Value addition, product diversification and by-product utilization in coconut

K. Muralidharan and Jayashree. A***

India is one of the largest producers of coconut in the world. Coconut in India is predominantly a small holders crop contributing to about Rs.83,000 million annually which is about 2% of the contribution of agriculture and allied sectors. More than 10 million farming families dependent on this crop for their livelihood.

Even though a major producer of coconut, India consumes more than 50% of its coconut production of 15.84 billion nuts per annum as raw nuts for culinary and religious purposes. 35% of the production is utilized for conversion to copra, 11% for tender nut, 2% for seed purposes and hardly 2% is utilized for value addition and industrial purposes. As such there is a need for the country to devote more intensive research and development and technology transfer on utilization and product diversification in both food and non food uses so that the practice of fixing the price of coconut based on the existing market price of coconut oil could be done away with.

Coconut has the advantage of having hundreds of uses which no other oil seed or horticultural crop can claim. Coconut products and by-products can be commercially utilized for multiple purposes. Coconut is a food as well as an oil seed crop. It is also a source of fibre, timber, and fuel. Coconut palm is also a beverage crop in many states in the country. The kernel is an integral part of the diet of the people of the West Coast of India. Nutritious milk is obtained from the kernel, which yields oil on its boiling.Coconut milk is an essential ingredient in many culinary preparations.

The dried kernel or the copra is the richest source of cooking oil of Kerala. Coconut oil is also used as hair oil, body oil and industrial oil throughout the country. It is an illuminant and lubricant as well. Coconut oil is an ingredient in most of the premium cosmetic products.

Coconut oil yields many oleo chemicals which have wide applications in various sectors. It can also be converted into bio-diesel. The coconut oil cake, the residue obtained after the extraction of oil from copra is a good cattle feed. Coconut palm yields toddy from which jaggery, vinegar and arrack are manufactured. The timber of coconut is used in house construction and to make furniture, wall panels, show pieces and floor tiles. The inflorescence of coconut is used to make ayurvedic medicines. Tender coconut is used as a nutritious health and sports drink and is a base for many ayurvedic preparations. The water of mature nut yields products such as vinegar, jelly, nata de coco and wine. The shell is used as a fuel besides

manufacturing various commercial products like shell powder, shell charcoal, shell based activated carbon, ice cream cups, buttons of garments, utility articles and show pieces.

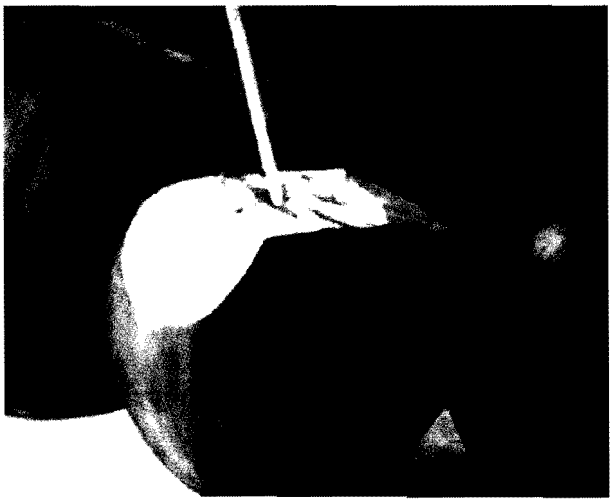
The soft bud of the palm is edible and nutritious. Spongy ball like haustorium developing inside the nut when stored over a period is a sweet delicacy which can be exploited as a commercial value added product. The leaf of the palm is used for thatching houses. Dried leaves are used as fuel besides serving as country torch in villages. The spindle leaf is used for decoration and costuming in folk dances. The midribs of leaves are used to make brooms, fish traps, baskets and tongue cleaners. The husk yields fibre and pith. The fibre is made into hundreds of products, which enjoy both domestic and export market. The pith is a soil conditioner and rooting medium besides having many other uses. The spathe and stipules are used as fuel and for manufacturing handicrafts.It is rightly said "The coconut palm is alone sufficient to build, rig and freight a ship with bread, wine, water, oil, vinegar, sugar and other commodities".

