Wilson added that such supercoatings are more common outside the U.S.

CBE can be used in chocolate-type and nonchocolate-type confections, in coatings and molded products, as cool melting center fats, or as an extra coating layer below a chocolate coating to protect the outer layer from center fat migration. The major fat used in CBE is fractionated palm oil, according to Doug Chapman of Monarch Fine Foods, Canada, and Evert Timme of Crocklaan, Holland.

Vegetable fats, including CBE based on symmetrical triglycerides, legally can replace cocoa butter up to 15% of the fat phase (5% of the total weight) in chocolate in Denmark, the United Kingdom and Ireland, and, in coatings only, in Switzerland. In the U.S., Canada, and other parts of Europe, however, products containing CBE cannot be labelled as chocolate.

In the U.S., FDA regulations for chocolate products allow the use of hard butters and confectionery coatings under the optional ingredient clause, identified as compound or confectionery coatings, or "sweet cocoa and vegetable fat (other than cacao fat) coating."

Meanwhile, legislation proposed in the EEC and drawn up by CAOBISCO —the chocolate and biscuit manufacturers group of EEC—would allow up to 5% addition of vegetable fats, primarily of CBE type, in chocolate.

Even if the EEC adopts the CAOBISCO proposal, whether, or when, the U.S. might act similarly is uncertain. Industry spokesmen agree that it would require support from the Chocolate Manufacturers Association, whose members would be directly affected.

"CBE could make a good compound coating, but the price differential is just not worth it, particularly when you lose the right to call the product chocolate," according to Joseph Monteleon, vice-president of operations of Ambrosia Chocolate Co. in Milwaukee.

Monteleon said he doesn't believe U.S. chocolate manufacturers are going to push for a change in identity standards. "They're very successful with chocolate. Why lobby for a change when pure chocolate is so popular?" he asked.

Babayan agreed. "The chocolate industry has a good thing in the restricted standard of identity. It has no reason to see other fats equated with chocolate. Why spoil a lucrative market? It appears to hold even when the price differential has widened."

Wilson said Durkee Foods is the only U.S. manufacturer of cocoa-butter equivalents. Other companies that market CBE in the U.S. include Unilever, through its Loders-Croklaan subsidiary; Friwessa Inc., oil division of Wessanen; and Fuji of Japan. Unilever currently has three CBE factories—in England, Holland and Canada.

"The biggest users of CBE are in England," Timme of Croklaan, Holland, said. Chapman, of Monarch Fine Foods, Canada, said CBE are well received in Canada as well.

"Because of the chocolate legislation in the U.K., there is a substantial usage of CBEs in that country. For the same reason, there is a sizeable market in Japan. In countries where the legislation does not permit the use of fats other than cocoa butter, the market for CBE is, of course, smaller. Nevertheless, in some parts of the world, CBE are used in nonchocolate products, in supercoatings, due to the satisfaction of the producers and the consumers," Andre Cormeau, president of Loders-Croklaan, explained.

Chapman and Timme said a major concern voiced in the EEC over the CAOBISCO proposal centers on how to monitor the amount of CBE used in a product. "Some question how they can be sure the CBE used is 5% and not 10%," Timme said.

Although Unilever researchers have developed analytical methods for determining the level of a noncocoa-butter fat in chocolate to protect against abuses, U.S. chocolate manufacturers are concerned the methods are not adequate, particularly as CBE are so closely matched chemically to cocoa butter. "There are feelings some

Turning triglycerides into candy

The Industrial Products Group of Stokely-Van Camp in Columbus, Ohio, operates a pilot plant and small confectionery laboratory to test the products Stokely-Van Camp designs and markets.

"Here we try out confectionery fats to see if they perform as intended," Bob Wainwright, group leader for confectionery and specialty fats research and development, explained to a visitor. Wainwright said analysis of the fat blend used in a confection is only one portion of a full study.

In fact, lab researchers replicate all the steps of a confectionery-making operation. First, raw ingredients and some fat are blended into a paste. This mixture is milled on a 3-roll refiner mill to reduce particle size and eliminate graininess. Then the remainder of the fat and lecithin are added and the batch is conched several hours. Depending on the type of fat used, the mixture may be tempered.

The resulting coating is tested by enrobing various substrates and by casting products into small candy molds. Pieces are stored in a controlled environment and monitored for gloss, bloom and overall appearance. Other criteria include mouth feel and flavor release, snap and mold release.

