

# Storing up problems?

DR TERRY MABBETT looks at the crucial factors in the handling of coffee and cocoa beans before, during and after shipment from origin, and the way they affect the final product.

**L**ike many other crop commodities, including cereal grains, legumes and oilseeds, coffee and cocoa is stored in the form of seeds, but that is where the similarity ends. Both coffee and cocoa are cured (fermented and/or dried). Cocoa is fermented and dried, and coffee washed (partially fermented) and dried, or dried only, depending on type and origin.

Unlike wheat grains, soya beans and sunflower seeds, cured cocoa beans and green coffee beans are not living and breathing seeds. This means that they are generally less susceptible to a wide range of storage insect pests and diseases, but more susceptible to moisture and chemicals. The porous condition developed during curing, which facilitates the exit of water and undesirable chemicals will, by the same token, allow unimpeded entry of moisture and chemicals in store.

Furthermore, coffee and cocoa are generally subjected to a wider range of storage conditions as well as longer periods in store. Both are produced in the hot, wet and humid conditions of the tropics, but largely processed and used in temperate countries. This means that marked changes in both temperature and humidity will be experienced during passage from farm to processor. Because they are not living seeds, they can be successfully stored for longer periods of time, and although there is a general deterioration with age, the flavour of some origins (e.g. harsh Rio, aged Venezuelan and monsooned Indian coffees) actually improves with time.

All of these factors make the storage susceptibilities and priorities of coffee and cocoa unique and generally more complex than those of other agricultural commodities. The factors that threaten the integrity, marketability and value of coffee and cocoa in store can be broadly divided into four categories – physical, biological, chemical, and biochemical. Each cannot be considered in isolation because of well-established interactions. For instance,

excessively high bean moisture content not only causes physical deterioration, but also triggers the development of insect pest infestation and the growth of fungal moulds.

## Physical storage of sensitive beans

Coffee can be stored in the producing country as dried cherry or parchment, but the vast majority, especially that destined for export, will be stored as green coffee. Moisture content for the satisfactory storage of coffee should not exceed 11 per cent w/w, at which level the development of moulds and general enzymatic activity is minimal.

If the relative humidity within the storage structure approaches 75 per cent (equivalent to a bean moisture content of 13 per cent w/w), a variety of “dry” moulds including *Rhizopus* sp and *Aspergillus* sp will start to develop. While most are innocuous, some, like *Aspergillus ochraceus*, are mycotoxin producers.

At relative humidity exceeding 85 per cent (bean moisture content of 18 per cent w/w) yeast and bacteria begin to bring in systematic wet rot and destruction of the beans.

Cured cocoa is even more sensitive to moisture, because the beans, like table salt, are hygroscopic—they actively absorb moisture from the air. Maximum moisture content of cured cocoa beans necessary for successful storage is just 8 per cent w/w. Values above this level lead to the development both of insect pest infestations of moulds. Beans will become covered with fluffy fungal mycelium and this mould growth internally causes a rise in free fatty acid content and problems with importers and chocolate manufacturers.

## The biological minefield

Biological agents, including insects, mites and moulds, with the capacity to damage and



destroy stored coffee and cocoa are ever present but generally require the right physical conditions to grow, reproduce and feed on these stored commodities. Coffee and cocoa each has one particular insect pest that causes most damage: respectively, the coffee bean weevil (*Araecerus fasciculatus*) for green coffee and the cocoa moth (*Ephestia cautella*) for cured cocoa beans. The situation is complicated for cocoa in that the cocoa moth is the main agent of destruction in tropical origin countries where cocoa stored before export, while a closely related species, *Ephestia elutella* (the warehouse moth), may become a problem in store on arrival in temperate countries.

While these are the main insect pests, there are others, including the red flour beetle (*Tribolium castaneum*) in coffee and the tobacco beetle (*Lasioderma serricorne*) in cocoa.

Chemical control options are limited by problems that may be caused by insecticide residues. The first line of defence is to provide storage conditions that do not encourage the pests. Pest monitoring using custom-designed traps loaded with pheromones (insect sex attractants) should be conducted wherever possible. Fumigation with insecticide should only be used as a last resort when pest numbers, as determined by monitoring, exceed the economic threshold. Controlled atmosphere storage, in which the commodity is sealed in an atmosphere of inert gas (nitrogen or carbon dioxide) and in which the insect pests are essentially suffocated—is another option.

## Bad chemistry

The chemical factors that may contribute to loss of integrity and value are many but there are only two main consequences. These are rejection of the commodity by the importing country and interference with the normal flavour and aroma of the finished product.

Pesticides used in the field to control insect pests and fungal diseases on cocoa and coffee trees may cause problems well into storage and beyond. Consignments of West African cocoa have been rejected at US ports of entry due to residues of gamma HCH (lindane) that was traditionally used to control mirids (sap sucking bugs). Other sources of potential pesticide contamination include insecticides applied in store which have not broken down by the time the commodity is tested before use, or the inadvertent storage of coffee or cocoa alongside volatile chemicals in the same warehouse. These chemicals are absorbed by the coffee and cocoa beans and impart a chemical taint.

Chemical contamination and tainting of coffee and cocoa with certain oils contained in jute bags has been a long term problem but only recently has it been fully recognised and appreciated. Hydrocarbon residues from jute batching oils, found in bags used to ship coffee and cocoa, are now being avoided by the use of custom-designed non-toxic oils of vegetable origin on the Indian sub continent, where most jute and jute bags are produced.

## The OTA scare

Contamination of coffee and cocoa with mycotoxins (chemicals manufactured by specific fungal moulds) is perhaps the biggest single threat to the integrity and marketing of coffee and cocoa worldwide in the future. Specific fungi have the ability to manufacture 'signature' chemicals that are highly toxic at very low concentration. Ochratoxin A (OTA) is the major mycotoxin that threatens coffee and cocoa. Ochratoxin A is produced by several fungi most notably *Aspergillus ochraceus* in the tropics and *Penicillium verrucosum* in temperate climates. Like other mycotoxins, their effect on animal (including human) metabolism can be catastrophic; OTA's effects can include kidney failure and carcinogenesis.

OTA contamination has long been recognised as a problem for coffee but is now causing increasing alarm in the cocoa industry. The fungi responsible for OTA synthesis are ubiquitous moulds dispersed by spores. It is practically impossible to exclude them and the only realistic course open is to ensure coffee and cocoa beans are never held in the combined conditions of temperature and humidity that encourage the growth of these particular moulds.

Comprehensive research projects using HACCP analysis are underway to identify lists of 'Critical Control Points' for OTA contamination, from harvest right through to factory processing.

Within the coffee industry, some individual countries, organisations and companies are currently testing for OTA at 2-4 ppb (parts per billion) equivalent to 2-4 µg/kg. A recent German proposal within the EC calls for testing at 3 ppb in roasted coffee and 6 ppb in instant coffee. Bureaucrats and laboratory-based scientists testing for OTA have often based their judgements on the results obtained from "high tech" equipment which offers ever-increasing sensitivity. Both groups, however, can be completely divorced from the reality of producing and processing coffee and cocoa on farms in the tropics, and are in danger of calling for limits that in practice may be impossible to achieve. **CCI**

