

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

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It is a well acknowledged fact that India is one of the largest producer of coconut. 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 & allied sectors with more than 10 million farming families dependent on the 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 nuts, 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 & 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. The 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. The 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, which 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. The 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 such as 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 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. A writer had 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 & commercialization, the description of which are given in this paper.

Food products from coconut water

Tender Coconut Water

Tender Coconut Water (TCW) is a gift of nature which is the first soft drink in the world. It is rich in vitamins, minerals proteins, amino acids, sugars and other biological growth factors and enzymes. It is an eco-friendly refreshing drink. Tender Coconut Water is a natural isotonic beverage which has almost the same level of electrolyte balance as in our blood. It is the 'fluid of life' that promote anti-aging, healthy cell growth and rehydration.



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. Glucose is highest at the seventh month stage of maturity. Tender Coconut Water contains most of the minerals such as potassium, sodium, calcium, phosphorous, iron, copper, magnesium etc.

The contents of arginine, alanine, cystine and serine in the protein of tender coconut water is higher than those in cow's milk. It also contains vitamins of C & B groups. Tender Coconut Water is a cheap indigenous fluid for curing dehydration. It has been reported from many countries that tender coconut water has been injected intravenously the cholera, epidemic patients and in the World War II in Indonesia & Sri Lanka.

Tender Coconut Water has become popular as an emerging, natural and healthy product. Reports have indicated that coconut water has now become 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. Another brand VitaCoco has even Madonna among its big name promoters. 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 (CDB) 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.

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.



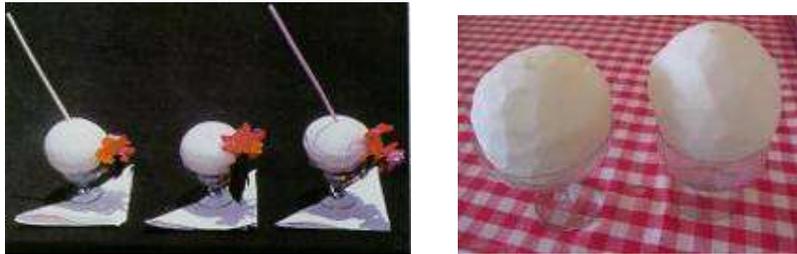
Handling of tender coconuts will be easy if a major part of the husk is removed. But, when partial removal of husk is done the colour of the nut will be changed to brown thereby reducing the attractiveness of the nut. Technologies for minimal processing of tender coconut have been developed by Kerala 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 place 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 are trimmed, treated and packaged with opener, straw and spoon are commercially produced and marketed (even exported) to the countries like Australia, Europe, Japan, USA, Taiwan, Hong Kong etc. The shelf life of the processed young coconut is 45 days in 3-6° C or 3 weeks in 7 – 10° C.

Snow Ball Tender Nut

Snow ball coconut is the whole round soft kernel pulled out from shell with the water intact in it. The soft tender kernel or solid endosperm of tender coconut is a delicious dessert. It is the tender coconut without husk, shell and testa which is in ball shape and white in colour. This white ball will contain tender coconut water,

which can be consumed by just inserting a straw through the top white tender coconut kernel. Coconut of 8 month maturity is more suitable for making snow ball tender coconut. Before scooping out the globular tender kernel with water, a groove is made in the shell by using a machine. By inserting the scooping tool, specially made for this purpose, in between the tender kernel and shell and then by rotation of the nut, the snow ball is scooped out from the shell. It is nutritive and is a drink and a snack at the same time.



The Central Plantation Crops Research Institute (CPCRI), Kerala has developed a technique and fabricated the machinery to pull out the whole round soft kernel from the nut. Snow ball tender nut can be packed in LDPE film of 200 gauge, which can be stored for 15 days at about 15°C under refrigerated condition without affecting its keeping quality. The technology is yet to take off commercially.

Fruit juice blended tender coconut water

Process for preparation of fruit juice blended tender coconut water beverage using pomegranate, blue grapes, pineapple, mango and lemon juice have been standardized by Central Food Technological Research Institute (CFTRI) under sponsored project of CDB. Storage studies of these products at room temperature revealed that the beverages were safe for consumption for a period of 6 months.



Products from Mature coconut water

Bottled Coconut Water

Bottling of coconut water for use as a soft drink is gaining popularity. Coconut water can be marketed as natural soft drink if preserved and packed. Non-carbonated beverages can be produced from the coconut water of mature nuts. The process involves collection of water filtration, upgradation (to adjust pH, taste, Total Soluble Sugar and shelf life), pasteurisation, filtration and bottling. The bottled drink can be stored for three months at ambient temperature. The drink can also be carbonated and used as beverage.



Coconut water beverages

The Regional Research Laboratory, Thiruvananthapuram has developed a process for the upgradation and preservation of mature coconut water. The main operations involve collection, upgradation, pasteurization, filtration and bottling. The process essentially consists of upgrading the flavour of mature coconut water to the level of tender coconut water by supplementation with additives including sugar and preserving it by a judicious combination of heat pasteurization and permitted chemicals. The drink can be carbonated and marketed as a beverage. In Philippines, matured coconut water formulations were developed with addition of sugars, acidulates and preservatives. The carbonated and non carbonated beverages ie. aluminum and poly ethelene laminated packages has a shelf life of six months at room temperature.

