Effect of roasting on the Ochratoxin A (OTA) reduction in green coffee beans

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Ochratoxin A (OTA) is a mycotoxin with proved carcinogenic (group 2B) effects (1), which is mainly produced by diverse fungus strains such as *A. carbonarius, A. niger, A. ochraceus, A. westerdijkiae* and *A. steynii,* as well as *Penicillium verrucosum* and *P. nordicum* (2, 3, 4). Coffee has been determined as the third major source of OTA that affect the European population, followed by cereals and wine. The natural occurrence of OTA in green coffee beans has been reported since 1974 in concentrations ranging between 0.2 and 360 $\mu g.kg^{-1}$ (5, 6). Several reports concerning to the roasting impact on OTA content in coffee beans have shown a large range of OTA reduction levels (7, 8). Such variability could be related to the different roasting process conditions.

The aim of this work was to assessed the effect of two roasting techniques [Cylinder (C) and fast-Fluidized Bed (FB)] on OTA reduction on *Coffea arabica* green coffee beans naturally contaminated at two different levels (L1 and L2).

Methodology

OTA production by *A. ochraceus* on green coffee beans

20 kg-batches of green coffee beans were inoculated with 800 mL of a toxigenic *A. ochraceus* spore solution (4.5×10^7 spores/mL) and incubated for 3 days (L1 = 5 ppb OTA), and 9 days (L2= 57 ppb OTA) at 25°C.

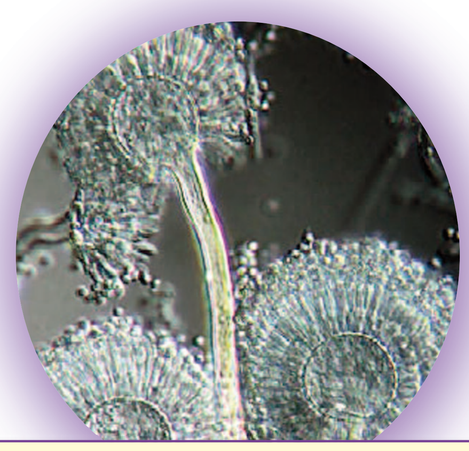
Roasting procedure

Roasting temperature: 230°C
Sample size: 200 g
Operating conditions:

- Cylinder (3,6,9,12 and 15 min)
- Fluidized Bed (0.9, 1.7, 2.6, 3.5 and 4.3 min)

OTA quantification

Was performed according to Mounjouenpou *et al.,* 2007 (9)



