FST 503: Pilot-scale Food Processing (2 0 0 = 2 units) (Harmattan)

Pilot-scale manufacture of a selection of the following: Canned foods. Concentrated foods, dehydrated foods, Frozen foods, Sugar and salt preserves, Soft drinks, Cocoa, Tea, Coffee, Fats and Oils.

COCOA PROCESSING AND CHOCOLATE PRODUCTION

The cocoa bean, also cacao bean or simply cocoa or cacao, is the dried and fully fermented fatty seed of *Theobroma cacao*, from which cocoa solids and cocoa butter can be extracted. They are the basis of chocolate, as well as many Mesoamerican foods. Cacao trees grow in a limited geographical zone, of about 20° to the north and south of the Equator. Nearly 70% of the world crop today is grown in West Africa (e.g Ghana).

Cocoa pod, beans in a freshly cut cocoa pod and roasted beans

Cocoa pod

A cocoa pod (fruit) has a rough, leathery rind (back) about 2 to 3 cm (0.79 to 1.18 in) thick (this varies with the origin and variety of pod) filled with sweet, mucilaginous pulp (called*baba de cacao* in South America) with a lemonade-like taste enclosing 30 to 50 large seeds that are fairly soft and a pale lavender to dark brownish purple color. Due to heat buildup in the fermentation process, cacao beans lose most of the purplish hue and become mostly brown in color, with an adhered skin which includes the dried remains of the fruity pulp. This skin is released easily after roasting by winnowing. White seeds are found in some rare varieties, usually mixed with purples, and are considered of higher value.

Varieties

The three main varieties of cocoa plant are Forastero, Criollo, and Trinitario. The first is the most widely used, comprising 95% of the world production of cocoa. Cocoa beans of the Criollo variety are rarer and considered a delicacy. Criollo plantations have lower yields than those of Forastero, and also tend to be less resistant to several diseases that attack the cocoa plant, hence very few countries still produce it. One of the largest producers of Criollo beans is Venezuela (Chuao and Porcelana). Trinitario (from Trinidad) is a hybrid between Criollo and Forastero varieties. It is considered to be of much higher quality than Forastero, but has higher yields and is more resistant to disease than Criollo.

Harvesting

Cocoa trees grow in hot, rainy tropical areas within 20° of latitude from the Equator. Cocoa harvest is not restricted to one period per year and a harvest typically occurs over several months. In fact, in many countries, cocoa can be harvested at any time of the year. Pesticides are often applied to the trees to combat capsid bugs and fungicides to fight black pod disease.

Immature cocoa pods have a variety of colours, but most often are green, red, or purple, and as they mature, their colour tends towards yellow or orange, particularly in the creases. Unlike most fruiting trees, the cacoa pod grows directly from the trunk or large branch of a tree rather than from the end of a branch, similar to jackfruit. This makes harvesting by hand easier as most of the pods will not be up in the higher branches. The pods on a tree do not ripen together; harvesting needs to be done periodically through the year. Harvesting occurs between three and four times weekly during the harvest season. The ripe and near-ripe pods, as judged by their colour, are harvested from the trunk and branches of the cocoa tree with a curved knife on a long pole. Care must be used when cutting the stem of the pod to avoid damaging the junction of the stem with the tree, as this is where future flowers and pods will emerge. One person can harvest an estimated 650 pods per day.

Harvest Processing

The harvested pods are opened, typically with a machete, to expose the beans. The pulp and cocoa seeds are removed and the rind is discarded (the rind can be used for other items, it can be incorporated into building materials). The pulp and seeds are then piled in heaps, placed in bins, or laid out on grates for several days. During this time, the seeds and pulp undergo "sweating", where the thick pulp liquefies as it ferments. The fermented pulp trickles away, leaving cocoa seeds behind to be collected. Sweating is important for the quality of the beans, which originally have a strong, bitter taste. If sweating is interrupted, the resulting cocoa may be ruined; if underdone, the cocoa seed maintains a flavor similar to raw potatoes and becomes susceptible to mildew. Some cocoa-producing countries distill alcoholic spirits using the liquefied pulp as it is a source of enzymes and micro-organism.

A typical pod contains 20 to 50 beans and about 400 dried beans are required to make one pound - or 880 per kilogram - of chocolate. Cocoa pods weigh an average of 400 g (0.88 lb) and each one yields 35 to 40 g (1.2 to 1.4 oz) dried beans (this yield is 40–44% of the total weight in the pod). One person can separate the beans from about 2000 pods per day

The wet beans are then transported to a facility so they can be fermented and dried. They are fermented for four to seven days and must be mixed every two days. They are dried for five to 14 days, depending on the climate conditions. The fermented beans are dried by spreading them out over a large surface and constantly raking them. In large plantations, this is done on huge trays under the sun or by using artificial heat. Small plantations may dry their harvest on little trays or on cowhides. Finally, the beans are trodden and shuffled about (often using bare human feet) and sometimes, during this process, red clay mixed with water is sprinkled over the beans to obtain a finer color, polish, and protection against molds during shipment to factories in the United States, the Netherlands, the United Kingdom, and other countries. Drying in the sun is preferable to drying by artificial means, as no extraneous flavors such as smoke or oil are introduced which might otherwise taint the flavor.

The beans should be dry for shipment (usually by sea). Traditionally exported in jute bags, over the last decade, beans are increasingly shipped in "mega-bulk" parcels of several thousand tonnes at a time on ships, or in smaller lots around 25 tonnes in 20-ft containers. Shipping in bulk significantly reduces handling costs; shipment in bags, however, either in a ship's hold or in containers, is still common.

