codex alimentarius commission

FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS

WORLD HEALTH ORGANIZATION

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CODEX COMMITTEE ON CONTAMINANTS IN FOODS

Second Session

The Hague, the Netherlands, 31 March - 4 April 2008

DISCUSSION PAPER ON OCHRATOXIN A IN COFFEE

BACKGROUND

1. The Codex Committee on Contaminants in Foods (CCCF) at its First Session held in Beijing, China (April 2007) considered a discussion paper on Ochratoxin A (OTA) in coffee (CX/CF 07/1/18). After some discussion, the Committee decided to establish an electronic working group, chaired by Brazil, to prepare a revised discussion paper for consideration at the Second session of the CCCF.

2. As agreed by the CCCF (see ALINORM 07/30/41 para. 113) , the electronic working group prepared the present revised discussion paper by incorporating new data and other relevant information including those submitted to the First session of the CCCF. This discussion paper is accompanied by a draft project document proposing new work (as presented in Annex II to this document) and possibly an outline of the proposed draft Code of Practice (as presented in Annex III to this document). Brazil, Cameroon, China, Côte d'Ivoire, European Community, Ghana, Madagascar, Philippines, Japan, Sweden, Switzerland, Thailand, Uganda, United Kingdom, European Coffee Federation, International Coffee Organization and FAO participated in the electronic working group. A list of the participants in the electronic working group is presented in Annex IV to this document.

INTRODUCTION

3. OTA is a mycotoxin that can be found in different sources, as cereals, wine, grape juice, dried vine fruit, beer, coffee, cocoa and spices. Cereals and cereal based products (flour, bran, breakfast cereals, bread, pasta, biscuits, cereal bars and others) represent the main source of dietary exposure, both for adults and children, particularly in Europe and North America, due to the presence of Penicillium verrucosum which is found in temperate climates. Besides the previously mentioned products, wine, beer, cocoa and coffee constitute other potential sources of exposure, as well as grape juice and raisins, which are of particular concern for children, due to their food consumption in relation to their body weight (CX/FAC 06/38/26).

4. OTA is produced in food by the following fungi: Penicillium verrucosum (cereals in Europe), P. nordicum (meat products) and Aspergillus species, especially A. ochraceus and related species (A. westerdijkiae and A. steynii), and A. carbonarius with a small number of isolates of A. niger which are more important for coffee. The latter two species are more important for grape products. All of these fungi occupy various ecological niches, affect several commodities, and have different frequency of occurrence in different geographical regions (WHO, 2002, Taniwaki *et al.*, 2003, Frisvad *et al.,* 2006).

5. A study carried out in Brazil investigated the distribution of OTA producing fungi and their ability to produce the toxin in 872 isolates. The most common species found was Aspergillus niger (549 isolates), but only 3% of the isolates produced OTA. A. ochraceus was also commonly found (269 isolates), with 75% being able to produce OTA. A. carbonarius was found (54 isolates) in only one region, which has a warm climate, and only in beans from the drying yard or from storage. However 77% were able to produce OTA (Taniwaki *et al*., 2003). A recent study has revised the taxonomy: most isolates described as A. ochraceus were likely to be A. westerdijkiae and A. steynii (Frisvad *et al*., 2004, Frisvad *et al*., 2006).
6. There are two main species of coffee, with several varieties, responsible for the world production and trade of the product: Coffea arabica (arabica coffee), that can be grown from an altitude of 600-2000m and average temperature between 18 ^{o} – 22.5 ^{o}C , in the wet tropics and Coffea canephora (robusta coffee), that can be grown at an altitude below 600m and average temperature between 22 ^{o} – 26 ^{o}C , also in the wet tropics.
7. According to FAOSTAT (2006) coffee is one of the most important and valuable commodities produced in 78 countries around the world, by 20 to 25 million families (most of them small farmers). It represents, for many developing countries, the major share of their total exports. Nineteen of these producer countries were responsible for 90% of the total world production (Annex I to this document). From the estimated US$55 billions per annum for the total retail coffee market, exporting countries are expected to receive around 15% of it.
8. This discussion paper considers different aspects related to coffee contamination with OTA: toxicological evaluation, sampling and analytical methods, data of occurrence, estimated exposure, and measures for the prevention and reduction of OTA contamination in coffee.

CHEMICAL STRUCTURE

9. OTA consists of a polyketide-derived dihydroisocoumarin moiety linked through the 12-carboxy group to phenylalanine. Due to its chemical structure (Figure 1), it is soluble in most organic solvents such as alcohols, ketones, benzene, and chloroform, but it is not very soluble in water and it is insoluble in petroleum ethers and saturated hydrocarbons. It degrades in alkaline media. OTA is also stable to the level of heat utilized in ordinary cooking. Heating at temperatures above 250 ^{o}C for several minutes is required to reduce its concentration. It is detectable by a blue-green fluorescence in ultraviolet light.

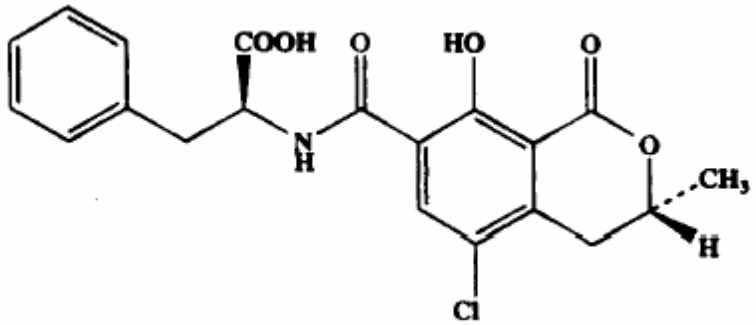

Figure 1. Chemical structure of ochratoxin A.

TOXICOLOGICAL EVALUATION

10. The toxicity of OTA has been reviewed by the International Agency for Research on Cancer (IARC, 1993) that has classified OTA as a possible human carcinogen (group 2B), and by the Joint FAO/WHO Expert Committee on Food Additives (JECFA, 2001; JECFA, 2007).

11. The kidney is considered to be the main target organ for OTA effects, and nephrotoxic and carcinogenic properties have therefore been the major focus of the safety evaluation performed by scientific bodies. Furthermore, OTA also has teratogenic, immunotoxic and possibly neurotoxic properties (Krogh, 1987; Kuiper-Goodman, 1996).

12. The JECFA considered, at its 56th meeting in February 2001 that new data raised further questions about the mechanisms by which OTA causes nephrotoxicity and renal carcinogenicity and the interdependence of these effects. The mechanism by which OTA causes carcinogenicity is unknown, although both genotoxic and non-genotoxic modes of action have been proposed. JECFA noted that studies to fill these gaps of knowledge are in progress and recommended a review of the results when they become available. JECFA retained the previously established Provisional Tolerable Weekly Intake (PTWI) of 100ng/kg of body weight, pending the results of these studies (WHO, 2002).

13. The JECFA considered at the 68th meeting in June 2007, the previous PTWI of 100 ng/kg bw was retained. The new data, including data on mode of action of OTA in the kidney, do not indicate any reason to modify the previous risk assessment approach taken by JECFA. The current estimate of overall dietary exposure of OTA from cereals, based mainly on European data, is about 8 – 17 ng/kg bw per week, based on processed cereals, compared with 25 ng/kg bw per week in the previous evaluation, based on raw cereals. (JECFA, 2007).

14. The European Food Safety Authority's (EFSA) Scientific Panel on Contaminants in the Food Chain established 120 ng/kg bw as the Tolerable Weekly Intake (TWI) for OTA (EC, 2002).

METHODS OF ANALYSIS AND SAMPLING

Sampling

15. The random nature of fungal contamination of raw materials (such as coffee) and thus the uneven distribution of subsequent OTA contamination means that sampling is a major issue (EFSA, 2002). Studies have indicated that in order to obtain a sample as representative as possible it is necessary to take a large number of incremental samples taken at various places distributed throughout a lot or sub-lot. The incremental samples are combined to provide an aggregate sample for analysis.

16. A study to measure the total variance (sampling, sample preparation and analytical variances) associated with testing green coffee for OTA demonstrated that this was influenced by the sample size, the sub-sample size, the particle size and the type of mill used to grind the sample (Vargas *et al*., 2004).

17. A number of studies have been carried out to develop sampling plans for OTA in green coffee (Thompson *et al*., 2002; Vargas *et al*., 2004; Vargas *et al*., 2005; EC, 2006 and Vargas *et al*., 2006). According to Vargas *et al*. (2005), the lognormal theoretical distribution should be selected to model sample OTA test results because it gave the best fit.

Analytical Methods

18. Several published analytical methods for the determination of OTA in cereals (maize, barley, wheat and rye), derived products (wheat bran and wholemeal products), and beverages (wine, beer and coffee) have been formally validated in collaborative studies (Vargas *et al*., 2005a, Ratola *et al*., 2006, Sugita-Konishi *et al*., 2006).

19. A criteria-based approach, whereby a set of performance criteria is established with which the analytical method used should comply, is appropriate. The criteria-based approach has the advantage that, by avoiding setting down specific details of the method used, developments in methodology can be exploited without having to reconsider or modify the specified method.

20. Performance Criteria for Methods of Analysis established by the European Commission (EC, 2006) are shown in Table 1.

21. The performance criteria established for methods should include all the parameters that need to be addressed by each laboratory such as the detection limit, repeatability coefficient of variation, reproducibility coefficient of variation, and the percent recovery necessary for various statutory limits (Table 1). Utilizing this approach, laboratories would be free to use the analytical method most appropriate for their facilities. Analytical methods internationally recognized may be used. The methods are regularly monitored and improved depending upon technological progress (CX/FAC 06/38/18).

Table 1 - Performance criteria for OTA (EC, 2006)

Level µg/kg	RSD_r	RSD_R	Recovery
< 1	≤ 40	≤ 60	50 to 120
1-10	≤ 20	≤ 30	70 to 110

Precision RSD_r may be calculated as 0.66 times the precision RSD_R at the concentration of interest. The analytical result must be expressed in x ± U (U = expanded measurement uncertainty)

The detection limits of the methods used are not stated as the precision values are given at the concentrations of interest;

The precision values (standard deviation) can be calculated using the Horwitz equation, i.e.:

$RSD_R = 2^{(1-0.5 \log C)}$

Where:

- RSD_R is the relative standard deviation calculated from results generated under reproducibility conditions [(sR/ X) x 100]
- C is the concentration ratio (i.e. 1 = 100g/100g; 0.001 = 1,000 mg/kg)

OCCURRENCE OF OTA IN COFFEE

22. The natural occurrence of OTA in green, roasted and soluble coffee has been reported, as described below.

Green coffee beans

23. OTA as a contaminant in green coffee beans was first reported by Levi *et al*. (1974) in 22 out of 335 samples at levels ranging from 20 to 360 µg/kg, with a detection limit of 20 µg/kg.

24. Later, Levi (1980) using data from several coffee companies, reported that OTA was not found in 502 consignments of commercial green coffee entering the port of Trieste, Italy. On the other hand, OTA was detected at levels of 24 and 96 µg/kg, in two of 201 green coffee samples analysed in the USA.

25. OTA concentration ranging from <10 to 200 µg/kg was found in 9 out of 31 green coffee samples by Norton *et al*. (1982).

26. Cantafora *et al*. (1983) reported OTA in 9 out of 40 commercial green coffee samples at levels of 0.5 to 23 µg/kg and Tsubouchi *et al*. (1985) reported levels from 9.9 to 46.0 µg/kg in 4 of 22 samples.

27. Micco *et al*. (1989) found OTA levels from 0.2 to 15.0 µg/kg in 17 out of 29 green coffee samples. Studer-Rohr *et al*.(1995) detected OTA in 13 out of 25 samples at levels ranging from 1.2 to 56.0 µg/kg.

