Drying, Storage, and Preparation of Copra for Extraction of Oil

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ABSTRACT

Various methods are used in drying copra. Because of costs, fuel oil and electricity are avoided by copra producers. Sun-drying remains as a cheap practical way of drying. Direct drying kilns rely on direct contact of combustion gases with coconut meat and produce a generally inferior grade of copra. Indirect drying kilns produce excellent copra. Various preparatory equipment may be used satisfactorily. A new copra oil mill will be most economically designed for handling copra as the main raw material. If, however, an existing oil mill is to diversify to include copra as new raw material, only minor equipment changes are needed. By 1980, copra will almost disappear as an export item, because the coconut producing countries will press and extract coconut oil domestically. The coconut-producing countries hope to obtain better quality of products, improve profit, and contribute to local economy by using local resources.

THE COCONUT TREE

The coconut tree, *Cocos nucifera* L., is called the Tree of Life because it provides man with food, drink, housing, shelter, fuel, implements, furniture, intoxicating liquors, and the pleasure of gazing upon one of Nature's most beautiful trees!

THE WORLD SITUATION: PRODUCTION AND TRADE

Sixty countries, mostly in the tropical areas, produce an estimated 27 billion nuts per year, from about .7 to 1 billion coconut trees, growing in about 16 million acres.

An estimated 25% of these nuts are consumed directly, leaving 75% to be converted to copra and a small amount of desiccated coconut. The kernel of the coconut, dried for oil extraction, is called copra. At 5,000 nuts per ton of copra, the amount of copra produced world wide is estimated to be about 4.1 million tons per year.

Of this copra, 43% is milled and used domestically in the producing countries. The balance of 57% amounting to 1.625 million tons oil equivalent per year flows into the export market either as copra or as coconut oil.

Understandably India and Indonesia, with their large populations and oil demand, locally consume almost all of their total production. Other areas have a small enough production that can be completely consumed locally.

The Philippines produces 26% of the world's coconuts, 43% of the world's copra, and accounts for 66% of the world's total combined copra and coconut oil exports. Other countries rank in coconut production as described in Table I.

COPRA DRYING PRACTICES

Freshly split coconut exposes the whitest, most palatable of nuts meats, but it soon ferments unless dried properly. The meat of the fresh mature coconut contains 40% oil, 43% moisture, and 17% carbohydrates, protein, and ash. Copra, dried to 6% moisture content, contains about 64% oil and 36% cake.

Drying accomplishes the following:

(a) Develops characteristics most suitable for milling of oil.
(b) Reduces volume, hence greater economy in transportation. The meat shrinks and separates from the shell.
(c) Prevents rapid formation of free fatty acids, and color deterioration. Stabilizes quality during storage and transportation.
(d) Develops resistance to molding.
(e) Develops resistance to insect infestation.

Improper drying and storage result in high free fatty acid, high moisture, poor color, bad odor, high amount of burnt copra, molding, and dirt incorporation, resulting in poor grade or rejectable copra. The oil derived therefrom is of poor quality, characterized by higher refining losses, heavier usages of caustic and bleaching materials, and reduction of plant capacity.

DRYING PRACTICES: PHILIPPINES

Sun-drying is widely practiced during the dry season. Proper sun drying takes about 5-6 days and produces excellent copra. Interrupted and insufficient drying results in dark, rancid, moldy copra.

Most popular artificial dryer is the "tapahan" which is a kiln dug out of the ground and provided with a raised wooden or metal grating on which split coconuts are laid one foot deep. Combustion gases from burning of coconut shells or husks rise up through this bed. Proper drying takes about 4 days. Quality of copra could be good if fuel used burns clean without soot, if platform is at least 8 ft above the fire, and if temperature is properly controlled to prevent scorching and discoloration.

A small number of producers use hot air dryers. Air is heated by crude furnaces fired with husks or shells. Heated air rises through the bed of nuts to effect the drying. Proper drying takes about 4 days. No soot contacts the meat, and temperature can be more accurately controlled. This dryer produces excellent grade of copra.