Cocoa and chocolate based beverages

Cocoa beans

Fermentation

Drying

Storage and transportation

Clean

Roast

Cracking and winning

Alkalization

Grunting

Pressing

Cocoa butter cake

Cake grounding

Flow diagram-: process of cocoa powder

Fermentation -: is liquefaction and removal of mucilaginous pulp, (b) killing the bean and initiate of the development of aroma, flower and color. The stages determine quantity of the cocoa powder heap fermentation covered banana leaves for 7 days

Drying necessary to prevent deterioration of beans during storage and transportation- sun drying

Storage and transportation-: thespian sacks, bulk containers are problem conducted (moisture)

Cleaning of raw seeds- to remove contaminant-air blast, screen, metal detectors.

Roasting-: to dry seed, remove undesirable flower, color and loosening of the shield compels 150^0Csample stage roasting. Multiplies 1000c to woolen shell them 125 -130 ^{0} C to roast in which xcal and physical changes take place

NARS process-: mils alkalizing, roast and sterilizing process beans -: heat -: shell removal---- winnowing -: *alkali* roasting -------*water spray* sterilizing.

Kibbling and winnowing-: to separate shell gram the nibs. Cracking roasted beans to loosen shell. Winnowing a separation process depends on difference in density between the milo and shell.

Grinding -: nibs contain about 55% cocoa butter. Grinding ruptures the cell wall releasing the CB while at the at the same time frictional/or applied heat raises temp above 34^0C melting point CB. The particular size of the non-fat portion is reduced and the cocoa liquor is produce. pinmill

Deodorization-: tot of thein films of liquor by scrubbing which hot humidified air

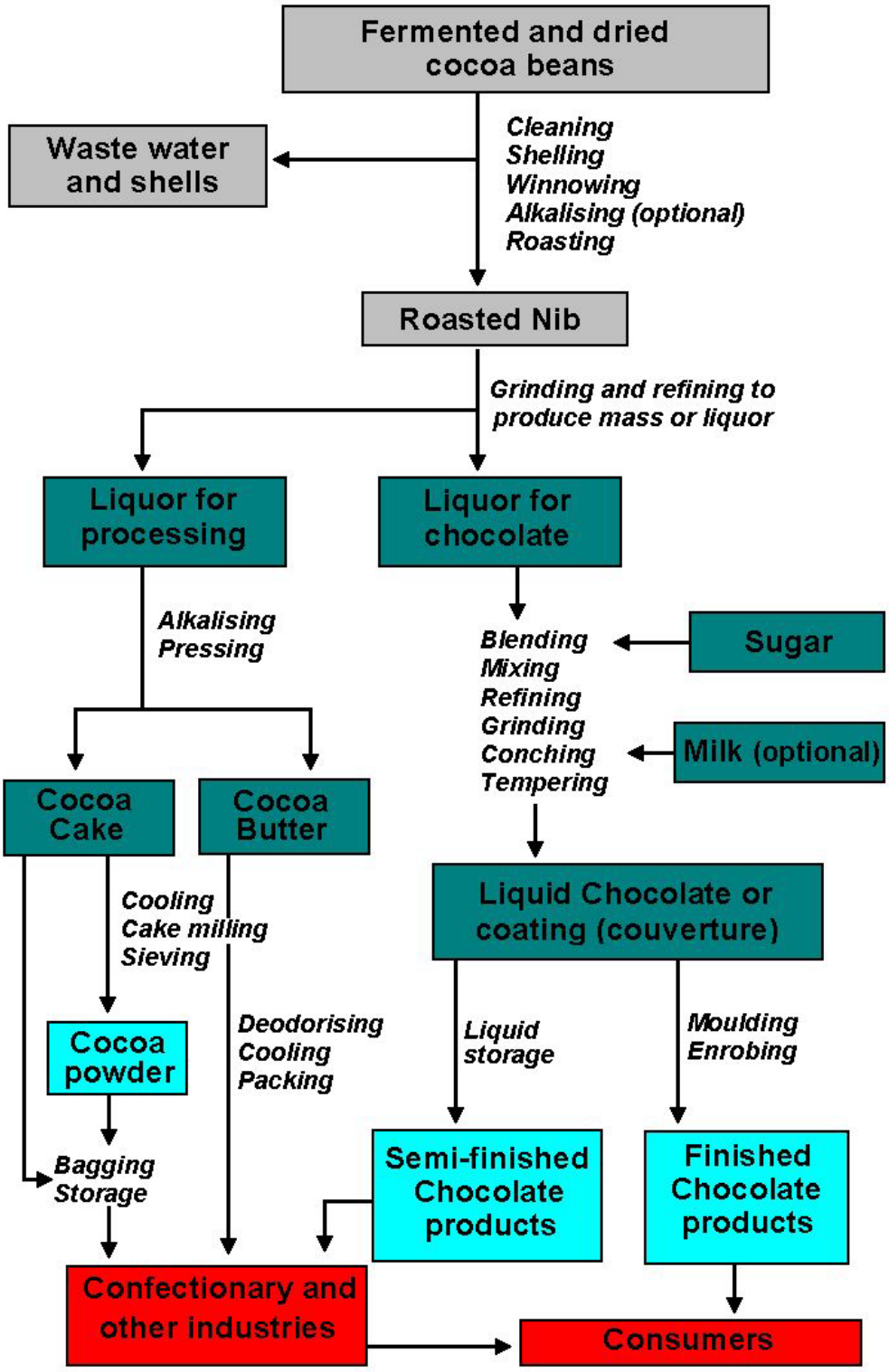
Alkalization – improves desirability as well as changes the color of the cocoa. K and $NaCO_3$ are widely used – the quality of alkali added varies with evident of color change desire greater quantities for redder

