FRICTION, WEAR AND LUBRICATION

MEMM 1343

Oil palms and the industrial revolution

Before abolition, most palm oil rode along with the slave trade in the most literal sense. A surviving freight bill for the Hawke offers one example: the vessel loaded 359 captives at Gallinhas and Bassa and discharged 328 survivors at Dominica in 1777.

On the return trip to Liverpool, the vessel brought back six puncheons of palm oil. Small shipments like this amounted to a few thousand gallons annually, and British port officials levied stiff duties on these imports. Given its medicinal uses, palm oil was classed and taxed as a drug.

The Industrial Revolution radically changed this situation for palm oil and the people who made it and used it. No longer an exotic medicine, palm oil embarked on new roles in soap, candles, and a seemingly endless array of industrial novelties.

Britain led the way in palm oil consumption, though France and Germany took a considerable share of Africa's exports by the end of the nineteenth century.

Germany became an especially important consumer of palm kernels, crushed for oil and turned into cattle feed.

Industrializing Europe could use as much palm produce as Africa could supply, on one condition: that it was cheap enough to compete with rival sources of fat.

Soap and the industrial revolution

Soap forms when alkali chemicals (obtained from plant ashes in the preindustrial era) react with fats. An alkali breaks apart the triglyceride molecule that all fats are made of, bonding to one of the three fatty acids in the triglyceride. The result is soap, a molecule that cleans because it attracts both oil and water.

Early accounts showed that Africans had long used palm and palm kernel oils to make soaps with ashes from palm fronds and other plants, and most observers praised their quality and cleaning power. One European complained that Africans on São Tomé washed so vigorously that the main river on the island was “nothing but Sudds, enough to poison our Men.”

Around the 1770s, British shepherds started using palm oil as a dressing to protect the skin and wool of sheep before shearing. Palm oil wasn’t yet cheap, but it was cheaper than butter, the traditional dressing. In time, spinners, weavers, printers, and dyers started using palm oil and soaps made from it throughout textile manufacturing.,

As the price of palm oil fell in the 1820s, manufacturers used more and more palm oil to the point of replacing tallow entirely. They were cheap and washed well enough to win British customers. By 1837, almost every soap maker visited by tax investigators in and around Liverpool used palm oil in their soap.

Candles and chemistry

Procter & Gamble, like many other soap manufacturers, was as famous for its candles as it was for its soap. The two trades used the same raw materials, and in the preindustrial era, soap boilers might pour their better tallow into candle molds before using the rest for soap, or vice versa.

Chevreul's work and the chemical discoveries that followed had little immediate impact on soap, but they revolutionized the candle industry. Tallow candles, made by congealing hot fat around a wick, had been expensive and imperfect. They melted in hot weather, dripped messily when lit, and produced smoke and foul odors.

Beeswax candles burned bright and clean, but not even the rich could afford them on a daily basis.

Spermaceti candles, made from a waxy material harvested from sperm whales, appeared in the late eighteenth century, but they still cost twice as much as tallow candles.(%

Greasing the wheels of industry

Palm oil washed hands and clothes and illuminated the rooms of industrializing Europe, but it worked at a more fundamental level by keeping the wheels of the Industrial Revolution in motion. With its thick consistency in European climates and high levels of antioxidants, palm oil emerged as a favorite lubricant.

While textbook accounts often link palm oil with cotton machinery to highlight continuities in Africa's ties to Atlantic capitalism before and after abolition, Lancashire's spinning machines in fact relied on much lighter oils. Several inventors in the 1830s tried and failed to sell palm oil lubricants to the cotton industry. Palm oil's real niche was in lubricating heavy machines, including the steam engines driving locomotives and factories.

Britain's new railways provided palm oil with its most iconic use outside soap and candles. When the Liverpool and Manchester Railway opened in 1830, carriages whisked passengers and goods along at speeds unimaginable in a world of canal boats and oxcarts. The investor Henry Booth praised it for effecting a "sudden and marvelous change . . . in our ideas of time and space." Besides being an investor, Booth was an inventor. In 1835, he received a patent for a new axle grease featuring palm oil, taking advantage of the growing quantities of the stuff for sale in Liverpool.

Booth combined 6 pounds of palm oil with 3 pounds of tallow, adding water and soda to make a soapy grease. The grease went into a box above the train axle; as the axle turned it rubbed the grease and melted it. Pure tallow was too stiff and pure palm oil too soft, melting away in as little as 40 miles. A blend had just the right consistency, lasting 1200 miles or more. Saponification with the soda kept the fats mixed and neutralized free fatty acids that might corrode the axle. With a few modifications, the recipe would keep trains rolling smoothly for more than a century.