The various products of coconut other than copra and coconut oil offer a vast scope for further development, value addition and commercialization. A large number of products are developed from coconut. However due to pausity of space, this article covers only the major products developed from coconut water, coconut kernel and coconut shell.

Food products from coconut water

Tender Coconut Water

Tender coconut water serves as a mineral drink with therapeutic properties that help in regaining the vitality of the human body. The characteristic flavor of tender coconut is contributed by delta lactones. Glucose and fructose form an important constituent of the tender nut water. Tender Coconut Water contains most of the minerals such as potassium, sodium, calcium, phosphorous, iron, copper, magnesium etc.



Tender Coconut Water has become popular as an emerging, natural and healthy product. Reports have indicated that coconut water has now became the fastest growing new beverage category in the US and is expected to be replicated in many other countries. Coconut water has recently caught on among athletes, health freaks and urbanites in many developed countries. Soft drink giants like Coca Cola and Pepsi have acquired top two brands, Zico and O.N.E. UK, Netherlands, Canada, Mexico, UAE, Japan, Korea and Australia are the major importers of tender coconut water.

Packaged Tender Coconut Water

The Coconut Development Board in collaboration with the Defence Food Research Laboratory (DFRL), Mysore has developed a technology for preservation and packing of tender coconut water in pouches and aluminum cans. The DFRL, Mysore has succeeded in retention of its flavour when packed in pouches/aluminum cans for a period of three months under ambient conditions and six months under refrigerated conditions. The product has acclaimed consumer acceptance through out the country. At present six units have been set up in the states of Orissa, Andhra Pradesh and Karnataka for the commercial production of this product. Another unit using the tetra pack technology has also been established recently in Tamil Nadu. The products are available in both domestic and international markets.

Major exporters of the product are Philippines, Indonesia, Malaysia and Thailand.

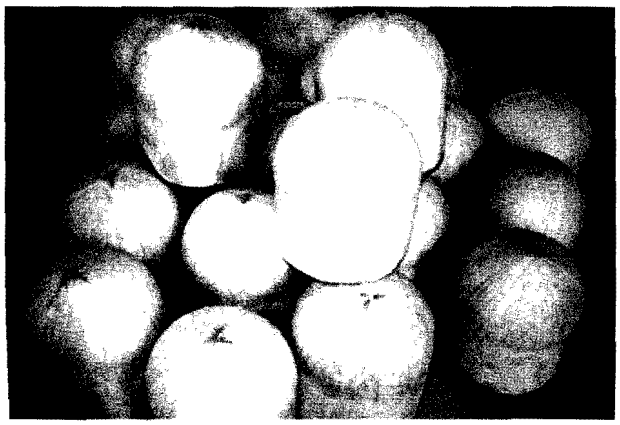
The Defence Food Research Laboratory, Mysore under sponsored project of the Board has also developed technologies for mechanical cleaning of

tender coconuts, mechanical chopping and collection of tender coconut water, additive treatment and mixing and filling of water into pouches/cans, modification of process (hot filling) for PET bottles, conveyor system to carry pouches/cans to continuous pasteurization system. The technology is being adopted by the existing units for quality upgradation. FAO has also patented a technology for bottling tender coconut water using micro filtration technology. Board has transferred the technology to 10 entreprenuers and 6 processing units with a capacity to process 78000 nut per day are operational now.

Minimal Processing of Tender coconut

Perishability of tender coconut is relatively high and once the tender coconuts are detached from the bunches its natural freshness will get lost within 24 to 36 hours even under refrigerated conditions unless treated scientifically. The bulkiness of tender coconut is due to the husk which accounts for two-third of the volume of tender nut.

Handling of tender coconuts will be easy if a major part of the husk is removed. But, when partial removal of husk is done the colour of the nut will be changed to brown thereby reducing the attractiveness of the nut. Technologies for minimal processing of tender coconut have been developed by Kerala Agricultural University (KAU) for retaining the flavour and to prevent discolouration. The process involves dipping (partially) dehusked tender coconut in a solution of 0.50% citric acid and 0.50% potassium metabisulphate for three minutes. The product can be stored up to 24 days in refrigerated condition at 5-7 degree centigrade. By using this process, tender coconut can be transported to distant places and can be served chilled like any other soft drink. Optimized uniform size facilitates using of plastic crates and insulated chill boxes for transporting and storage.