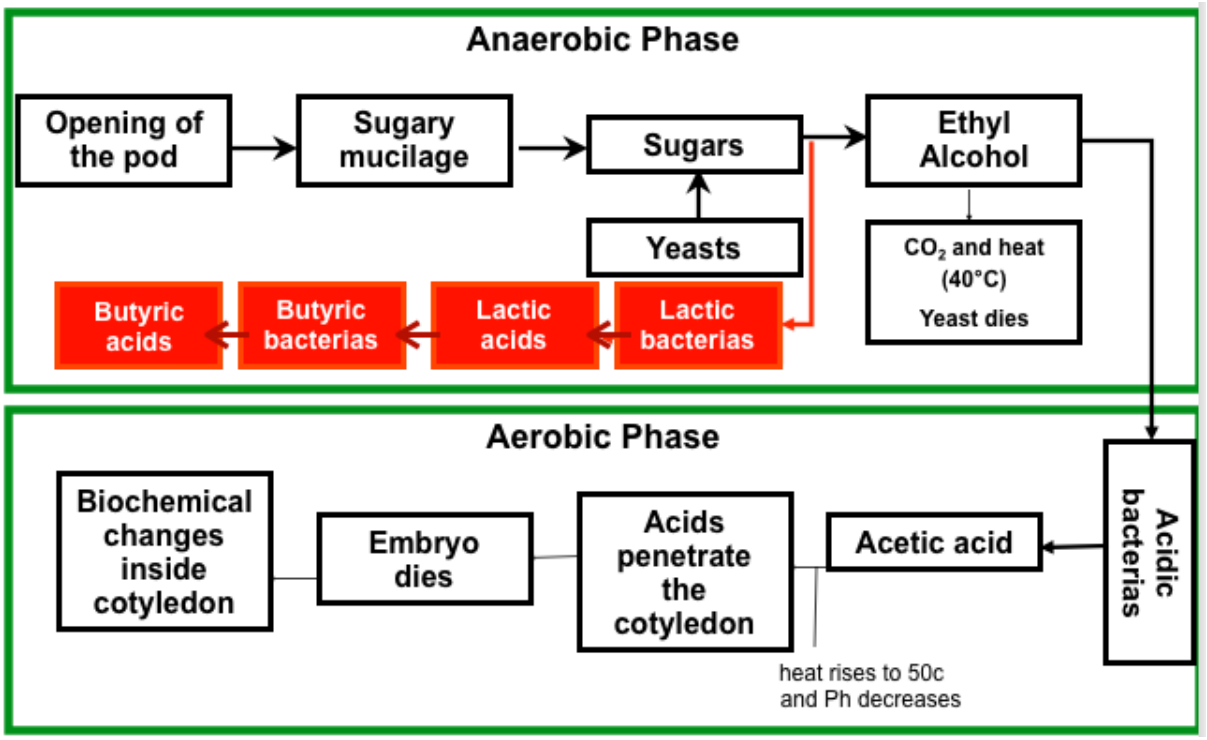
color. Alkalization can take place at any stage from whole bean to cocoa cake.

Pressing to separate cocoa butter – press or expeller pressing

Cocoa press cake grounding to powder for use either as a bar or for ingredient in their polls.

Packaging – moisture proof bags cardboards


Fermented and dried cocoa beans
Waste water and shells
Cleaning
Shelling
Winnowing
Alkalising (optional)
Roasting
Roasted Nib
Grinding and refining to produce mass or liquor
Liquor for processing
Liquor for chocolate
Alkalising
Pressing
Blending
Mixing
Refining
Grinding
Conching
Tempering
Sugar
Milk (optional)
Cocoa Cake
Cocoa Butter
Liquid Chocolate or coating (couverture)
Cooling
Cake milling
Sieving
Deodorising
Cooling
Packing
Liquid storage
Moulding
Enrobing
Cocoa powder
Bagging
Storage
Semi-finished Chocolate products
Finished Chocolate products
Confectionary and other industries
Consumers



PRODUCTION OF COCOA LIQUOR

After roasting and drying, the cocoa nib is disintegrated and milled in order to rupture the cell walls of aggregated and expose the cocoa butter. Crushing rolls are used for disintegration, while roller-ball, horizontal 'stone' or steel disc or disc attrition mills are used for fine disintegration of cocoa particles. The resultant product is a homogenous mobile paste, a flowing cocoa mass or cocoa liquor.

PRODUCTION OF COCOA LIQUOR WITH IMPROVED DISPERSABILITY-DUTCH COCOA PROCESS

The cocoa nib or the cocoa mass is subjected to an alkalization process in order to:

1. mellow the flavor by the partial neutralization of free acids
2. improve the color
3. enhance the wettability (instant properties) of cocoa powder
4. Improve dispersability
5. Lengthen suspension holding ability, thus preventing formation of sediment in the cocoa drink.

The process involves the use of solutions or suspensions of Mg oxide or OH, K or $NaCO_3$ or their OHs. It is occasionally performed at elevated temperature and pressure, usually using steam. The roasted nibs are treated with a dilute 2-2.5% alkali solution at

75-100°C, then neutralized if necessary, by tartaric acid, and dried to a moisture content of about 2% in a vacuum dryer or further kneading of the mass at a temperature above 100°C. This in addition to acid neutralization causes swelling of starch (gelatinization) and an overall spongy and porous cell structure of the cocoa mass.

