Chocolate—
A food from the past with a future

This article is excerpted from the 2002 AOCS Stephen S. Chang Award presentation given by award recipient Vijai K.S. Shukla at the Annual Meeting in Montréal. He is director of the International Food Science Centre A/S in Lystrup, Denmark.

Chocolate provides instant energy. It not only has nutritional value but also is an emotional confection—it can be used to comfort, apologize, and celebrate and also as a token of gratitude. The word chocolate derives from the Mayan XOCOATL and the word cocoa from the Aztec word CACAHUATL. The Mexican Indian word chocolate comes from a combination of the terms choco (foam) and atl (water). As a part of a ritual in twelfth century Mesoamerican marriages, a mug of the frothy chocolate was shared.

Chocolate is derived from the cocoa bean, which in turn comes from the cacao (ka-ka-o) tree Theobroma cacao. Theobroma means “food of the gods,” and cacao is as rich in history as in flavor. The tree is said to have originated in the Amazon or the Orinoco River basin at least 4000 years ago. Christopher Columbus was the first European to encounter the beans during his fourth voyage to the New World in 1502, but he virtually ignored them. It was two decades later that the Spanish conquistador Hernando Cortés helped spread the valuable cocoa bean crop to the Caribbean and Africa and introduced drinking chocolate into Spain in 1528. Today the cocoa tree is cultivated in West Africa, South America, Central America, and the Far East. At world level the demand for cocoa is generally measured by reference to grinding figures. The world grindings of cocoa beans in 1999/2000 set a new record of 2.95 million metric tons.

Chemistry of chocolate
Cocoa beans are converted into chocolate liquor by a combination of roasting, winnowing, and grinding. Until 1828 the only known product was “drinking chocolate,” but high fat levels were a deterrent to an acceptable product. It was not until the 1828 invention of the cocoa press, by Van Houten in Holland, that a more acceptable product was forthcoming. The chocolate liquor could now be further processed by pressing into cocoa butter and cocoa powder. The availability of quantities of cocoa butter made it possible to produce “eating chocolate.”

Cocoa liquor, cocoa butter, and cocoa powder are all important ingredients in the chocolate/confectionery industry. Of these, cocoa butter is the most expensive, followed by cocoa liquor and cocoa powder. Cocoa powder is used mainly in chocolate drinks and in confectionery coatings. Chocolate liquor, cocoa butter, lecithin,
and sugar are the main ingredients in dark chocolate. Milk crumb or milk powder also may be added to give milk chocolate. Chocolate is produced by a combination of techniques such as refining, conching, standardizing, and molding.

The total fat content of the whole bean on a dry basis is around 48–49%, and triglyceride is the major storage component. A mature cocoa bean can store up to 700 mg of cocoa butter. Since a tree may produce as many as 2000 seeds a year, a single tree could yield up to 15 kg of cocoa butter annually.

There is a good correlation between the triglyceride composition and solid fat content of cocoa butters. Malaysian, Sri Lankan, and Indian cocoa butters are the hardest; Brazilian is the softest; and others lie in between. The quality of Brazilian cocoa butter can be improved by mixing it with Malaysian cocoa butter, which will result in higher solid fat content at various temperatures.

**Confectionery fats**
The historical uncertainty in the cocoa butter supply and the volatility in the cocoa butter prices, which depend on fluctuating cocoa bean prices, forced confectioners to seek alternatives that may have had a stabilizing influence on cocoa butter prices. Ever-increasing demand for chocolate and chocolate-type products increases the demand for cocoa beans. However, it is difficult to predict the supply of cocoa beans. This ensures the continuing need for economical vegetable fats to replace cocoa butter in chocolate and confectionery products.

As early as 1930 confectioners attempted to use fats other than cocoa butters in their formulations. These experiments did not succeed because the incompatibility of the fat blends used resulted in discoloration and fat bloom. However, these experiments demonstrated the need for cocoa butter-type fats in the chocolate and confectionery industry.

