

onto a shaft making it easy to “tune” the screw profile to match the processing requirements and reducing operating costs since individual screw elements can be replaced in the event of wear rather than the entire screw.

In the chocolate industry, extruders have been used to treat cocoa mass, for flavour improvement (Section 15.5.2), as a liquefier to partially or fully replace the conche (Section 15.5.3) or to shape tempered chocolate to produce novel products (Section 15.5.4).

### 15.5.2 The extruder as a flavour modifier

The ability of an extruder to heat and de-gas liquids has led to its use in pasteurisation or flavour modification of cocoa mass or nibs. Traditionally this has been carried out by thin film or spray devices (Chapter 10). One system using an extruder, developed by Werner and Pfeleiderer (Elsner, 1989), adds water or steam into the extruder, where the cocoa nibs are thoroughly wetted and slightly crushed. Pasteurisation is carried out by applying a high temperature over a short time. The steam de-gasses at the machine outlet, taking with it many other compounds, including some acidic ones, which are detrimental to chocolate flavour. The high humidity during the process also raises the water activity (equilibrium relative humidity) of the material, thereby increasing the probability of destroying *Salmonella* and other bacteria (Chapter 25).

In addition to treating cocoa mass to remove flavours and thereby shorten conching times, an extruder can also be used to treat the chocolate ingredients to produce a crumb type of flavour. As was described in Chapter 6, chocolate crumb was produced historically to give the milk needed for chocolate making a longer shelf life. Although this may now no longer be necessary, the cooked caramel flavour is preferred in some markets, for example the United Kingdom. The manufacture of crumb usually involves a vacuum drier and is relatively slow and expensive.

In the Continua crumb process (Anon., 1996; Figure 15.7) a crumb-like flavour can be produced in about 60s. Sweetened condensed milk and/or milk powder, water and sugar are fed into a twin screw extruder together with cocoa mass. Here they are thoroughly mixed and heated to a temperature of 95–130 °C (203–266 °F) depending upon the desired final flavour. Towards the end of the process the mixture is reduced in temperature by applying a vacuum. At this stage the residual moisture is 1–3% and the mixture has a consistency which enables it to be pelletised. This granulate is then milled to a powder, which can be used as the main ingredient in a traditional chocolate making process. The milling will also reduce the moisture by up to a further 0.5%.

### 15.5.3 The extruder as a chocolate conche

In Chapter 10, the importance of high shear and temperature control in reducing chocolate viscosity during conching was emphasised. Extruders are ideally suited to such applications.

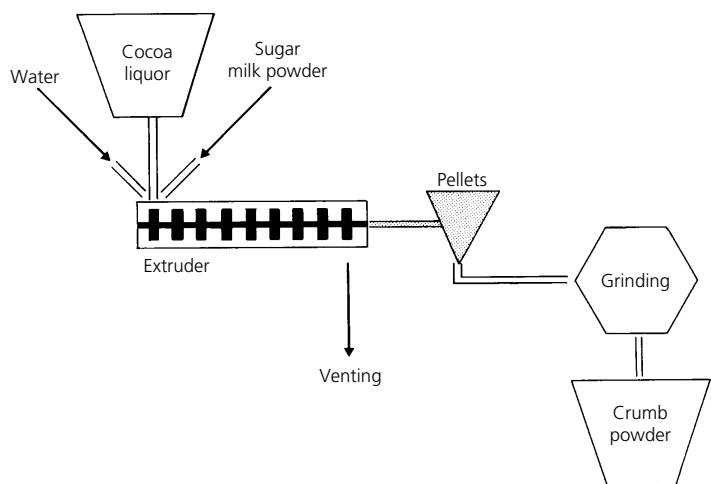


Figure 15.7 Chocolate crumb making process using an extruder (Anon., 1996).

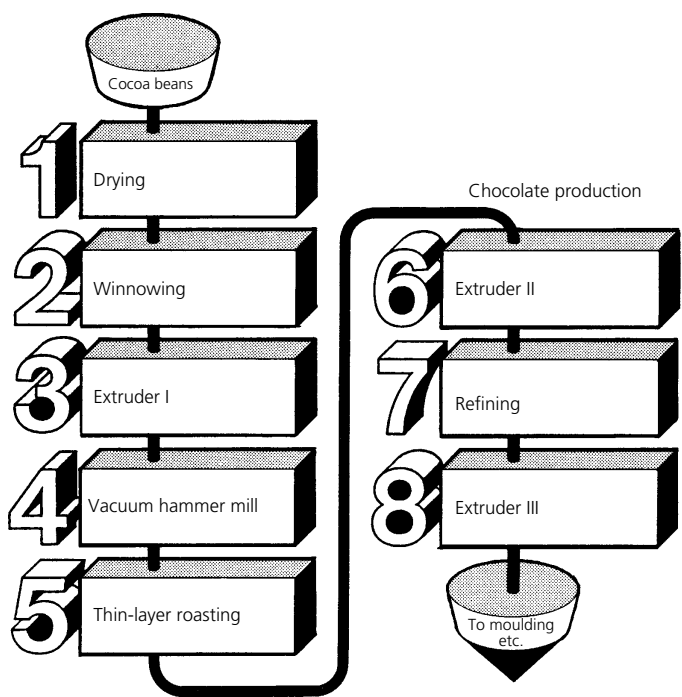


Figure 15.8 Werner and Pfeleiderer system for chocolate manufacture.

One of the first descriptions of their being used for this purpose was as part of a novel chocolate process developed by Werner and Pfeleiderer (1970). The total process used three extruders (Figure 15.8). The beans were dried and winnowed before being slightly crushed under high moisture conditions in the first extruder,