laboratory measurements do not take account of bean cleaning losses and ease of winnowing. Therefore actual yields should be assessed on the production plant (see Chapter 3).

2.6.4 Contaminants and residues

Modern methods of analysis can detect minute or trace levels of undesirable materials in foodstuffs (see Chapter 25). This has given rise both to some legitimate concerns and some "food scares" which were not based on sound rationale.

Heavy metals, such as lead and cadmium, are found at very low levels in many foodstuffs including cocoa products. The source is mainly environmental including soil type, fertilisers, pesticides or vehicle emissions. The levels found depend on the origins of the cocoa materials and the recipe and process. There is a concern that some products could provide a significant proportion of the tolerable daily intake. Therefore, limits on cadmium are proposed, ranging from 0.2 to 2.0 mg/kg, depending on the level of cocoa solids in the product (dark chocolate with >50% cocoa solids will have the high limit). These limits will be applied in the European Union from 1 January 2019.

Mineral hydrocarbons have been used in the past in manufacturing jute sacks. Very small quantities of mineral oil were transferred to the cocoa beans and then into cocoa products. As a result of a joint initiative covering several foodstuffs, the sack manufacturers carried out some developments and have switched to using a food grade vegetable oil.

Polycyclic aromatic hydrocarbons (PAH), such as benzo-a-pyrene [B(a)P] result from combustion products and are generally present at low levels in the environment. In cocoa, the main risk is from artificial drying or sun drying in polluted areas such as roadsides. Hydrocarbons are fat soluble and will be found at higher concentrations in cocoa butter.

Mycotoxins [such as ochratoxin A (OTA) or aflatoxin] are produced by some types of moulds under certain conditions. However, there is no correlation between the level of visible mould revealed in the cut test and the amount of mycotoxins present. Generally, aflatoxin is not a concern in cocoa. OTA is present in cereals and most agricultural commodities. In cocoa, it is frequently present at extremely low levels, and cocoa products are not a significant source of OTA in the diet. OTA appears to develop in damaged pods prior to the fermentation stage.

The manufacturer needs to have a monitoring process in place for these contaminants and also needs to keep aware of new, potential contaminants. In all cases, the manufacturer must ensure food safety and compliance with the relevant legislation.

2.6.5 Cocoa butter hardness

The quantity of fat and its melting characteristics, especially hardness, depends on the variety or type of cocoa, the fermentation and drying and the environmental conditions (see Chapter 7). In particular, the average daily temperature during the

last few months of pod development affects the hardness of the cocoa butter. Lower temperatures give butters that are softer or have a lower melting point. Generally, cocoa butters made from Indonesian beans are harder than West African butters, which in turn are harder than Brazilian butters from Bahia region.

Mouldy cocoa beans, caused by inadequate drying, contain high levels of FFA. This also has an undesirable softening effect on the cocoa butter and the level of FFA is limited by regulations in some countries (e.g. 1.75% in the countries of the European Union) and by FCC contract rules.

Quality criteria that can be applied to the semi-processed cocoa materials (cocoa butter, powder and mass) are described in Chapter 3.

2.6.6 Sensory evaluation

Flavour is the most important property for chocolate consumers and hence manufacturers (see Chapter 21). Off-flavours (such as smoke or putrid over-fermentation flavours) can be readily detected by tasting roasted ground nib or cocoa mass (cocoa liquor) directly. Alternatively these can be made more palatable by mixing the mass with finely ground sugar and/or water or preparing a small-scale dark chocolate. These tests are essential for beans from origins that are inconsistent in quality or prone to off-flavours. The level of cocoa flavour and other flavours (such as acidity, bitterness, astringency and any ancillary flavours for fine cocoas) are more difficult to assess. A well-trained sensory evaluation panel with appropriate test designs and statistical analysis of results is required.

2.7 Types and origins of cocoa beans used in chocolate

Chocolate manufacturers need to produce a product of consistent quality from a raw material that may be variable. It is common practice for chocolate manufacturers to purchase cocoa mass or liquor from cocoa processors. Increasingly, these may be situated in the cocoa producing countries (known as origin processors).

The only significant volumes of cocoa exports in the world are from West Africa and Indonesia; the other large producing countries having internal markets for their cocoa products. It is usual to apply some selection to the origin and type of cocoa beans or mass used for chocolate making. Cocoa processors will frequently blend beans from different origins and/or deliveries to achieve a consistent product of the desired quality. In choosing the type of cocoa and the recipe or blend there are a number of factors to consider. These include availability of the required quantity of beans, the reliability of supply, consistency of quality (especially flavour), price, yield (both of cocoa mass and the % fat in the mass) and how easy it is to process. Blending can be carried out before or after roasting. If it is carried out after roasting, this allows different levels of roasting to be used for different types of beans.