

# Coconut Tree (*Cocos nucifera*) Products: A Review of Global Cultivation and its Benefits

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**Abstract:** The coconut tree (*Cocos nucifera*) is one of the most extensively and widely used palm trees. The coconut palm is regarded as the "tree of life," or "Kalpavriksha." Humans have been cultivating a wide range of coconut trees around the world. This study is based on analysis of secondary data on cultivation of coconut trees and its benefits. Due to increased insect infestations and a changing habitat, the lifespan of coconut trees have been affected. Coconut product market has become the fastest expanding business due to the anti-viral compounds found in it. The coconut is used to produce oils, even the shells used for craft materials. People have been using coconut trees to make brooms and woods are being used to make furniture, construction materials for dwellings, and hardwood floors. It shows the livelihood of people around the world have been changed due to the cultivation of coconut trees. Indonesia, India and Philippines are top three countries to be economically benefitted from the plantation of coconut trees. As there is high demand of coconut based products worldwide, farmers need to be made aware about this economic value for increment in production.

**Keywords:** Agriculture, Coconut, *Cocos nucifera*, Palm, Product

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## 1. Introduction

Coconuts are diversified based on its shapes and sizes. The most essential thing of coconut fruit is its antiviral capabilities. It comprises of three major sections that are utilized extensively, namely, endosperm (kernel meat), endocarp (shell), and mesocarp (coir) (Varghese and Jacob, 2017). Both the flesh and dried form of kernel meat can be used. The shell is utilized to design handcrafts, and coir is used to create mat rope. According to a study conducted by Dayrit (2020), the coconut product market is the fastest expanding business due to the anti-viral compounds found in it, which demonstrate efficacy in the treatment of COVID-19. It also includes minerals including Salt, Iron, Calcium, Magnesium, Phosphorus, and Selenium, as well as Vitamin C, E, B1, B3, B5, and B6 (Ijnu, Anish, Shiju, George, & Pushpangadan, 2011). Coconut oil benefits cardiovascular health, blood sugar management, and cognitive performance in Alzheimer's

patients. Coconut milk is a hair conditioner as well as a component of a DIY face mask. To celebrate the production, September 2nd has been declared as the World Coconut Day by the members of the International Coconut Community (ICC), of which India is also the founder member (Jayasekhar, Chandran, Thamban and Muralidharan, 2019).

According to Mandal (2011), coconut is considered as the most beneficial plant groups known to humans. Among the beneficial palms, three species are commercially valued, the date palm (*Phoenix dactylifera*), oil palm (*Elaeis guineensis*), and coconut palm (*Cocos nucifera*). Palm trees have offered food, water, fuel, and shelter to people in tropical and subtropical climates for generations. As a result, the coconut palm is known as "Kalpavriksha," or "Life Tree" (Chalbhagath & John, 2014). Oil palm and coconut palm fruits provide valuable oil, which is used in margarine, cooking oil, soap, cosmetics, pharmaceuticals, and fuel. Additionally, the white meat section of the coconut, copra is frequently

utilized in the confectionery and pastry industries, particularly in Sri Lanka (De Silva, 1979). Eastern Indonesian countries refer copra as "green gold" (Evita, 2020). Loomba (2013) has mentioned coconut having the medicinal properties and herbal remedies. Coconut husks are used for coconut matting and provide a considerable source of fuel. This study was conducted to explore the numerous aspects of coconut and its beneficial effects globally. The beneficial of nutritious intake and anti-viral agents against COVID-19 (Henrietta, 2021) has also been discussed.

## **2. Materials and methods**

The literatures for the review were collected from Google Scholar. Most of the studies carried in last five years have been included in the study. The literatures were searched by using Phrases (keywords) like "Coconut Tree", "Benefits of Coconut", "Products from Coconut", "Planting Coconut Trees" and "Coconut in India".