Locomotives and other steam engines also used palm oil grease in moving parts of the engines, such as pistons. One estimate from the late 1850s suggested that the nearly 20,000 locomotives and 5,000 steamships at work in the United Kingdom and the United States each needed “25 lbs. of grease a day, or more.”

This estimate is probably too high, but it does give a sense of the scale of the market for palm oil as a lubricant. Even mundane oxcarts and farm wagons needed grease, and although much of this came from domestic tallow, palm oil found some uses here, too.

Britain’s axle-greasing needs ran to well more than 17,000 tons annually in the 1860s, though only 25 to 35 percent of this weight was actually fat, the rest being water trapped in the grease emulsion.

Tin plate and tin cans

Few people in the industrialized world ate much palm oil until the 1920s, but practically everyone ate things that came in a can. Tin coatings made canned food possible, creating an envelope that protected iron cans and the food inside from air, water, bacteria, fungus, acid, and rust.

Palm oil's role in tinplate was critical but completely invisible to consumers. When a British colonial official mentioned tinplate as the major use for palm oil behind soap in an 1891 address before the Royal Geographical Society, he met with "skeptical amusement." The learned crowd couldn't imagine what palm oil had to do with tin cans. The official couldn't explain it either: he had read the fact but had no idea what purpose palm oil served.

Tinplating dates back to the 1670s in Britain, when an entrepreneur brought the secrets of the industry (then concentrated in Saxony) to Wales. The "tinman" and a crew of assistants dipped thin iron sheets in acid, then moved them to a pan of hot oil. The oil cleaned away the acid, leaving a layer that prevented oxidation. Next, the tinman moved plates through a series of molten tin baths of increasing purity.

A layer of oil coated on top of the tin to protect it from oxygen. The "washman" took over midway in the process, wiping droplets of molten tin off the sheets with a brush. He then fed the sheets into a pot of the purest tin, and then into another bath of oil. On the far end of the process, a group of "girls" scrubbed the sheets with mild abrasives to remove residual oil. Finally, another set of women hand polished the sheets with sheepskin, the final step before the tinplate was ready for sale. Similar processes were used for terneplate, coated with a mixture of tin and lead, as well as for zinc plate. Other workshops rolled, folded, and stamped the shiny plates into finished cans, biscuit tins, roofing sheets, and more.

Palms and petroleum

The tinplate story is one more example of how palm oil emerged as an industrial substitute in the nineteenth century. All of the tasks it performed had been done by other substances, and this meant that cheaper or better performing replacements would displace palm oil, too.

In the hands of chemists, palm oil was merely a collection of fatty acids and glycerin. These chemicals could be interchanged with a global smorgasbord of plant and animal fats by the 1870s. The color and smell that had once been prized by manufacturers in soap became a liability, forcing manufacturers to employ costly bleaching and deodorizing processes. Though highly productive, Africa's palm producers had to compete with farmers spread across the planet, as well as with ranchers and whalers. This fact became painfully clear in the 1870s and 1880s, as prices for palm oil dropped to new lows—£19 a ton by 1887.

Historians often point to the late-nineteenth-century arrival of petroleum, gas, and electricity to explain this crushing drop in the price of palm oil.

Though chemists had already tapped coal and shale deposits for waxes, oils, and gases, the sheer amount of petroleum bubbling out of new wells in Pennsylvania in 1859 was something new.

Chemists could now turn cheap, plentiful fossil fuels into wonderous substances, with catastrophic results for farmers.

Synthetic rubber made from petroleum ate away at markets for natural latex.

Cheap aniline dyes made from coal tar wrecked the market for natural dyestuffs.

Mineral oils shoved aside plant and animal fats in lubricants, lighting, and a warehouse's worth of minor uses like inks and polishes.

Palm oil

The oil palm produces two types of oils; crude palm oil (CPO) from the fibrous mesocarp and crude palm kernel oil (CPKO) from the kernels. Although both oils originate from the same fruit, palm oil is chemically and nutritionally different from palm kernel oil. It is one of the only two mesocarp oils available commercially, the other being olive oil. Figure 1 shows the fresh fruit bunches and Figure 2 shows the cross-sectional of palm fruit.

Figure 1: Palm tree and fresh fruit bunches.