28. Data from MAFF (1996) reported OTA occurrence in 110 out of 291 green coffee samples of Coffea arabica and C. canephora, imported by the UK from 27 different countries. The highest levels in C. arabica and C. canephora were 9 and 27.3 µg/kg, respectively.

29. OTA was detected in green coffee beans at levels ranging from 0.1 to 17.4 µg/kg (Nakajima *et al*., 1997) and from 0.1 to 4.6 µg/Kg (Trucksess *et al*., 1999).

30. Romani *et al*. (2000) showed 106 out of 162 green coffee samples OTA positive at levels ranging from 0.1 to 48 µg/kg.

31. Leoni *et al*. (2001) detected OTA in 27 out of 132 green coffee samples, collected at point of sale, at levels from 0.7 to 47.8 µg/kg.

32. Data collected from EU Member States on the OTA occurrence in 1704 green coffee samples showed 36% positive samples and the mean level was 3.6 µg/kg. (European Commission, 2002).

33. Taniwaki *et al*. (2003) reported that the average OTA content in 135 samples of mature cherries from trees, overripe cherries from trees, overripe cherries from the ground, drying yard and storage was 0.1, < 0.2, 1.6, 2.1 and 3.3 µg/kg, respectively. Although OTA levels varied widely, only 9 of 135 samples exceeded 5 µg/kg, with 1 sample of poor quality coffee exceeding 100 µg/kg.

34. Batista *et al*. (2003) reported that 22% of 40 green coffee samples were contaminated with OTA at levels from 0.47 to 4.82 µg/kg with an average contamination of 2.45 µg/kg.

35. Martins *et al*. (2003) analysed 60 green coffee samples. Twenty (33.3%) were contaminated with OTA at levels ranging from 0.2 to 7.3 µg/kg. The average level was 2.38 µg/kg.

36. Nakajima (2003) reported the presence of OTA in 50 out of 121 green coffee samples at a level of 0.07 to 72.7 µg/kg, imported from several producing countries (Africa, Asia). The effect of handpicking to remove OTA and fungal infection was also evaluated. The levels of OTA were <0.05 to 7.7 µg/kg and 0.02 to 72.7 µg/kg in good beans and bad beans, respectively.

37. OTA was detected in 37 green coffee samples at levels from <0.16 to 6.24 µg/kg and an average of 3.20 µg/kg (Gollücke *et al*. 2004). Five samples were separated into sound and defective beans. Sound beans showed levels ranging from 0.22 to 0.80 µg/kg (average 0.46 µg/kg) and defective beans from 0.42 to 17.46 µg/kg and an average 4.52 µg/kg.

38. Yani (2004) reported OTA contamination in green coffee beans collected from farmers, district and regency sectors in Indonesia. Twelve (40%), 8 (53%), and 5 (33%) out of 30, 45, and 15 samples, respectively, were contaminated with OTA at levels from 0.09 to 3.74 µg/kg (average of 0.70 µg/kg); 0.08 – 0.75 µg/kg (average of 0.30 µg/kg) and 0.16 – 1.03 µg/kg (average 0.38 µg/kg) at farmers, collectors district and regency, respectively.

39. Pardo *et al*. (2004) detected OTA contamination in all 57 green coffee samples from different origins. The average level was 6.7 µg/kg, ranging from 1.3 to 31.5 µg/kg. OTA levels in Arabica and Robusta coffee samples were not significantly different.

40. A total of 36 green coffee samples of different origin were analysed by Pérez de Obanos *et al*. (2005). The highest concentration of OTA were found in Vietnamese robusta samples, with range of 0.64 to 8.05 µg/kg, that also showed the highest percentage of defective beans (7.6%).

41. Moraes *et al*. (2006) analysed 30 green coffee samples and found OTA levels ranging from <1 to 133.7 µg/kg, with an average contamination of 14.7 µg/kg.

42. Surveillance carried out in Japan during 2004-2006 found OTA in 5 out of 20 green coffee samples at the level of 0.1 to 0.8 µg/kg (Japan, 2007).

43. Additional information, including the geographical origin of analysed samples, is shown at Table 2 (Taniwaki, 2006).

Table 2 - Incidence of ochratoxin A (OTA) in green coffee worldwide

Origin	Number of positive/ Total samples	Range of OTA(μg/kg)	Coffee type	Reference
Angola	0/4	< 20[a]	N.S.[b]	Levi *et al.* (1974)
Brazil	3/7	Trace – 360	"	"
Colombia	17/139	Trace – 50	"	"
Cameroon	0/1	< 20[a]	"	"
Ivory Coast	1/12	Trace	"	"
Uganda	1/ 2	Trace	"	"
Unknown	7/102	Trace	"	"
Unknown	0/502	N.D.[c]	"	Levi (1980)
Unknown	2/201	N.D.[c] – 96	"	"
Brazil	10/14	0.2 – 3.7	Arabica	Micco *et al.* (1989)
Cameroon	3/3	Traces – 2.2	Robusta	"
Colombia	1/ 2	3.3	Arabica	"
Costa Rica	1/ 2	Traces	Arabica	"
Ivory Coast	1/2	1.3	Robusta	"
Kenya	0/2	< 0.01[a]	Arabica	"
México	1/ 2	1.4	Arabica	"
Zaire	2/2	8.4 – 15.0	Robusta	"
Brazil	3/5	2.0 – 7.4	N.S.[b]	Studer-Rhor *et al.* (1995)
Colombia	3/5	1.2 – 9.8	"	"
Central America	0/1	< 0.5[a]	N.S.[b]	Studer-Rhor *et al.* (1995)
Costa Rica	0/1	< 0.5[a]	"	"
Guatemala	0/1	< 0.5[a]	"	"
Ivory Coast	2/2	9.9 – 56.0	"	"
Kenya	0/3	< 0.5[a]	"	"
New Guinea	0/1	< 0.5[a]	"	"
Tanzania	1/1	2.2	"	"
Zaire	1/1	17.3	"	"
Unknown	2/4	2.2 – 11.8	"	"
America, Africa, Papua New Guinea	31/153	0.2 – 9.0	Arabica	MAFF, 1996
America, Africa, Asia	55/75	0.2 – 27.3	Robusta	"
Unknown	24/63	0.2 – 7.7	N.S.[b]	"
Yemen	7/10	0.7 – 17.4	Arabica	Nakajima *et al.* (1997)
Tanzania	5/9	0.1 – 7.2	Arabica	"
Indonesia	2/9	0.2 – 1.0	Robusta	"
Ethiopia	0/1	< 0.1[a]	Arabica	"
Central America	0/6	< 0.1[a]	Arabica	"
South America	0/12	< 0.1[a]	Arabica	"
East Africa	33/42	0.2 – 62.0	N.S.[b]	Heilmann *et al.* (1999)

West Africa	9/9	0.3 – 5.0	"	"
Asia	20/29	0.2 – 4.9	"	"
Central America	6/15	0.2 – 0.8	"	"
South America	5/17	0.2 – 1.0	"	"
South America	9/19	0.1 – 4.9	N.S.[b]	Trucksess *et al.* (1999)
Africa	76/84	0.5 – 48.0	N.S.[b]	Romani et al. (2000)
Latin America	19/60	0.1 – 7.7	"	"
Asia	11/18	0.2 – 4.9	"	"
Brazil	27/132	0.7 – 47.8	Arabica	Leoni *et al.* (2001)
Unknown	374/1704	0.2 – 80.0	N.S.[b]	EC (2002)
Brazil	9/135	0.2 – 100	Arabica	Taniwaki *et al.* (2003)
Brazil	5/40	0.4 – 4.82	Arabica	Batista *et al.* (2003)
Brazil	20/60	0.2 – 7.3	Arabica	Martins *et al.* (2003)
Brazil	22/54	0.3 – 160	Arabica	Moraes & Luchese (2003)
Africa, Asia	50/121	0.07 – 72.7	N.S.[b]	Nakajima (2003)
Brazil	17/37	0.2 – 6.2	Arabica	Gollücke *et al.* (2004)
Indonesia	25/60	0.08 – 3.7	Robusta	Yani, 2004
Africa	12/12	2.4 – 23.3	Robusta	Pardo *et al.* (2004)
America	31/31	1.3 – 27.7	Arabica	"
Asia	14/14	1.6 – 31.5	Arabica and Robusta	"
Colombia	3/3	0.08 – 0.12	Arabica	Pérez de Obanos *et al*. (2005)
Costa Rica	7/9	0.02 – 0.12	Arabica	"
Brazil	9/11	0.01 – 1.6	Arabica	"
Vietnam	9/9	0.64 – 8.05	Robusta	"
India	2/2	0.10 - 0.14	Robusta	"
Uganda	2/2	0.28 – 0.31	Robusta	"
Brazil	15/30	1.0 – 133.7	Arabica	Moraes *et al.* (2006)
Various origins	5/20	0.1 – 0.8	N.S. [b]	Japan (2007)

[a] Corresponds to the detection limit of the method; [b] Not Specified; [c] Not Detected (limit not specified).

Roasted and Soluble Coffee

44. As a result of the introduction of a HPLC method, for the determination of OTA in coffee beans and coffee products, the presence of OTA in commercial roasted coffee beans was reported for the first time by Tsubouchi *et al*. (1985). Five out of 68 samples contained levels from 3.2 to 17 µg/kg.

45. OTA was detected in 16 out of 40 coffee brews (1.0 – 7.8 µg/kg) prepared using roasted coffee samples Studer-Rohr *et al*. (1994a, 1994b, 1995). In these studies, a partial destruction of OTA was found after roasting.

46. The presence of OTA in 20 out of 30 commercial roasted coffee samples was described by Koch *et al*. (1996) at levels ranging from 0.3 to 7.5 µg/kg.

47. Pittet *et al*. (1996) surveyed 116 soluble coffee samples from various countries and different manufacturers. The contamination levels ranged from <0.2 to 15.9 µg/kg. The highest levels of OTA were detected among soluble coffee samples adulterated with coffee husks and/or coffee parchments (mean contamination level of 5.9 µg/kg). By comparison, OTA concentrations in pure soluble coffee samples were significantly lower, with a mean contamination level of 1.1 µg/kg.

48. Patel *et al*. (1997) detected OTA in 17 out of 20 roasted coffee samples with levels ranging from 0.2 to 2.1 µg/kg.

49. Van der Stegen *et al*. (1997) analysed 633 samples of coffee products collected from the markets of different European countries. The levels of OTA in roasted coffee ranged from <0.5 to 8.2 µg/kg, with an average of 0.8 µg/kg. From 149 soluble coffee samples only four exceeded a level of 10 µg/kg, with a mean of 1.3 µg/kg.

50. OTA was detected by Jorgensen (1998) in 11 out of 11 roasted coffee beans samples at levels ranging from 0.1 to 3.2 µg/kg, and mean of 0.5 µg/kg.

51. Trucksess *et al*. (1999) detected OTA in 9 out of 13 roasted ground coffee samples in the USA at levels ranging from 0.1 to 1.2 µg/kg and mean of 0.4 µg/kg.

52. The occurrence of OTA was detected by Prado *et al*. (2000) in soluble coffee and roasted ground coffee samples. Samples of soluble (mean of 0.7 µg/kg) and roasted ground coffee (mean of 1.7 µg/kg) showed levels ranging from 0.3 to 1.8 µg/kg and 0.1 to 5.9 µg/kg, respectively.

53. In a study performed by Fazekas *et al*. (2002), in 50 commercial coffee samples, 66% were contaminated with OTA. The average was 0.57 µg/kg, ranging from 0.17 to 1.3 µg/kg.