Coconut water concentrate

M/s Winter Umwelttechnik of Germany had developed the technology for manufacture of fruit juice concentrate using spray evaporation technique. The special advantage of this technique is that the product retains all the original characteristics of juice. Application of this technique for concentration of coconut water was attempted in India by M/s Miracle Food Processors International (P) Ltd, Perinthalthana, Kerala. The coconut water concentrate had a shelf life of 6 months to 24 months depending upon the degree of concentration. Ten litres of coconut water would yield about 800 g. of concentrate. The concentrate could be used to prepare aerated & bottled RTD beverages.

Frozen coconut water

Fresh coconut water from newly opened coconuts is collected under hygienic condition and suspended solids and oil in the samples are removed by means of three-way centrifuge. The salts present in coconut water may be removed if desired, prior to concentration, to produce a very sweet product by centrifugation and passing the centrifuged coconut water through a mixed-bed ion-exchange resin. The concentrate can be frozen or preserved in cans and after dilution to the desired strength, it can be used as base for the production of carbonated and non-carbonated coconut beverages. The concentrated coconut water is also reported to be used successfully in the brewery industry.



Nata-de-coco

Nata de -coco is a gelatinous product prepared from matured coconut water by the action of cellulose forming bacteria namely *Acetobacter aceti* subspecies *xylinium*. The culture solution is prepared by mixing coconut water with sugar and acetic acid at a stipulated proportion, which is inoculated with *Acetobacter, xylinium* through a culture liquid. It is filled in glass jars covered with thin cloth and kept for 2-3 weeks without any disturbance. During this period a white colored jelly like substance forms and floats on the top of the culture medium. It is harvested, cut into pieces and washed in pure water to remove all acids, immersed in flavoured sugar syrup for 12 hours and packed in glass bottles. It is an excellent ingredient for sweet fruit salads, pickles, fruit cocktails, drinks, ice cream, sherbets and other recipes.



CDB has developed a technology under laboratory conditions for the production of nata-de-coco from matured coconut water. It was found that 100 litres of coconut water would yield about 20 kg of raw nata. There is very good demand for nata de-coco in countries viz. USA, Europe, UAE, Japan, Taiwan, and Korea. It is commercially produced and marketed mainly by the Philippines, Indonesia and Malaysia.

Coconut jelly

The College of Home Science, Tamil Nadu Agricultural University, Madurai has developed a technology for preparation of coconut Jelly. The process for preparation of coconut jelly using tender coconut water was developed through the sponsored research programme of the Board. Coconut jelly stored in glass bottles was found to be best up to 180 days.



Coconut Vinegar

Coconut water can be converted into vinegar by using vinegar generators. The vinegar generator assembly comprises a feed vat, an acetifier and a receiving vat for collection on vinegar. The process involves fortification of coconut water with sugar, fermentation by inoculation of yeast and then mother vinegar, oxidation and acidification. Vinegar has extensive use as a preservative in the pickle industry and flavouring agent in food processing sector. Natural vinegar enjoys export market in place of synthetic vinegar prepared from commercial acetic acid.



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.

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.

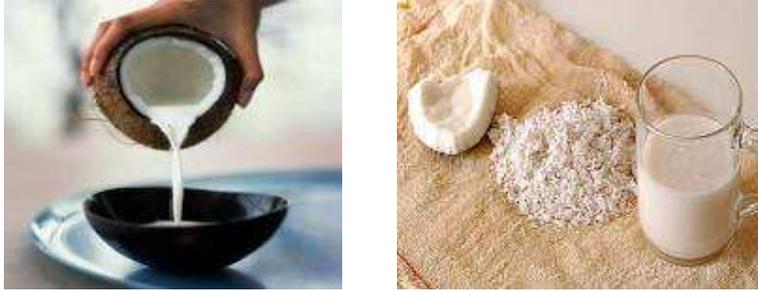


CPCRI, Kasaragod has developed a process for preservation and packing of coconut chips. The CPCRI and CDB have already provided training to large number of women entrepreneurs and self help groups in coconut chips making. A few units have started commercial production. There is a insatiated demand for 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.

The CDB in collaboration with the Regional Research Laboratory, Trivandrum has developed technology for the 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, filtration 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.

Sweetened condensed skim milk

Skim milk as stated above as a base for the production of sweetened condensed milk. The process involves adding pasteurised milk, corn oil, coconut cream and sugar and passing the mixture through a colloid mill. It is then heated in a steam jacketed kettle with constant stirring to a total soluble solids content of 68 percent. The finished product is packed hot in sterilised tin cans and cooled immediately in cooling tanks.