Cocoa so treated is often incorrectly designated as 'Soluble cocoa' the process does not increase solubility. Finally, the cocoa is disintegrated with juice roller mills. The alkalized cocoa generally contains 52-58% cocoa butter, up to 5% ash and up to 7% alkalized mass or liquor.

Production of Cocoa Powder by Cocoa Mass Pressing

To convert the cocoa mass or liquor into cocoa powder, the cocoa fat (54% of nib weight on the average) has to be reduced by pressing using a mechanical press (hydraulic) at a pp of 400-500 bar and a temperature of 90-100°C. High temperature reduces viscosity and also dentures protein, causing coagulation which creates easy passage of oil. To remove the contaminating cell debris, the hot cocoa butter is passed through a filter press, then molded and cooled. The bulk of the cocoa butter produced is used in chocolate manufacturing. The 'stone hard' coca press cake, with a residual fat content of 10-24% is disintegrated by a cooker breaker i.e. rollers with intermeshing teeth, then is ground in a peg mill and separated into a fine and a coarse fraction by an air surface, the coarse powders are divided according to the extent of defatting into likely defatted powder, with 20-22% residual cocoa butter, extensively defatted powder which contains less than 20% but more than 10% butter.

Lightly defatted powder is darker in colour and milder in flavor. Cocoa powder is widely used in the manufacture of other products e.g. Cake filling, icings, pudding powders, cocoa beverages.

Chocolate Production

To obtain a highly aromatic, structurally homogenous and stable form and a product which 'melts in the mouth' a set of chocolate processing steps are

1. Mixing- ingredients such as cocoa liquor, highly grade crystalline sucrose, Cocoa Butter, milk powder is brought together in a mixer ('melangeur') or pasteur. A homogenous coarse chocolate paste is formed after intense mixing.
2. Refining- performed by single or multiple refining rollers which disintegrated the chocolate paste into a smooth textured mass made up of much finer

particles. The rollers are hollow and can be adjusted to the desired temperature by water cooling.

3. Conching- the refined chocolate mass is dry and powdery at room temperature and has a harsh sour flavor. It is ripened before further processing by keeping it in warm chambers at 45-50°C for about 24hrs.ripening imparts a doughy consistency to the chocolate and it may be used for the production of baking of other commercial chocolate. An additional couching step is reproduced to obtain juice chocolate of extra sweetness. It is performed in oblong or round Conches pots with rollers or rotary conches. The chocolate mass is mixed, ground and kneaded. The steps are in 2 stages.

a. The mass is heated at 80°C for 6-12hrs. Loss of moisture occurs, the portion of the volatiles is removed (ethanol, acetone, diacetyl, methanol, isopropanol, ethanol etc.) and the fat becomes uniformly distributed such that each cocoa particles is covered with a film of fat. The temperature at this stage is not allowed to rise, since important aromatic substance (e.g. Pyrazines) may be lost.

b. The mass is liquefied by the addition of residual Cocoa Butter and homogenised further. Lecithin is then added to reduce the viscosity of chocolate, or rather to give chocolate a required fluidity by the use of less Cocoa Butter, and homogenization is continued.

   Conching is a mixing process which produces a fume flavor and the desired texture which was not attainable in the refining step.

4. Tempering and molding

Cocoa Butter exist in a number of polymorphic forms and the nature of the crystalline form depends on the method of cooling the liquid fat. If chocolate is solidifying from the liquid state without any attention to controlled cooling, it will be granular in texture and be of poor color or blotchy in appearance. To obtain chocolate tablets or covered confectionery of good texture, color, and in a stable condition, good tempering and correct cooling are essential. For this purpose, molten chocolate is initially cooled from 45°C to 18°C within 10 minutes with constant stirring. it is kept at this lower temperature for 10 minutes to form the stable better modification of Cocoa Butter. The temperature of the chocolate is then raised in 5 minutes to 29-31°C. The process conditions vary according to composition. Tempering severs to provide a great abundance of small fat extract with high

melting properties. During the cooling step, the bulk of the molten chocolate develops a solid, homogenous, finely crystalline, heat-stable fat structure characterized by good melting properties and a nice glossy surface.

Before molding, the chocolate is kept at 30-32°C and delivered to warmed plastic or metal molds with a metering pump. The filled molds pass over a vibrating shaker to let the trapped air escape. They then pass through a cooling channel where, by slow cooling, the mass hardens, and finally, at 10°C, the final chocolate product falls out of the mold. Tempering, metering, filling, cooling, wrapping and packaging mills now provide nearly fully mechanized and automated production of chocolate.

Processing

Cacao pods are harvested by cutting them from the tree using a machete, or by knocking them off the tree using a stick. The beans with their surrounding pulp are removed from the pods and placed in piles or bins, allowing access to micro-organisms so fermentation of the pectin-containing material can begin. Yeasts produce ethanol, lactic acid bacteria produce lactic acid, and acetic acid bacteria produce acetic acid. The fermentation process, which takes up to seven days, also produces several flavor precursors, eventually resulting in the familiar chocolate taste.

It is important to harvest the pods when they are fully ripe, because if the pod is unripe, the beans will have a low cocoa butter content, or sugars in the white pulp will be insufficient for fermentation, resulting in a weak flavor. After fermentation, the beans must be quickly dried to prevent mold growth. Climate and weather permitting, this is done by spreading the beans out in the sun from five to seven days.

The dried beans are then transported to a chocolate manufacturing facility. The beans are cleaned (removing twigs, stones, and other debris), roasted, and graded. Next, the shell of each bean is removed to extract the nib. Finally, the nibs are ground and liquefied, resulting in pure chocolate in fluid form: chocolate liquor. The liquor can be further processed into two components: cocoa solids and cocoa butter.