54. OTA was detected in 4 out of 26 samples of roasted coffee in Japan, at levels of 0.1 to 8.9 µg/kg (Nakajima, 2003).

55. Lin *et al*. (2005) analysed 51 coffee samples detecting OTA in 13 (25%) samples with levels ranging from <0.1 to 0.5 µg/kg.

56. Data collected from EU Member States on the OTA occurrence in 1184 processed coffee samples showed 46% of positive samples and the mean level was 1.1 µg/kg. (European Commission, 2002).

57. Moraes *et al*. (2006) analysed 33 market samples of roasted coffee, including low cost brands and found OTA levels ranging from < 1 to 13 µg/kg and mean of 1.5 µg/kg.

58. OTA was detected in 81 out of 82 instant coffee samples surveyed in Brazil, at levels ranging from 0.17 to 6.3 µg/kg (Almeida *et al*., 2007).

59. Surveillance carried out in Japan during 2004-2006 found OTA in 13 out of 29 roasted coffee samples at the level of 0.1 to 0.9 µg/kg. For instant coffee, OTA was found in 35 out of 36 samples at the level of 0.8 to 4.2 µg/kg (Japan, 2007).

60. Additional information on the presence of OTA in roasted and soluble coffee is shown at Tables 3 and 4, respectively.

61. Surveys all over the world have confirmed the presence of OTA in commercial raw, roasted and soluble coffee. Extensive sampling of raw coffee from all origins and both types of coffee (Arabica and Robusta) has shown that OTA contamination may be more frequent in some areas, but that coffee from every producing country is not entirely free from contamination (Taniwaki, 2006).

Table 3 - Worldwide incidence of ochratoxin A (OTA) in commercial roasted coffee

Retail country	Number of positive/ Total samples	Range of OTA (µg/kg)	Reference
Japan	5/68	3.2 – 17	Tsubouchi *et al.* (1988)
United Kingdom	17/20	0.2 – 2.1	Patel *et al.* (1997)
Europe	?/484	0.5[a] – 8.2	Van der Stegen *et al.* (1997)
Denmark	11/11	0.1 – 3.2	Jorgensen (1998)
Spain	29/29	0.2 – 5.6	Burdespal and Legarda (1998)
United States	9/13	0.1 – 1.2	Trucksess *et al.* (1999)
Brazil	23/34	0.3 – 6.5	Leoni *et al.* (2000)
Brazil	41/47	0.1 – 5.9	Prado *et al.* (2000)
Germany	22/67	0.3 – 3.3	Wolff (2000)
Germany	273/490	0.2 – 12.1	Otteneder and Majerus (2001)
Canada	42/71	0.1 – 2.3	Lombaert *et al.* (2002)
Hungary	33/50	0.17 – 1.3	Fazekas *et al.* (2002)
Japan	4/26	0.1 - 8.9	Nakajima (2003)
Brazil	17/33	1 – 13	Moraes *et al.* (2006)
Japan	13/29	0.1 – 0.9	Japan (2007)

[a] Corresponds to the detection limit of the method.

Table 4 - Worldwide incidence of ochratoxin A (OTA) in commercial soluble coffee

Retail country	Number of positive/ Total samples	Range of OTA (µg/kg)	Reference
Austrália	7/22	0.2 – 4.0	Pittet *et al.* (1996)
United States	3/6	1.5 – 2.1	"
Germany	5/9	0.3 – 2.2	"
United Kingdom	64/80	0.1 – 8.0	Patel *at al.* (1997)
Europe	?/149	0.5[a] – 27.2	Van der Stegen *et al.* (1997)
Spain	9/9	0.2 – 1.1	Burdaspal and Legarda (1998)
Brazil	8/10	0.3 – 1.8	Prado *et al.* (2000)
Brazil	16/16	0.5 – 5.1	Leoni *et al.* (2000)
Germany	23/52	0.3 – 9.5	Wolff (2000)
Germany	12/41	0.3 – 4.8	Otteneder and Majerus (2001)
Canada	20/30	0.1 – 3.1	Lombaert *et al.* (2002)
Brazil	81/82	0.17 – 6.3	Almeida *et al.* (2007)
Japan	35/36	0.8 – 4.2	Japan (2007)

[a] Corresponds to the detection limit of the method.

FACTORS AFFECTING THE PRESENCE OF OTA IN COFFEE

62. The presence of OTA in coffee beans is a result of contamination by a few fungal species, mainly Aspergillus ochraceus, A. westerdijkiae, A. niger and A. carbonarius (Urbano *et al*., 2001a; Taniwaki *et al*., 2003; Batista *et al*., 2003; Suarez-Quiroz *et al*., 2004). Practices that restrict fungal development throughout the production chain must be adopted to avoid OTA contamination and preserve the final quality of coffee.

63. Mycological analyses of cherry beans collected from trees did not demonstrate the presence of these ochratoxigenic fungi, indicating that OTA contamination in green coffee is a post-harvesting problem. The main sources of these fungi come from soil, equipment and drying yard surfaces (Taniwaki *et al*., 2003).

64. When coffee cherries are overripe, the fruits generally dry on the tree and then fall off. If these beans remain for a long period on the soil, an increase of infection by ochratoxigenic species may occur. If infected beans are mixed with healthy ones, fungal contamination will spread.

65. The influence of the harvest procedure, fruit ripening and drying process on risk contamination was evaluated. It was concluded that gleaning coffee and coffee dried directly on bare ground were the highest sources of contamination (Moraes and Luchese, 2003).

66. Moisture content and water activity (aw) are the most important factors that influence fungal growth. To avoid the development of toxigenic fungi in coffee, the water activity should be kept under control from post-harvest to final processing.

67. Drying coffee beans to 11-12% mc, which correspond to aw of 0.60, avoids subsequent fungal growth and consequently OTA production. Laboratory studies have shown that the limiting aw for growth of A. ochraceus (A. westerdijkiae) and A. niger are 0.79 and 0.77, respectively (Palacios-Cabrera *et al*, 2004).

68. Different climates and production systems confer different risks for the development of OTA-producing fungi. In shaded plantations, the soil remains relatively moist even if there is a dry season. In some regions the harvest period (typically stretching over three months) coincides with a rainy season or humid conditions. Under these scenarios, there is a high risk of fallen coffee fruit to become grossly contaminated. In unshaded production systems where the harvest is conducted in a dry season, the risk is reduced. (FAO, 2005).

69. Coffee roasting may remove a very significant percentage of OTA, as shown in Table 5. However depending on the roasting process the residual OTA percentage in coffee can differ from 0 to 100%.

Table 5 - Effect of roasting on ochratoxin A (OTA) reduction

Number of samples	Toxin origin	Roasting condition	% of reduction	References
4	Inoculation[a]	200°C/10-20 min	0 –12	Tsubouchi *et al.* (1988)
2	Natural[b]	5 – 6 min/dark roasting	90 – 100	Micco *et al.* (1989)
3	Natural	252°C/100-190 sec	14 – 62	Studer-Rohr *et al.* (1995)
2	Inoculation	252°C/100-190 sec	2 – 28	"
6	Natural	223°C / 14 min	84	Blanc *et al.* (1998)
3	Inoculation	200ºC/10 min (medium roasting)	22.5	Urbano *et al.* (2001b)
3	"	200ºC/15 min (medium roasting)	48.1	"
3	"	210ºC/10 min (medium dark)	39.2	"
3	"	210ºC/15 min (medium dark)	65.6	"
3	"	220ºC/10 min (dark)	88.4	"
3	"	220ºC/15 min (dark)	93.9	"
6	Natural	470 ºC roasting air and 217ºC in coffee bed before cooling/2.5 min (light medium)	67.3	Van der Stegen *et al.* (2001)
6	Natural	490 ºC roasting air and 228ºC in coffee bed before cooling/2.5 min (dark)	63.3	"
6	Natural	490 ºC roasting air and 228ºC in coffee bed before cooling/4 min (dark medium)	73.5	"
5	Natural	400 ºC roasting air and 224ºC in coffee bed before cooling/10 min (light medium)	53.1	"
5	Natural	490 ºC roasting air and 228ºC in coffee bed before cooling/2.5 min (dark)	83.7	"
9	Natural	260ºC roasting air/5min	66.5	Perez de Obanos *et al.* (2005)

[a] Coffee beans inoculated with toxigenic spores of *Aspergillus ochraceus*; [b] Naturally contaminated beans.

70. The transfer of OTA into coffee brew has been studied in several parts of the world. Leoni *et al*. (2000) prepared the coffee beverage by two methods: a) the drip method1 and b) the Brazilian country style method2. No significant difference was observed between the two methods in terms of extraction of the toxin using five contaminated samples containing between 0.7 and 6.5 µg/kg OTA. The drip methods extracted 85 ± 15% and the Brazilian country style 74 ± 20% of the OTA initially present in the roast and ground coffee.

71. Van der Stegen *et al*. (1997) found differences in the transfer of OTA into coffee beverage from 38 to 133%, with an average of 93.8% and a coefficient variation of (CV) 28%. According to Viani (1996), 70% of OTA is transferred to beverage during coffee preparation.

72. Coffee brew was prepared by the three brewing processes more used in Europe: a) moka, b) auto-drip and c) espresso. A reduction of OTA level was greater when using a espresso coffee maker (49.8%) than using auto drip (14.5%) or moka brewing (32.1%) in this study carried out by Perez de Obanos *et al*. (2005).

[1] Drip coffee: to 20g of roast and ground coffee in a paper filter 200 mL of boiling water were added and allowed to filter.

[2] Brazilian Country Stile Method : to 20 g of roast and ground coffee in a beaker 200 mL boiling water were added mixed with the powder under heat in order to keep the boiling while mixing and then filtered through a pepar filter

DIETARY EXPOSURE

73. Exposure to mycotoxins has been associated with the observation of adverse effects in humans and livestock. Health concerns related to dietary exposure to mycotoxins depend on: the levels of mycotoxins in food as consumed, the amount of food consumed, the body weight and physiological state of the individual, and the bioavailability and toxicity of the mycotoxin to humans. Other dietary factors may increase or decrease the toxicity (Kuiper-Goodman, 1994).

74. In its evaluation of OTA in 2001, JECFA calculated the human exposure to OTA from different food sources. The approach followed resulted in a mean total intake of OTA of about 45 ng/kg bw per week, assuming a body weight of 60 kg. Cereals and wine contributed about 25 and 10 ng/kg of b.w per week, respectively, to mean intake in Europe, whereas grape juice and coffee each contributed 2-3 ng/kg of bw per week. Other food products (dried fruits, beer, tea, milk, cocoa, poultry and pulses) contributed less than 1 ng/kg bw per week (WHO, 2002).

75. The current estimates are well below the PTWI. Contamination levels in the majority of raw cereal samples were below 5 µg/kg. Due to the very small number of samples contaminated above the highest proposed limit of 20 µg/kg, such an ML would have very limited impact compared with no ML. The Committee concluded that the use of an ML of 5 or 20 µg/kg would be unlikely to have an impact on dietary exposure to OTA. The Committee was unable to reach a conclusion regarding the situation in developing countries, due to the lack of adequate data to consider (JECFA, 2007). This is because the question to JECFA regarding exposure was specific to cereals and effects of various maximum levels, as cereals are the by far biggest contributor to overall exposure.

76. In an evaluation of OTA exposure, in the position paper prepared by Sweden for the 31st session of CCFAC, the mean values used for coffee were those from countries with high consumption rates. In the calculation, coffee represented 12% of the total European intake and 8.6 or 3.6% of the TDI established by the Nordic group or JECFA, respectively (CX/FAC 99/14).