Bottled coconut milk

This product is of high commercial utility which can be used as a substitute for cow's milk, and is being produced in many countries particularly in the Philippines and Malaysia. The processing technology involves extraction of milk from finely grated unpared coconut with the addition of some water or coconut water, straining the milk in a cheese cloth into an aluminium kettle with 0.1 percent benzoic acid before placing the kettle in an autoclave at 117°C for three minutes with steam injection. The temperature of the milk in the pot is then brought down to 80-85°C, by running tap water. The milk is then homogenised for about five minutes and bottled at 70°C to 80°C. The final product is as good as cow's milk and is highly nutritious.



Coconut cream

Coconut cream is a white, smooth, liquid cream with excellent coconut flavour and 20-30% fat, aseptically packed. The product is easily pourable and ready for direct serving or to be used in other food preparation.



For normal household uses, coconut cream is diluted with three times water if an undiluted coconut milk is needed and with five times water if the intention is to have diluted coconut milk for the traditional food preparations. Coconut cream is chiefly used as a fat source for the reconstitution of the skimmed dairy milk and as a component of infant milk powders. The cream could be included as a component for the production of recombined milk or filled milk into three types of milk product: beverage type, evaporated type and sweetened condensed type.

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. The 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.

Coconut syrup

Coconut syrup is a translucent, free-flowing liquid with the characteristic creamy, nutty flavour of the coconut. Coconut syrup is produced from coconut milk. Coconut milk extracted from the freshly grated pared coconut meat. After homogenisation, an equal quantity of sugar and 0.05 percent citric acid or 0.25 percent sodium phosphate are added and then steam-cooked to a total soluble solids content of 65 to 68 percent. The boiling hot syrup is poured into lacquered tin cans, sealed and cooled under running water. It gives a delicious instant drink, which is milk-white in colour when mixed with water and is also an excellent bread spread. It is used as a topping or bakery products or a mixer in alcoholic drinks, or may be diluted in water and used in cooking rice cakes and other delicacies. Coconut syrup is becoming an important export oriented product to countries, where coconut is not grown.



Coconut jam

Coconut jam is a high-sugar coconut food product commonly consumed as dessert, bread-spread, etc. It is prepared by cooking sweetened coconut milk to a very thick consistency at low heat with constant stirring. Process for preparation of coconut jam using tender coconut pulp with a shelf life of 6 months has already been standardized. Coconut milk is extracted after mixing coconut gratings with equal quantity of water and mixed

with brown sugar and glucose in the proportions of 10.25 percent and 5.5 percent respectively based on the weight of the milk, and cooked over a slow fire with constant stirring for about 20 minutes. The mixture is strained for removing suspended matter and again cooked over high heat. Before the mixture begins to thicken, citric acid at the rate of 0.25 percent of the original weight of the milk is added and cooking continued over low heat until the mixture thickens. The product is hot filled in sterilised containers and sealed hermetically. The jam so obtained has a rich creamy coconut flavour.



Pinacolada (coconut milk with pineapple juice)

The process for preparation of Health drink of coconut milk and pineapple juice packed in tetra packs in tetra packs was developed by Nadukkara Agro Processing Company Ltd, Muvattupuzha under a sponsored research project. The manufacturing process of Pinacolada consists of blanching of ingredients homogenize, sterilize to required temperature time combinations, cool and pack aseptically in tetrapak containers.



Yoghurt

Coconut milk can serve the purpose of extracting the cow's milk for the preparation of yoghurt which has high commercial value in providing highly nutritious food items at reduced price. The process involves reconstitution of milk containing 50% non fat dry milk and 50% coconut milk, pasteurization, inoculation with bacteria, packaging, incubation and chilling.

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. This technology is capable of complete utilization of the coconut. 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.



Virgin Coconut Oil (VCO) is obtained from fully matured, fresh coconut kernel by mechanical or natural means with or without application of heat which does not lead to alteration of the oil and its properties.

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:

- ✚ 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 and useful where the desiccated coconut which does not pass the quality standards can be converted into high value VCO and coconut four 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 bi products are full proteins medium fat coconut 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 to 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.



The CDB has developed a technology through the CFTRI for production of Virgin Coconut Oil by wet processing. Technology has been transferred to 9 entrepreneurs and have established units and product marketed commercially under various brand names such as Keravita, Indhulekha etc.

Philippines is the top exporter of virgin coconut oil (VCO) in the world market. Thailand, Indonesia, India, Malaysia, Sri Lanka, Vietnam, Fiji, Western Samoa and 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 the demand for VCO could be attributed to the now re-discovery on the health benefits of coconut oil as a medium-chain triglyceride (MCT). The major demand for VCO is as a food supplement. Emerging major uses of VCO are as a nutraceutical and functional food, as scalp conditioner, oil base for cosmetic and skin care products and as a carrier for aroma therapy and massage oils.

Margarine

Technology for preparation of virgin coconut oil based margarine to be operated at small and micro level industries is reported to be patented by Indonesia. The process involves mixing of emulsifiers, stearine, antioxidants, β -Carotene, water & salt with VCO, blending at 60⁰ C for 10 min. filling, packing and cooling at 16⁰ C. The product can be used as bread spread. It contains high lauric acids and no transfacts.