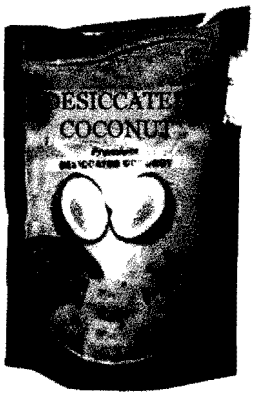


In Thailand young coconuts trimmed, treated and packaged with opener, straw and spoon are commercially produced and marketed (even exported) to countries like Australia, Europe, Japan, USA, Taiwan, Hong Kong etc. The shelf life of the processed young coconut is 45 days in 3-60 C or 3 weeks in 7 – 100 C.

Major products from coconut kernel

Desiccated Coconut

Desiccated coconut is the white kernel of the coconut, disintegrated and desiccated to a moisture content of less than three percent. It is white in colour. It is a popular commercial product having demand all over the world in the confectionary and food industries, as one of the main subsidiary ingredients of fillings for chocolate, candies, etc. It is also used uncooked, as decoration for cakes, biscuits, ice cream and toasted short eats. Common grades of desiccated coconut like granulated and fancy cuts like flakes, treads etc. are popular. Granulated cuts include coarse medium fire and superfine grades.



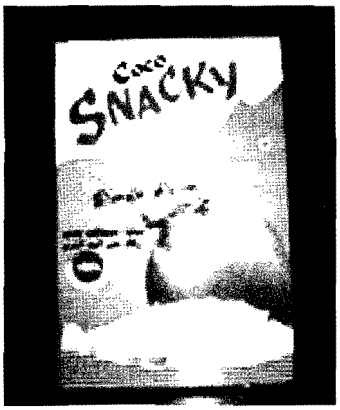
The manufacturing process involves selection of matured, seasoned, ungerminated, undamaged, dehusked nuts, deshelling by a small hatchet chisel, paring of the testa using the paring knife, slicing the kernel and removal of water, washing, sterilizing (blanching) using hot water, disintegrating into granular pieces of 1-5 mm size, drying in batch type of semi automatic tray drivers or fluid bed dryers to bring down the moisture to 3%, cooling the product to room temperature, sieving, grading and packing in polyethylene lined craft paper.

Sri Lanka, Philippines, Indonesia and Malaysia are major producing countries. Other countries producing small quantities of desiccated coconut are India, Fiji, Tonga, Ivory Coast and Brazil. Among its major export markets are the USA, United Kingdom, France,

Netherlands, Italy, Eastern Europe, Australia, Japan, Taiwan and the Middle Eastern countries. 23 desiccated manufacturing units are established with the financial assistance from Board which could together having processing capacity of 6.60 lakh nuts per day.

Coconut Chips

Coconut chips is a ready to eat snack prepared from 9-10 months old coconuts. It can be prepared by dehydrating the intermediate moisture coconut kernel. Intermediate moisture coconut kernel is the mature coconut kernel after removing the moisture content of the kernel partially by osmotic dehydration by using osmotic mediums like sugar syrup. Coconut Chips is crispy and can be packaged and marketed in laminated aluminium pouches, which will have a shelf life of 6 months. Since it is in ready-to-eat form, it could be used as snacks at any time. Coconut chips with different flavours can be prepared by adding the required flavour essence in the osmotic medium. Instead of sweet, salted coconut chips and medicated coconut chips can also be prepared by suitable change in the osmotic medium.

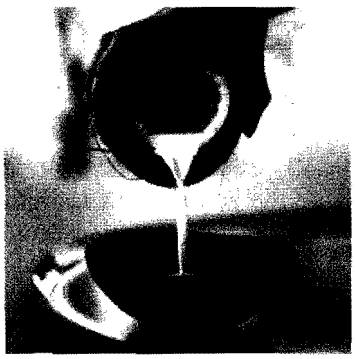


CPCRI, Kasaragod has developed a process for preservation and packing of coconut chips. CPCRI and CDB have already provided training to many women entrepreneurs and self help groups in coconut chips making. A few units have started commercial production. There is a insatiated demand for this product in the domestic market and elsewhere.