Blending

Chocolate liquor is blended with the cocoa butter in varying quantities to make different types of chocolate or couvertures. The basic blends of ingredients for the various types of chocolate (in order of highest quantity of cocoa liquor first), are:

- Dark chocolate: sugar, cocoa butter, cocoa liquor, and (sometimes) vanilla
- Milk chocolate: sugar, cocoa butter, cocoa liquor, milk or milk powder, and vanilla
- White chocolate: sugar, cocoa butter, milk or milk powder, and vanilla

Usually, an emulsifying agent, such as soy lecithin, is added, though a few manufacturers prefer to exclude this ingredient for purity reasons and to remain GMO-free, sometimes at the cost of a perfectly smooth texture. Some manufacturers are now using PGPR, an artificial emulsifier derived from castor oil that allows them to reduce the amount of cocoa butter while maintaining the same mouthfeel.

The texture is also heavily influenced by processing, specifically conching (process of refinning). The more expensive chocolate tends to be processed longer and thus have a smoother texture and mouthfeel, regardless of whether emulsifying agents are added.

Different manufacturers develop their own "signature" blends based on the above formulas, but varying proportions of the different constituents are used. The finest, plain dark chocolate couvertures contain at least 70% cocoa (both solids and butter), whereas milk chocolate usually contains up to 50%. High-quality white chocolate couvertures contain only about 35% cocoa butter.

Producers of high-quality, small-batch chocolate argue that mass production produces bad-quality chocolate.[45] Some mass-produced chocolate contains much less cocoa (as low as 7% in many cases), and fats other than cocoa butter. Vegetable oils and artificial vanilla flavor are often used in cheaper chocolate to mask poorly fermented and/or roasted beans.

In 2007, the Chocolate Manufacturers Association in the United States, whose members include Hershey, Nestlé, and Archer Daniels Midland, lobbied the Food and Drug Administration(FDA) to change the legal definition of chocolate to let them substitute partially hydrogenated vegetable oils for cocoa butter, in addition to using artificial sweeteners and milk substitutes. Currently, the FDA does not allow a product to be referred to as "chocolate" if the product contains any of these ingredients. In the EU a product can be sold as chocolate if it contains up to 5% vegetable oil, and must be labelled as 'family milk chocolate' rather than 'milk chocolate' if it contains 20% milk.

Conching

The penultimate process is called conching. A conche is a container filled with metal beads, which act as grinders. The refined and blended chocolate mass is kept in a liquid state by frictional heat. Chocolate prior to conching has an uneven and gritty texture. The conching process produces cocoa and sugar particles smaller than the tongue can detect, hence the smooth feel in the mouth. The length of the conching process determines the final smoothness and quality of the chocolate. High-quality chocolate is conched for about 72 hours, and lesser grades about four to six hours. After the process is complete, the chocolate mass is stored in tanks heated to about 45 to 50 °C (113 to 122 °F) until final processing.

Tempering

The final process is called tempering. Uncontrolled crystallization of cocoa butter typically results in crystals of varying size, some or all large enough to be clearly seen with the naked eye. This causes the surface of the chocolate to appear mottled and matte, and causes the chocolate to crumble rather than snap when broken.[58] The uniform sheen and crisp bite of properly processed chocolate are the result of consistently small cocoa butter crystals produced by the tempering process.

The fats in cocoa butter can crystallize in six different forms (polymorphous crystallization). The primary purpose of tempering is to assure that only the best form is present. The six different crystal forms have different properties.

Crystal	Melting temp.	Notes
I	17 °C (63 °F)	Soft, crumbly, melts too easily
II	21 °C (70 °F)	Soft, crumbly, melts too easily
III	26 °C (79 °F)	Firm, poor snap, melts too easily
IV	28 °C (82 °F)	Firm, good snap, melts too easily
V	34 °C (93 °F)	Glossy, firm, best snap, melts near body temperature (37 °C)
VI	36 °C (97 °F)	Hard, takes weeks to form

Chocolate Production

To make 1 kg (2.2 lb) of chocolate, about 300 to 600 beans are processed, depending on the desired cocoa content. In a factory, the beans are roasted. Next, they are cracked and then deshelled by a "winnower". The resulting pieces of beans are called nibs. They are sometimes sold in small packages at specialty stores and markets to be used in cooking, snacking, and chocolate dishes. Since nibs are directly from the cocoa tree, they contain high amounts of theobromine. Most nibs are ground, using various methods, into a thick, creamy paste, known as chocolate liquor or cocoa paste. This "liquor" is then further processed into chocolate by mixing in (more) cocoa butter and sugar (and sometimes vanilla and lecithin as an emulsifier), and then refined, conched and tempered. Alternatively, it can be separated into cocoa powder and cocoa butter using a hydraulic press or the Broma process. This process produces around 50% cocoa butter and 50% cocoa powder. Standard cocoa powder has a fat content around 10–12%. Cocoa butter is used in chocolate bar manufacture, other confectionery, soaps, and cosmetics.

Treating with alkali produces Dutch-process cocoa powder, which is less acidic, darker, and more mellow in flavor than what is generally available in most of the world. Regular (nonalkalized) cocoa is acidic, so when cocoa is treated with an alkaline ingredient, generally potassium carbonate, the pH increases. This process can be done at various stages during manufacturing, including during nib treatment, liquor treatment, or press cake treatment.

Another process that helps develop the flavor is roasting, which can be done on the whole bean before shelling or on the nib after shelling. The time and temperature of the roast affect the result: A "low roast" produces a more acid, aromatic flavor, while a high roast gives a more intense, bitter flavor lacking complex flavor notes.