77. In 2002, an assessment of OTA dietary intake by the population of EU was published. Coffee represented 10% of the total intake, while cereals and cereal products contributed (50%) to the mean European total human OTA exposure. For the overall population, the OTA intake from coffee ranged from 0.06 to 0.42 ng/kg bw/day. In most European countries no marked differences in dietary intake values among groups of population were found (EC, 2002).

78. A total diet study performed in France (Leblanc *et al*., 2005) showed that the estimated average OTA intake of the French population was 2.2 ng/kg bw/day for adults aged 15 or more, 4.1 ng/kg bw/day for children aged 3 to 14. The 95th percentile exposure was 3.6 ng/kg bw/day for adults and 7.8 ng/kg bw/day for children. The food groups contributing most (>70 %) to the exposure for both population groups were cereals and cereal products. Grape-based products (raisins, table grapes, juice and wine), coffee, nuts and oilseeds contributed less than 5 % to the total exposure.

PREVENTION AND REDUCTION OF OTA IN COFFEE

79. Some research projects have been carried out to identify the factors related to the formation of OTA in coffee. The most recent initiative came from the governments of producing countries, with collaboration of the FAO, the International Coffee Organization (ICO) and the European Coffee Industry, resulting in the project “Enhancement of Coffee Quality through the Prevention of Mould Formation”.

80. Good practices should be applied at all stages of coffee production to reduce OTA contamination, as follows:

(a) During harvesting, ground beneath the coffee plants should be covered with a clean tarpaulin or plastic sheet to avoid contact of the harvested cherries with the soil, foreign material and cherries already fallen during the crop season. The latter are likely to be highly contaminated with fungal spores, posing a high risk for OTA contamination. Also overripe cherries should not be mixed with those just picked from the tree.

(b) After harvesting, fresh cherries should be processed as quickly as possible, either by dry or wet processing, preferably on the same day.

(c) Processing facilities should be located in a dry area, with equipment and facilities maintained clean. Byproducts (husk, pulp) obtained during processing, must be disposed of in a separated area and composted before their utilization in the orchard.

(d) Undesirable or risk material, such as husks, floaters, un-hulled cherries or mouldy beans, should be separated from good quality cherries.

(e) Water utilized must be of good quality.

(f) Equipments must be cleaned thoroughly after use.

(g) Drying must be carried out as quickly as possible, either in wet or dry processing, to avoid fungal growth and OTA production. Cherries and beans must be dried on clean surfaces, spread in layers with maximum of 4 cm thickness; protected to avoid re-wetting; be constantly turned over to permit uniform drying, in order to reach a maximum safe moisture content of 12.5%.

(h) Only clean bags should be used for dried coffee.

(i) Bags must be transported and loaded/unloaded only in dry weather or in a protected environment to prevent re-wetting.

(j) Warehouses must be well aerated and the grains must be protected against rain and moisture from the ground, walls and ceiling.

(k) Dried coffee in bags must be stored on pallets above ground level and distant from the walls.

CONCLUSIONS & RECOMMENDATIONS:

81. The present Discussion Paper on OTA in coffee leads to the following broad conclusions and recommendations of the electronic working group for consideration at the Second Session of the CCCF:

I The CCCF should start new work for development of a Codex Code of Practice for the Prevention and Reduction of OTA in Coffee. The CCCF should consider the proposed draft project document as presented in Annex II, for submission to the 31st Session of the Commission, through the Critical Review of the Executive Committee, for approval of new work.

II This Code, subject to the approval of new work by the Commission, should be developed on the basis of FAO Guidelines for the Prevention of Mould Formation in Coffee (available at http://www.coffee-ota.org). The proposed outline of the Code presented in Annex III to this discussion paper can also be used as a basis.

III The necessity of setting a maximum level for OTA in coffee should be assessed after the development of the Code of Practice and it should consider:

- The significant differences between the level of OTA contamination in green, roasted and soluble coffee.
- The significant variations of the OTA reduction during processing which is dependent on the technological process used.
- The necessity to obtain reliable data on wide world exposure and occurrence after the Code of Practice has been implemented.

REFERENCES

1. Almeida, A.P., Alaburda, J., Shundo, L., Ruvieri, V., Navas, S.A., Lamardo, L.C.A., Sabino, M. 2007. Ochratoxin A in Brazilian instant coffee. **Brazilian J. Microbiol., 38:** 300-303.
2. Batista, L.R., Chalfoun, S.M, Prado, G., Schwan, R.F., Wheals, A E. 2003. Toxigenic fungi associated with processed (green) coffee beans (*Coffea arabica* L.) **Int. J. Food Microbiol., 85:** 293– 300.
3. Blanc, J., Pittet, A., Muñoz-Box, R., Viani, R., 1998. Behavior of ochratoxin A during green coffee roasting and soluble coffee manufacture **J. Agric. Food Chem., 46:** 673-675.
4. Burdaspal, P.A., Legarda, T.M. 1998. Ochratoxin A in roasted and soluble coffee marketed in Spain. **Alimentaria, 296:** 31-35.
5. Cantafora, A., Grossi, M., Miraglia, M., Benelli, L. 1983. Determination of ochratoxin A in coffee beans using reversed-phase high performance liquid chromatography. **La Rivista della Societa Italiana di Scienza dell'Alimentazione, 12:** 103–108.
6. Codex Committee on Food Additives and Contaminants (CCFAC). 1999. CX/FAC 99/14. Position paper on ochratoxin A.
7. Codex Committee on Food Additives and Contaminants (CCFAC). 2005. ALINORM, 05/28/12, Appendix XXIX.
8. Codex Committee on Food Additives and Contaminants (CCFAC). 2006. ALINORM, 06/29/12. Discussion Paper on Ochratoxin A (OTA) in Coffee, paragraph 145.
9. Codex Committee on Food Additives and Contaminants (CCFAC). 2006. CX/FAC 06/38/18. Working document for information and use in discussion on the GSCTF.
10. Codex Committee on Food Additives and Contaminants (CCFAC). 2006. CX/FAC 06/38/26. Discussion paper on ochratoxin A in wine.
11. Codex Committee on Contaminants in Foods (CCCF). 2007. ALINORM, 07/30/41. Discussion Paper on Ochratoxin A (OTA) in Coffee, paragraph 109 – 113.
12. European Community. 2002. Report on tasks for scientific co-operation "Assessment of dietary intake of Ochratoxin A by the population of EU Member States", January 2002. http://europa.eu.int/comm/food/food/chemicalsafety/contaminants/task_3-2-7_en.pdf.
13. European Community. 2006. Commission Regulation (EC) Nº 401/2006 of 23th February 2006. Laying down the methods of sampling and analysis for the official control of the levels of mycotoxins in foodstuffs.
14. Food and Agriculture Organization (FAO). 2005. Good Hygiene Practices along the coffee chain: a training resource for coffee producing countries. Food and Agriculture Organization of the United Nations: Rome, Italy.
15. Fazekas B., Tar, A. K, Zomborszky-Kovacs, M. 2002. Ochratoxin A contamination of cereal grains and coffee in Hungary in the year 2001 **Acta Veterinaria Hungarica, 50:** 177–188.
16. FAOSTAT 2006. http:// faostat.fao.org
17. Frisvad, J.C., Frank, J.M., Houbraken, J.A.M.P., Kuijpers, A.F.A., Samson, R.A. 2004. New ochratoxin A producing species of *Aspergillus* section *Circumdati*. **Stud. Mycol., 50:** 23-43.
18. Frisvad, J.C., Thrane, U., Samson, R.A., Pitt, J.I. 2006. Important mycotoxins and the fungi which produce them. . In: Advances in Food Mycology. Hocking, A.D., Pitt, J.I., Samson, R.A. and Thrane, U. (eds). Springer, New York. p. 3-31.
19. Gollücke, A.P.B, Taniwaki, M.H, Tavares, D.Q. 2004. Survey on ochratoxin A in Brazilian green coffee destined for exports. **Cienc. Tecnol. Aliment., 24:** 641-645.
20. IARC. 1993. Monographs on the Evaluation of Carcinogenic Risks to Humans, Some Naturrrally occurring Substances: Food Items and Constituents, Heterocyclic Aromatic Amines and Mycotoxins, Vol 56, International Agency for Research on cancer: Lyon, p. 489-521.
21. Joint FAO/WHO Expert Committee on Food Additives (JECFA). 2001. Safety Evaluation of certain Mycotoxins in Food. Food and Agriculture Organization: Rome, Italy. 281p.
22. Joint FAO/WHO Expert Committee on Food Additives (JECFA). 2007. JECFA/68/SC. Summary and Conclusions. Geneva, 19-28 June, 2007. 18p.

23. Jorgensen, K. 1998. Survey of pork, poultry, coffee, beer and pulses for ochratoxin A. **Food Addit. Contam., 15:** 550-554.
24. Koch, M., Steinmeyer, S., Tiebach, R., Weber, R., Weyerstahl, P. 1996. Bestimmung von Ochratoxin A in Ro¨stkaffee. (Determination of ochratoxin A in roasted coffee.) **Dtsch. Lebensm.-Rundsch., 2:** 48-51.
25. Krogh, P. 1987. Ochratoxins in Food. In: P. Krogh ed. Mycotoxins in Food. Academic Press: London. p. 97-121.
26. Kuiper-Goodman, T. 1994. Prevention of human mycotoxicoses through risk assessment and risk management. In: Mycotoxins in grains – Compounds other than aflatoxins. J.D.Miller and H Trenholm (eds), p. 439-469.
27. Kuiper-Goodman, T. 1996. Risk assessment of ochratoxin A: an update. **Food Addit. Contamin., 13:** 53-57.
28. Leblanc, J.C, Tard, A., Volarier, J.L., Verger, P. (2005). Estimated dietary exposure to principal food mycotoxins from the first French total diet study. **Food Addit. Contamin., 22:** 652-672.
29. Leoni, L.A.B., Valente Soares, L.M., Oliveira, P.L.C. 2000. Ochratoxin A in Brazilian roasted and instant coffees. **Food Addit. Contam., 17:** 867-870.
30. Leoni, L.A.B., Furlani, R.P.Z., Valente Soares, L.M., Oliveira, P.L.C. 2001. Ochratoxin A in Brazilian green coffee. **Cienc. Tecnol. Aliment., 21:** 105-107.
31. Levi, C. P. 1980. Mycotoxins in coffee. **J. AOAC, 63:** 1282-1285.
32. Levi, C.P., Trenk, H.L., Mohr, H.K., 1974. Study of the occurrence of ochratoxin A in green coffee beans. **J. AOAC, 57:** 866– 870.
33. Lin, L.C., Chen P.C., Fu, Y.M., Shih, D.Y.C. 2005. Ochratoxin A contamination in coffees, cereals, red wines and beers in Taiwan. **J. Food Drug Anal., 13:** 84-92.
34. Lombaert, G.A., Pellaers, P., Chettiar, M., Lavalce, D., Scott, P. M., Lau, B.P.Y. 2002. Survey of Canadian retail coffees for ochratoxin A. **Food Addit. Contam., 19:** 869-877.
35. Martins, M.L., Martins, H.M., Gimeno, A. 2003. Incidence of microflora and of ochratoxin A in green coffee beans (Coffea arabica). **Food Addit. Contamin., 20:** 1127 – 1131.
36. Micco, M., Grossi, M., Miraglia, M., Brera, C. 1989. A study of the contamination by ochratoxin A of green and roasted coffee beans. **Food Addit. Contam., 6:** 333– 339.
37. Ministry of Agriculture, Fisheries and Food (MAFF). 1996. Surveillance of ochratoxin A in green (unroasted) coffee beans. Food Surveillance Information Sheet 80.
38. Moraes, M.H.P., Luchese, R.H. 2003. Ochratoxin A on green coffee: influence of harvest and drying processing procedures. **J. Agric. Food Chem., 51:** 5824-5828.
39. Moraes, M.H.P., Santos, R.B., Cavalcante, J.P. 2006. Micotoxinas e Legislação. Proceedings of Simpósio Brasileiro de Vigilância Sanitária, 3 – SIMBRAVISA. Florianópolis, Brasil. nov. 2006.
40. Nakajima, M. 2003. Studies on mycotoxin analysis using immunoaffinity column (2002 Japanese association of mycotoxicology achievement award). **Mycotoxins, 53:** 43-52.
41. Nakajima, M., Tsubouchi, H., Miyabe, M., Ueno, Y. 1997. Survey of aflatoxin B_1 and ochratoxin A in commercial green coffee beans by high-performance liquid chromatography linked with immunoaffinity chromatography. **Food Agric. Immun., 9:** 77– 83 .
42. Norton, D.M., Toule, G.M., Cooper, S.J., Partington, S.R., Chapman, W.B. 1982. The Surveillance of Mycotoxins in Human Food. In Proceedings, Fourth Meeting on Mycotoxins in Animal Disease; Pepin, G.A., Patterson, D.S.P., Gray, D.E., eds.; Ministry of Agriculture, Fisheries and Food: Alnwick, Northumberland. p.77-81.
43. Otteneder, H., Majerus, P. 2001. Ochratoxin A (OTA) in coffee: nation wide evaluation of data collected by German food control 1995-1999. **Food Addit. Contam., 18:** 431-435.
44. Palacios-Cabrera, H., Taniwaki, M.H., Menezes, H.C., Iamanaka, B.T. 2004. The production of ochratoxin A by *Aspergillus ochraceus* in raw coffee at different equilibrium relative humidity and under alternating temperatures. **Food Control, 15:** 531-535.
45. Pardo, E., Marim, S., Ramos, A.J., Sanchis, V. 2004. Occurrence of ochratoxigenic fungi and ochratoxin A in green coffee from different origins. **Food Sci. Tech. Int., 10:** 45-50.