## **3. Results and discussion**

### **3.1. Coconut plantations**

The coconut palm is a popular tree crop that produces a variety of items for both home and commercial usage. According to Then kek hoe (2018), the coconuts are cultivated in 93 nations with major portion occupied by Indonesia, Philippines, and India. According to Coconut Development Boards (CDB) figures for 2018-2019, India produced 21,384 million nuts from a 2.1 million area, with a yield of 9,815 nuts per hectare (Novarianto, 2021).

### **3.2. Site selection**

For coconut plantation, a site should have well-drained soil, sandy loam, or loamy texture to make it easier to remove seedlings from the nursery at planting time. The recommended pH range for a nursery is between 5.5 and 7.0, whereas seedlings tolerate a pH range of 4.5 to 8.5. Thamban (2020) proposed that the seed nuts should be planted in long, thin beds with a 40cm\*30cm spacing either vertically or horizontally in 20-25cm deep trenches. Irrigation systems like sprinklers, microjet sprinklers, and hoses are ideal for coconut nurseries. The polybag nursery technique also helps to grow more strong seedlings with the improved establishment.

Only 9-12 month-old seedlings should be chosen for early germination, rapid development, and seedling vigor. Novarianto (2021) suggested that before planting is done it is essential to use the best planting materials to provide increased production per unit area per unit time. In the square system, a spacing of 7.5m\*7.5m to 8.0m\*8.0m is commonly suggested (Subramanian, Maheswarappa, Zachariah, Surekha, Selvamani, & Bhat, 2016). There will be 177 and 156 palms per hectare respectively (Rani,

2020). An extra 25 palms can be planted if the triangle technique is used. The depth of planting trenches will be determined by the soil type.

### **3.3. Fertilizers**

Fertilizers with 500 grams of nitrogen, 320 grams of P<sub>2</sub>O<sub>5</sub>, and 1200 grams of potassium per palm per year are normally suggested for mature plantations (Thomas & Shantaram, 1984). Biofertilizers like Azospirillum species and phosphate soluble bacteria produced in carriers like talc or vermicompost should be applied at a rate of 100g per palm. Rhinoceros beetle is the most well-known pest in the coconut industry (Bedford, 2014). Prophylactic treatment of the top three-leaf axils with either botanical cake [Neem cake, Marotti cake, or pungam cake(250g)] admixed with an equal amount of sand or placing of 12g naphthalene balls coated with sand can be used to manage this pest.

The palm continues to yield for over 80 years (Narayana & Nair, 1989). Coconut can also support a wide range of intercrops and businesses. Nihad (2020) discussed that floriculture is a form of agriculture in which flowering plants are placed in between the spacing of coconut trees, since the gap between the trees is broader, providing farmers with a higher yield in addition to coconut production to sustain their livelihood (Chikaire, Ajaero & Atoma, 2022). The dual purpose of hydroponics was analyzed (Henrietta, 2021).

### **3.4. Dwarf coconuts plantations**

In recent years, the proliferation of dwarf coconut variants has grown. Copra produced by hybrid coconuts is of a higher grade. These dwarf coconut variants have become popular due to a scarcity of coconut climbers. Tebing Tinggi Dwarf (TTD), Bali Yellow Dwarf (BYD), Nias Yellow Dwarf (NYD), Jombang Green Dwarf (JGD), Nias Green Dwarf (NGD), Waingapu Red Dwarf (WRD), Raja Brown Dwarf (RBD), Sagerat Orange Dwarf (SOD), Salak Green Dwarf (SGD), and Hybrid Coconut (KHINA 1) are the noteworthy dwarf coconut kinds (Sopade, Samosir, Rival, & Adkins, 2010; Novarianto, Mashud, Samosir, & Adkins, 2014; Welewanni & Bandupriya, 2017; Novarianto, Tulalo, & Mawardi, 2021). In Brazil, dwarf variants are commonly employed for economic purposes. When compared to the red type, the green variety is the most marketable owing to its flavor (Joao, 2017), Marcelo Coconut is derived from these dwarf variants, which are commercially farmed. Dissanayaka (2012) proposed that these types of varieties generate huge, high-quality nuts in three years after planting.