Kinds of Chocolate

Chocolate at least 40% cocoa liquor or a blend of liquor and Cocoa Butter and up to 60% sugar. The composition of the more important kinds of chocolate and confectionery coatings are shown in the table.

1. Baking chocolate made by a special process
2. Cola chocolate is a caffeine containing product (max 0.25% caffeine) prepared by mixing with extracts obtained from coffee, cola or caffeine containing plants

3. Diabetic or diet chocolates are made by replacing sucrose with fructose, mannitol, sorbitol, xylitol
4. Chocolates can also contain nuts and almonds whose oil content are reduced by pressing to reach 2/3 of the original amount. This is because the oil has a melting point lower than that of Cocoa Butter
5. In filled chocolate, the filler is 1st placed into a chocolate and then closed with a chocolate lid or cover. Fine crops of chocolate are made by pressing low fat chocolate through a place with orifices
6. Hollow figures are made into 2 part molds by hollow press of by gumming together the individually molded parts
7. Chocolate for beverages or drinks is made from cocoa liquor or cocoa powder and sucrose. It is customary to incorporate seasonings e.g. vanillin. The sugar content in chocolate drink is at most 65%
8. Chocolate syrups are made by adding bacterial amylase. The enzyme prevents the syrup from thickening or setting by solubilizing and dextrinizing cocoa starch. The fat coating is a glazing on top of chocolate coatings other than. It is often used in baked or confectionery products
9. Tropical chocolates contain high melting fats or are specially prepared to make the chocolate resistant to heat. The melting pH of Cocoa Butter can be raised by a controlled pre-crystallisation procedure. Another option is based on the formation of a coherent sugar skeleton in which the fat is deposited in hollow or void spaces. In this case, in contrast to regular chocolate, there is no continuous fat phase to collapse during heating.
10. Pralines- many processing options

a. Pralines with a hard core, the hot, supersaturated sugar syrup(fondant) is prepared into molds dusted with wheat powder and left to cool. The congealed core (korpus) is dipped into molten kurverture and in this way, covered with a chocolate coat(crème-praline). The fondant can be fully or partly replaced by fruit pastes like marzipan, jams, nuts, almonds etc.
b. For pralines without sugar crust (branchy or linear), the processing involves hollow-body machines in which the chocolate shell is formed, then filled with e.g. brandy and covered with a lid in a second machine. The fondant may also contain invertase and there by the praline filling liquefies after several days.

Several types of chocolate can be distinguished. Pure, unsweetened chocolate, often called "baking chocolate", contains primarily cocoa solids and cocoa butter in varying proportions. Much of the chocolate consumed today is in the form of sweet chocolate, which combines chocolate with sugar. Milk chocolate is sweet chocolate that also contains milk powder or condensed milk. In the U.K. and Ireland, milk chocolate must contain a minimum of 20% total dry cocoa solids; in the rest of the European Union, the minimum is 25%. "White chocolate" contains cocoa butter, sugar, and milk, but no cocoa solids. Chocolate contains alkaloids such as theobromine and phenethylamine, which may havephysiological effects in humans, but the presence of theobromine renders it toxic to some animals, such as dogs and cats. Dark chocolate has been promoted for unproven health benefits.

White chocolate, although similar in texture to that of milk and dark chocolate, does not contain any cocoa solids. Because of this, many countries do not consider white chocolate as chocolate at all. Because it does not contain any cocoa solids, white chocolate does not contain any theobromine, so it can be consumed by animals.

Dark chocolate is produced by adding fat and sugar to the cacao mixture. The U.S. Food and Drug Administration calls this "sweet chocolate", and requires a 15% concentration of chocolate liquor. European rules specify a minimum of 35% cocoa solids. Semisweet chocolate is a dark chocolate with a low sugar content. Bittersweet chocolate is chocolate liquor to which some sugar (typically a third), more cocoa butter, vanilla, and sometimes lecithin have been added. It has less sugar and more liquor than semisweet chocolate, but the two are interchangeable in baking.

Unsweetened chocolate is pure chocolate liquor, also known as bitter or baking chocolate. It is unadulterated chocolate: the pure, ground, roasted chocolate beans impart a strong, deep chocolate flavor. It is typically used in baking or other products to which sugar and other ingredients are added. Raw chocolate, often referred to as raw cacao, is always dark and a minimum of 75% cacao.

c. Chocolate may have whitish spots on the dark chocolate part, called chocolate bloom; it is an indication that sugar and/or fat has separated due to poor storage. It is not toxic and can be safely consumed.

Composition of some chocolate products

Product	Cocoa	skim milk powder, %	Cocoa butter, %	Total fat, %	Butter fat, %	Sugar, %
Baking chocolate	33-50		5-7	22-30		50-60
Chocolate for coating	35-60		To 15	28-35		38-50
Milk cream chocolate	10-20	8-16	10-22	33-36	5.5-10	35-60
Whole milk chocolate	10-30	9.3-23	12-20	28-32	3.2-7.5	32-60
Skim milk chocolate	10-35	12.5-25	15-25	22-30	0-2	30-60
Icings	33-65		5-25	35-46		25-50

Storage Of Cocoa Products

All products from the raw cocoa to chocolate demand careful storage- dry, cool, well-aerated space, protected from light and sources of other colors. A temperature of 10-12 °C and a RH of 55-65% are suitable. Chocolate products are readily attacked by pests, particularly cacao moths and flour moths and beetles, cockroaches and ants.