DRYING PRACTICES: DOMINICA

Most producers use the "Malayan" type dryer which is a small windowless two-floor house of light construction. Coconut shells are fired at the first floor, and the sootless combustion gases rise up through the second floor, 8 ft above, to pick up moisture from the coconut meats. Drying

TABLE I

Coconut Production

	Coconuts	Copra	Export (oil equivalent)
Indonesia	20.8%	18.7%	NIL
India	17.3%	9.2%	NIL
Sri Lanka	6.9%	5.3%	2.3%
Malaysia	4.1%	4.7%	6.0%
Oceania	7.7%	7.3%	18.2%
Africa	5.7%	3.8%	5.1%
Latin America & Caribbean	8.0%	6.0%	.8%

cycle is 3 to 4 days. Quality is very good.

Several producers abandoned use of oil-fired hot air dryers because of high costs of fuel oil. Only one estate was observed to use this type of dryer. Quality is excellent.

DRYING PRACTICES: INDIA

A curious and expensive method is used to dry copra for edible purposes. To produce ball copra, the whole coconut is dried in the shell for 8-12 mo by smoke from husk and leaves, till all the coconut water dries out, and the kernels detach from shells, which one can audibly detect by shaking the dried nut. The dried nut is split carefully and the dried copra is obtained as a whole kernel in the shape of a hollow ball, hence, ball copra. Ball copra is a delicacy.

For copra oil milling, two principal methods are used: (a) Sun-drying for 4 or 5 days, and covering against dew or rains at night; (b) during rainy season, kilns are used for drying. The kiln is usually a smoke dryer. Encouragement is given to produce better copra by using the "kumkum" or hot air dryer. For estates or large areas planted to coconuts, the Chula patented dryer is recommended. It produces good quality copra, such that it does not accumulate penalties or deductions for moisture allowance or low quality such as that obtainable with other methods of drying.

DRYING PRACTICES: BRITISH SOLOMON ISLANDS

Hot air dryers are preferred in Malaita, Guadalcanal, Russells, Savo, San Cristobal.

DRYERS IN OTHER COUNTRIES

The Ceylon dryer is similar to the Malayan dryer. Basically it is a two-floor house, with the first floor serving as the firepit or oven. It is about 6 meters long by 4 meters wide by 3.72 meters high. This height is recommended to avoid over heating and scorching copra. At the top of this oven is a grating on which copra is to be dried. This second floor is 1.73 meters high, and the roof of the house begins at this level. The split coconuts are placed face down to a depth of 1 ft. The flue gas from shells comes into direct contact with the meat.

The actual operation begins with predrying of the split coconuts under the sun. After 1 day the splits are picked up and placed on the grating over the oven. The sun has great bactericidal action, hence the predrying. The dryer uses coconut shells as fuel. Including 9½ hr of sun-drying, the copra is dried for the first 24 hr from 50 to 55% moisture to 35%. In the next 48 hr, the moisture drops to 20%. In the last 24 hr, the moisture drops to 5-6%, resulting in brittle copra with good color.

The copra is subjected to flame testing. If a sliver of copra is ignited, it will burn with the following characteristics at various moisture levels: (a) at 7% moisture or less, the flame is steady and regular; (b) at 7-10%, the flame crackles; (c) at 10%, the copra burns with difficulty or not at all.

Force drying burns and discolors the copra. The oil decomposes. Copra is more vulnerable to infestation by insects. Oil yield drops.

The Ceylon system dried the meat in the half shell. The shells are gouged off when copra is fully dried.

The operation involves 15 man days of labor per 7500 nuts or 1½ tons copra.

DRYING PRACTICES: SAN SALVADOR, EL SALVADOR

Coconuts are gathered from plantation trees by men who ride on a tall platform pulled by oxen between rows of trees. The men hook the ripe nuts from the trees, and the nuts fall to the ground where men pick them up and load onto trailers which are pulled by farm tractors to the drying area. Men split the nuts and then lay them face up on the sun-drying area. The sun-drying area is a patio with suitable pavement material. The patio slopes up to the center.

Sun-drying can be carried out almost throughout the year. The country has a definite and prolonged dry season so that copra can be left on the patio overnight without danger of wetting from rain. During the rainier months, the sun usually shines in the morning and rain falls during certain hours of the afternoon.

During the rainy season the nuts are split, then the kernels are gouged out of the shell by special curved instruments, and the meat is strewn mechanically on patios and left to dry 6 to 10 days depending on the sunlight.

Every evening the drying kernels are bulldozed into the center of the patio, and the next morning they are again spread out by the dozer. Because the center of the patio is raised and the copra is gathered to this point and covered, there is little chance of rainwater getting underneath the pile.