### **3.5. Coconut components**

Coconut water, the white fleshy section (known as copra when dried), shells, husks, leaves, and flowers are the most important parts of the coconut. Until the coconut is opened, the delicate coconut water is utilized as a beverage. Coconut water is also used to make the

gelatinous delicacy "Nata de Coco," which has gained popularity in Japan (Gayathry, 2015). The white fleshy section of an immature coconut has a flavor and consistency similar to custard, and it may be eaten or scraped and pressed through cloth to produce a 'cream' or 'milk' that can be used on a variety of meals. In China and Vietnam, half-dried coconut shells are utilized as the bodies of musical instruments. Ringworm is treated using a mixture of ash from the mature shell of the fruit and lime. Pieces of coconut shell cut into coin-like spheres were used as money in the South Pacific. Coconut shells are now utilized as craft materials as well. The fibrous coating on the thick mesocarp (middle layer) of the coconut fruit is referred to as coconut husks. The coconut husk is made up of 75% fibre and 25% fine particles. It's also known as 'coir pith.' Coco husk chips, coco peat, coir fibre, and coco crush are all made from the husks.

Coco peat has long been utilized as a fertilizer in indigenous peoples' gardens (Lu, Wang, Liu, He, Wu, Li, & Tang, 2020). Coco peat is also utilized economically to conserve wetlands as a renewable resource. Coir pith may be used to make good manure by putting it in the cow shed and then removing it every day and dumping it in the compost pit. It is also utilized in horticulture and has taken the place of peat moss. Coconut leaves are used for thatching. These leaves are used to construct fences and roofs for tiny homes. In the Philippines, rice is wrapped in coconut palm leaves for cooking and storage, a process known as Puso. Coconut blossoms may be eaten. In ancient times, they were combined with curd and consumed by diabetics, as well as used for a variety of medical purposes. In Kiribati, an island country in the central tropical Pacific Ocean, cutting a coconut blossom cluster yields a delicious juice that is consumed for breakfast and supper when it is fresh and not fermented. Subash (2014) indicated that through ancient times, coconut blossoms have been widely employed in medicine.

### **3.6. Coconut products**

Coconut goods are divided into kernels, inflorescence, shell, water, and handy food items by the Coconut Development Board. Virgin coconut oil, desiccated coconut, coconut milk, coconut skimmed milk, spray-dried coconut milk powder, coconut cream, coconut chips, coconut oil, and copra are examples of kernel-based coconut goods (Appaiah, Sunil, Kumar, & Krishna, 2015).

#### **Virgin coconut oil**

The white fleshy section of the coconut is broken down and pressed in a screw press to extract coconut milk, which is then filtered, and the cream is separated using centrifugation. A method known as phase inversion is used to extract the Virgin Coconut Oil (VCO) from the cream. The resulting oil is crystal clear, nutrient-dense, and has a longer shelf life. Wet processing without heat treatment is used to extract virgin coconut oil from fresh, mature coconuts. Virgin coconut oil is colorless and smells strongly of coconut. This oil contains lauric fatty

acid, which has been shown to have antiviral and antibacterial properties. Due to the presence of natural antioxidants in coconut oil, high-grade VCO has a long shelf life. Navin (2019) discussed that coconut oil is a tropical climate product which is in high demand in the cosmetics sector and in worldwide cuisine.

#### **Desiccated coconut**

Desiccated coconut meat is grated and shredded dehydrated coconut (DC) meat (Jayasekara & Gunathilake, 2007). It is widely utilized in India, mostly in the confectionery and other food sectors. It's also used as a replacement for shredded coconut in a variety of dishes.

#### **Coconut milk**

Coconut milk is an emulsion of two liquids made from the flesh of the coconut. The coconut cream and coconut water are sterilized coconut flesh that is grind into paste using a hammer mill, then passed through a screw press and vibrating screens to make coconut milk on an industrial scale (Sudheer, 2018). To dilute coconut milk, it is cleansed and blended with coconut water and pure water. After that, 10-12% sugar is added and a 2% stabilizer, emulsifier, and taste, then the blend is sterilized and packed in bottles and sent for sales.