Results

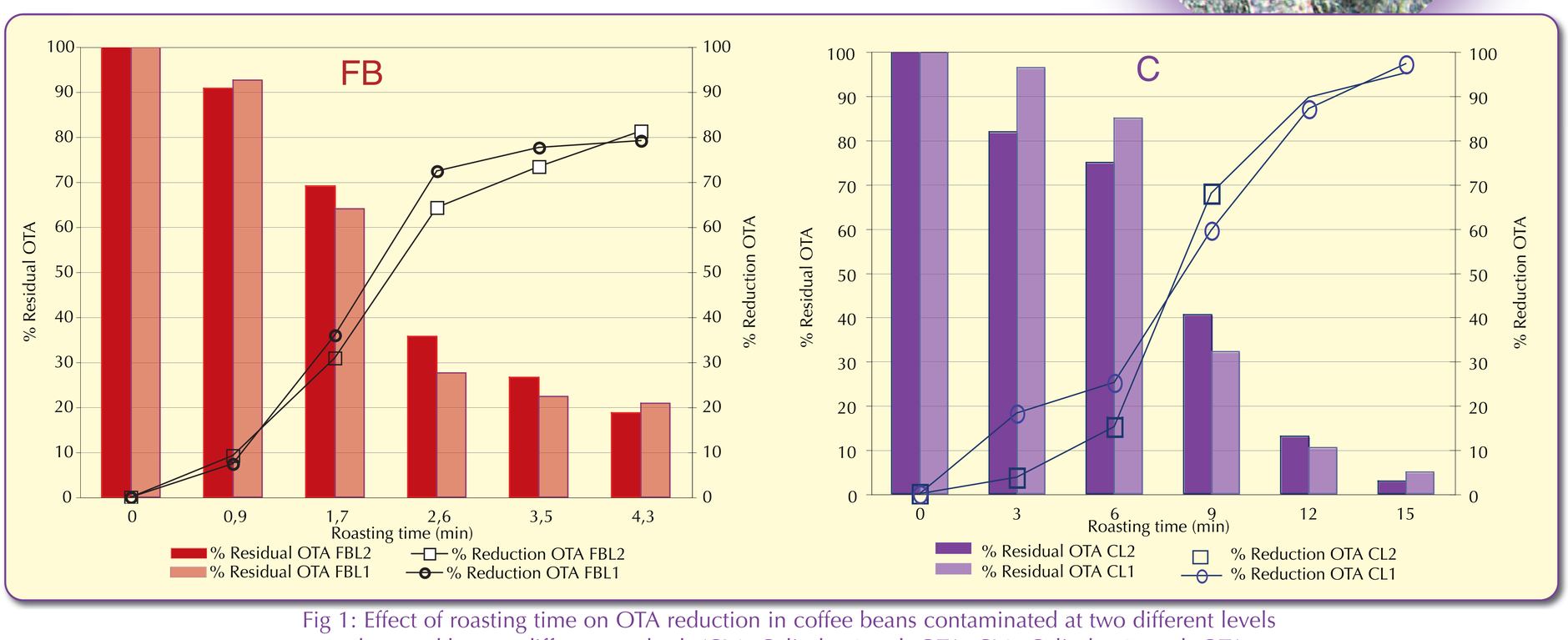


Fig 1: Effect of roasting time on OTA reduction in coffee beans contaminated at two different levels and roasted by two different methods (CL1: Cylinder, 5 ppb OTA; CL2: Cylinder, 57 ppb OTA; FBL1: Fluidized Bed, 5 ppb OTA; FBL2: Fluidized Bed, 57 ppb OTA)

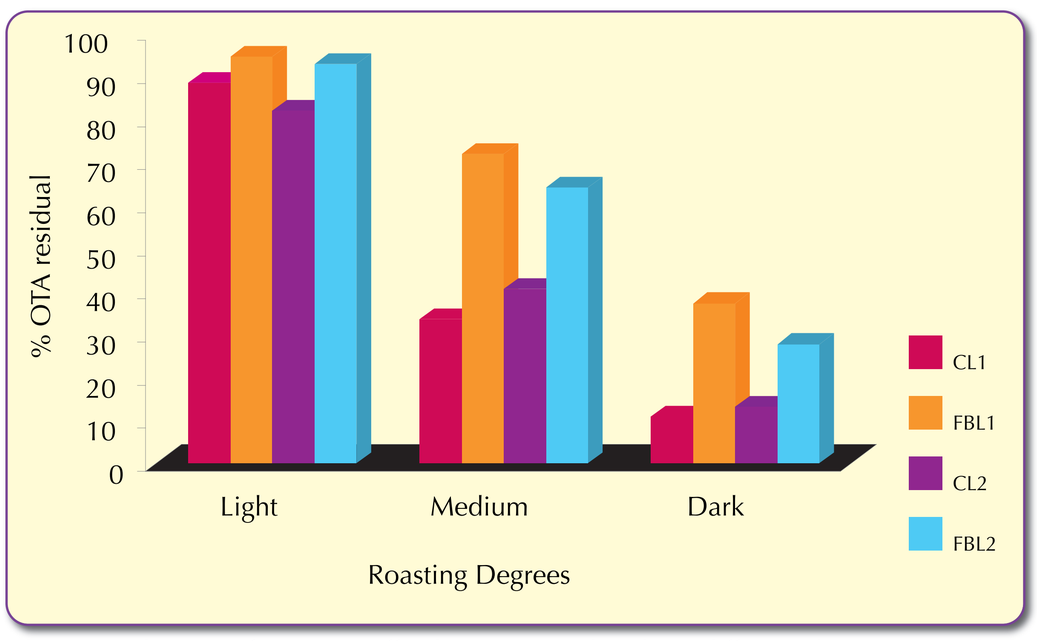


Fig 2: Reduction of OTA in coffee beans roasted at three different degrees (L: Light; M: Medium; D: Dark), contaminated at two different levels and roasted by two different methods (CL1: Cylinder, 5 ppb OTA; CL2: Cylinder, 57 ppb OTA; FBL1: Fluidized Bed, 5 ppb OTA; FBL2: Fluidized Bed, 57 ppb OTA)