46. Patel, S., Hazel, C.M., Winterton, A.G.M., Gleadle, A.E. 1997. Survey of ochratoxin A in UK retail coffees. **Food Addit. Contam., 14:** 217-222.
47. Perez de Obanos, A., Gonzales-Penas, E., Lopez de Cerain, A. 2005. Influence of roasting and brew preparation on the ochratoxin A content in coffee infusion. **Food Addit. Contam., 22:** 463-471.
48. Pittet, A., Tornare, D., Huggett, A., Viani, R. 1996. Liquid chromatographic determination of ochratoxin A in pure and adulterated soluble coffee using an immunoaffinity column cleanup procedure. **J. Agric. Food Chem., 44:** 3564–3569.
49. Prado, G., Oliveira, M.S., Abrantes, F.M., Santos, L.G., Veloso, T., Barroso, R. E. S. 2000. Incidência de Ocratoxina A em Café Torrado e Moído em Café Solúvel Consumido na Cidade de Belo Horizonte, MG. **Cienc. Tecnol Aliment., 2:** 192-196.
50. Ratola, N., Barros, P., Simões,T., Cerdeira, A., Venâncio,A., Alves, A. 2006. Worldwide interlaboratory study on the determination of ochratoxin A in differente wine type samples. **Talanta,** (in press).
51. Romani, S., Sacchetti, G., López, C.C., Pinnavaia, G.G., Rosa, M.D. 2000. Screening on the occurrence of ochratoxin A in green coffee beans of different origins and types. **J. Agric. Food Chem., 48:** 3616–3619.
52. Studer-Rohr, I., Dietrich, D.R., Schlatter, J., Schlatter, Ch. 1994a. Ochratoxin A im Kaffee: Neue Erkenntnisse und Toxikologie (Ochratoxin A in coffee: new evidence and toxicology). **Lebensm. Technol., 27:** 435-441.
53. Studer-Rohr, I., Dietrich, D.R., Schlatter, J., Schlatter, Ch. 1994b. Ochratoxin A and coffee. **Mitt. Geb. Lebensmittelunters. Hyg., 85:** 719-727.
54. Studer-Rohr, I., Dietrich, D.R., Schlatter, J., Schlatter, Ch. 1995. The occurrence of ochratoxin A in coffee. **Food Chem. Toxicol., 33:** 341-355.
55. Suárez-Quiroz, M., González-Rios, O., Barel, M., Guyot, B., Schorr-Galindo, S., Guiraud, J.P. 2004. Study of ochratoxin A producing strains in coffee processing. **Int. J. Food Sci. Technol., 39:** 501-507.
56. Sugita-Konishi, Y., Tanaka, T., Nakajima, M., Fujita, K., Norizuki, H., Mochizuki, N., Takatori, K. 2006. The comparison of two clean-up procedures, multifunctional column and immunoaffinity column, for HPLC determination of ochratoxin A in cereals, raisins and green coffee beans. **Talanta, 69:** 650-655.
57. Taniwaki M.H. 2006. An update on ochratoxigenic fungi and ochratoxin A in coffee. In: Advances in Food Mycology. Hocking, A.D., Pitt, J.I., Samson, R.A. and Thrane, U. (eds). Springer, New York. p. 189-202.
58. Taniwaki, M.H., Pitt, J.I., Teixeira, A.A., Iamanaka, B.T. 2003. The source of ochratoxin A in Brazilian coffee and its formation in relation to processing methods. **Int. J. Food Microbiol., 82:** 173-179.
59. Thompson, M., Willetts, P., Anderson, S., Brereton, P., Wood, R. 2002. Collaborative trials of the sampling of two foodstuffs, wheat and green coffee. **Analyst, 127:** 689-691.
60. Trucksess, M.W., Giler, J., Young, K., White, K.D., Page, S.W. 1999. Determination and survey of ochratoxin A in wheat, barley and coffee – 1997. **J. AOAC Int., 82:** 85-89, 1999.
61. Tsubouchi, H., Yamamoto, K., Hisada, K., Sakabe, A. 1985. A survey of occurrence of mycotoxins and toxigenic fungi in imported green coffee beans. **Proceedings of the Japanese Association of Mycotoxicology, 19:** 16–21.
62. Tsubouchi, H., Terada, H., Yamamoto, K., Hisada, K., Sakabe, Y. 1988. Ochratoxin A found in commercial roast coffee. **J. Agric. Food Chem., 36:** 540-542.
63. Urbano, G.R., Taniwaki, M.H., Leitão, M.F.F., Vicentini, M.C. 2001a. Occurrence of ochratoxin A producing fungi in raw Brazilian Coffee. **J. Food Prot., 64:** 1226-1230.
64. Urbano, G.R., Leitão, M.F.F., Vicentini, M.C., Taniwaki, M.H. 2001b. Preliminary studies on destruction of ochratoxin A in coffee during roasting. Proccedings of the 19th International Scientific Colloquium on Coffee, Trieste- Italy, May 14 – 18th 2001. CD- Rom, 5p.
65. Van der Stegen, G., Jorissen, U., Pittet, A., Saccon, M., Stiner, W., Vincenzi, M., Winkler, M., Zapp, J., Sschlatter, C. 1997. Screening of European coffee final products for occurrence of ochratoxin A (OTA). **Food Addit. Contam., 14:** 211-216.

66. Van der Stegen, G.H.D., Essens, P.J.M., van der Lijn, J. 2001. Effect of Roasting Conditions on Redution of ochratoxin A in Coffee. **J. Agric. Food Chem., 49:** 4713-4715.
67. Vargas, E.A., Whitaker, Santos, E.A., Slate, A.B., Lima, F.B., Franca, R.C.A. 2004. Testing green coffee for ochratoxin A, Part I: Estimation of variance components. **J. AOAC Int., 87:** 884-891.
68. Vargas, E.A., Santos, E.A., Pittet, A. 2005a. Determination of ochratoxin A in green coffee by immunoaffinity column cleanup and liquid chromatography: collaborative study. **J. AOAC Intern., 88:** 773-779.
69. Vargas, E.A., Whitaker, T.B., Santos, E.A., Slate, A.B., Lima, F.B., Franca, R.C.A. 2005b. Testing green coffee for ochratoxin A, Part II: Observed distribution of ochratoxin A test results. **J. AOAC Int., 88:** 780-787.
70. Vargas, E.A., Whitaker, T.B., Santos, E.A., Slate, A.B., Lima, F.B., Franca, R.C.A. 2006b. Testing green coffee for ochratoxin A, Part III: Performance of ochratoxin A sampling plan. **J. AOAC Int., 89:** 1021-1026.
71. Viani, R. 1996. Fate of ochratoxin A (OTA) during processing of coffee. **Food Addit. Contam., 13 (Suppl):** 29-33.
72. WHO. 2002. Technical Report Series 906 Evaluation of Certain Mycotoxins in Food.
73. Wolff, J. 2000. Forschungsbericht: Belastung des Verbrauchers und der Lebensmittel mit Ochratoxin A, study funded by German Federal Ministry of Health (BMG vom 03.02.2000. Gesch.Z. 415-6080-1/54).
74. Yani, A. 2004. Serangan cendawan pascapanen dan kontaminasi okratoksin pada biji kopi di tingkat petani dan pedagang pengumpul di Propinsi Bengkulu (Fungal infection and ochratoxin contamination in green coffee beans collected from farmers and collectors in Bengkulu province). Thesis. Postgraduate Study. Bogor Agricultural University, Bogor.

Annex I

Main Green Coffee Producing Countries (years 2000 to 2004) (source: FAOSTAT)

Green Coffee, production (Mt)	**2000**	**2001**	**2002**	**2003**	**2004**	**Total**
Brazil	1,903,562	1,819,569	2,649,610	1,996,850	2,475,780	10,845,371
Vietnam	802,500	840,600	699,500	793,700	834,600	3,970,900
Colombia	636,000	656,160	690,840	694,080	663,660	3,340,740
Indonesia	625,009	575,160	698,589	702,274	702,274	3,303,306
México	338,170	302,996	313,027	310,861	310,861	1,575,915
Índia	292,000	301,000	301,000	275,000	275,000	1,444,000
Guatemala	312,060	275,700	221,820	244,200	216,600	1,270,380
Ethiopia	229,980	228,000	225,360	221,580	259,980	1,164,900
Ivory Coast	336,273	209,000	182,001	140,027	159,769	1,027,070
Honduras	193,309	205,545	182,160	152,040	178,140	911,194
Uganda	143,475	197,410	189,000	150,871	186,000	866,756
Peru	158,283	159,936	178,285	169,548	176,137	842,189
Costa Rica	161,395	150,289	140,874	132,259	126,000	710,817
Ecuador	138,030	164,790	79,149	82,720	83,000	547,689
Philippines	107,557	112,271	107,080	106,388	100,911	534,207
El Salvador	114,087	112,201	91,513	91,513	78,510	487,824
Venezuela	78,440	91,877	76,946	64,265	65,559	377,087
Papua New Guinea	83,000	62,500	66,000	69,000	60,000	340,500
Nicaragua	82,206	66,799	60,235	59,659	70,909	339,808

According to FAOSTAT data, there are 78 green coffee producers, considering the years 2000 to 2004.
From these 78, 19 producers were responsible for 90% of the total green coffee world production. The remaining 59 countries, named below, were responsible for the other 10% of the total green coffee world production.

