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Coffee and Ochratoxin Contamination

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Abstract
New European regulations being considered to limit maximum levels of ochratoxin A present in coffee may have major consequences on international coffee trade, leading to a drop in farm revenues and foreign exchange earnings for governments. While one may question the appropriateness of the levels proposed for coffee (which accounts for a relatively low share of ochratoxin intake in comparison with other food groups like cereals), producing countries have little choice but to prepare for the change if they do not wish to see their trade diminish. Since little is known about how this mycotoxin develops and proliferates, putting into place control measures raises significant challenges. The challenges are compounded by the fact that production is mainly in the hands of very small farmers, who have limited access to resources and modern techniques, and who are frequently in weak bargaining positions vis a vis downstream actors in the supply chain. Since early 2000, a project to improve quality through the prevention of toxigenic molds has been launched, with the objectives of increasing our understanding of ochratoxin development, introducing good practice guides and training actors all along the supply chain. Seven African, Asian and Latin American countries are participating in the project, which is being run by the FAO.

Introduction

Preventing the risks of contamination by bacteria, pesticides, chemicals, mycotoxins, etc. in food products is a major challenge for all stakeholders in agrifood supply chains. Cases of food poisoning have always hit the headlines and can have very serious economic consequences. As society develops, consumers and citizens are demanding greater protection from such risks. Whilst agribusiness and large-scale distributors are taking increasingly strict steps to guarantee that food is safe, public authorities are also introducing increasingly high standards to ensure as far as possible that health risks are prevented.

Among the many contaminants known to date, aflatoxins, fumonisins, trichotecenes, zearalenones and ochratoxins belonging to the mycotoxins group are responsible for extremely serious human pathologies. Ochratoxin A, or OTA, produced by fungi of the genera Aspergillus and Penicillium, is acknowledged to be responsible for certain kidney pathologies in pigs and is suspected of causing some human kidney pathologies (FAO/WHO/UNEP, 1999). It has been shown in rats that OTA has carcinogenic and immunotoxic properties. In addition to effects linked to direct intake, OTA has a long biological cycle, remaining in the bloodstream and thereby contaminating the meat from animals having ingested it, just as it can contaminate mother's milk.

Ochratoxin and Human Health

Fairly little is known about the conditions for contamination by fungi responsible for OTA production, or of their propagation, or of conditions for OTA production by such fungi. However, it is acknowledged that inadequate drying and storage without taking precautions are exacerbating factors. OTA contents in agricultural products vary considerably, and can range from 0 to several dozen μg/kg.

In 1994, the European Commission asked a group of scientists to evaluate the quantities of ochratoxin A ingested in the average diet of Europeans. Opinions differ substantially depending on the countries and the evaluation committees. For the European Union, the tolerable daily dose is under 5 ng/kg of body weight (2 100 ng/week for a person weighing 60 kg), in Canada it is estimated at between 1.5 and 5.7 ng/kg (630 to 2 394 ng/week), and the joint FAO/WHO (Food and Agriculture Organization of the United Nations/World Health Organization) panel of experts proposes 100 ng/kg/week (6 000 ng/week).

Coffee and Ochratoxin

Six million t of coffee are produced annually by around 70 countries. The vast majority (90%) of the producers are smallholders, farming between 0.1 and 5 ha of coffee plantings. This production amounts to 12 to 15 billion dollars per year, 45 to 50% of which goes back to farmers, the remainder being distributed among the different operators in the national supply chains. Money from coffee is often the main, if not only, source of income for these farming families, and the main source of foreign currency in many countries.

Around 80% of coffee is exported to industrialized countries. Some of this coffee goes back to the producing countries in instant or roasted coffee form, and producing countries consume unexportable second grade coffees directly.

Standards for cereals and cereal products, and dried fruits are to be applied from January 2001. For coffee and other agricultural products, they are under discussion and are likely to be applicable from January 2002 onwards. The standard for coffee would be 3 ppb in roasted coffee. Setting such standards for international coffee trade risks the following consequences:

- **Loss of market shares**. The risks associated with OTA differ across geographical regions. Apparently for coffee, differences reflect a disparity depending on the cultivated species, arabica and robusta. The major producing regions with the lowest risks are predominantly arabica producers. In fact, the risks are linked to the post-harvest processing methods, and arabica is mostly processed by the wet method, whereas robusta is processed by the dry method. This explains the high risks in East Africa (Ethiopia), where arabica is mostly processed by the dry method. A study by the Institute for Scientific Information on Coffee (ISIC), in conjunction with the International Coffee Organization (ICO), showed that applying the 3 ppb limit envisaged is likely to remove from international trading circuits some 600 to 700 000 t of coffee, equivalent to the combined production of the Ivory Coast, Uganda and Ethiopia in Africa, Guatemala, El Salvador and Costa Rica in Central America.

- **Fall in producer prices.** It is to be feared that unless the quality of coffee purchased at the farm-gate can be controlled, processors and traders will minimize their risks by purchasing coffee at the lowest price possible. Nothing is yet known about the geographical distribution of contamination risks, whether on a national, regional,

village or plantation scale. By purchasing at low prices, and then mixing different origins, traders or exporters minimize the risk of seeing coffee batches rejected on entry into Europe.

