HORIBA Scientific

Application Note

Particle Sizing of Chocolate

AN138

Particle size measurement of chocolate samples is a vital factor in producing a consistent and attractive final product. Several stages of manufacturing are controlled by particle size and the particle size of cocoa powder used in chocolate affects color and flavor strength.

History of Cocoa

As long ago as the 600AD the Maya Indians were enjoying the delights of the cocoa bean on the Yucatan peninsula. By the 1300s the Aztecs in what is now Mexico City made a drink form the cocoa bean described as 'finely ground, soft, foamy, reddish, and bitter, added to the mix was aromatic flowers, vanilla and wild bee honey'.

Chocolate remained a drink until 1849 when the first chocolate for eating was produced. By today's standards these chocolate bars would not be considered particularly palatable.

Cocoa trees resemble apple trees except the fruit grows directly on the trunk instead of on the ends of the branches. Each tree is capable of producing 20-30 pods per year. Each pod contains 20-40 seeds. It takes a whole year's production from one tree to yield 450 grams of chocolate.

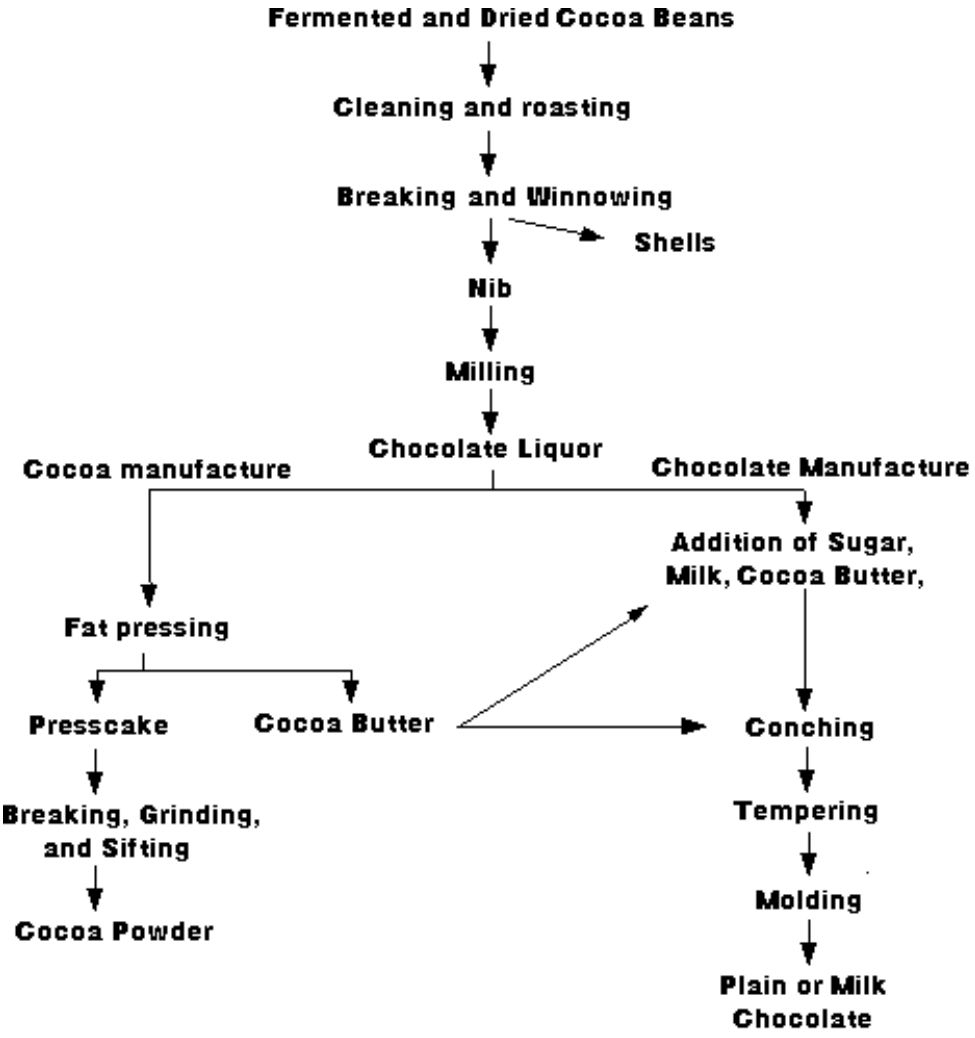
Fig. 1 Cacao tree fruit and seeds

Production Process

Beans are harvested and fermented for a period of 5-6 days in the country where they were grown. After arrival at the production facility the beans are roasted for 10-115 minutes depending on the quality. Next the shells are removed by a process known as winnowing, where shells are removed using compressed air. The nib is what remains; this is the meat of the seed.

Milling of the nib takes place in a steel pin mill or a vertical ball mill. The nib is ground until the friction and heat of the milling reduces it to a thick chocolate colored liquid, known as mass or liquor. The chocolate liquor contains 50-58% cocoa butter and cocoa particles with a median around 100 microns. Depending on how the liquor is processed it is either made into cocoa powder (usually lower quality liquor) or processed into chocolate for eating.