- **Africa** - S.Tome and Príncipe, Gabon, Benin, Comoros, Angola, Republic of Congo, Ghana, Mozambique, Liberia, Nigeria, Equatorial Guinea, Zimbabwe, Zambia, Malawi, Central African Republic, Togo, Sierra Leone, Guinea, Rwanda, Burundi, Cameroon, Tanzania, Democratic Republic of Congo, Madagascar, Kenya
- **America** - Suriname, Guadeloupe, Martinique, Belize, Guyana, St.Vincent/Grenadines, Trinidad Tobago, Dominica, Jamaica, Paraguay, United States of America, Puerto Rico, Panama, Cuba, Bolivia, Haiti, Dominican Republic
- **Asia** - Nepal, Cambodia, Myanmar, SriLanka, Yemen, Timor-Leste, China, Malaysia, Laos, Thailand
- **Oceania** – Cook Islands, Samoa, Vanuatu, Tonga, Fiji Islands, French Polynesia, New Caledonia

Annex II

Project Document

Proposal for a "Code of Practice for the Prevention and Reduction of Ochratoxin A Contamination in Coffee"

1. Purpose and Scope of the new work

The purpose of the proposed new work is to provide to member countries and the coffee industry a guidance to prevent and reduce Ochratoxin A (OTA) contamination in coffee. The scope of the new work encompasses the development of a draft Code of Practice for the Prevention and Reduction of OTA Contamination in Coffee, which will cover all the stages of the coffee chain, excluding consumers practices. It is anticipated that this new work would be undertaken based on FAO Guidelines for the Prevention of Mould Formation in Coffee.

2. Relevance and timeliness

The toxicity of OTA has been reviewed by the International Agency for Research on Cancer (IARC), that has classified OTA as a possible human carcinogen (group 2B), and by the Joint FAO/WHO Expert Committee on Food Additives (JECFA).

OTA can be found in different food, including coffee, which represents a significant source of dietary exposure in some countries. Besides that, coffee is an important commodity for international trade, which means, there is a high human consumption of this product.

The most effective way to prevent and reduce OTA contamination in coffee is the use of Good Practices in all coffee chain stages.

3. Main aspects to be covered

The proposed new work will focus on identifying, preventing and controlling relevant aspects associated with:

- Coffee infection by OTA producing fungi;
- Ochratoxigenic fungal growth; and
- OTA production

The code will cover all stages of the coffee production chain (cultivation, harvest, post harvest, and transportation practices) developing strategies to prevent and reduce OTA contamination in coffee.

4. Assessment against the criteria for the establishment of work priorities

1. Consumer protection from the point of view of health, food safety, ensuring fair practices in the food trade and taking into account the identified needs of the developing countries.

   The new work will provide additional guidance for countries in order to improve coffee quality, preventing and reducing OTA contamination and consequently minimize consumer dietary exposure to OTA from coffee.

2. Diversification of national legislations and apparent resultant or potential impediments to international trade.

   The new work would provide internationally recognized scientific guidance in order to improve to the enhancement of international trade.

3. Work already undertaken by other organizations in this field.

   This new work will be based on FAO Guidelines for the Prevention of Mould Formation in Coffee

5. Relevance to Codex Strategic Goals

The work proposed fall under all five Codex Strategic Goals:

Goal 1. Promoting Sound Regulatory Frameworks.

The result of this work will assist in promoting sound regulatory frameworks in international trade by using scientific knowledge and practical experience for prevention and reduction of OTA contamination in coffee.

With a view to promoting maximum application of Codex Standards, due to the importance of coffee international trade, this work will harmonize procedures for developed and developing countries, leading to a fair trade.

Goal 2. Promoting Widest and Consistent Application of Scientific Principles and Risk Analysis.

This work will help in establishing risk management options and strategies to control OTA in coffee.

Goal 3. Strengthening Codex Work-Management Capabilities

By establishing a general framework for the management of food safety risks associated with the Prevention and Reduction of OTA Contamination in Coffee will provide a general document that can be referenced by CCCF and it can be used by many countries.

Goal 4. Promoting Cooperation between Seamless Linkages between Codex and Other Multilateral Bodies.

The involvement of FAO in CODEX activities has already formed a close link and the work developed by FAO on this issue will be the base of this new Codex work.

Goal 5: Promoting Maximum Application of Codex Standards.

Due to the international nature of this problem, this work will support and embrace all aspects of this objective by requiring participation of both developed and developing countries to conduct the work.

6. Information on the relationship between the proposal and other existing Codex documents

This new work is recommended in the Discussion Paper on OTA in coffee to be presented and discussed at the Second Session of Codex Committee on Contaminants in Foods (CCCF).

7. Identification of any requirement for and availability of expert scientific advice

Additional scientific advice is not necessary at this moment, as FAO has already published the Guidelines for the Prevention of Mould Formation in Coffee as a result of the project Enhancement of Coffee Quality through the Prevention of Mould Formation.

8. Identification of any need for technical input to the standard from external bodies

There is no need for additional technical input from external bodies.

9. The proposed timeline for completion of the new work, including the starting date, proposed date for adoption at step 5 and the proposed date for the adoption by the Commission, the timeframe for developing a standard should not normally exceed 5 years.

If the Commission approves, the draft Code of Practice will be circulated for consideration at step 3 at the 3rd meeting of CCCF in 2008. Adoption at step 5 is planned for 2010 and adoption at step 8 can be expected by 2011.

Annex III

An outline of a proposed draft CODE OF PRACTICE FOR THE PREVENTION AND REDUCTION OF OCHRATOXIN A CONTAMINATION IN COFFEE

TABLE OF CONTENTS

1. IntroductionN

Ochratoxin A (OTA) is a heat stable fungal metabolite produced by a few species in the genera *Aspergillus* and *Penicillium*. In coffee, only *Aspergillus* species, especially *A. ochraceus* and related species *(A. westerdijkiae and A. steynii)* and *A. carbonarius* are involved. OTA is produced when conditions of water activity, nutrition and temperature required for growth and biosynthesis are present.

OTA has been classified by the International Agency for Research on Cancer (IARC, 1993) and the Joint FAO/ WHO Expert Committee on Food Additives (JECFA, 2001; JECFA, 2007), as a possible human carcinogen (group 2B).

Restriction of toxigenic fungal development, while preserving coffee sensorial quality and safety, can basically be carried out through the management of the free water content from the beginning of drying onward and favoring the development of competitive micro-organisms and restrictive growth conditions.

The main commercial coffee varieties produced and traded are *Coffea arabica* (arabica coffee) and *Coffea canephora* (robusta coffee). Both require wet tropical highlands, but different altitudes. Arabica has higher cost and sensory quality than robusta coffee. The bulk of robusta coffee is mainly used in soluble coffee production.

After harvest, the initial processing is drying to a safe level to prevent microbial deterioration. Coffee is processed under two basic systems: wet processing, that generates what is called parchment coffee, which is the seed enclosed in the inner integument or endocarp. The second system is the dry or natural processing, that generates what is called dried coffee, which is the seed enclosed in the complete dried fruit tissue.

In dry or natural processing, the whole fruit is directly sun dried, on bare soil, cement, brick, bamboo mat and tarpaulin. A combination of sun and mechanical drying can be used, particularly on more technologically advanced farms. Optionally, floating cherries can be separated by the hydraulic process, before drying. The dried fruits will have the seeds separated from the fruit tissues by hulling.

In wet processing, the seeds are mechanically split out of the fruit, giving the pulp as by-product and the parchment as main product. The latter is coated with mucilage, which can be degraded by fermentation and then washed or mechanically removed directly, without fermentation. After removing the mucilage, the parchment is usually sun dried, on cement, brick terrace or tables, with variations and technological innovations to this basic scheme. Also here sun and mechanical drying can be combined and used.

The dried coffee can be stored and passed through sizing (grading), sorting, polishing, cleaning and sacking, before commercialization. The coffee commercial value is related to its taste characteristics, whose preservation is fundamental to processing methods.

Coffee roasting may remove a very significant percentage of OTA. However depending on the roasting process the residual OTA in coffee can differ. Most roasting coffee traded on the international market does not show detectable OTA under the current detection limit of 0.1 – 0.5 µg/kg, for different analytical methods. When detected, most of the positive samples show OTA under 5 µg/kg .

2. Definitions

Cherry (or Coffee cherry): The complete fresh or dry fruit of the coffee plant.

Conditioning: The storage of dried beans in ventilated bins to achieve even moisture content within the bulk of the coffee.

Conditioning bin: Large wire-mesh holding bins usually of 1 x 1 x 3m (or larger), with or without fan ventilation, used for conditioning coffee.

Curing: The final stage of preparing coffee, which can comprise operations such as cleaning, polishing, screening, sorting and grading. It is usually done before coffee is sold.

Defects: The general term for common undesirable particles, which can include various types of beans, parts of beans, fruit tissue and foreign matter, found in green and roasted coffee beans. Diverse and specific terms, according to the producing country, are used to describe the defects. The fruit defects are generally caused by faulty processing, pest damage, or adverse climatic conditions. Defects receive specific weight values to assist in the classification and grading of coffee lots under various national and international systems.

Dry processing: The process of drying coffee cherries to obtain husk coffee, which after mechanical removal of the dried pericarp produces green coffee, called ‘cherry coffee’, ‘unwashed coffee’ or ‘natural coffee’.

Floating (or floats) coffee: Cherry coffee separated by virtue of it being positively buoyant in water.

Gleaning (or Sweeping): Coffee fruit found lying on the ground beneath coffee bushes, detached during harvest or abscised during development. This word is the general term for coffee collected in this manner.

Green coffee bean: The dried seed of the coffee plant, separated from non-food tissues of the fruit.

Hull: The dried endocarp of the coffee fruit.

Husk: Waste material resulting from the hulling of parchment or dry cherry coffee, made up of the dried pulp and outer covering of the parchment.

Mechanical drying: Any drying technology where heat is artificially supplied.

Mechanical washing: Any mechanical method for removing the mucilaginous mesocarp from the surface of the parchment, done after pulping without fermentation.

Mucilage: The coffee fruit mesocarp, a mainly pectinaceous and pulp layer of tissues between the epicarp and the endocarp (parchment).

Naked beans: Parchment coffee that has been partly or entirely peeled of its parch during pulping and/or washing.

Natural processing: See ‘Dry processing’.

Parchment (or Parch): The coffee fruit endocarp located between the fleshy part (pulp) and the silver skin. It is a thin, crumbly paper-like covering left on wet-processed beans after pulping and fermentation, removed during hulling.

Parchment coffee (or Pergamino): Wet-processed beans after pulping, dried to about 12% moisture content, whose hard outer covering (the endocarp/parchment) is removed during hulling..

Processing: Steps involving the transformation of harvested coffee fruits to a dry and stable condition.

Pulp: The fleshy outer layer of the mesocarp, directly beneath and including the skin, which can be mechanically removed

Pulping: Mechanical treatment used in wet processing to remove the exocarp and as much of the mesocarp of the coffee fruits as possible

Wet processing: A method of processing coffee cherries into dried pergamino/parchment coffee. Its sequential steps are: exocarp mechanical removal in presence of water; mesocarp removal by fermentation or other methods; washing; drying to obtain parchment coffee and parchment removal to obtain green coffee.

3 Pre-harvest

It is not totally clear whether OTA-producing fungi can infect the coffee fruits still in the plant and develop to produce OTA at the harvest. If the infection occurs in the plants, it may involve two different contamination routes: either through the flowers, without visible sign or by coffee berry borers (CBB) (*Hypothenemus hampei*), that can take spores to the fruits, making a hole in the cherry and one or more tunnels in the bean, which are visible signs.

Coffee fruits detached from the plant, by natural ways or through agricultural activities, which remain on the ground, are more likely to have fungi development and be OTA contaminated.

Recommended practices to reduce the development and spore load from OTA-producing fungi in the plants, and the CBB occurrence.

1) Improve soil texture and fertility using plant material from weeding, organic materials or coffee by-products (pulp and husk). These last two should be fully composted before use. Do not apply these organic materials just before or during flowering.

2) Keep coffee plants vigorous, through the regular use of good agricultural practices (GAP) at the proper time, such as weeding, pruning, fertilization, pest and disease control, irrigation.