Coconut milk

Coconut Milk refers to the oil-protein-water emulsions obtained by squeezing fresh grated coconut kernel. The undiluted and diluted are referred to as coconut milk and concentrated form as coconut cream.

Coconut milk is obtained by extraction of fresh coconut wet gratings with/without water. This is an instant product, which can either be used directly/



diluted with water to make various preparations such as fish & meat dishes, curries, sweets, deserts, puddings, cocktails, cakes, cookies, coconut jam, ice creams etc. It can also be used in the manufacture of bakery products and for flavouring food stuffs. Preserved forms of coconut milk such as canned cream or milk and dehydrated whole milk are now available in many coconut growing countries. Commercial production of these products has been promoted in the Philippines, Thailand, Indonesia, Western Samoa, Sri Lanka and Malaysia and to some extent in India. Indonesia is the leading exporter followed by Sri Lanka, Thailand and Philippines.

CDB in collaboration with the Regional Research Laboratory, Trivandrum has developed technology for preservation and packing of coconut cream in tin containers with a shelf life of six months. The process involves dehusking of the fully mature nuts, breaking the nuts into halves, deshelling, washing and blanching of the kernel, grating, comminutions of the grated kernel to extract the milk, filteration through vibrating screens, additions of emulsifier and stabilizers, emulsifications, pasteurizations, hot filling in cans, can seaming and sterilization. 10,000 mature nuts could yield about 2500 kg of coconut cream and 500 kg of residual grating.

The technology has been transferred for commercialization and the product is available in the domestic markets at reasonable rates. Production of canned coconut milk is also commercialized in Thailand, Malaysia, Philippines, Indonesia and Sri Lanka.

Coconut Skimmed Milk

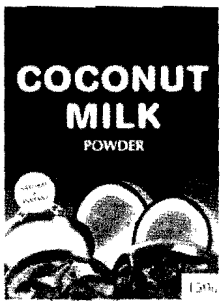
Coconut fresh kernel is a rich source of plant protein and could well be an invaluable material for the preparation of milk substitutes. Coconut skim milk is a solution of the soluble components of coconut after the cream is separated in a cream separator. Skimmed milk is a good source of quality protein suitable for the

preparation of many useful food products or as supplemental protein source, especially in regions deficient in animal proteins. Freshly prepared coconut milk from pared kernel is filtered through a 120 mesh vibrating screen and the pH of the filtered milk is raised from 6.3 to 7.0 with the additions of sodium hydroxide. The milk is then pasteurised at about 60°C for one hour and subsequently centrifuged in a cream separator to yield the aqueous phase or the protein rich skim milk.

Skim milk can be concentrated to a protein rich non-fat solid-product for industrial use. Skim milk can be used for the production of a variety of products like spray dried powder, coconut honey, coconut jam and sweetened condensed milk. In addition, it can also be used as a substitute for the preparation of fermented beverage concentrate and also as a source of vegetable casein. The gastro-intestinal disturbances in infants can be treated by feeding coconut milk, which shows that coconut skim milk having the same protein level (1.6 percent) as mother's milk is well-utilized by infants.

Spray Dried Coconut Milk powder

Coconut milk powder is the dehydrated form of the coconut milk. This product has a good keeping quality and retains the natural flavor, texture and taste of coconut milk. CDB in collaboration with the CFTRI has developed technology for spray drying of coconut milk, which is the most potential method for preservation of flavour and texture of coconut milk with good keeping quality. The process involves deshelling, paring disintegration of the kernel, squeezing the comminuted kernel in a screw press, standardization of coconut milk with maltodextrin and sodium cassienate, pasteurization spray drying and packing in aluminum packets. The powder is easily dissolved in water to form a milky white liquid with the flavour and texture of coconut milk. To make coconut cream, it is suggested to mix or blend 100g powder with 120 ml water. The product contains 60.5 per cent fat, 27.29 per cent carbohydrates, 9.6 per cent protein, 1.75 per cent ash, 0.8 to 2.0 per cent moisture and 0.02 per cent crude fibre.