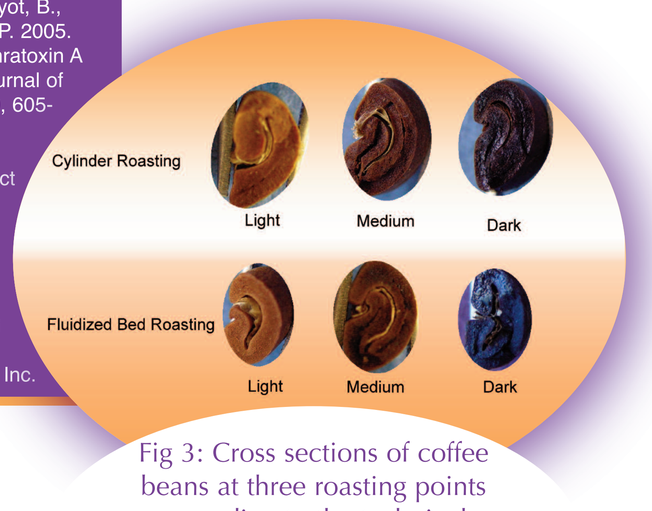


Fig 3: Cross sections of coffee beans at three roasting points according to the technical process (C: Cylinder; FB: Fluidized Bed; L: Light; M: Medium; D: Dark)

Discussion and conclusion

The OTA reduction in coffee beans contaminated at two different levels (L1 = 5 ppb OTA and L2= 57 ppb OTA) was compared for a same roasting technique. The reduction observed was similar for the two contamination levels: 95, 1 % and 97, 2 % for cylinder technique, while 81,3% and 79,2% for fluidized bed method at the maximal time of roasting (Fig 1).

Three different roasting points were set according to the L* color coordinate (10). The OTA reduction was compared for the different roasting degrees: Light (L), Medium (M) and Dark (D). The OTA reduction levels were 63% and 33% at medium roasting point, and 88% and 68% at dark roasting point for the cylinder and the fluidized bed techniques, respectively (Fig 2), the cylinder was then the most efficient technical process for OTA reduction (88%).

The study of the thermal diffusion process in the coffee beans during roasting could probably explain the efficiency of the roasting cylinder technique which was more efficient for OTA reduction. In the case of the fluidized bed, the heat diffusion time was reduced and only the external layer of the coffee beans was concerned by the thermal processing and then OTA reduction was worse (Fig 3).

Références

1. IARC (International Agency Research of Cancer), 1993. Some naturally occuring substances: food items and constituents, heterocyclic aromatic amines and mycotoxins. IARC monographs on the Evaluation of Carcinogenic Risks to humans. IARC Press, Lyon, 56, 489-521.
2. Pitt J.L., Basilico J.C., Abarca M.L., Lopez C., 2000. Mycotoxins and toxigenic fungi. Medical Mycology 38, 41-46.
3. O'Callaghan, J., Caddick, M.X., Dobson, D.W., 2003. A polyketide synthase gene required for Ochratoxin A biosynthesis in Aspergillus ochraceus. Microbiology-SGM 149, 3485-3491.
4. Noonim P., Mahakarnchanakul W., Nielsen K.F., Frisvad J.C., Samson R.A., 2008. Isolation, identification and toxigenic potential of ochratoxin A-producing Aspergillus species from coffee beans grown in two regions of Thailand. International Journal of Food Microbiology 128, 197-202.
5. Levi, C.P., Trenk H.L., Mohr H.K., 1974. Study of the occurrence of ochratoxin A in green coffee beans. J. Assoc. Off. Anal. Chem. 57, 866-870.
6. Gopinandhan, T.N., Kannan, G.S., Panneerselvam, P., Velmourougane, K., Raghuramulu, Y., Jayarama, 2008. Survey on ochratoxin A in Indian green coffee destined for export. Food Additives & Contaminants Part B-Surveillance 1, 51-57.
7. Amezqueta, S., Gonzalez-Penas, E., Murillo-Arbizu, M., Lopez de Cerain, A., 2009. Ochratoxin A decontamination: A review. Food Control 20, 326-333.
8. Suárez- Quiroz, M., De Louise, B., Gonzalez-Rios, O., Barel, M., Guyot, B., Schorr-Galindo, S. & Guiraud, J. P. 2005. The impact of roasting on the ochratoxin A content of coffee. International journal of Food Science and Technology 40, 605-611.
9. Mounjouenpou P., Durand N., Guyot B., Guiraud J.P. 2007. Effect of operating conditions on ochratoxin A extraction from roasted coffee. Food Additives & Contaminants 24, 730-734.
10. Illy, A., & Viani, R. (1995). Espresso coffee: the chemistry of quality. Chap. 4. pages 169-191. San Diego, CA: Academic Press, Inc.

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