3) Remove fallen cherries, especially in the off-season, use traps for CBB control especially before and throughout harvesting and processing, and encourage the use of integrated pest management (IPM) program.

4) Avoid disposal of uncomposted organic wastes, from coffee or any other sources, in or around the orchard. Especially coffee seed and seed-associated material can allow proliferation of OTA producing fungi, many of which are seed-borne.

4. Harvest

The harvesting method to be chosen is a conjunction of the requirements of the processing method, economic considerations and labor availability. Four basic harvesting systems are known:

1) single-pass stripping, where all branches bearing fruits are harvested at once;

2) multi-pass stripping, where only branches bearing mainly ripe cherries are harvested;

3) multi-pass selective picking (finger picking), where only ripe cherries are harvested;

4) mechanical harvesting, using different types of machines.

Besides these basic main harvest systems, previous and post activities can take place, such as a ‘fly harvest’ to collect prematurely ripened fruit or the collection (gleaning or sweeping) of cherries that fall on the ground or are left on the plants during harvest.

In humid climates cherries which have fallen onto the ground should be collected on the same day. If this coffee goes into the coffee chain these time limits must be guaranteed.

Irregular maturation generates different maturity classes, with different physical properties and sensory quality, creating a problem for farmers and processing. If selective harvesting is used, the heterogeneity can be minimised but at a higher cost. So, the timing of the harvest is an important issue especially when non-selective methods are used.

In early season there is an imbalance between ripe and unripe cherries, the latter having low cup quality, and are improper to be pulped or machine separated from ripe cherries. Over-ripe and tree dried cherries also cannot be pulped, show cup defects and can be a safety problem in regions with a humid harvesting season.

Coffee cherries should be processed as soon as possible after harvesting, which is weather dependant. The harvesting rate, processing performance and labor availability must follow the pace of the drying rate. Lack of proper planning should not be replaced by improper practices such as maintenance of harvested cherries in sacks or under water, transfer to conditioning bins of partly dried coffee or drying in thick layers, which can allow fungal growth and OTA contamination.

Coffee ready to be processed should be uniform, not mixing different categories: wet with dry coffee in dry processing; pulpable with not pulpable in wet processing; sound with unsound fruits in all processing. The product of the harvest must be adequate to the processing procedure with evaluation of its development and results.

1) The area around the coffee plants should have weeds, fallen cherries and brush removed before harvest. This cleaning protects the workers, improves harvesting efficiency and reduces the risk of contamination for the main-crop, as fallen cherries would not be mixed with the just harvested ones.

2) Coffee cherries left on the ground for longer than specified should be destroyed.

3) As soon as ripe cherries are enough for a viable harvest this process should be started.

4) Under favorable topographic conditions mats, canvas or tarpaulin should be used, as they increase harvesting efficiency and protect the main crop from contamination by old fallen cherries.

5) Remove visible low quality cherries from the main production, at any stage before processing, as an improvement for the processing method.

With CBD or *Phoma* attacked fruits, only hand sorting can be done, which also removes unripe or over-ripe fruits from the main harvest.

Water sorting allows separation of diseased, CBB attacked and tree-dried fruits, all of which float, from ripe and immature fruits, which sink. Even reducing the surface microbial load it is not clear if this helps to reduce the risk of OTA contamination.

6) Define clear routines for processing and handling of secondary products excluded by sorting or separation procedures.

7) Keep a close co-ordination between harvesting and processing activities, avoiding time longer than necessary to send harvested coffee cherries for processing.

5. Post-harvest

After coffee fruits are removed from the plant a rapid change and senescence start. The post harvest period is divided into two distinct phases joined by a transitional phase. The initial or high moisture phase starts with harvest, its product is in an unstable state and spoilage can only be controlled through competitor micro-organisms, restricting oxygen and lasting of this state.

The last or low moisture phase starts at the end of drying and goes until roasting. The product is at a stable condition and control must prevent water re-introduction or redistribution in the coffee bulk.

During the transitional phase spoilage can only be controlled by time limitation. Mesophilic and xerophilic spoilage organisms have enough water to grow but not their hydrophilic competitors. Aeration is an essential part of drying.

In wet processing the high moisture phase may be extended, controlled through fermentation, but it is desirable to reduce this time.

The transitional phase is the least stable and most difficult to predict. When harvest coincides with a rainy or high humidity season measures to optimise drying must be adopted.

At some point during drying further growth cannot happen as the product reaches the low moisture phase.

5.1 Dry processing

In this type of processing the whole harvested fruits, pre-selected or not, are dried. Although a simple process compared to wet processing, a good finished product can only be obtained through the application of good practices and proper management.

Depending on the producing region specific practices are used, before drying, such as retaining harvested coffee in bags or unstirred layers and fruit splitting. Or it can be dried as a uniform mass.

Whole cherries offer a higher resistance to water loss compared to split ones. Splitting cherries is a relatively cheap procedure that can be used to reduce drying time but, if improperly done, damaged beans lose quality and are more susceptible to fungal growth and possible OTA contamination.

One option used in regions where the harvest time normally occurs under arid weather condition is fruit drying on the plant. This method results in a lower level of immature fruits, which are safe and good quality and is cheaper than the traditional harvest, as it allows one-pass stripping

It is quite usual to retain harvested fruits in bags or heaps until one week. This practice, even without clear evidence to condemn it, leads to high temperatures and quick fermentation, and cannot be fully controlled, causing quality losses in the product. Therefore, fresh cherries should be sent for drying preferably the same day they have been harvested.

Compared to the main-crop cherry coffee wet processing also generates cherry coffee, not comparable to the first one and originating from 'floats coffee', that are ripe cherries, not part of the main crop, removed by floating in water. Also immature and over-mature cherries are removed by hand sorting. Another possibility is cherries damaged by CBD, which are part of the main crop, and also removed by floating. Diseased, immature, and over-mature cherries are dried as cherry.

In most regions stripping harvest is used to get cherry coffee, often with floatation to separate the fruits. Tree dried cherries can also be separated by floatation and processed without mixing with fresh cherries. Even among ripe cherries, the removal of floats coffee is helpful to reduce the percentage of defects, some of which can be linked to high levels of OTA. So, this practice can play an important role in OTA control.

Basically, the drying equipment consists of: drying surfaces, mechanical dryers (optional), floatation separation facilities (optional), rakes and covers.

Before the beginning of the crop season: clean, reassemble and lubricate the processing equipment; inspect installation and make tests in advance, in order to have enough time for repairs if any problem happens.

At the end of the crop season: clean, repair, lubricate and protect from water and dust all the equipment.

The harvest activities and the drying facilities should work in a coordinated way, in order to avoid undesirable delays once the harvested cherries arrive for drying.

Damaged or diseased cherries can be separated from the sound ones by hand sorting or by floatation.

When single-pass stripping is the harvest method used floatation is appropriate to separate ripe and immature cherries from tree-dried ones.

5.2 Wet processing

Wet processing usually needs uniformly ripe cherries, generating parchment coffee as the main product and cherry coffee as a secondary one. Evolution in pulping technology can allow the presence of a certain level of immature cherries among the ripe ones.

The quality control of parchment coffee can be achieved by:

- fermentation - under a low level of available oxygen the mucilage is degraded by micro-organisms, followed by washing and drying of the beans.
- mechanical removal - the mucilage removed this way can go to immediate drying.
- skin removal - the pulped parchment is immediately dried without mucilage removal.

The main point of care, in OTA control during the wet processing, is the coffee fruit (also the bean). Skins, crushed immature, un-pulped and under-sized cherries in fermentation and drying have serious general quality consequences. At high levels they could be an OTA risk but the evidence is weak for their significant impact on OTA accumulation, at acceptable quality frequencies of occurrence. Research has showed that remains of pulp allow a rapid growth of bacteria and yeasts, but are not a good source for OTA-producing fungi. Even so, proper cleaning program should be used to control unnecessary sources of contamination. Also recycled pulping water can be safely re-used for pulping.

The parch, when wet, is a protection against fungal contamination. Nipped and naked beans can be more susceptible to OTA contamination and are much more common from low water use mechanical washers and unrefined pulpers, thus requiring special attention during their operation.

Any kind of equipment should receive regular maintenance, to reduce the possibility of failures which could delay processing and compromise coffee quality and safety.

Before the beginning of the crop season: clean, reassemble and lubricate the processing equipment; inspect installation and make tests in advance, in order to have enough time for repairs if any problem happens.

At the end of the crop season: clean, repair, lubricate and protect from water and dust all the equipment. Check pulping surfaces for wear.

Define acceptability criteria for each key element of the process and give proper orientation/training to the workers to ensure they are achieved. Pulping, a very important operation in the wet processing, must be very well done and take into account:

- Cherry quality – if you do not use a siphon define the maximum acceptable proportion of immature and over-mature / tree-dried cherries; your criteria to define it; personal responsible and frequency of monitoring and corrective measures if norms are exceeded.
- Pulping quality - define the acceptable proportion of un-pulped cherries and nipped beans; how to monitor that proportion and under which frequency; justified corrective action due to consequences of processing those classes; cost-benefit to increase size uniformity of the cherries; effectiveness of skin removal, need for monitoring and frequency; determination of causes of inappropriate skin removal; corrective measures if norms are exceeded. The efficiency of the operation can be improved based on the various estimates of the monitoring and the quality and safety of the product.
- Water quality – even with weak evidence that low water quality can lead to OTA contamination, clean water is desirable for processing. Avoid turbid water, as it can decrease coffee sensory quality.
- Fermentation – it should be as short as possible, to get the mucilage degradated and the beans able to be washed; how to monitor it and frequency; how to evaluate the type and level of inoculum (in the in-coming cherry) and ambient temperature.
- Fruit-flies – should be monitored, as high populations can unbalance fermentation.
- Secondary cherry coffee – it should have a specific control program; good drying practices should be applied to it, being processed in separate facilities
- Washing efficiency – this control measure should be implemented and criteria defined to check its efficiency (amount and proper use of water)
- Non-coffee by-products – its amount should be checked after washing.
- Broken, nipped and naked beans - its amount should be checked after washing.

5.3 Drying

The main purpose of the drying operation is to efficiently decrease the high water content of the just harvested cherries to a safe level in order to get a stable, safe and good quality product.

In this item cherry and parchment coffee will be discussed together, because proper drying is very important to control the quality and safety of the product. Most of the produced coffee is dried using direct sun-drying, with the product spread on surfaces such as cement or brick terraces, tarpaulin, plastic canvas, compacted earth, bamboo and sisal mats, tables covered in wire mesh or fish farm netting. To complete drying, mechanical drying can also be used.

The drying process can be divided into three steps. In each step OTA-producing fungi can have less or more chance to succeed.

At the first step, an initial lag period, there is a slight decrease in moisture content that takes a time interval between 1 to 3 days for cherry coffee and 1 day or less for parchment coffee. OTA-producing fungi, under this high moisture content, do not find suitable conditions to succeed.

The second step is the one of maximum loss in moisture content, both for cherry and parchment coffee, under similar conditions at the same period of time. It is mainly dependant on drying conditions and second on drying yard technology. At this step, OTA-producing fungi find most favorable conditions to succeed.

At the third step coffee, both cherry and parchment, is much drier compared to the previous two steps. There is a slower little decrease in the remaining moisture content. Conditions at this step do not favour the development of OTA-producing fungi.