The product has consumer demand in both domestic and international markets. Spray dried milk powder is produced on a commercial scale in the Philippines, Indonesia, Malaysia, Thailand and India.

The major markets for coconut milk and milk powder are European countries like UK, Netherlands, Germany, France, USA, Mexico, Canada, UAE, Australia, Japan, Korea, Malaysia, South Africa, Singapore etc.

Virgin Coconut Oil

VCO can be produced from fresh comminuted coconut kernel or coconut milk. Different production processes are adopted depending upon the scale of operations, degree of mechanisms and investment available. VCO produced from each process exhibits different organoleptic characteristics of which brief description of the process are given below:

Virgin Coconut Oil through Wet Processing of Coconut

Wet processing of coconuts is a new process of oil extraction from fresh matured coconuts producing high value, high quality Virgin Coconut Oil (VCO) rich in vitamin E and possessing long shelf life period of one year. Apart from virgin coconut oil, a number of other value added coconut products like coconut milk, low fat coconut powder, skim milk and packed coconut water, could be developed from the process. A plant processing 1 lakh nuts per day can produce 7.5 tons of virgin coconut oil, 9 tons of medium fat DC, 11,500 liters of matured coconut water 16.5 tons of skim milk and 11.5 tons of coconut shell.

Fresh dry process – Wet milling route – Oil is extracted from partially dried coconut meat using special screw type press. This is applicable for small to medium scale plants. By product is food grade full protein medium fat coconut flakes and coconut flour.

Fresh dry process – Desiccated coconut route – This process involves extracting the oil from the desiccated coconut. This process can be applied for converting the desiccated coconut which does not pass the quality standards into high value VCO and coconut flour or aflatoxin free cattle feeds. This process is useful in medium scale plan operations and involve

high investment or mechanical equipments.

Fresh dry process – Grated coconut route – This process involves splitting the coconut, grating, blanching and drying of the meat and extracting oil using screw press. This is similar to DC route except that this requires fewer process steps and equipments and useful for small scale plant operations. The by products are flakes and coconut flour.

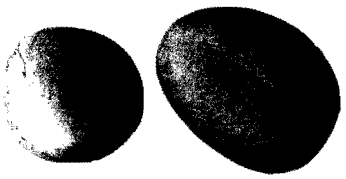
Wet processing of coconut – VCO through wet processing – Traditional wet processing – modified kitchens method. The process involves gradually heating the coconut milk mixture (first & second extract) until all the water is evaporated to produce VCO and proteinaceous residue. The milk is allowed to stand for three hours. Watery portion that settles at the bottom is removed and the remaining cream is gradually heated to produce the oil. This process produces the VCO with intense coconut aroma. If the oil is not heated in dryers it became rancid within five days. The proteinaceous residue has no commercial value but can be consumed by adding to rice cakes. Investment is low and useful for home scale operations.

Virgin Coconut Oil through cold process of centrifugal separation - The process involves a two staged centrifuging process wherein the skimmed milk (watery phase) is separated and the cream is subjected to vacuum evaporation and passed through the centrifuge again to obtain the VCO.

CDB has developed a technology through the CFTRI for production of virgin coconut oil by wet processing. Technology has been transferred to 9 entrepreneurs the product is marketed commercially under various brand names like Keravita, Indhulekha etc. 10 VCO units using wet processing method are assisted by Board under Technology Mission on Coconut. These units have the capacity to process 1 lakh nuts per day.

Philippines is the leading exporter of virgin coconut oil (VCO) in the world market. Thailand, Indonesia, India, Malaysia, Sri Lanka, Vietnam, Fiji, Western and Samoa also produce and export VCO. The major buyers are USA, Canada, Europe, Asia and Pacific, Middle East, Australia and South Africa.

VCO is used as food supplement, body oil, massage oil and in various personal care products. The increase in demand for VCO could been attributed to the re-discovery of the health benefits of coconut oil as a medium-chain triglyceride (MCT). The major demand for VCO is as food supplement.



