: 326-333.
10. Abrunhosa, L., R.M. Robert and A. Venâncio, 2010. Biodegradation of Ochratoxin A for Food and Feed Decontamination. Toxins, Rev., 2: 1078-1099.
11. Varga, J., K. Rigo, J. Teren and A. Mesterhazy, 2001. Recent advances in ochratoxin research I. Production, detection and occurrence of ochratoxins. Cereal Res.Communications, 29: 85-92.
12. Majerus, P., I. Cutko, A. Dreyer, S. El-Dessouki, W. Eyrich, H. Reusch, B. Schurer and H.U. Waiblinger, 1993. Zur Belastungssituation von Ochratoxin A, in Lebensmitteln pflanzlichen Ursprungs, Deutesche Lebensmitteln- Rundschau, 89: 112-113.
13. El-Dessouki, S., 1992. Ochratoxin A in beer. Deutsche Lebensmittel-Rundschau, 11: 354-355.
14. Zimmerli, B. and R. Dick, 1996. Ochratoxin A in table wine and grape juice: occurrence and risk assessment. Food Addit. Contam., 13: 655-668.
15. Ngundi, M.M., L.C. Shriver-Lake, M.H. Moore, F.S. Ligler and C.R. Taitt, 2006. Multiplexed detection of mycotoxins in foods with a regenerable array. J. Food Prot., 69: 3047-3051.
16. Jorgensen, K., 1998. Survey of pork, poultry, coffee, bier and pulses for ochratoxin A. Food Addit. Contam., 5: 550-554.
17. Selouane, A., S. Zouhair, D. Bouya, A. Lebrihi and A. Bouseta, 2009. Natural Occurrence of Ochratoxigenic Aspergillius Species and Ochratoxin a in Moroccan Grapes. World Applied Sciences Journal, 7: 297-305.
18. Merwe, K.J., P.S. Steyn, L. Fourie, D.B. Scott and J.J. Theron, 1965. Ochratoxin A, a toxic metabolite produced by *Aspergillus ochraceus.* Wilh. Nature, 205: 1112-1113.
19. Abdulkadar, A.H.W., A.A. Al-Ali, F.M. Al-Kildi and J.H. Al-Jedah. 2004. Mycotoxins in foods available in Qatar. Food Control, 15: 543-548.
20. Ghali, R., K. Hmaissia-khlifa, H. Ghorbel, K. Maaroufi and A. Hedili, 2008. HPLC determination of ochratoxin A in high consumption Tunisian foods. Food Control, Article in Press.
21. Gholampour Azizi, I. and M. Azarmi, 2009. Determination of Zearalenone and Ochratoxin in Food stuffs. World Applied Science Journal, 7: 1388-1391.
22. Domijan, A. M., M. Peraica, V. Zlender, B. Cvjetkovic, Z. Jurjevic, S. Topolovec-Pintaric and D. Ivic, 2005. Seed-borne fungi and ochratoxin A contamination of dry beans (*Phaseolus vulgaris* L.) in the Republic of Croatia. Food Chem. Toxicol., 43: 427-432.
23. Legarda, T.M. and P.A. Burdaspal, 2001. Occurrence of ochratoxin A in samples of bread marketed in Spain and twelve other countries. Alimentaria, 321: 89-96.

24. Roscoe, V., G.A. Lombaert, V. Huzel, G. Neumann, J. Melietio, D. Kitchen, S. Kotello, T. Krakalovich, R. Trelka and P.M. Scott, 2008. Mycotoxins in breakfast cereals from the Canadian retail market: A 3-year survey, Food Additives & Contaminants: Part A: Chemistry, Analysis, Control, Exposure & Risk Assessment, 25: 347-355.
25. Kabak, B., 2009. Ochratoxin A in cereal-derived products in Turkey: Occurrence and exposure assessment. Food Chem. Toxicol., 47: 348-352.
26. Juan, C., A. Zinedine, L. Idrissi and J. Mañes, 2008. Ochratoxin A in rice on the Moroccan retail market.Int. J. Food Microbiol., 126: 83-85.
27. Ozden, S., A.S. Akdeniz and B. Alpertunga, 2012. Occurrence of ochratoxin A in cereal-derived food products commonly consumed in Turkey. Food Control, 25: 69-74.
28. Birzele, B., A. Prange and J. KrÄmer, 2000. Deoxynivalenol and ochratoxin A in German wheat and changes of level in relation to storage parameters. Food Addit. Contam., 17: 1027-1035.
29. Juan, C., A. Pena, C. Lino, J.C. Molto and J. Manes, 2008. Levels of ochratoxin A in wheat and maize bread from the central zone of Portugal. Int. J. Food Microbiol., 127: 284-289.
30. Zinedine, A., C. Juan, L. Idrissi and J. Manes, 2007. Occurrence of ochratoxin A in bread consumed in Morocco. Microchem. J., 87: 154-158.