"Sometimes a product works out well in our laboratory but when it's given to a customer, who may have different conditions in his operation, it doesn't behave the same," Wainwright said, explaining that is what makes research and development in confectionery fats an art as well as a science.

manufacturers would overstep the legal limits," Pease of Stokely-Van Camp's Industrial Products Group, said. "Additional concerns are who would police this, to test products, enforce the 5% limit and set penalties?"

World supply of raw materials for CBE appears to be adequate for current demand. But, as illipe and shea butters are products of uncultivated "jungle" plants, whether sufficient supplies and suitable raw materials would be produced to meet demand should the EEC adopt the CAOBISCO legislation is uncertain.

M.S.A. Kneiri, in a paper published by the Palm Oil Research Institute of Malaysia, predicted that if the EEC adopts the CBE legislation and similar action is taken in other countries, a potential demand for 93,000 metric tons (195.5 million pounds) of CBE annually could be created.

Nonlauric CBS

Nonlauric cocoa-butter substitutes usually are blends of partially hydrogenated, and sometimes fractionated, soybean and cottonseed oil. Sources of other nonlaurics include palm, peanut, corn, safflower and sunflower oils.

Nonlauric CBS are divided into 2 types: selectively hydrogenated and fractionated. Selective hydrogenation is used with oils with high levels of unsaturated fatty acids to reduce flavor instability and improving structural stability. By seeking high levels of *trans* oleic acid and minimizing development of stearic acid, oil chemists can optimize solid fat content at room temperature with melting ranges only slightly higher than body temperature (37-40 C), Laning said.

Selective hydrogenated CBS are used mainly in compound coatings for biscuits and crackers, in imitation chocolate-flavored chips for baking, and in high-volume, low-cost chocolate-flavored coatings. Their use in candy centers is limited because of fair-to-poor mouth feel and accompanying flavor-release properties.

Fractionated nonlaurics, however, have a relatively high solid-fat content at room temperature and better flavor release, making them more suitable for confectionery use. According to Durkee's Wilson, compound coating formulated with fractionated nonlauric hard butters are considered most desirable when used with chocolate liquor and milk powder containing butter fat. Fractionated nonlauric CBS can tolerate up to 25% cocoa butter on a fat basis when used in a confectionery coating, whereas lauric fats typically will not tolerate more than 6% cocoa butter (Table II).

Nonlauric hard butters display good flavor, odor and color properties. Comparing nonlauric CBS to laurics, Mike Schaff of Ambrosia Chocolate said the nonlaurics do not need tempering, are more compatible with cocoa butter, can be subjected to heat and reset to the original gloss and sheen and can be used on a higher moisture center without risk of saponification. However, they taste more gummy or waxy than laurics. In addition, to achieve the same viscosity at the same fineness, a confectioner must use 3 to 4% more total fat than in a lauric coating. Nonlauric coatings are generally more difficult to remove from larger molds, such as 10-pound blocks.

Lauric CBS

Lauric-based, cocoa-butter substitutes may be hydrogenated, fractionated or interesterified-hydrogenated-fractionated. The most widely used oils are from palm kernel and coconut. Other sources include South American palm-kernel oils, tucum, cohune and babassu oils.

Lauric oils can be hydrogenated and interesterified to yield a melting point and solid fat index approximating cocoa butter. Manufacturers can blend hydrogenated interesterified palm-kernel oil with other hydrogenated or partially hydrogenated lauric oils to produce lauric hard butters with a variety of melting points and solid-fat indices.

Fats from coconut and palm kernel characteristically contain low levels of unsaturated fatty acids such as oleic and linoleic. When hydrogenated to near saturation, coconut and palm-kernel fats exhibit relatively rapid and complete melting on heating as opposed to the gradual softening of the nonlaurics. However, some triglycerides found in the lauric group are incompatible with those of cocoa butter and those typically found in domestic hard butters. Consequently, when used in coating formulations, they must be mixed with low-fat cocoa powder. Use of chocolate liquor or cocoa butter could lead to eutectic formations, softening and surface bloom during storage. Eutectic mixtures can result because of incompatibilities, Babayan said, adding that a skilled chemist can use such effects

Table II

Coating Characteristics

Fractionated laurics	Fractionated/hydrogenated nonlaurics	Hydrogenated/interesterified laurics	Hydrogenated nonlaurics
Excellent mouth feel	Good/fair mouth feel	Good mouth feel	Fair/poor mouth feel
Excellent flavor release	Good flavor release	Good flavor release	Fair/poor flavor release
Good belt and mold release	Good belt and mold release	Good belt and mold release	Fair belt and mold release
Good gloss	Good gloss	Good gloss	Good gloss
Excellent oxidative stability	Good oxidative stability	Excellent oxidative stability	Good oxidative stability
Cocoa butter tolerance 6%	Cocoa butter tolerance 25%	Cocoa butter tolerance limited	Cocoa butter tolerance limited

Source: Steve Laning, Industrial Products Group, Stokely-Van Camp, Columbus, Ohio.

to advantage.