#### **Coconut skimmed milk**

After the cream has been separated in a cream separator, coconut skims milk is a solution of the soluble components of coconut. Skimmed milk is a great source of protein that is used to make a variety of beneficial foods (Naik, Raghavendra, & Raghavarao, 2012). With the addition of sodium hydroxide, freshly obtained coconut milk from the kernel is filtered through a 120-mesh vibrating screen and the pH of the filtered milk is increased from 6.3 to 7.0. The milk is then pasteurized for one hour at 60 degrees Celsius before being centrifuged in a cream separator to extract the aqueous phase, which contains the protein-rich skim milk. The skimmed milk is also used to make items like spray-dried powder, coconut honey, coconut jam, and sweetened skim milk (Muralidharan, 2011).

#### **Spray dried coconut milk powder**

The manufacturing of whole coconut milk powder entails several activities, including size reduction, milk extraction, emulsion stabilization, homogenization, and spray drying (Seow & Gwee, 1997). Spray drying is a technique that has been developed to help stabilize coconut milk. The white endosperm is removed from the shell and driven out via a rotary wedge cutter with a filter plate (3 mm hole). In a screw press, the wet coconut grating is then pressed to obtain coconut milk. For over 30 minutes, the coconut milk is homogenized in two stages of high and low pressure. The milk is then manufactured by adding various additives and chemicals. The coconut milk

is then homogenized again after being pasteurized at 60-70 degrees Celsius for 5 minutes. Finally, the milk is spray-dried at a feed flow rate of 120 ml/minute at a temperature of 100-150 degrees Celsius and packaging is done.

### Coconut cream

Coconut milk is made from partly defatted coconut cream. Coconut cream/milk is used as a component of processed foods and as an ingredient in domestic cooking. Coconut milk is also known as coconut cream, which is used as a mixer in alcoholic beverages. According to Novariant (2021), in ice cream industry, coconut milk is utilized as a dairy milk alternative. Because dairy milk has a larger fat content than coconut milk which reduce the fat content of coconut milk and can be utilized to make a variety of goods.

### Coconut chips

Coconut chips are a snack item that is ready to consume (Manikantan, 2015). Coconut chips are dehydrated mature coconut kernel slices that have been dipped in an osmotic medium such as sugar syrup. Coconut chips do not alter nutritionally or chemically after six months. To reduce chip breakage during shipping, nitrogen flushing is done in pouches (Sudheer, 2018).

### Coconut oil

Coconut oil is an edible oil that has been eaten for thousands of years in tropical areas (Boateng, Ansong, Owusu, & Steiner-Asiedu, 2016). Crushing of dried coconuts (copra) for oil recovery is done with rotary and expeller machines (Figure 1) used in the outskirts of Tanjore, Tamil Nadu. The oil content from copra is 60-65%. There are two major ways of extracting coconut oil; dry and moist (Marina, Man & Amin, 2009). The coconut is dried in the dry extraction method, but the wet extraction method does not include any drying. The goal of dry extraction is to remove moisture from coconut fruit while minimizing microbial contamination. Heating, fermentation, cream centrifuge, pH adjustment, and chilling are all used in the wet extraction process. Large enterprises frequently carry out oil extraction by employing dry extraction with copra processing. As a result, dry extraction requires more oil refinement. A centrifuge may be used to do mechanical extraction. Apart from this, enzyme extraction and solvent extraction are the two more ways of extracting oil (Subroto, 2020).

### Copra

There are two types of copra produced in India: milling and edible copra (Ramakumar, 2001). The edible coconut is consumed as dry fruit, while the ground copra is used to extract oil. When compared to other oilseeds, copra has the greatest amount of oil. Eastern Indonesia's economy has been reliant on copra for over eight decades (green

gold). The need for cooking oil in European nations increased in the 1880s, prompting the discovery of copra oil as a new cooking tool. Copra is also a component in the making of butter. The Copra is also utilized in the production of soap (Evita, 2020).

## 3.7. Coconut water-based products

It is observed that numerous products result from coconut water; tender coconut water, Vinegar, Coconut squash, and Nata-de-coco.