31. Molinie, A., V. Faucet, M. Castegnaro and A. Pfohl-Leszkowicz,. 2005. Analysis of some breakfast cereals on the French market for their contents of ochratoxin A, citrinin and fumonisin B_1: development of a method for simultaneous extraction of ochratoxin A and citrinin. Food Chem., 92: 391-400.
32. Muller, G., H. Rosner, B. Rohrmann, W. Erler, G. Geschwend, U. Grafe, B. Burkert, U. Moller, R. Diller, K. Sachse and H. Kohler, 2003. Effects of the mycotoxin ochratoxin A and some of its metabolites on the human cell line THP-1. Toxicology., 184: 69-82.
33. Krogh, P., 1992. Role of ochratoxin in disease causation. Food Chem. Toxicol., 30: 213-224.
34. Pfohl-Leszkowicz, A. and R.A. Manderville, 2007. Ochratoxin A: An overview on toxicity and carcinogenicity in animals and humans. Mol. Nutr. Food Res., 51: 61-99.
35. Pfohl-Leszkowicz, A., T. Petkova-Bocharova, I.N. Chernozemsky and M. Castegnaro, 2002. Balkan endemic nephropathy and associated urinary tract tumours: A review on aetiological causes and the potential role of mycotoxins. Food Addit. Contam., 19: 282-302.
36. Pfohl-Leszkowicz, A., 2009. Ochratoxin A and Aristolochic Acid Involvement in Nephropathies and Associated Urothelial Tract Tumours. Arh. Hig. Rada Toxicol., 60: 465-483.
37. Castegnaro, M., R. Plestina, G. Dirheimer, I.N. Chernozemisky and H. Bartsch (Eds.), 1991. Mycotoxins, Endemic Nephropaty and Urinary Tracts Tumours, IARC Scientific Publication No. 115, International Agency for Research on cancer, Lyon.
38. International Agency for Research on Cancer. 1993. In: IARC Monograph on the Evaluation of Carcinogenic Risks to Humans, IARC, Lyon, pp: 489.
39. Pitt, J.I., 2000. Toxigenis fungi and mycotoxins, Br. Med. Bull., 56: 184-92.
40. Obrien, E. and D.R. Dietrich, 2005. Ochratoxin A: The continuing enigma. Crit. Rev. Microbiol., 35: 33-60.
41. Zimmerli, B. and R. Dick, 1995. Determination of ochratoxin A at the ppt level in human blood, serum, milk and some foodstuffs by high-performance liquid chromatography with enhanced fluorescence detection and immunoaffinity column cleanup: methodology and Swiss data. J. Chromatogr. B., 666: 85-99.
42. Abdel-Wahhab, M.A., M.M. Abdel-Galil and M. El-Lithey, 2005. Melatonin counteracts oxidative stress in rats fed with an ochratoxin A contaminated diet. J. Pineal Res., 38: 130-135.
43. Schaaf, G.J., S.M. Nijmeijer, R.F.M. Mass, P. Roestenberg, E. M. de Groene and J. Fink-Gremmels, 2002. The roles of oxidative stress in the ochratoxin Mediated toxicity in proximal tubular cells. Biochemistry and Biophysic Acta., 1588:149-158.
44. Grosse, Y., L. Chekir-Ghedira, A. Huc, S. Obrecht-Pflumio, G. Dirheimer and H. Bacha, 1997. Retinol, ascorbic acid and a-tocopherol prevent DNA adduct formation in mice treated with the mycotoxins ochratoxin A and zearalenone. Cancer Letters, 114: 225-229.
45. Guerra, M.C., F. Galvano, L. Bonsi, E. Speroni, S. Costa, C. Renzulli and R. Cervellati, 2005. Cyanidin-3-o-b-glucopyranoside, a natural free-radical scavenger against aflatoxin B_1 and ochratoxin A - Induced cell damage in a human hepatoma cell line (Hep G2) and a human colonic adenocarcinoma cell line (CaCo-2). British Journal of Nutrition, 94: 211-220.

46. Baldi, A., M.N. Losio, F. Cheli, R. Rebucci, L. Sangalli and E. Fusi, 2004. Evaluation of the protective effects of alpha-tocopherol and retinol against ochratoxin A cytotoxicity. Br. J. Nut., 91: 507-512.
47. Renzulli, C., F. Galvano, L. Piredomenico, E. Speroni and M.C. Guerra, 2004. Effects of Rosmarinic acid against aflatoxin B1 and ochratoxin A - Induced cell damage in a human hepatoma cell line (Hep G2). J. Appl. Toxicol., 24: 289-296.
48. Costa, S., A. Utan, R. Cervellati, E. Speroni and M.C. Guerra, 2007. Catechins: Natural free-radical scavengers against ochratoxin A-induced cell damage in a pig kidney cell line (LLC-PK1). Food Chem. Toxicol., 45: 1910-1917.