Coconut Mayonnaise

Mayonnaise is a semi solid food product mixed into fresh vegetables or fruits or cooked meat to enrich flavour. It is prepared by mixing coconut oil, vinegar or citric acid or emulsifiers. Carbohydrates, spices and flavour enhances are added to modify the flavour and avoid crystallization. The final formulation would consist of 70% VCO, 6% natural vinegar, 7% fresh yolk and 1% emulsifiers and cooled boiled water. Mayonnaise production units can be commercially operated at home or micro level to enhance the income of farmer families.



Coconut Flour

After expelling the milk, the protein rich residue is dried and powdered to obtain a product called coconut flour. The flour so obtained typically contains 7-8 percent protein, 3-5 percent moisture and 17 percent oil. It can be used as an ingredient in weight control foods because of its high fibre content. The protein contained in the flour is identical to that contained in the original fresh kernel. After blanching the residue is

dried and passed through a special type of screw press under a specified expeller setting to reduce oil content without too much change in colour. The de-fatted flakes are re-dried to reduce its moisture content to 2.5 to 3.0 per cent which is finally ground to a fine mesh.



The product has a low content of fat and higher percentages of protein, sugars and minerals and has been found to possess better water holding and thickening properties. The oil extracted from the dried gratings is of superior quality, which could command premium price. Flour derived after removing 60 percent oil has been found to have higher consumer acceptability. It is also seen that five percent coconut flour can replace proportionate amounts of wheat flour and non-fat dry milk powder used in school nutrition programmes without affecting baking qualities and food value. Nutritionally coconut flour compares favourably with most of the common cereal flours. Coconut flour is naturally low in digestible carbohydrates and high in fibre content and good proteins and hence is a health / promoting food. This has 4 times more fibre than oat bran, 2 times more than wheat bran.

Coconut flour can be used in baking recipes. It can be used in making high-nutritious breakfast bread (20 - 25% blend with wheat flour), cereals and cookies.

Dietary fibre from coconut residue

The importance of dietary fibre in the human diet is gaining more attention due to the increasing awareness of its beneficial effect. The CFTRI, Mysore has carried out a study to develop a natural laxative based on dietary fibre from coconut residue under a sponsored project of the Board. The study proved that water retention capacity, water holding capacity and swelling capacity of coconut fibre is comparable with other commercially available dietary fibres.



Coconut Honey

This is another useful product prepared from coconut milk and is an excellent substitute for real honey. The milk is extracted from the gratings of unpared fresh kernel after adding an equal quantity of water. To this extracted milk, 60 percent by weight of brown sugar and 30 percent by weight of glucose are added and then boiled in steam heated containers until a thick consistency is reached. The product is then hot filled in

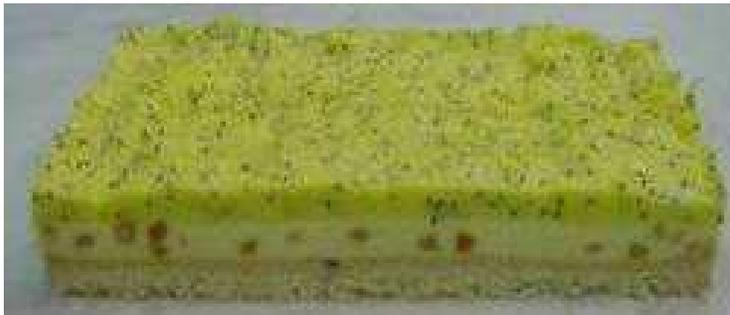
lacquered tin containers or bottles and sealed. The final product is a golden coloured thick paste with a nutty flavour. This can also be used as an excellent base for soft drink.



Coconut honey contains many growth promoting trace elements besides glucose, fructose and levulose. Coconut water is filtered, evaporated and blended with a little golden syrup to produce coconut honey, a palatable, nutty flavoured breakfast food, soft drinks additive and a sweetener.

Coconut Cheese

White soft cheese can be made from a mixture of 40% skimmed milk and 50% coconut milk which will have the same flavour, aroma, texture & acceptability as 100% cow's milk cheese. Fresh kernel is grated and pressed to extract milk. The milk is allowed to stand for eight hours, until the cream has collected at the top. The cream is slowly scooped out and the skimmed milk heated with vinegar to coagulate the proteins. The coagulated protein is mixed with the cream and kneaded with salt. The process is simple and can be done as a household industry.



Fermented beverage concentrate

This is a type of cultured milk using skim milk as a substrate and *Lactobacillus bulgaricus* as a starter culture. This product has been commercially prepared in many countries and named as 'Calpis' in Japan and 'Bulgaricus milk' in Bulgaria. Milk is pasteurised at 90°C for 30 minutes in a water bath, cooled to 40°C and inoculated with 3 percent culture of *Lactobacillus hugaricus*. The mixture is incubated at 37 - 38°C for 24 hours. Curdled milk is homogenised for five minutes and heated to 60°C before the addition of sugar. Sugar is then added in the ratio 1: 1. The mixture is further heated to 80°C and cooled down to 60°C, then 0.5 percent flavoured extract is added. The finished product is bottled and pasteurised in water bath at 70°C for 30-60 seconds. The product is stable even after two months of storage, both at ambient and refrigerated temperatures.