### Tender coconut water

Coconut water is the liquid endosperm of a delicate coconut nine months after pollination when the solid endosperm, or white flesh, appears. The most healthy and healthful beverage is tender coconut water. Tender coconuts are excellent for preserving coconut water. However, according to Sudheer (2018), the nuts cannot be kept at room temperature for more than six days.

### Vinegar

Coconut vinegar is a natural product made from the fermentation of coconuts, with no additional preservatives or additives (Othaman, Sharifudin, Mansor, Kahar & Long, 2014). Coconut water or fermented coconut sap is used to make this vinegar. It's made with *Saccharomyces cerevisiae* (yeast) and *Acetobacter aceti* (bacteria) to help with ethanol and acetic acid fermentation. (Sudheer, 2018) discussed that coconut vinegar is made by the alcoholic fermentation of coconut water with the addition of 10-12% sugar and it entails fermenting sugar into ethanol and then oxidizing the ethanol to make vinegar.

### Coconut squash

Coconut squash is a healthful soft drink made with coconut water, sugar, and natural preservatives like lemon and ginger (Chinnamma, Bhasker, Binitha Hari, Sreekumar, & Madhav, 2019). It has a high vitamin and mineral content while being low in calories. This product has a three-month life at room temperature. It's a relatively new product that's gaining traction in Asia and the Pacific.

### Nata de coco

*Acetobacter aceti* subspecies *xylinium*, a cellulose-forming bacterium, produces nata-de-coco, a gelatinous substance made from matured coconut water. The culture solution is made by combining coconut water, sugar, and acetic acid in a predetermined proportion, then inoculating it with *Acetobacter*, *Xylinium* via a culture liquid. It is placed in glass jars with thin linen covering and left undisturbed for 2-3 weeks. During this time, a white jelly-like substance develops on top of the culture medium and floats. It is picked, chopped into pieces, cleaned in pure water to eliminate all acids, and then soaked in flavored

sugar syrup for 12 hours before being packaged in glass bottles (Muralidharan, 2011).

### 3.8. Coconut based products

There are two major categories of foods that are extracted from coconut, coconut inflorescence-based foods, and coconut convenience foods.

#### Coconut inflorescence-based foods

It is seen that neera, coconut jaggery, and coconut flower syrup are all coconut inflorescence-based foods.

**Neera:** Neera is a fresh form of vascular sap taken from immature unopened coconut inflorescence (Chinnamma, Bhasker, Binitha Hari, Sreekumar, & Madhav, 2019). To preserve the product, it is tapped from coconut inflorescence, filtered, pasteurized, and bio preservatives are added. Neera can be stored in cans for up to two months at room temperature. Tetra packs or glass bottles are also available.

**Jaggery:** Jaggery is also known as palm sugar. Toddy is the sap from the young inflorescence. Palm sugar or coconut jaggery is made from unfermented toddy that has been carefully boiled. By adding a few drops of coconut oil or little coconut gratings, scummy contaminants are eliminated and foaming is avoided. Before boiling, the juice is filtered through sand filters to eliminate contaminants, and a tiny amount of alum is added to induce lime and magnesium precipitation, which provides the jaggery a better color and make it tougher for a longer period of time (Muralidharan, 2011).

**Coconut Flower Syrup:** This is a mineral-rich substance that is comparable to jaggery. It has a high potassium concentration and a low sodium content. It's made from fresh neera that's been condensed into syrup. The syrup contains 50% sucrose and is beneficial to diabetic individuals.

#### Coconut convenience foods

Coconut cookies, coconut candy, coconut chocolate, and coconut burfi are examples of coconut convenience foods. Coconut biscuits are made using coconut powder and Maida and may be made in a variety of flavors by adding butter, ginger, chocolate, and other ingredients. It has a three-month life at room temperature and is both tasty and healthful, with less calories. Coconut candy is made by combining shredded coconut with coconut milk. It is mostly produced in Asian and Pacific nations and has a high fibre content. The coconut chocolate has chocolate-coated confectionary treat made from coconut gratings, sugar, and milk butter. Cashew, almond, and other dry fruits can be added to make it even more delectable. Under refrigerated circumstances, this product has a three-month life (Shameena, 2020). North America, Europe, Australia, the Middle East, and China all have a high demand for it. Similarly, the coconut burfi is made by toasting coconut gratings and the product's preparation technique is standardized (Thamban, 2020). The coconut

gratings are roasted, then fat is added at a rate of 3% and sugar at a rate of 10%.

