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Chocolate: a delight for body and soul

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Cocoa

The history of cocoa can be traced back to 600 AD, to the jungles of Yucatan and the Mayan empire. These early Mexicans established plantations of cocoa trees. The cocoa beans were valuable commodities, used in trade as a form of payment, and were important accessories to religious rituals. By 1200, the Mayans had been conquered by the Aztecs. In the Aztec culture, cocoa beans were also roasted, ground and mixed with liquid and spices to form the basis of a frothy, though rather bitter, drink known as chocolatl. Cocoa was regarded as the food of the gods, from which is derived the botanical name of *Theobroma cacao*. This drink was reserved for the emperor, his nobles and his warriors.

In the year 1519 a party of Spaniards, led by Hernando Cortés, landed in Mexico and was welcomed by the Aztec emperor, Montezuma. There, as honoured guests, they were served with chocolatl to drink. Impressed by the obvious status attached to chocolatl, Cortés took cocoa beans to Spain in 1528. The Spanish added sugar to chocolatl to make it more palatable, and kept it secret for half a century. Only in the 17th century did the secret of cocoa spread to the rest of Europe. In 1615 the drink was officially introduced into France. In the 1650s the drinking of chocolatl reached England. In 1697 a citizen of Zurich tasted chocolate in Belgium, and from there introduced it into Switzerland.

The drinking chocolate of the 18th century was still far from the palatable drink that it is today; it was fatty and scummy, and difficult to digest. This problem of palatability was remedied by the invention in 1828 of the cocoa press by C.J. van Houten, a Dutchman. By pressing cocoa beans he was able to extract some of the fat from cocoa. Van Houten's work opened the way for the invention of eating chocolate, as we know it today.

Chocolate business

François-Louis Cailler opened Switzerland's first chocolate factory near Vevey in 1819, which was later transferred to Broc (Gruyères) where the factory is still to be found today. Other famous names can trace their origins to the first half of the 19th century, for example, Suchard, Kohler and Sprüngli. The Swiss chocolate industry made some major contributions to the development of chocolate. In 1875, Daniel Peter perfected a method of adding milk to chocolate, thereby creating milk chocolate. In 1880 Lindt invented the process known today as conching. Lindt improved this further by adding extra cocoa butter to the chocolate, and the result was a smooth chocolate with good melting qualities. Elsewhere the chocolate business was also developing. In England, it was largely developed by Quaker families like the Rowntrees, Frys and

Cadburys. Other famous names include Menier and Poulin in Paris, van Houten in Holland, Perugina in Italy and Hershey in the USA.

Cocoa comes from cocoa beans, the fruit of the cocoa tree, *Theobroma cacao* (family Sterculiaceae) which originated in the tropical rainforests of South or Central America where it thrives. There are two main subspecies of cocoa, Forastero, which produces purple beans and Criollo, which gives white beans. Most commercial cocoa comes from Forastero varieties. The cocoa tree grows in the shade of big trees. Numerous small flowers grow directly off the trunk and from these develop the cocoa pods, containing 30 to 40 cocoa beans embedded in white mucilage. Cocoa beans have an outer shell, which encloses two cotyledons, known as the nibs.

There are four major steps in processing cocoa beans, which are carried out in the country of origin: harvesting, fermentation, drying and storage. Cocoa pods are cut from the tree, split open and the beans removed. After being heaped together the beans are fermented for five to six days. Initially, yeasts ferment the sugar in the mucilage to alcohol (ethanol). This phase lasts around twenty-four hours and operates under anaerobic conditions. Bacteria then use the ethanol as an energy source, producing acetic acid. At the same time heat is generated and the temperature of the beans rises to 50°C or more. This, combined with the acid, kills the beans, destroying their cellular structure.

Following fermentation beans must be dried to enable them to be stored and transported. Sun drying is said to give the best quality and takes approximately one week in good conditions.

Fermentation initiates a series of reactions leading to the formation of the chocolate flavour, which finally develops during roasting of the cocoa in the chocolate factory. During fermentation the proteins in the cocoa beans are hydrolysed to peptides and amino acids, and polyphenols are oxidised. Peptides and oxidised polyphenols react with each other. In the process, the colour of the beans changes from purple to brown, and their bitterness is reduced. Other important reactions taking place during fermentation and drying include those of the Maillard type where free sugars react with peptides and amino acids.