This is a highly nutritious drink suitable for kids and adults alike. Unlike carbonated drinks, the fermented beverage contains proteins. It is nonfattening and easily digestible and is a perfect beverage for those suffering from digestive ailments.

Coconut Sap

Coconut sap based products such as coconut sugar/jaggery, beverage, toddy and vinegar are gaining much attention mainly due to their beneficial properties. Coco sugar's glycemic index is low at 35 which can be taken both by normal and diabetic patients. Coconut sugar also contains macro and micronutrients as well as essential vitamins. Most of the producers are small to medium scale village level operations. Coconut based alcoholic beverages particularly, coconut arrack, coconut vodka, coco wine, have also gained popularity in the major coconut producing countries.

Toddy

Sap from the young inflorescence is called Toddy. In India unfermented sap is called Neera, In Srilanka Raa, in Philippine Tuba and in Indonesia Tuvak. The sap has high sucrose content varying from 12-17% depending on the cultivar. The sap is obtained by tapping the inflorescence before splitting of the inner bract and emergence of spike from the spathe. The word tapping collectively refers to the extractions and various manipulations like tying of the spathe beating the spadix, bruising and rupturing the tender tissues of the floral bract by hammering and pounding the spathe and slicing the apical tissue. The interval from the beginning of the tapping to dripping of the toddy varies from 5 days to 32 days. Tall cultivar yield more toddy than dwarf palms. Yield varies from 1.5 to 2 lts per day. Under natural conditions, toddy is fermented by the native microflora consisting of yeast and bacteria. This process will take place from the time when sap come out and contact with the air. To reduce the rate of fermentation, traditionally, lime is put in the collecting container, usually in earthen pot.



Products derived from unfermented toddy

Jaggery / palm sugar

The sugar content of toddy is above 15% which means it can yield 300 to 400 gm sugar per palm per day. Unfermented toddy on careful boiling gives palm sugar or coconut jaggery. The scummy impurities which froth are removed and the saturated solution is poured out in moulds for hardening. Since the removal of scummy impurities involves considerable wastage of sugars, in certain places, the frothing is avoided by adding a few drops of coconut oil or a little coconut gratings. Before boiling the juice is filtered through sand filters to remove the impurities and a small quantity of alum is added to induce the precipitation of lime and magnesium. This will render the final jaggery much less deliquescent with a better colour and will remain hard for a reasonable period.



Refined Sugar

For recovering the raw sugar, toddy is treated with two percent lime to coagulate albuminous impurities. The limed toddy is then carbonated in two stages and filtered each time to remove excess lime. The clarified juice is evaporated to the extent of 75 per cent sugar content and the resultant syrup is concentrated in vacuum pans till crystallisation commences. The syrup is then discharged into crystallisers and the crystalline sugar is separated by centrifugation.



Treacle

This is the concentrated form of unfermented toddy obtained by boiling down the unfermented toddy. The final product is a golden coloured syrup. The treacle is considered a delicacy in many places and its preparation is very common in Lakshadweep Islands. The recovery is about 16 percent of the toddy used.



Faster methods for making ball copra and scale up of natural convection driers with reverse hot air flow.

Two models of driers with capacity to dry 3000 coconuts for production of ball copra and 1000 nuts for cup copra were developed by National Institute for Interdisciplinary Science and Technology, Thiruvananthapuram (NIIST) under a sponsored research project of the Board. The drying period required for each drier and optimum temperature to be maintained in these two driers were standardized. The time required

for production ball copra can be reduced from 12 months to 90 days in the faster dryer developed under the study.

Coconut bites and others

Central Food Technological Research Institute (CFTRI), Mysore has developed technology for three coconut based value added products namely, Coconut based instant rice mix, Chutney powder/mix, Filling powder, Coconut bites (Ready-to-eat sweet snack). The products have been standardized and the shelf life studies have revealed that the product would have a keeping quality of 6 months.

Coconut bites is a ready to eat snack having characteristic flavor of fresh coconut. Coconut bites of different colours and flavours provide a range of snacks meeting the requirement of consumers. The coconut after washing are diced and cooked in sugar syrup for 45 mts. The cooked cubes removed from sugar syrup are dried in a hot air oven. Then coated with sugar syrup in a coating pan with permitted food colours and flavours are sprayed on the coconut pieces. Initial moisture content of coconut bites were 2.6 % (27°C, 65% RH), which was packed in 200 gauge (50 gauge metalized polyester / 150gauge polyethylene) pouches and stored at ambient temperature for 4 months.