Lauric hard butters are used in coatings that require tempering and in those that are self-tempering. They are bland in taste, light in color, free from objectionable odors and show resistance to oxidative rancidity. Babayan said they also have sharp clean melting and mouth-feel characteristics, with a cooling effect.

When saturated, coconut oil will reach a melting point near 38 C and palm-kernel oil will melt about 45 C. Although these hydrogenated lauric fats are not suitable for confectioner's coatings, they regularly are used in whipped toppings, vegetable dairy applications, biscuit and cracker formulations and nut roasting.

"Lauric fats resist bloom but are not known for their exceptionally long bloom resistance," Wilson said. "Usually, nonlaurics far out-distance laurics and are selected for products that must resist cycling and have shelf lives of one year or more."

According to Laning, the best lauric CBS are made from fractionated palm-kernel oils. Palm-kernel stearines offer the firmness, snap and characteristically steep melting curve typical of cocoa butter but at a lower cost. By partially or fully hydrogenating fractions of palm-kernel oil, manufacturers can obtain solid fat contents at 27 C ranging from 40-75%. In applications where the softening effects of fats and oils from other confectionery ingredients must be considered, the fractionated lauric CBS have enough tolerance to provide sufficient binding characteristics to maintain product integrity until consumption.

Lauric fats can be susceptible to hydrolytic decomposition. This can lead to a soapy flavor as small amounts of lauric fats are attacked and split by enzymes in the presence of water. According to Babayan, use of sanitation and good quality, clean raw materials avoids and eliminates most such enzymatic problems. "By being cautious about the presence of enzymes in confectionery systems with excessive moisture levels and by using reasonable sanitary precautions, confectioners have been using CBS for years at increasing levels without an incident of soapy flavor development," Laning explained.

Comparing laurics to nonlaurics, Schaff said positive features of the laurics are they have a tighter SFI than nonlaurics, are less waxy at the same melting point, have a wider range of melting points and offer a wider choice of fats. However, their incompatibility with cocoa butter limits the amount of cocoa or liquor that can be added. Also, they should not be used in high-moisture pieces, and, in transit, if heated will not reset as nicely as nonlaurics.

A worker at the Ambrosia Chocolate factory, Milwaukee, Wisconsin, inspects cookie chips as they come off the conveyor.

Chocolate and confection statistics show lauric fats have outsold the nonlauric fats, despite lauric fats' low cocoa-butter compatibility and the contention of possible off-flavor enzymatic hydrolysis. Babayan credited this to 2 factors: "Lauric fats have a clean, nongreasy, smooth getaway in the mouth with a cooling sensation, and they not only offer a price advantage but also greater flexibility for tailormaking hard butters of specific specifications. This is the primary reason why confections have become an accepted food rather than an expensive treat for special occasions."

Although attempts have been made to construct cocoa-butter substitutes from glycerine and fatty acids, Wilson said, "To date these reactions prove too costly and difficult to control on a commercial basis."

Hard-butter manufacturers sell their products to industrial chocolate suppliers and companies that manufacture coatings for captive use. The industrial chocolate suppliers, in addition to producing chocolate, also make chocolate-flavored coatings, chocolate-flavored chips (also called cookie drops), and a variety of pastel coatings.

All good hard butters, whether lauric, nonlauric or CBE, are resistant to bloom, more so than chocolate is.

"The fats and oils industry has been able to develop a range of products that are resistant to bloom. The last 10 to 20 years have seen much growth and sophistication in this field to produce higher quality and a greater variety of hard butters," Laning said.

Pease believes this will continue. "New product development by confectioners challenges the fats and oils producers to further their research and development efforts to produce specialized fats to fill the needs of the confectionery industry."

Babayan, in a 1978 *JAOCS* article "Hard Butters and Confectionery Coatings," wrote, "What chocolate offered was flavor and aroma. If one could capture the flavor and aroma of chocolate in combination with a hard butter, then the confectionery coatings could become an item of true benefit to their industry. Over the years this is what essentially has happened since many firms which have learned to use hard butters have stayed with confectionery coatings even in such periods when the price of chocolate has come down."

(All photos courtesy the Ambrosia Chocolate Company and Hershey Foods Corp.)