Ball Copra

Ball copra is made by storing unhusked coconuts in a suitable store, which is usually a two-storey brick and mortar building, the floor and the four sides of the upper storey being made of wooden bars spaced two to three inches apart. Fully ripe nuts of twelve to fourteen months are stored in the upper floor of the store. They are frequently stirred and smoked by a slow fire, set under the platform using coconut palm waste or cheap firewood. During the period of storage, the water inside the nuts gets dried up and the kernel gets detached from the shell. The entire process takes eight to twelve months. When quite dry, the nuts are husked, the shells are broken with a heavy iron knife and the copra balls removed. The copra is clean, white inside and sweet in taste and is therefore highly priced. A study conducted by the erstwhile Central Coconut Research Station, Kasargod (India) on the preparation of ball copra revealed that small sized nuts are best suited for making ball copra, as it takes less time for conversion into ball copra.

Major products from coconut shell

Coconut shell powder, coconut shell charcoal and activated carbon are the three major products that can be made from coconut shell. Coconut shell powder finds extensive uses in plywood and laminated board industries, as a phenolic extruder and as a filler in synthetic resin glues, mosquito coils and agarbathy industries.

Coconut shell powder is manufactured from matured coconut shell by using pulverizes / ball mills. 12,000 shells would yield around one tonne shell powder. Coconut shell charcoal is manufactured by burning shells of fully matured nuts in limited supply of air sufficient only for carbonisation, but not for complete destruction. The output of charcoal in the traditional pit method is just below 30 per cent of the weight of the original shells. In India the average output in the traditional method has been found to be 35 kg of charcoal from 1000 whole shells or about 30,000 whole shells yield 1 tonne of charcoal. Shell is converted to shell charcoal by carbonization process

in mud pits, brick kilns and metallic kilns.

Activated Carbon is a non graphite form of carbon which could be produced from any carbonaceous material. Coconut shell based activated carbon is considered superior to those obtained from other sources due to its small macro pore structure which renders it more effective for the adsorption of gas/ vapor and for the removal of color and odor of compounds. It is widely used in the refining and bleaching of vegetable oils and chemical solutions, water purification, recovery of solvents and other vapors, recovery of gold, and in gas masks for protection against toxic gases. On an average 3 tons of coconut shell charcoal would yield 1 ton of activated carbon.

Taking into account the versatility of coconut and as can be seen from the above there is immense scope for more processed foods to be manufactured with coconut as base. Cooperation between producing countries will be mutually beneficial in the area of new product development, technology development and product diversification which will result in increased demand for coconut globally. Considering the dwindling market for traditional products like copra and coconut oil such efforts on manufacture of increased value added products will enhance the competitiveness of the coconut industry globally.

A brief on various other products from coconut will be continued. For full version of the article visit www.coconutboard.gov.in.

*Director, **Senior Technical Officer, CDB, Kochi-11

Production and export of value added coconut products

Export share of major coconut producing countries (Metric ton)

Coconut Products	India	Indonesia	Malaysia	Philippines	Sri Lanka	Thailand
Coconut	30602	72818	4149	1638	59199	24210
Copra	29625	39517	2569	84	8592	339
Coconut Oil	5870	570311	128855	826237	1932	17886
Coconut Cake	214	209035	3011	399782	20007	1326
Desiccated Coconut	900	46699	9448	116421	38651	1181
Coconut Milk/ Milk Powder	-	23264	3641	3723	10089	-
Shell Charcoal	15523	199045	-	34747	3550	-
Activated Carbon	38712	22741	17730	20027	17635	7023

Major coconut products and number of producers in India

Products	No. of producers
Copra	Above 10000
Coconut Oil	Above 2000
Desiccated Coconut	80
Coconut Milk Powder	2
Virgin Coconut Oil	15
Activated Carbon	16
Shell Charcoal	Above 1000
Shell Powder	Above 20

Major Importers of Copra (Metric Ton)	
Philippines	68764
Malaysia	29607
Bangladesh	19000
Pakistan	9944
Australia	9440
Other countries	1891
Total	138646

Major Importers of Desiccated Coconut (Metric Ton)	
U.S.A.	35886
Singapore	27109
Belgium	16372
Germany	15618
U. K.	13315
Netherland	10487
Turkey	10228
Other countries	233344
Total	362359