During extremely long rainy periods, when the rains continue for 3 or more days at a time, the copra is dried in mechnical dryers. This type of weather fortunately comes only once or twice during each rainy season.

STORAGE PRACTICES

Before the copra ever gets to the oil miller, it may have gone through several hands. The small copra producer has little or no storage. He wants to sell the copra immediately and convert it into cash. The middleman buys the copra by visual and tactile inspection. He opens the bags and spreads the copra in his bodega (or warehouse) where the copra is air-dried, reweighed, and rebagged. The middleman may or may not be the ultimate exporter or seller to oil mills. In some countries the middleman acts as a financier, loaning out money in advance of copra deliveries. He gains an advantage this way, by being able to impose lower prices in exchange for immediate cash. This practice is prevalent in the Asian countries.

The buying activity is often fiercely competitive, and middlemen and buyers have their buying agencies, offering good deals for the farmers. This is often the cause for passing off poor quality copra into the trade, because buyers will accept poor copra so as not to lose the source. This happens in countries with big local oil milling demand.

However, for small countries like Dominica, where the only buyer is the Dominica Coconut Products, a local oil miller, and where there is little chance for export, the price and the rules for accepting and rejecting copra is more under the control of the oil miller, and the farmers are more receptive to penalties for low quality; as a matter of fact, in Dominica, the quality improved greatly from Grade D or C to B or A, within a short time after the start-up of this mill.

Resecada, or redried copra, with 6% moisture, is more or less stable in storage. Moisture in copra in the trade often goes beyond 6%, and sometimes as high as 15%. In this case, the copra must be redried immediately by the oil miller to prevent molding, free fatty acid (FFA) formation, color deterioration, and heating up.

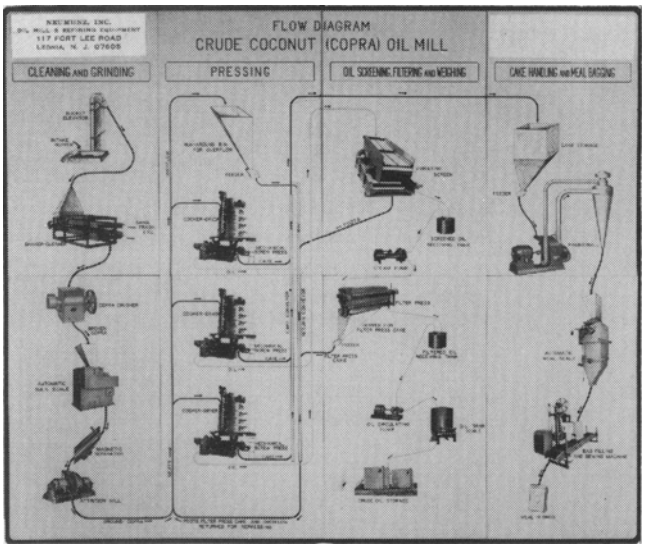
Larger oil mills employ a copra classifier, who is expert in grading copra and is authorized to accept, impose penalties on, or reject copra shipments. He looks for poor quality by touch, sight, and smell. Rubbery copra indicates immature nuts or insufficient drying. Rancidity indicates FFA formation due to poor drying or storage; it indicates enzymatic action. He also sends samples to the laboratory for analysis of moisture and FFA content.

Larger oil mills have copra warehouses, often of the Muskogee type, where receipts are stored in piles of 1000 to 2000 tons in each quarter of the building. Aeration and

rotation of stocks for milling are provided for.

Smaller millers such as those in Dominica have little or no storage for copra. Daily receipts from 200 suppliers keep the oil mill supplied at all times.

OIL MILL PREPARATORY OPERATIONS FROM SEED CLEANING TO COOKING-DRYING



Almost all of the commercial production of coconut oil today is based on the extraction of oil from copra.

Expression of oil from the fresh meat is an old domestic procedure. However, only experimental or pilot plants have been set up utilizing fresh meat, and the main deterrents to this procedure are several serious problems: (a) Emulsion of oil-water results from pressing of fresh meat. To break emulsion requires heavy investment in equipment and time consuming processes, such as centrifugation and fermentation or heating. (b) Emulsion has high water content. Heavy investment is required for evaporating equipment, and large operating costs are incurred because of the fuel required to dry large amounts of water. (c) Fresh nuts must be transported over long distances to the plant, and this involves transporting the whole nut which is four times heavier than the obtainable copra. Large amounts of fresh coconuts must be available every day. To make 200 tons of oil per day, the equivalent of 780,000 nuts weighing 780 tons whole nuts or 516 tons husked nuts must be trucked to the oil mill. (d) Fresh nuts are highly perishable, and subject to germination and cracking, disadvantages when compared to copra.