Cocoa powder is produced by removing about half of the cocoa butter from the liquor using heavy presses. The resulting press cake is then subjected to another grinding process to yield cocoa powder which is used in beverages and cooking. The removed cocoa butter is used in solid chocolate production as seen in the flow chart on the following page.



Final Product Quality Measures

Particle size of cocoa powder used in chocolate affects color and flavor strength. The industry refers to “mouth feel” as a gauge of acceptability or rejection. If the particles are too large, it will not have a consistent creamy taste. If the particles are too small, the taste will be powdery and chalky. In this application, the range of particle size is more important than median or mean values.

Chocolate for eating is made by adding sugar, cocoa butter and in the case of milk chocolate, milk. The mixing is called conching. Conching is where the mouth feel is developed by the sharp sugar crystals further grinding and polishing the cocoa particles. When milk is added it is in the form of spray dried milk powder. During conching the milk particles are also reduced in size.

During conching the cocoa particles are reduced from about 100 microns to about 18 microns. The final size of the cocoa particles and sugar crystals and amount of additional cocoa butter is critical to the final product. The amount of conching varies greatly between manufactures.

Some domestic supermarket chocolates use only a few minutes of conching resulting in mediocre taste and consistency. The finest of the European chocolates claim to be conched for five days resulting in highly polished cocoa particles which give a very smooth and creamy mouth feel.

Tempering is an essential step before chocolate is used in food applications. Tempering is the controlled heating and cooling of chocolate to promote small, stable crystals of fat. Most of us are familiar with the white spots on chocolate that has been melted and re-solidified. The spots are simply a larger, less stable crystal of cocoa butter.

Fig. 2 HORIBA LA-960 Particle Size Analyzer

Analysis Methods

Particle size measurement of chocolate samples is a vital factor in producing a consistent and attractive final product. HORIBA's LA-series particle size analyzers have proven to be very popular for this application.

The LA-960 and LA-300 instruments are used by manufacturers to closely control the chocolate manufacturing process. If the particles are too large, it will not have a consistent creamy taste. In this application, the range of particle size is more important than median or mean values.

Particle size of the cocoa powder can be measured after the chocolate liquor has been rendered from the bean at about 100 microns, after the press cake is ground into cocoa powder, and after conching is done, about 18 microns. In addition, The LA-Series instruments can measure the size of the sugar to be added for the conching process. This is important because it is the sugar crystals that help break down the cocoa particles in the conching process.

Dispersion Methods

There are two methods that work for measuring chocolate. For testing of the final product, a suitable dispersing medium must be selected, usually an oil of some type. The cocoa butter is dissolved in a solvent like Butyl Cellosolve, mineral oil, or a vegetable oil, leaving the cocoa powder and sugar crystals available for measurement.

The second method involves using a temperature controlled sampling unit to liquefy the cocoa butter or use heated vegetable oil to suspend the sugar and cocoa powder suspended in a mix of cocoa butter and vegetable oil. The sample testing system maintains an elevated temperature for the duration of the measurement.

The example below shows a sample run on the LA-300.

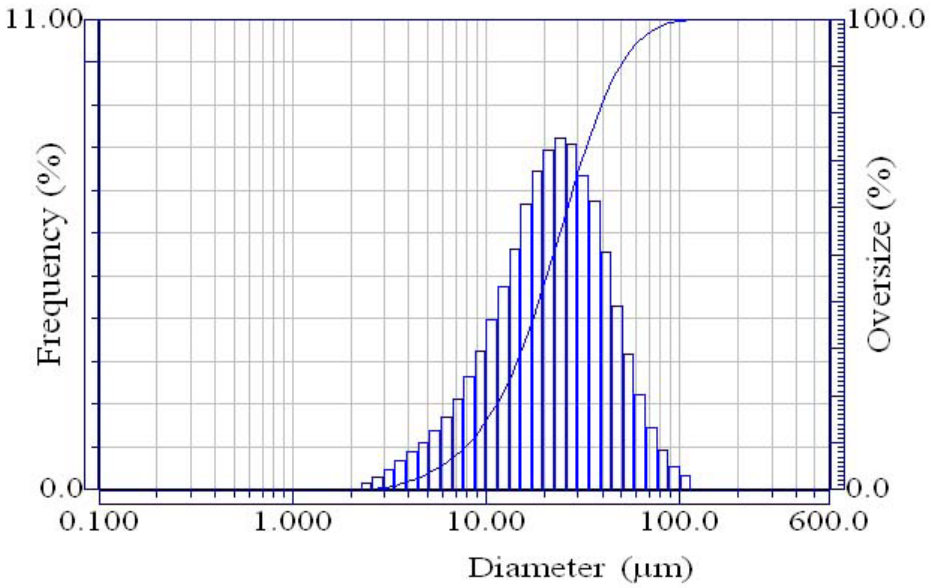


Fig 3. Chocolate measured on the LA-300
Median: 22.362µm
D(10%): 8.176µm
D(90%): 49.292µm
SD: 17.461µm