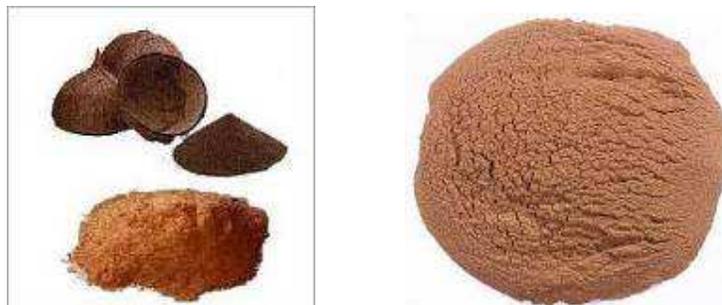
Market survey conducted by IMRB showed that 2 products namely filling mix and Coconut bites had high consumer acceptability followed by Chutney powder/mix & rice mix. The technology has been demonstrated to entrepreneurs in the pilot plant at CFTRI. Other coconut convenience foods include Coconut cookies, coconut lemonade, coconut milk toffee, coconut chocolate, coconut pickle, coconut candy & coconut burfi etc.



Products from coconut by- products

Coconut shell powder

The 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, agarbathy industries. Coconut shell powder is preferred as substitute for bark powder, furfural and peanut shell powder because of uniformity in quality and chemical composition and also has better properties in respect of water absorption and resistance to fungal attack. Coconut shell powder is manufactured from matured coconut shell by using pulverizes / ball mills. 12,000 shells would yield around one tonne shell powder. The manufacture of shell powder is not an organised industry in India. It is manufactured in sizes ranging from 80-200 mesh. Philippines, Indonesia and Sri Lanka are the major exporters of coconut shell powder.



Coconut Shell Charcoal

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. To obtain good quality charcoal, fully dried, clean, mature shells should be used. Now several modern methods are in vogue for the production of charcoal. In the modern waste heat recovery unit the heat generated by the burning of coconut shells is used for drying copra and shell charcoal is obtained as by-product.



Waste Heat Recovery Technology

The waste heat recovery technology is currently available indigenously for coconut shell carbonization. The technology is advantageous in reducing the smoke problem and produces clean and well carbonized charcoal using the coconut shell. The flue gases, during carbonization, is passed through a heat exchanger process, produces heat which could be effectively utilised for drying operation in copra making, D.C. production and in coir industries. The application of the WHU technology would generate coconut shell charcoal which could be utilized for the manufacture of activated carbon.

The Philippines, Sri Lanka and India are the major suppliers of coconut shell charcoal. Production of coconut shells charcoal and its subsequent conversion to activated carbon have opened up an avenue for industrial level processing for value addition of these by-products.

Activated Carbon

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.



Though activated carbon can be made from various kinds of biomass, coconut shell based activated carbon is reported to be superior in quality and commands a good price in the international market. The world demand for activated carbon is estimated at 1.2 million tons. Japan, USA, Germany, Singapore, Ghana, Korea & Taiwan are the major importers of activated carbon. Philippine, Sri Lanka, India, Indonesia, Thailand are the major activated carbon producing countries.

Coconut Oil Based Oleochemicals

Coconut oil is a source of many oleo-chemicals such as fatty acids, glycerol, methyl esters, fatty alcohols, etc. Coconut oil has the maximum content of glycerin, The natural glycerin has superior efficiency when used in pharmaceuticals and cosmetics. From the above primary chemicals various oleo-chemical derivatives or down stream chemicals such as alkanolamides, medium chain triglycerides, etc. are manufactured. The fatty acids of coconut oil can be fractioned to obtain industrially important products which have varied applications in many industries.

Biofuel / Oleo Chemicals/ Fatty Acids

In some of the major coconut growing countries R&D efforts on the development of coconut biodiesel started a few years back initially to stem spiraling prices of petro-diesel and to diversify the product use of coconut oil as a marketing strategy and to promote greater domestic utilization of coconut products.

Oleo chemicals are also produced from coconut oil. The formation of basic oleo chemical substances like fatty acids, fatty acid methyl esters (FAME), fatty alcohols, fatty amines and glycerol are done by various chemical and enzymatic reactions. Intermediate chemical substances produced from these basic oleo chemical substances include alcohol ethoxylates, alcohol sulfates, alcohol ether sulfates, monoacylglycerols (MAG), diacylglycerols (DAG), structured triacylglycerols (TAG) and sugar esters. Consumer trend is increasing globally towards the application of oleochemicals in the detergent, soap and personal care products.

One of the applications of oleo chemicals is for biodiesel production. The fatty acids in coconut oil is esterified with an alcohol, commonly methanol to form methyl esters. Another common application is in the production of detergents and surfactants. Lauric acid is also used to produce sodium lauryl sulfate, the main ingredient in many personal care products. Other applications include the production of lubricants, green solvents, and bioplastics.

Energy security prospective and environmental factors have drawn attention to the uses of vegetable oil based bio diesel, fuel. The major challenges for popularization of bio fuels and bio lubricants would be the price factor, lack of awareness and impact of glycerin supply. Philippine, Marshal Islands and Vanuatu are reported to be using biofuel for running Govt. vehicles. Coconut oil as bio-lubricant has been found to be feasible for three wheelers in India.

Coco-Chemicals: Non-Edible Uses of Coconut Oil

Coconut oil contains, besides lauric and miristic acids many other fatty acids including capric, caprillic, caproic and palmitic, stearic, oleic acids. These fatty acids find large applications in cosmetic and personal care products. The C12 and C14 fatty acids in coconut oil are good for skin care products.