The preparatory operations in the oil mill proper consist of the following: feeding and conveying copra from warehouse to mill, cleaning, weighing, size reduction, drying (and cooking), feeding into presses.

Methods of preparation vary from manual operations to fully mechanized operations; they vary in types of equipment used depending on whether the oil mill is strictly designed for milling copra or is a diversified operation handling various types of oilseeds.

The typical mill includes the following principal equipment:

(a) Payloader for feeding floor conveyors from the copra warehouse to intake hopper.
(b) Bucket elevators from intake hopper to shaker cleaner.
(c) The shaker cleaner which removes sand, trash, stones, etc. Single shakers are generally sufficient for copra.

The purpose of seed cleaning is to remove rocks, sand, trash, metal, and other foreign matter before feeding into crushing and milling equipment.

Reels, rotary screens, revolving screens may also be used to remove dust, sand, shell pieces, stalks, etc. They are in the form of elongated drums or octagonal cages, rotating on a longitudinal shaft, and at a speed which depends on the diameter. The copra rotates inside the screen or mesh, and the impurities drop out of the drum or cage. Copra has rather big particle size and can be separated easily from small particles of foreign matter.

Flat screens are preferred by many because of simple construction and operation. The screens are slightly inclined. The flat screens may be shaken or vibrated. The vibratory screens are preferred by many because of their efficiency and smooth drive.

Shakers have 200 to 400 strokes per min; vibrators, 3000 vibrations per min. Both induce the fines and heavy impurities to work down to the surface of the screen.

Two or more screens may be placed in one machine, in series. A single shaker is adequate for copra cleaning.

Where large particles of stones or foreign material are mixed with copra, most cleaners would be inadequate and laborious hand picking may be required.

Other mill equipment includes the following.

Copra crusher, otherwise called a pre-breaker breaks the copra into particles about ¼ in. in size.

The automatic bulk weighing scale is a major accounting point in the mill. At this point the copra weighed would have lost moisture at the warehouse, and the impurities of sand, stones, and foreign matter already removed.

The inventory variations are often sizeable and frequent in-process measurements would indicate where these variations occur.

The magnetic separator of the continuous drum or belt type picks up ferrous metal bits such as nails, bolts, nuts, etc. and discharges them. Removal of metal protects the equipment in subsequent operations. Smaller mills may use permanent plate type magnets, which are only 20-25% of the cost of drum type separators.

The attrition mill grinds the copra to smaller particles or granules. The attrition mill is a disk mill which grinds copra between two plates, as in the single disk mill which has one rotating plate and one stationary plate, or in the double disk mill which has two plates rotating counter to each other. Copra is not a hard material and disintegrates rather easily. However, one has to avoid too much milling because oil may be prematurely released by copra, and this causes difficulty in discharge through the screens of the mills.

Hammermills and fluted rolls are also used for final size reduction in a good number of oil mills.

It is claimed by some oil millers that oil residue in cake after single pressing was reduced by as much as .50 to .75% after replacing hammermills with disk attrition mills. On the other hand, an old mill with single pressing operations discontinued use of crushing rolls and replaced them with vertical hammermills.

After final grinding the copra is fed into the dryer. Recommended temperature is 105-115 C. The material is dried to 2 or 3% moisture before pressing. The stack cooker-dryer is suitable for this purpose.

Most other oilseeds require full thermal pretreatment or cooking before pressing. Copra merely requires drying slowly at lower temperatures.

Many Philippine oil mills were designed presumably to handle copra to 6% moisture. Drying equipment was horizontal cylindrical conditioners. However, in the face of competitive buying, oil mills found it necessary to accept higher moisture in copra. Then the conditioners were unable to dry to proper moisture levels. Some large oil mills were forced to install huge rotary steam heated dryers to assist the conditioners.

OIL MILLING TRENDS

Major coconut producing countries plan to crush copra locally and export oil and meal. The Philippines has a program to install sufficient crushing facilities by 1980 to handle all its copra production. The United States stopped crushing copra in March 1974 and is importing coconut oil instead. These trends are expected to be followed by traditional producers and importers respectively.

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