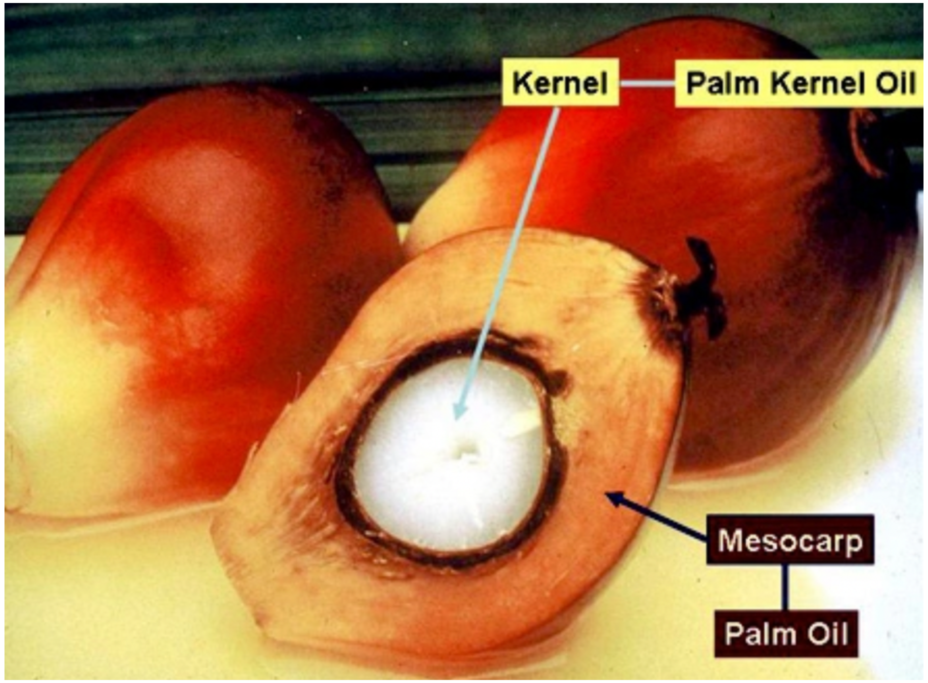

Figure 2: Cross sectional view of palm fruit.

Commonly three fruit forms or "varieties" of oil palm can be identified based on the thickness of the shell criterion. The Dura has a shell thickness between 2 to 8 mm, the fleshy mesocarp of Dura yields between 15 to 17% oil, while the Pisifera has no shell, the oil yield is more than 23%. The shell thickness of the hybrid Tenera is between 0.2 to 2 mm, while in Tenera yields between 21 to 23% oil. According to commercial purpose, Pisifera is not cultivated on large scale because of its ability to fruits abortion and thereby virtual empty bunches production. Tenera which is a hybrid of Dura and Pisifera varieties remains the commercial variety with 60 to 96% of mesocarp. The hybrid produces more fruit bunches than Dura, as shown in Figure 3.

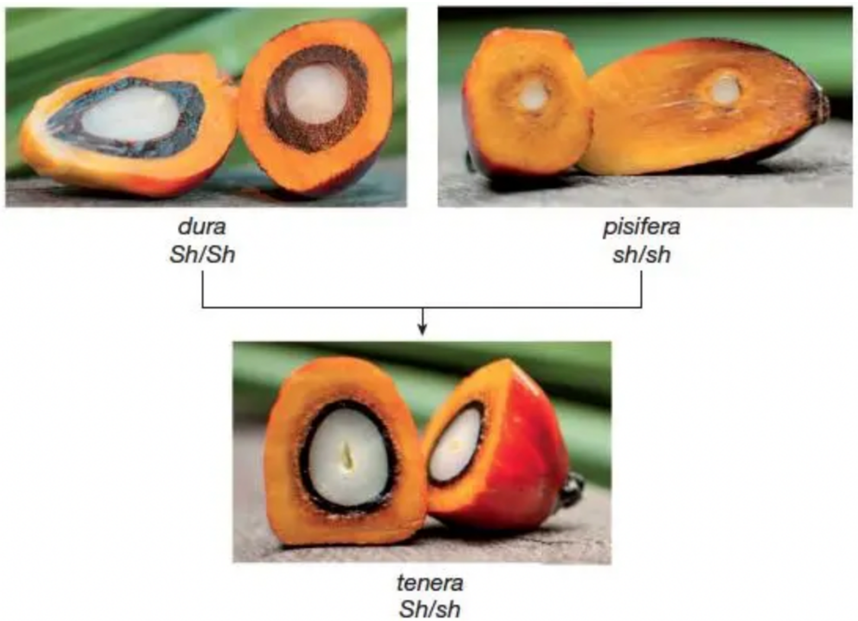

Figure 3: Tenera, the hybrid palm fruit.

The process of RBD palm olein

In conventional milling process, the fresh fruit bunches (FFB) are sterilized and the fruitlets stripped off. The loose fruitlets are then digested and pressed to extract the crude palm oil (CPO). The kernels are separated from the fibrous mesocarp in the press cake and later cracked to obtained crude palm kernel oil (CPKO).

RBD palm oil refers to the edible oil after crude palm oil is sent to an edible oil refinery plant for refining, decolorization and deodorization. RBD palm oil is nearly colorless and transparent in liquid and nearly white in solid. Figure 4 shows the brief process of refining RBD palm olein.