- **Rise in the consumption of contaminated coffee in producing countries or countries without regulation,** (as exporters sort and send the non-contaminated coffee to markets which control for OTA).

- **Fall in demand.** The coffee industry in the industrialized countries is worried about its supplies, but also about possible consumer disenchantment with coffee.

- **Rise in coffee prices at the distribution stage**, in response to higher costs of controlling product quality, an increase which could also lead to a decline in consumption.

Difficulties in Establishing Standards

The European Commission proposes fixing a standard for roasted coffee at 3 micrograms per kg. We saw earlier that human health experts have differing views on the daily quantities that can be ingested without risk. Across Europe, consumption statistics vary from 2 kg per person per annum for Ireland to over 11 kg in Finland. It is clear that with a mean standard, the largest coffee consumers theoretically take more risks for their health, and that too strict a standard will appear excessive in a country like Ireland.

The European diet also needs to be taken into account, due to the possible existence of OTA in other agricultural products (cereals and by-products, wine, dried vegetables, dried fruits, etc.). All in all, coffee is considered to be a minor contributor to daily OTA intake: from 1 to 10% depending on the country, and 5 to 6% on average. This needs to be compared with the share of cereals, which amounts to 40-55%.

A standard applied to green coffee necessarily requires green coffee to be quality controlled, since in principle, mixing contaminated batches with healthy batches will be banned. A few severely contaminated beans within a batch of healthy beans will be enough for the sample to test positive. Systematic checking of imported batches requires the sampling of large volumes. This raises the problem of sampling methodology to ensure the best possible representativeness. However, coffees are homogenized during roasting, grinding and packaging, which improves sampling representativeness.

Although the molecule is stable, it is acknowledged that around 40 to 90% of OTA is destroyed during roasting (data which some challenge). On the other hand, the roasting procedure undoubtedly has an effect on the final ochratoxin content. As OTA is water–soluble, the remainder not destroyed during roasting ends up in the cup.

Preventing the Risk of Toxigenic Mold and Fungus Development

Scientific knowledge of toxigenic fungus development and on conditions for OTA development is very limited. Unlike for Fusarium, which is responsible for the production of trichotecenes, and which has pathogenic effects on cereals, it has yet to be demonstrated that the genera Aspergillus and Penicillium affect production. Very little is known about environmental factors and biological variables propitious or not to the development of toxinogens.

Earlier studies have nevertheless made it possible to define the level of contamination risk depending on the treatments undergone by coffee, and also to draw up a brief charter of good practices. If these general recommendations were strictly applied, the minimum risk that was assessed revealed that 2% of coffee would still be rejected. This corresponds to around 120 000 t of coffee for a value of 160 to 170 million dollars, and shows that these recommendations are probably insufficient.

Putting into place a charter of good practices will encounter significant difficulties related to conditions in the field. Coffee is produced by a multitude of small farmers, whose income, and often technical know–how, are limited. The socio-economic environment in which they operate is a powerful brake on the adoption of new techniques. Operators in national commodity chains often exert enormous pressure that is not particularly favorable to a general improvement in coffee quality, particularly as most producers stand alone against a more or less organized downstream profession.

In this context, it is necessary to envisage accompanying measures to help producing countries adopt prevention programs.

The Global Initiative for Preventing OTA Contamination in Coffee

Preventing OTA contamination is a worldwide problem, and no producing country is spared. The International Coffee Organization, of which virtually all producing and consumer countries are members, has launched a prevention project with support from European industry (ISIC), in which mycology research plays a relatively important role, though the activities primarily concern training and extension. It will also take into account essential socio-economic aspects, for understanding the behavior of producers, and for analyzing the structure of national commodity chains. Project implementation has been entrusted to the FAO. The project is scheduled to last 4 years, and is to be implemented in 7 important producing countries (Indonesia, India, Uganda, Côte d'Ivoire, Brazil, Colombia and Kenya), which together account for roughly 60 % of world output.

The Common Fund for Commodities (CFC) is funding half of the US$ 5.6 million estimated budget for its implementation. Two European research organizations are taking part: the University of Surrey, for mycology aspects, and CIRAD for all the technical and socio–economic aspects concerning production, knowledge of commodity chains, and experience in training and extension.

The project was launched very recently and the first year's work should provide an understanding of the development mechanisms of fungi involved in contamination and the conditions for ochratoxin production. At the same time, surveys undertaken in each of the participating countries should provide a set of technical, social and economic data designed to provide an understanding of farmer behavior and make it possible to establish a code of conduct based on a HACCP (Hazard Analysis and Critical Control Points) approach.

The multitude of factors contributing towards fungus proliferation and mycotoxin production make preventive measures difficult to define and especially to apply. It is probable that the introduction of a standard will have a strong influence on the behavior of stakeholders in the national supply chains, an influence as strong as that following liberalization programs introduced over the past decade. The traditional attitudes of farmers will have to evolve, stakeholders in the supply chains, both national and international, will be increasingly obliged to take into account the additional cost of the efforts that will have to be made, both by producers in improving the quality of their coffees and by traders and processors so as not to risk adversely altering the coffee during processing, storage and transport.

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