Later the formation of the basic chocolate flavour is completed by roasting the beans in the chocolate factory at between 120-150°C for 10-50 minutes. This completes the generation of the main components of chocolate flavour. The cocoa beans are then ground to form a paste known as cocoa mass, the basic material for chocolate production. It contains 55% cocoa butter. Additional cocoa butter is needed for chocolate manufacture, and this is extracted from cocoa mass under pressure. The other main ingredient of chocolate is sugar, together with milk for milk chocolate.

The first stage of chocolate manufacture is to mix the main ingredients together. A stiff, granular paste emerges from the mixers, which is then transferred to refiners in order to reduce the size of the individual non-fat particles still further, so that they are not perceptible on the tongue or palate. The next stage in chocolate manufacture is conching where the paste is mixed at an elevated temperature (50-80°C). This allows unwanted flavour volatiles to escape thereby optimising the flavour of the chocolate. The process also leads to fat coating the sugar particles, which is assisted by the addition of lecithin emulsifier, thereby reducing the viscosity of the paste.

In the final stage of making a chocolate bar, the liquid chocolate must be 'tempered' to achieve a stable crystalline form of cocoa butter. Cocoa butter has at least six

crystalline forms, of which only one is stable at room temperature. The chocolate is heated to around 50°C to ensure that all the fat is melted and then cooled to about 28°C to allow the chocolate to 'seed' with the right type of crystal form and then slightly reheated again. The chocolate is then ready for moulding or other uses.

Current research

Chocolate research is concerned with all the parameters which affect its organoleptic qualities, i.e. its texture and flavour. This involves investigations into all aspects of the preparation of cocoa beans and the manufacture of chocolate. The formation of flavour precursors and substances occurring during cocoa fermentation, drying and roasting (Maillard reactions) are fields where a significant amount of chemical research has been carried out, leading to a basic understanding of these processes. Further investigations are continuing to deepen our knowledge. Other aspects of current research are linked specifically to the crystallisation behaviour of cocoa butter with its six different polymorphic forms and its «incompatibility» with most other fats due to the formation of eutectics. Oil chemists are developing new fats classified as cocoa butter equivalents, replacers or improvers. Other research is focusing on the development of lipids or lipid analogues with physical properties similar to those of cocoa butter but with a significantly reduced calorie content. Fat bloom of chocolate is a further problem which has been the subject of numerous investigations but which is still not yet solved.

This research involves a broad spectrum of different scientific disciplines. To illustrate this, two examples are given:

1. In 1997 a paper was published on work carried out at the Herschel Smith Laboratory for Medicinal Chemistry in Cambridge, on «Visualisation of liquid triacylglycerol migration in chocolate by magnetic resonance imaging». This involved collaboration between food science and clinical medicine.
2. A television film from the BBC was recently dedicated to a cold extrusion process of chocolate and included physicists of the famous Cavendish Laboratories in Cambridge in the investigation of this new technology of chocolate forming.

Finally, chocolate masses behave like non-Newtonian fluids, which means there are strong links to the rheological research into synthetic plastic materials.

A delight for body and soul

Chocolate is one of the most universally appealing of foods. People not only like chocolate, some even crave it. Wherever it has been consumed in the world, chocolate has usually gained a special place among the foodstuffs available. In the Aztec culture, the consumption of chocolate was limited to a circle of persons such as the emperor, his nobles and warriors. Later on in Europe, old advertisements show that chocolate consumption was deemed appropriate for children and women, or the old and the sick, but not for healthy, especially male, adults. The publication in 1995 of a book with the title «Why women need chocolate» shows that a particular attitude on chocolate liking persists even to the present time.

The indulgent consumption of chocolate by adults has symbolic significance. Chocolate is shared during festive seasons like Christmas and Easter; it is given as gift or reward; it is consumed to relax from stress; or offered as an expression of affection as exemplified by products such as «Baci». Pleasure and self-indulgence, however, have a touch of sin in most cultures. Perhaps this is why chocolate attracts adverse comment, being said to cause acne, to generate obesity, to precipitate migraine and to be rich in stimulants. But scientific studies provide little credence for such negative views of chocolate. Armed with a positive attitude to life, a little indulgence in chocolate - but not too much - will always be a delight for body and soul.