Continued research in the field of confection science resulted in the development of fats with characteristics resembling cocoa butter. These fats, known as hard butters, were developed using palm kernel, coconut, palm, and other exotic oils such as sal, shea, and illipe as raw materials. The processes used to produce such fats include hydrogenation, interesterification, solvent or dry fractionation, and blending. The most elementary hard butters are manufactured by combining the processes of hydrogenation and fractionation.

**Hard butters**
The hard butters can be divided into the following three main groups based on their characteristics and the raw materials used to produce them.

- **Lauric cocoa butter substitutes (lauric CBS).** These fats are incompatible with cocoa butter but have physical properties resembling those of cocoa butter.
- **Nonlauric cocoa butter substitutes (nonlauric CBS).** These fats are partly compatible with cocoa butter.
- **Cocoa butter equivalents or extenders (CBE).** These fats are fully compatible with cocoa butter (i.e., they have chemical and physical properties similar to those of cocoa butter).

Other terms used to describe hard butters include cocoa butter partial replacers, total replacers, modifiers, and extenders. These categories can be further divided into a range of specialty fats, tailored to suit particular purposes.

**Business of chocolate**
The value of global confectionery consumption is about twice that of coffee, and the market volume is more than that of cereals. Due to the higher price of chocolate, the latter represents about 57% and sugar about 43% of the market value.

The highest sales per capita of chocolate are in Western Europe, followed by the United States and Australia. The sales per capita in South Africa and East Asia are still quite low (Figure 1). High consumption of confectionery seems to be associated with temperate climates.

Asia offers strong growth potential for the chocolate industry because of the sheer size of the market, which includes highly populous China, India, and Indonesia. Despite its size, Asia currently accounts for only around 10% of the world chocolate and confectionery consumption. India and China are seen as the future markets for chocolate and confectionery.

The world’s leading confectionery products firms, roughly in order of sales...
Cocoa butter is the main lipid in dark chocolate and consists of oleic acid (monounsaturated) and stearic and palmitic acids (saturated). Stearic acid, unlike other saturated fatty acids, appears to have a neutral effect on total LDL (low-density lipoprotein) and HDL (high-density lipoprotein) cholesterol. Cocoa butter appears to decrease platelet activity, which is a potential contributor to heart diseases.

**Chocolate as a FoE**

Chocolate has been accused of making people fat. Obesity results from an imbalance between energy intake and energy expenditure—excess body fat is stored because intake exceeds usage. A direct link between sugar and obesity has yet to be established, and confectionery is not a significant contributor to dietary fat intake.

Cholesterol is another area that often concerns consumers. Modern research reveals that cocoa butter does not raise cholesterol because of the neutral effects of stearic acid on blood cholesterol.

The word chocolate is often a misnomer for anything that is sugary and brown. These products are not pure chocolate and are produced with the cheapest vegetable fats with excessive amounts of trans fatty acids. Trans fatty acids do not make a positive contribution to human nutrition.

Pure chocolate produced with cocoa butter can enhance human nutrition if it is consumed in moderation with other foods.

**Chocolate as a functional food**

Generally chocolate is regarded as a junk food, but recently published research indicates it can be upgraded to health-promoting.

Functional foods, also known as nutraceuticals, designer foods, therapeutic foods, super foods, foodiceuticals, and medifoods, are loosely defined as “foods that contain some health-promoting components beyond traditional nutrients.” It is becoming clear that a single nutrient may be less effective in promoting health and that a balance of several nutrients may be required to provide optimal nutrition and further improve health.

We can define these interactions as nutrient clusters. Chocolate can play a dominant role in providing these nutrient clusters and should be designed to include

- nutritionally balanced triglycerides with specific positions occupied by essential fatty acids;
- natural antioxidants to provide enhanced *in vitro* and *in vivo* protection of lipids;
- essential nutrients such as selenium and zinc to provide corrective nutrition.

**Bibliography**


Readers may contact the author at International Food Science Centre A/S P.O. Box 44, Sønderskovvej 7, Lystrup 8520, Denmark, Fax:+45=8622=9996, e-mail: shukla@ifsc.dk.