If further processed, RBD palm oil can also be processed into palm olein and palm stearin. RBD palm oil, palm olein and palm stearin all have more uses and greater market demand.

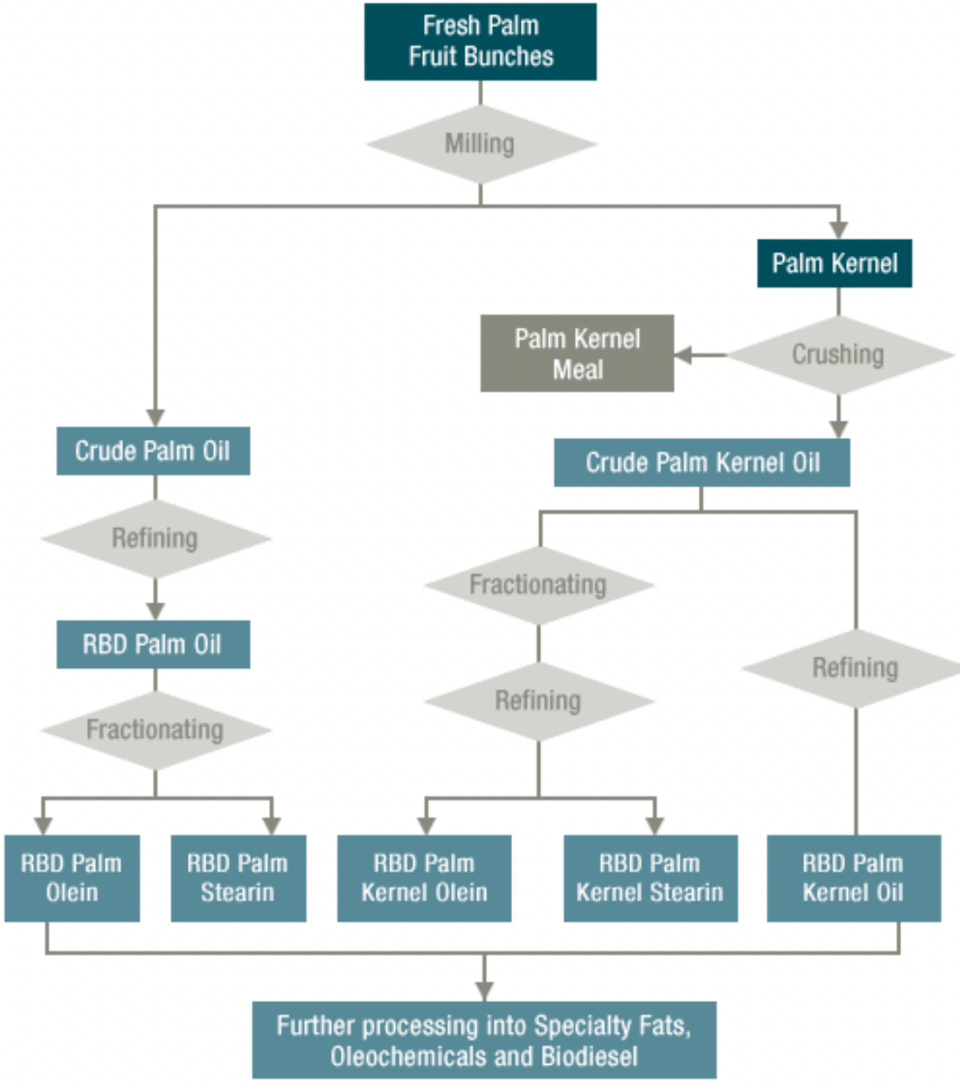

Figure 4: RBD palm olein refining process.

The main steps in palm oil refining include degumming, deacidification, decolorization and deodorization.

Degumming is the process of removing colloidal impurities in the crude oil by adding hot water or phosphoric acid to the crude oil .

Deacidification is the removal of free fatty acids from crude oil. This is one of the most critical stage in the entire RBD palm oil refining process. That is, using alkali to neutralize free fatty acid, so that free fatty acid produces saponin and separates out from oil.

Decolorization refers to the quantitative decolorization agent (active clay, activated carbon) by vacuum inhalation in the oil, and continue to stir heating, maintain about 25 minutes, and then pump the mixture of oil and clay into the filter to complete the decolorization process.

Deodorization means that the decolorizing oil is sucked into the deodorization tower and heated.

When the oil is added to more than 100 degrees, the steam will take away all kinds of flavour. Deodorization can not only remove the odorous substances in the crude oil, increase the smoke point of the oil, improve the flavour of the oil, but also effectively remove impurities.

The RBD palm oil obtained through the above steps also called edible oil, which has reached the food grade standard, people can eat it safely.