### 3.9. Components of a coconut shell-based product

Coconut shell powder, coconut shell charcoal, and activated carbon are the shell-based products from coconuts.

#### Powder of coconut shells

Coconut shell powder is widely used in the plywood and laminated board industries, as well as a phenolic extruder and a filler in synthetic resin glues, mosquito coils, and incense sticks. It's also a good alternative for bark powder, furfural, and peanut shell powder because of its consistency in quality and chemical composition, as well as its superior characteristics. Sri Lanka, Philippines, and Indonesia are the main exporting countries of coconut shell powder (Muralidharan, 2011).

#### Coconut shell charcoal

Coconut shell charcoal is made by burning fully grown nut shells in a little amount of air, just enough to carbonize. Shell is carbonized in mud pits, brick kilns, and metallic kilns to produce shell charcoal. Fully dried, clean adult shells are utilized to make top-grade charcoal. It is utilized as a raw material for the production of activated carbon because of its inherent value.

#### Activated carbon

To make activated carbon, the coconut shell is first transformed to shell charcoal through a carbonization process that takes place in mud pits, brick kilns, and metal portable kilns. The coconut shell charcoal is activated in a rotating kiln by reacting with steam at 900-1100 degrees Celsius in a controlled environment. Three tons of coconut shell charcoal may provide up to 1 ton of activated carbon on average (Dhamodaran & Babu, 2011).



**Figure 1:** Expeller machines used to retrieve coconut oil from copra.

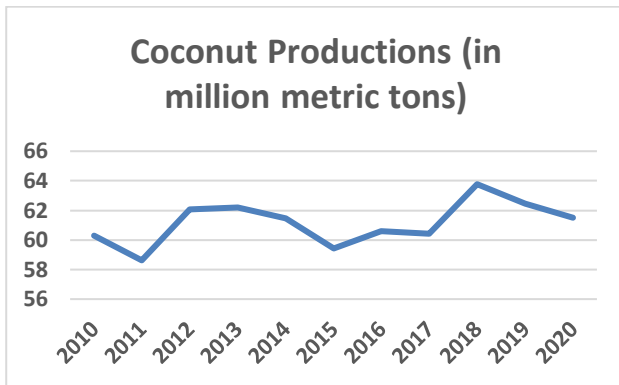


Figure 2: World-wide coconut productions (statista.com)

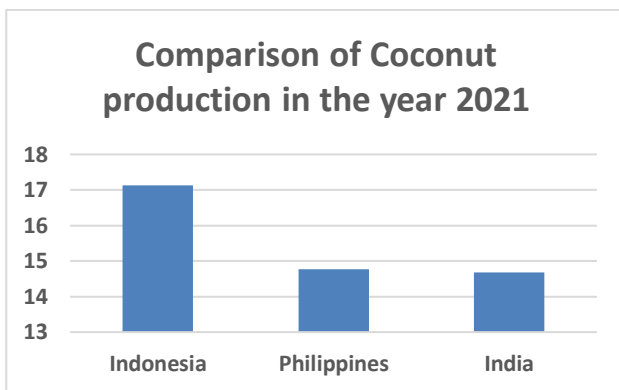


Figure 3: Comparing coconut production among three countries in the year 2021.

## 4. Conclusion

The coconut tree has a wide range of applications with huge influence on the lives of people all around the world. It provides medical benefits, food, and a major source of income for the people. Indonesia, India and Philippines are top three countries to be economically benefitted from the plantation of coconut trees. As there is high demand of coconut-based products worldwide, farmers need to be made aware about this economic value for increment in production.

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