Coconut oil and its derivatives (coco-chemicals) are used chiefly in the manufacture of soaps, surfactants, plastics, surface coatings and lubricants. At present, the USA, the Federal Republic of Germany, the United Kingdom and Japan account for 75% of the total non-edible usage of coconut oil.

Soap

The most important non-edible application of coconut oil has been in the manufacture of soaps, which accounts for 25% of the total oil consumption and 50% of the non-edible consumption. In the last few years, one of the world's largest soap manufacturers has increased its average composition of coconut oil from 20% of the fats used to 30%, with some brands containing as much as 40% coconut-derived fatty acids.



The increase in the proportion of coconut oil in soap has been due to the fact that the major soap manufacturers no longer boil fats with alkali but instead use the fatty acids they need to produce soap suitable for the market.

Surfactants

Surfactants are surface-active agents whose molecular structures enable them to modify the surface tension of aqueous systems, for example in the stabilization of oil-in- water emulsions. Surfactants are used in many ways, like household detergents, petroleum, food, plastics, rubber, textiles, cosmetics, leather, paper, dry cleaning, paint and cement.

Plastics

Coconut oil is used in the manufacture of vinyl plastics. As plasticizers, the coconut oil derivatives are added to aid in vinyl fabrication, and as stabilizers, to prevent discoloration and degradation during fabrication and use.

Surface Coatings

The major application of coco-chemicals in the surface coating industry is in the manufacture of alkyd resins. The fatty acids formerly employed in the manufacture of alkyd resins are now almost entirely replaced by tallow oil and soya oil fatty acids because of cost.

Lubricants

The most important continuing use of coconut derivatives in lubricant additives appears to be as amine derivatives of coconut fatty acids for which no substitute has been found.

Coconut oil as alternate automobile lubricant

Cochin University of Science & Technology Board has formulated a viable two stroke engine lubricant using coconut oil suitable for use in tropical countries. This formulation developed through chemical modification by adding additives meets most of the criteria required for two stroke engine oil except pour point. But it can still be used in midland and coastal areas of India where temperature does not fall below 18°C.

Monolaurin from coconut oil

Coconut oil with 44 – 52% lauric acid is a potential source for producing mono laurin (Lauricidine) which has been experimentally found to reduce HIV virus disease. Large scale pilot studies involving large number of AIDS patients would open up opportunities for developing a cost effective control measures.

Bioconversion of tender coconut waste into high quality organic manure

A study on bioconversion of tender coconut shell wastes into organic manure with bio agent *Pleurotus* was undertaken by Central Coir Research Institute, Kalavoor with the financial assistance of the Board. A potential microbial decomposition method for conversion of the tender coconut husk chips into organic manure by composting using a consortium of microorganisms has been standardized. The compost produced shows an increase in major nutrients viz. potassium and phosphorus and nitrogen content and pH was found ideal for plant growth.

In order to explore the possibility of making pulp and hand made paper from the tender coconut fibre an organosolv treatment using acetic acid in the presence of sulfuric acid catalyst followed by alkaline nitrogen

peroxide bleaching of pulp was conducted. The pulp obtained can be used for wrapping, packing and for making corrugated containers.

Bio conversion of tender coconut shell wastes into organic manure with bio agents, evaluation of various bio agents for bio conversion of tender coconut shell tissues (bits) into organic manure and identification of a promising bio agent and to standardize the process of composting is also perfected at Agricultural research station, Ambajipetta, ANGRAU, Andhra Pradesh.

Coconut Wood products

In Coconut palm the trunk once formed does not increase in diameter with the age. The palm grows up to 30 meter lone' or even beyond and 25-35 cm in diameter. The high density wood of the outer portion of the stem is quite strong. On the other hand, the low density wood of the central core is soft and therefore it is used as fuel.



Coconut wood is traditionally used for making roofing components like rafters, joists, purlins, beams, banister, etc in the coconut growing areas. It is also used for the construction of temporary sheds, cow sheds, workshop buildings, farm buildings, small rural bridges, etc. only the first 8 to 10 m in of the mature tree will be good for making, doors, windows and furniture. About 0.15 – 0.2 m³ of the sawn sizes will be available from an average size of a fully mature tree. Normally the coconut stem of a lower age group and upper half of mature and over mature trees are used as fire wood. The timber of coconut palm, because of the lasting grains excels other woods in beauty. The timber is also suitable for carved decorations in the hands of an expert craftsman. Coconut wood is also used to make wall panels, floor tiles and handicrafts. Grocery pallets are manufactured from coconut wood in Philippines.

Coconut wood has good strength and elasticity and its resilience helps it to absorb impact shocks. Therefore it is suitable for making handles of tools. Coconut wood is widely used as fuel in brick kilns. It is believed that use of coconut wood will help enhance the reddish colour to the bricks due to the resins present in the wood.