The OTA-producing fungi must find favorable conditions during a certain period of time to grow and produce the toxin. The level of available water is the most important factor to be considered. At high water level (Aw above 0.95) OTA-producing fungi can not grow, as fast-growing hydrophilic fungi and yeasts grow first. At lower water level (Aw less than 0.80) the OTA-producing fungi can be present but not produce the toxin, and at Aw below 0.78-0.76 they cannot grow. Therefore the most important point is to control the period of time which coffee remains in the drying yard, in the range of water available where OTA-producing fungi can grow. According to experimental results 5 days or less is enough and effective to prevent OTA accumulation.

A slow drying is less risky than rewetting. In this last situation, a favorable condition, beans with a certain level of contamination can get a rapid growth of the mycelium and possibility of OTA production.

A broad study confirmed the safety of the recommended maximum acceptable moisture content (12 to 13%, wb), for parchment and cherry coffee, against the growth of OTA-producing fungi. The moisture content of 18% for robusta cherry and 16% for arabica parchment correspond to an average water activity (Aw) of 0.76, the minimum requirement for growth of OTA-producing fungi. This Aw of 0.76 means approximately 13% for both cherry and parchment.

Dealing with sun-drying equipment compared studies showed there is little difference among different equipment but a large difference depending on how they are used and the meteorological conditions during the drying time. Data about what is done and the obtained results should be regularly recorded, in order to better use the available equipment, allow the improvement of the used practices and the reduction of risky conditions for OTA contamination.

In the case of mechanical drying, it is generally used as a complement after sun-drying, but in some regions it plays a major role in the drying process. Mechanical driers usually need to have control of two items:: inlet temperature and duration of drying time. The most common problems with mechanical drying are: over drying, causing weight loss and consequently income loss. The other problem is black beans derivated from immature beans submitted to excessive inlet temperature, decreasing the quality of the product.

The recommended measures to get an efficient water removal from the coffee beans are:

1) Proper location of the drying yard

It must be located to receive maximum sun exposure and air circulation, during most of the day, to speed the drying of the beans. Shady and low areas should be avoided.

2) Definition of the surface for the drying yard

Different studies showed little difference in drying rates comparing different drying surfaces. It should be chosen according to the climate of the region, cost and quality of the dried product, as any type of surface has advantages and disadvantages. Bare soil is not appropriate for rainy areas. Plastic canvas gets humid under the coffee layer, allowing fungal growth. In rainy or wet regions coffee must be covered and re-spread, once the surface has dried. Depending on what kind of coffee is to be dried, if cherry or parchment, this last one taints more easily and therefore it requires cleanable and easily drained surfaces.

3) Planning of the harvest

The pace and total time of the harvest must be based on the available area of the drying yard and the average time necessary for drying, considering both good and bad weather. For this last situation the drying time will take longer than under good weather conditions.

4) Management of coffee to be dried

Dry coffee only in thin layers, 3 to 5 cm in depth which is equivalent to 25 to 35 kg/m^2 of fresh parchment or cherry coffee. Just under very favorable conditions such as low air humidity, good air circulation and sun intensity, or in usually dry regions, thicker layers can be used.

The coffee layer should be turned four times during the day time. As a just harvested agricultural product, coffee cherries have high water content and the regular turning of the static layer during the day allows for faster drying, reduces the risk of fungi growing and helps to produce a better quality product. At night fully wet coffee should not be covered, to avoid condensation of the water to be lost. After one day of drying for parchment and three days for cherry coffee, it can be heaped and covered at night, to avoid re-wetting.

Under rainy weather dry or partially dried coffee must be protected from re-wetting. Parchment always and cherry coffee with three days of drying as well.

Do not mix different types of coffee nor different days of harvest, using a specific identification for each one of them to avoid mistakes.

Protect the drying yard area against the access of animals, which can be a source of biological contamination for the drying coffee.

Monitor regularly CBB populations, distributing alcohol traps around the drying yard. The CBB females are attracted by the drying cherries and can cause additional damage to the beans.

Determine a standard to evaluate the evolution towards full dryness (<13% for cherry and <12% for parchment - wb). Start taking samples from different points of each lot, two or three days before it is expected to be fully dry and continue re-evaluating it daily until it reaches the desired dryness. Besides traditional methods to check it, such as biting or shaking the beans, precise instrumental measurements should also be adopted at field level. Instruments must be regularly calibrated and operators well trained for their correct use.

5) Organisation of the operations in the drying yard

Workers should receive a clear and practical training about what they have to do and how to do it. Train people to be able to perform more than one task, in order to have all the necessary work done in case of absences. When not possible to designate a group or a single person to oversee drying operations an additional training in communication skills among the workers would be an advantage to reach the desired objectives.

6) Proper storage

The properly identified lots of dried cherries or the dried parchment coffee should be stored, at the farm level or in out-of-farm warehouses, in bulk or in clean bags under appropriate storage conditions.

7) End of season operations

Once the harvest season is finished, the drying yard surface and equipment, not only machines but also baskets, barrows, rakes, tarpaulins, plastic canvas, bags and others, must be repaired, cleaned, protected and kept in a proper place until the next season

5.4 Dried coffee handling and trading

In different producing countries handling coffee in local trading varies in relation to the proper structure of the chain and the way the operations are performed. Here can be included the post-cleaning, sorting, grading into size classes, re-bagging, re-drying (eventually), storage and transport, operations that add value to the traded product, coffee green beans, before being sold and sent to be roasted, closing the coffee chain. During the whole period it must also be protected from re-wetting, degradation and cross-contamination. During storage, that can take long time, the main factor to care about is humidity. Under a relative humidity below 60% coffee will continue to dry but if the relative humidity is above 80% coffee starts to absorb water. Moisture in the storage place can originate from damp floors and walls, rain (wind-driven or through leaks), dead air, and even mixing of dry with wet coffee. Appropriate storage facilities, the use of good storage practice and regular monitoring can prevent or reduce problems.

The main parameter to evaluate the condition and storability of green coffee lots is moisture content. Moisture meters, that should be more widely used, are simple to use but the results can be subjected to errors. To prevent or reduce this possibility the equipment must be properly and regularly calibrated and users must receive adequate training about how to use it.

Contamination must be clarified through additional research. While this information is not available special handling should be applied, establishing low levels of tolerance for such defects in sorted green beans. The discarded beans must be properly sampled and OTA analysed, being allowed for re-blending or roasting only after results show they are safe for consumption.

From the production areas coffee may be transported by different means of transportation to the trading points. The main aspect of concern here is to avoid rewetting of coffee, due to possible climatic changes between different regions, taking the necessary control measures.

In the production chain the local market is the most sensitive part to requiring changes. Here the authorities, through regulatory and non-regulatory mechanisms, can enforce and influence practices in order to guarantee producers reliably operate in a way to assure the product safety.

Stakeholders should adopt procedures to protect coffee in each part of the chain, not accepting suspect coffee and avoiding practices that could generate or increase a problem. Dried coffee must be protected from re-wetting, through contact with liquid water, mixture with wet lots, absorption from wet air or surfaces or redistribution of water within the lot. Defects associated with high levels of OTA should be reduced to acceptable levels. Protection from contamination by other materials is also necessary.

1. Operators should establish minimum hygiene requirements and a rapid assessment method (including a sampling method with representative sub-sample of the in-coming lot for moisture content determination, defect levels, general physical quality assessment and visual or smell signs of moldiness) to assure the coffee intended to be bought conforms to these established criteria. Also reliable suppliers, who follow the recommended hygiene practice, should be chosen as suppliers.

As a lot can have coffee from different sources each bag must be sampled. A spear is the most convenient tool for sampling. Incremental samples will be joined in a global sample to be analysed. A well maintained and calibrated moisture meter should be used to estimate moisture content.

The assessment criteria of the in-coming coffee should be improved, based on an annual review of the records. Besides the basic records of weight and prices, also evaluations, moisture content, origin, and other (e.g. reports of cup quality, curing reports, and complaints) should be recorded to allow the mentioned improvement.

The warehouse design and structure, not necessarily expensive, must be adequate to maintain dryness and uniformity of the stored coffee. The desirable characteristics are: cement floor with a damp proof course; not subject to flooding; water pipelines properly located to avoid wetting coffee in case of plumbing problems; water proof windows and roof, and a high ceiling to allow good air circulation.

Do not expose stored coffee to direct sunlight nor store it near heating sources, to avoid possibility of temperature differentials and water migration. Efficient options to store bulk coffee are silos with elevators, more expensive, or inner and above floor slatted wooden bins, cheaper than the first one.

1 The operation of a storage facility must be optimised to prevent cross contamination, the reintroduction of moisture and to allow the best execution of receiving, sale and value-added operations, preserving the coffee quality until it is sold to the next stakeholder in the production chain. The main recommendations here are:

2 The initial condition and age of the received stocks should be recorded.

When storing in bags these must be arranged on pallets and away from walls, to allow good air circulation.

To implement cleaning and maintenance programmes in order to ensure that storage facilities are periodically inspected, cleaned and renewed.

Coffee weevil should be checked in the warehouse. It survives only in over wet coffee and therefore its presence indicates this problem requires the adoption of correcting measures.

Farms and other operations must separate coffee types, which require planning of the storage area and adoption of a labelling system. Non-food materials should not be stored with coffee to prevent contamination or taints in the product.

Depending on the time of storage, the moisture content of the stocks should be checked, allowing proper measures to be taken if problems arise.

3. Coffee cleaning and sorting should not physically damage the product to neither make it more susceptible to contamination/deterioration nor introduce new contamination and should assure reduction of undesirable materials to acceptable pre-determined levels.

Ensure the facilities and equipment are regularly inspected, maintained and cleaned, through implementation of cleaning and maintenance programmes.

When storage is combined with cleaning and sorting, attention is required to avoid contamination of post-cured coffee with the curing by-products of dust and foreign matter, e.g. through the use of partition walls or extractor fans.

Remove defects from main-crop production, discarding or screening them before their inclusion into the food chain. There is no uniform distribution of defects within the classes of beans separated from bulk coffee and evidence shows that defective beans and husk (also a defect) sometimes contain higher OTA levels than sound beans. Based on further investigations of OTA contamination of defects authorities should provide clear guidance to the stakeholders.

4. Transport of coffee also requires the adoption of practices to avoid re-wetting, to maintain temperature as uniform as possible and to prevent contamination by other materials. The main requirements here are:

where and when rain is present, coffee lots must be loaded and unloaded under covered structures;

before receiving a new cargo, the vehicles must be cleaned from residues of the previous cargo;

the vehicles must have floor, side walls and the ceiling (in closed vehicles) checked for the presence of points where exhaust fumes or water from rain can be channeled into the coffee cargo. Tarpaulins and plastic canvas used to cover the cargo must also be regularly checked to be clean and without holes. The vehicles should also receive regular maintenance to be kept in good condition;

reliable transport service-providers, which adopt the recommended good transportation practices should be selected by operators.

6. Transportation

Coffee is still transported from producing to consuming countries in bags or in bulk, usually in 18 to 22 tonnes capacity containers. Temperature fluctuations, during the transportation time, can cause condensation of the remaining water (present even in well-dried beans) and local re-wetting. The redistribution of water lead to fungal growth, with the possibility of OTA production. The recommended practices during transportation in the port are:

- to cover coffee loading and unloading areas to protect against rain.

- to check coffee lots are uniformly dried and below 12% moisture content, free of foreign matter and respecting the established defect levels.

- to check containers, before loading, to ensure they are clean, dry and without structural damage that could allow water entrance into the container.

- bags must be well stacked, crossed over for mutual support and avoid the formation of empty vertical columns (chimneys). It is advisable to cover the top layer of bags with materials that can absorb condensed water, such as silica gel or cardboard, and protect against OTA contamination. For coffee in bulk a sealable plastic liner is desirable and should be kept away from the roof of the container.

- to choose an appropriate place, not directly exposed to the weather, aboard the ship to reduce the possibility of undesirable situations mentioned that can lead to OTA contamination.

Annex IV

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