Chocolates not properly stored are recognized by a greyish matte surface. Sugar bloom is caused by storage of chocolate in moist conditions (RH>75-80%) or by deposition of dew, causing the tiny sugar particles on the surface of the chocolate to solubilize and then after evaporation, to form larger crystals. A fat bloom arises from chocolate fat at temperature >30°C. At these temperatures, the liquid fat is separated fat is separated and, after repeated congealing forms a white and large spot. This may also occur as a result of improper pre-crystallisation or tempering during chocolate production. The defect may be prevented or rectified by post tempering at 30°C for 6hrs.

Chocolate is very sensitive to temperature and humidity. Ideal storage temperatures are between 15 and 17 °C (59 and 63 °F), with a relative humidity of less than 50%. Various types of "blooming" effects can occur if chocolate is stored or served improperly. Fat bloom is caused by storage temperature fluctuating or exceeding 24 °C (75 °F), while sugar bloom is caused by temperature below 15 °C (59 °F) or excess humidity. To distinguish between different types of bloom, one can rub the surface of the chocolate

lightly, and if the bloom disappears, it is fat bloom. One can get rid of bloom by re-tempering the chocolate or using it for any use that requires melting the chocolate.

Chocolate is generally stored away from other foods, as it can absorb different aromas. Ideally, chocolates are packed or wrapped, and placed in proper storage with the correct humidity and temperature. Additionally, chocolate is frequently stored in a dark place or protected from light by wrapping paper. If refrigerated or frozen without containment, chocolate can absorb enough moisture to cause a whitish discoloration, the result of fat or sugar crystals rising to the surface. Moving chocolate from one temperature extreme to another, such as from a refrigerator on a hot day, can result in an oily texture. Although visually unappealing, chocolate suffering from bloom is perfectly safe for consumption

Reaction Occurring During Fermentation and Drying

The pulp is fermented by yeast to alcohol and CO_2 on the first day. Lactic acid fermentation may also occur to a small extent. Pectolytic enzymes and other glycosidases affect the degradation of polysaccharides (CHO). This is reflected in the fruit pulp becoming liquid and draining away. This improves aeration, resulting in oxidation of alcohols to acetic acid by acetic acid bacteria during the 2nd to 4th days. The pH drops from about 6.5-4.5 and the temperature increases to 45-50 °C. The seed cell walls become permeable, the living cacao seed is killed and an oxidative process takes over the entire mass. From the 5^{th} to the 7^{th} day, the oxidation and condensation reactions of phenolic compounds predominate.

Amino acids and peptides react with the oxidation products of the phenolic compounds, giving rise to water insoluble brown or brown-violet phlobaphenes, which confer the characteristics color to fermented cacao beans. A decrease in the content of soluble phenols mellow the original ash and astringent cacao flavor.

Finally, the oxidation remains are fermented by drying the cocoa seeds to a moisture content of < 8%. It is extremely important to properly handle the fermentation process for the formation of cocoa aroma. The growth of detrimental micro-organisms such as Molds, Butyric acid bacteria, and putrefaction inducing bacteria, is there by prevented.

Nutrition

A 100 gram serving of milk chocolate supplies 540 calories. It is 59% carbohydrates (52% as sugar and 3% as dietary fiber), 30% fat and 8% protein. Approximately 65% of the fat in milk chocolate is saturated, composed mainly of palmitic acid and stearic acid, while the predominant unsaturated fat is oleic acid. In 100 gram amounts, milk chocolate is an excellent source (> 19% of the Daily Value, DV) of riboflavin, vitamin B12 and the dietary minerals, manganese, phosphorus and zinc. Chocolate is a good source (10-19% DV) of calcium, magnesium and iron.

Chocolate and cocoa are under preliminary research to determine if consumption affects the risk of certain cardiovascular diseases or cognitive abilities. Chocolate may be a factor for heartburn in some people because one of its constituents, theobromine, may affect the oesophageal sphincter muscle, hence permitting stomach acidic contents to enter into the oesophagus. Theobromine is also toxic to some animals unable to metabolize it.

Excessive consumption of large quantities of any energy-rich food, such as chocolate, without a corresponding increase in activity to expend the associated calories, can increase the risk of weight gain and possibly obesity. Raw chocolate is high in cocoa butter, a fat which is removed during chocolate refining, then added back in varying proportions during the manufacturing process. Manufacturers may add other fats, sugars, and milk as well, all of which increase the caloric content of chocolate.

Chocolate and cocoa contain moderate to high amounts of oxalate, which may increase risk for kidney stones. During cultivation and production, chocolate may absorb lead from the environment, but the total amounts typically eaten are less than the tolerable daily limit for lead consumption, according to a World Health Organization report from 2010. However, reports from 2014 indicate that "chocolate might be a significant source" of lead ingestion for children if consumption is high and "one 10 g cube of dark chocolate may contain as much as 20% of the daily lead oral limit."

Health benefits

In general, cocoa is considered to be a rich source of antioxidants such as procyanidins and flavanoids, which may impart antiaging properties.[2][57] Cocoa

also contain a high level of flavonoids, specifically epicatechin, which may have beneficial effects on cardiovascular health. The stimulant activity of cocoa comes from the compound theobromine which is less diuretic as compared to theophylline found in tea Prolonged intake of flavanol-rich cocoa has been linked to cardiovascular health benefits, though this refers to raw cocoa and to a lesser extent, dark chocolate, since flavonoids degrade during cooking and alkalizing processes. Short-term benefits in LDL cholesterol levels from dark chocolate consumption have been found. The addition of whole milk to milk chocolate reduces the overall cocoa content per ounce while increasing saturated fat levels. Although one study has concluded that milk impairs the absorption of polyphenolic flavonoids, e.g. epicatechin, a study failed to find the effect.