Kerala Forest Research Institute (KFRI), Peechi under a sponsored study of the Board has developed appropriate technology for community level production of charcoal from coconut stem wood and activated carbon from coconut shell. A pilot plant with an input capacity of 3 tones raw material which can produce about one tone charcoal per day and an Fluidized Bed Reactor (FBR) with an input capacity of 0.25 tone charcoal which can produce 0.125 tone of active carbon has been designed, fabricated, installed and trial runs conducted.

Under another sponsored project M/s. Ecoboard Industries Limited, Maharashtra have developed good quality particle boards using the coconut soft wood and fronds.

Coconut based handicrafts

Coconut palm provides raw materials for the handicraft industry. A variety of handicraft pieces are manufactured in the country. Wood, shell, fibre/husk and leaf midribs are the main coconut based materials utilized by the artisans to manufacture various objects of artistic and utility value.



Durability of the shell renders it suitable for longstanding use. Coconut shell is hard, takes a high polish, can be carved, coated with lacquer, inlaid with silver or other metals and generally used with ornamental effect. Coconut shell is also used in the manufacture of hookah, which is a traditional cottage industry in Kerala. Of late, coconut shell cups are used for serving ice-cream, coconut birds nests and hanging pots. Bangles, rings, chains, show pieces, spoons, forks, etc are also made using coconut shell.

The timber of coconut palm, because of its lasting grains, excels other woods in beauty. It is ideal for the manufacture of various products such as furniture, doors, windows, curios, handrails of staircases, wall panels etc. The timber is ideally suited for carved decorations.

Coconut fibre is also used to manufacture a variety of utility items such as bags, table mats, wall hangings, chains, bangles etc. Other coconut palm products such as midribs of leaflets, spathes and stipules are used in the manufacture of a variety of handicraft items. Coconut husks are used to carve out human figures. All coconut based handicrafts have export market especially to European countries. Coconut shell ice cream cups are regularly exported from India, to some West European countries.

Coconut Leaf

Coconut leaves are mainly used as thatch. It is also used for shading seedlings, mulching nursery beds, decoration etc. Coconut leaves are also used as a feed for elephants. It has been reported that laminates and panels can be made by pressing coconut leaves with an adhesive and they can be used as paneling materials and partition walls. It can also be used to make paper trays and waste paper baskets. The most tender leaves are used for decorations and for costuming in folk arts of Kerala. Dry leaves are used as a fuel. The dry leaflets tied into small bundles are used in villages as country torches. Woven coconut leaves are used for thatching houses, cattle sheds, covering husk retting pits, making temporary compound wall, partition wall, making baskets, etc.



Leaf Midrib

The midribs of leaves are used for making brooms, baskets, fish traps, fancy articles and tongue cleaners. Manufacture of brooms using coconut leaf midribs is a cottage industry in some parts of south India. It has market all over the country because it is suitable for rough use in cleaning bathrooms, courtyards etc. For sweeping living rooms long brooms with their soft and pliable tips may be effective while cleaning rough surfaces short and stiff brooms are used. For making short brooms, the soft and pliable tip of the leaflets is cut and removed.



Husk and coir

Coconut husk is the raw material for the coir industry. It is also used as a domestic fuel and as a fuel in copra kilns. It is used in coconut gardens to conserve the soil moisture besides being used as surface mulch in coconut basins. The husk of the mature coconut consists of numerous fibres embedded in a soft cork-like ground tissue usually referred to as pith. The fibres are 15 to 35 cm. long and have a high tensile strength which is unaffected by moisture. They consist mainly of lignin and cellulose with about ten per cent pectins, tannins and other water soluble and insoluble substances. The ground tissue on the other hand is mostly made up of pectins, tannins and other water soluble substances and hemicelluloses.

Coconut husk is the raw material for the coir industry. It is also used as a domestic fuel and as a fuel in copra kilns. It is buried in coconut gardens to conserve the soil moisture besides being used as surface mulch in coconut basins. Coir is a hard and versatile fibre. It has varied uses on account of its natural resilience, durability, and resistance to dampness and other properties. Manufacture of coir and coir products is an important agro based cottage industry of great significance in India. It is a highly labour intensive industry covering a wide range of activities including collection of husk, retting, fibre extraction, spinning and manufacture of coir and coir products. The two major coir-manufacturing methods are mechanical de-fibering and traditional retting process. The National Environmental Engineering Research Institute, India has developed a cost effective technology for recovery of value added products such as natural colouring compound (cellulose, tannin, lignin, etc) and paper from coconut husk producing the brown fibre and the micro-biological retting process producing white fibre.



Coir geotextiles

The application of coir geo textiles or coir bhoovastra is in soil erosion control measures and consolidation of soil. It breaks up and dissipates the energy of flowing water. Coir geo textiles is widely used against soil erosion on hilly slopes, river banks and other vulnerable areas. When used as a protective surface cover, it will hold the soil till the vegetation takes over.



Coirpith

Coir pith is the by-product obtained during the extraction of coir fibre. It is an excellent soil conditioner, rooting medium and mulching material. Pith constitutes about 70 percent of the husk itself. Coir pith which is known as coco peat has a growing market in the world for use in horticulture/agriculture.



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.

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