49. Creppy, E.E., 2002. Update of survey, regulation and toxic effects of mycotoxins in Europe. Toxicology Letters, 17: 19-28.
50. Lee, S.E., B.S. Park, P. Bayman, J.L. Baker, W.S. Choi and B.C. Campbell, 2007. Suppression of ochratoxin biosynthesis by naturally occurring alkaloids. Food Addit. Contam., 24: 391-397.
51. Hundhausen, C., C. Bösch-Saadatmandi, K. Augustin, R. Blank, S. Wolffram and G. Rimbach, 2005. Effect of vitamin E and polyphenols on ochratoxin Ainduced cytotoxicity in liver (HepG2) cells. J. Plant Physiol., 162: 818-822.
52. FAO/WHO/UNEP, 1999a. Minimising risks posed by mycotoxins utilising the HACCP Concept. Third Joint FAO/WHO/UNEP International Conference on Mycotoxins, 8 b, 1-13. Available at: ftp://ftp.fao.org/es/esn/food/myco8b.pdf (accession date: 2008/03/10).
53. EMAN, 2004. Fact sheets on HACCP - Prevention and control. Available at: <http:// 193.132.193.215/eman2/fsheet3_1.asp> (accession date: 2008/03/10).
54. Riley, R.T. and W.P. Norred, 1999. Mycotoxin prevention and decontamination—A case study on maize. Food Nutr. Agric., 23: 25-32.
55. Karlovsky, P., 1999. Biological detoxification of fungal toxins and its use in plant breeding, feed and food production. Nat. Toxins., 7: 1-23.
56. Deberghes, P., A.M. Betbeder, F. Boisard, R. Blanc, J.F. Delaby, S. Krivobok, R. Steiman, F. Seigle-Murandi and E.E. Creppy, 1995. Detoxification of ochratoxin A, a food contaminant: Prevention of growth of *Aspergillus ochraceus* and its production of ochratoxin A. Mycotoxin Research, 11: 37-47.
57. Varga, J., K. Rigó and J. Téren, 2000. Degradation of ochratoxin A by *Aspergillus* species. Int. J. Food Microbiol., 59: 1-7.
58. Stander, M.A., U.T. Bornscheuer, E. Henke and P.S. Steyn, 2000. Screening of commercial hydrolases for the degradation of ochratoxin A. J. Agr. Food Chem., 48: 5736-5739.
59. Abrunhosa, L., L. Santos and A. Venancio, 2006. Degradation of ochratoxin A by proteases and by a crude enzyme of Aspergillus niger. Food Biotechnol., 20: 231-242.
60. Abrunhosa, L. and E.A. Venâncio, 2007. Isolation and purification of an enzyme hydrolyzing ochratoxin A from *Aspergillus niger*. Biotechnological Letters., 29: 1909-1914.
61. Peteri, Z., J. Teren, C. Vagvolgyi and J. Varga, 2007. Ochratoxin degradation and adsorption caused by astaxanthin-producing yeasts. Food Microbiol., 24: 205-210.
62. Reddy, K.R.N., N.I. Farhana, B. Salleh and C.A.F. Oliveira, 2010. Microbiological Control of Mycotoxins: Present Status and Future Concerns, Current Research, Technology and Education Topics in Applied Microbiology and Microbial Biotechnology A.Mende Z- Vilas.
63. Abrunhosa, L., R. Serra and A. Venâncio, 2002. Biodegradation of ochratoxin A by fungi isolated from grapes. J. Agr. Food Chem., 50: 7493-7496.
64. Fuchs, S., G. Sontag, R. Stidl, V. Ehrlich, M. Kundi and S. Knasmuller, 2008. Detoxification of patulin and ochratoxin A, two abundant mycotoxins, by lactic acid bacteria. Food Chem. Toxicol., 46: 1398-1407.
65. Krogh, P., B. Hald, P. Gjersten and F. Myken, 1974. Fate of ochratoxin A and citrinin during malting and brewing experiments. Appl. Microbiol., 28: 31-34.
66. ICV, Institute Français du Vin, 2002. Ochratoxine A dans les vins. État des connaissances. ICV, pp: 9.
67. Richard, J.L., 2007. Some major mycotoxins and their mycotoxicoses—An overview. Int. J. Food Microbiol., 119: 3-10. www.elsevier.com/locate/ ijfoodmicro. doi: 10.1016/j.ijfoodmicro.2007.07.019.
68. Duarte, S.C., A. Pena and C.M. Lino, 2010. A review on ochratoxin A occurrence and effects of processing of cereal and cereal derived food products. Food Microbiol., 27: 87-189.
69. Glenn, A.E., 2007. Mycotoxigenic Fusarium species in animal feed. Animal Feed Sci. Technol., 3-4: 213-240.