_____ Stop here_____a

Hollenberg and colleagues of Harvard Medical School studied the effects of cocoa and flavanols on Panama's Kuna people, who are heavy consumers of cocoa. The researchers found that the Kuna people living on the islands had significantly lower rates of heart disease and cancer compared to those on the mainland who do not drink cocoa as on the islands. It is believed that the improved blood flow after consumption of flavanol-rich cocoa may help to achieve health benefits in hearts and other organs. In particular, the benefits may extend to the brain and have important implications for learning and memory.

Foods rich in cocoa appear to reduce blood pressure but drinking green and black tea may not, according to an analysis of previously published research in the April 9, 2007 issue of Archives of Internal Medicine. A 15-year study of elderly men published in the *Archives of Internal Medicine* in 2006 found a 50 percent reduction in *cardiovascular* mortality and a 47 percent reduction in *all-cause* mortality for the men regularly consuming the most cocoa, compared to those consuming the least cocoa from all sources.

Labeling

Some manufacturers provide the percentage of chocolate in a finished chocolate confection as a label quoting percentage of "cocoa" or "cacao". It should be noted that

this refers to the combined percentage of both cocoa solids and cocoa butter in the bar, not just the percentage of cocoa solids. The Belgian AMBAO certification mark indicates that no non-cocoa vegetable fats have been used in making the chocolate. Chocolates that are organic or fair trade certified carry labels accordingly. In the United States, some large chocolate manufacturers lobbied the federal government to permit confections containing cheaper hydrogenated vegetable oil in place of cocoa butter to be sold as "chocolate". In June 2007, as a response to consumer concern after the proposed change, the FDA reiterated "Cacao fat, as one of the signature characteristics of the product, will remain a principal component of standardized chocolate.

Cocoa Based Beverages

Cocoa powder--: traditional cocoa powder contains no ingredient flavors are added as powder to minimize problem of flavor deterioration due to oxidation. Fat reduced 8% cocoa powder---------involves solvent extraction of poor dispensability and required hot water.

2. Instant (cold dispersing) cocoa powder -To (1) above add food grade wetting agent, lecithin 3% is sprayed onto the press cake during grinding. It may be added in powder form to un-instantized powder.

3. Drinking chocolate contains about 70% sugar and 30% cocoa. Boiling of sucrose syrup to a super saturated state, mixing cocoa powder and dry -- milk powder may be incorporated.

4. Cocoa substitute high cost of CP has meant a demand for low cost substitute. These are used as extenders at a level up to 30%. Carob powder has been used on significant commercial scale: carb powder is produced from the pools of the leguminous tree ceratodus silique

	White chocolate is easy to identify because of its cream or ivory color. It is made by combining sugar, cocoa butter, milk, vanilla, and lecithin (an emulsifier that helps the ingredients blend together). These ingredients give white chocolate its sweet vanilla aroma. White chocolate often has a flavor profile that can be described as predominately sweet, with bold notes of sweetened condensed milk and vanilla. Good **quality white chocolate** will have a rich, soft, and creamy texture — a

	characteristic that comes from its cocoa butter base and high sugar and milk content.
	Milk chocolate is a classic that we all know and love from childhood. With its light brown color, creamy texture, and sweet flavor, milk chocolate is widely regarded as the most popular type of chocolate. It is made by combining chocolate liquor (cocoa solids and cocoa butter) with sugar, and milk. Sometimes an emulsifier, such as soy lecithin, is added to enhance its smoothness. According to the FDA definition, milk chocolate must contain at least 10% chocolate liquor and 12% milk.
	Dark chocolate, with its notable deep brown color, is the second most popular type of chocolate. It is sometimes referred to as black or semisweet chocolate and is noticeably less sweet than milk chocolate. In recent years, dark chocolate has surged in popularity thanks to a number of articles being published about the health benefits.
	Bittersweet chocolate has gained a lot of traction recently as people started to learn more about **cacao and cocoa percentages**. This kind of chocolate, sometimes referred to as **extra-dark chocolate**, rose to popularity when people began claiming that you should eat dark chocolate with a cocoa content of 70% or more, in order to get the most health benefits. The recent rise in bean-to-bar chocolate makers and craft chocolate has also lead to an increase in awareness and popularity of **higher cocoa content dark chocolate**.

	Cocoa powder is created when chocolate liquor is separated under high pressure, and the resulting cocoa solids are crushed into a powder. **Unsweetened cocoa powder** is essentially 100% cocoa. There are two types of cocoa powder, natural cocoa and dutch-processed cocoa. Natural cocoa is lighter brown in color and has a strong chocolate flavor that is often acidic. Dutch cocoa is natural cocoa that has been alkalized to neutralize the acidity. The dutch-process gives the cocoa powder a deep, warm color and slightly milder flavor.
	Ruby Chocolate In 2017, a fourth type of chocolate, ruby chocolate was discovered by Belgian chocolate maker, Barry Callebaut. With its red-pink hue, this distinctive chocolate is noticeably different than its other chocolate counterparts. It is not colored white chocolate, but rather a color derived from a specific type of cacao — the ruby cocoa bean (a bean typically grown in Ecuador, Brazil, and the Ivory Coast.) Because this is a relatively new discovery (and the exact cacao making process developed by Barry Callebaut is proprietary), there is no standard FDA definition. Made from 47.5% cacao content and 26.3% milk, ruby cacao has flavors of intense fruitiness and fresh sour notes. This trendy new type of cacao is great for creating bold, fruit-forward chocolate treats and colorful Instagram-worthy chocolate confections. When stored properly, ruby cacao can have a shelf-life of about 12 months.