Post Harvest Operations and Processing of fruits, Vegetables, Spices and Plantation Crop Products

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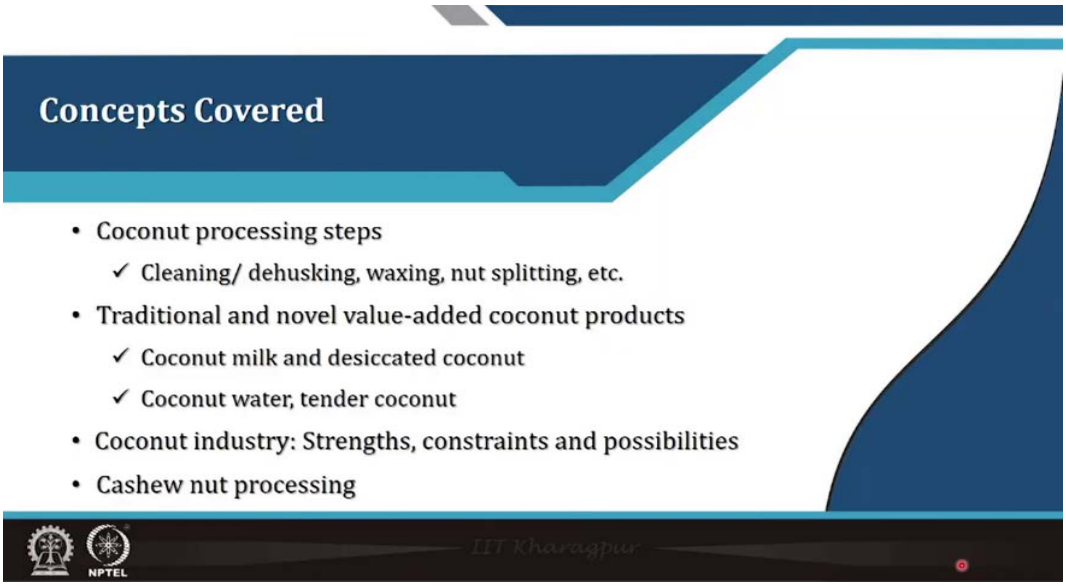
Lecture 40

Coconut and Cashew Processing

Hello, everybody, Namaste. In the last lecture of 8th module, today we will discuss on coconut and cashew processing.

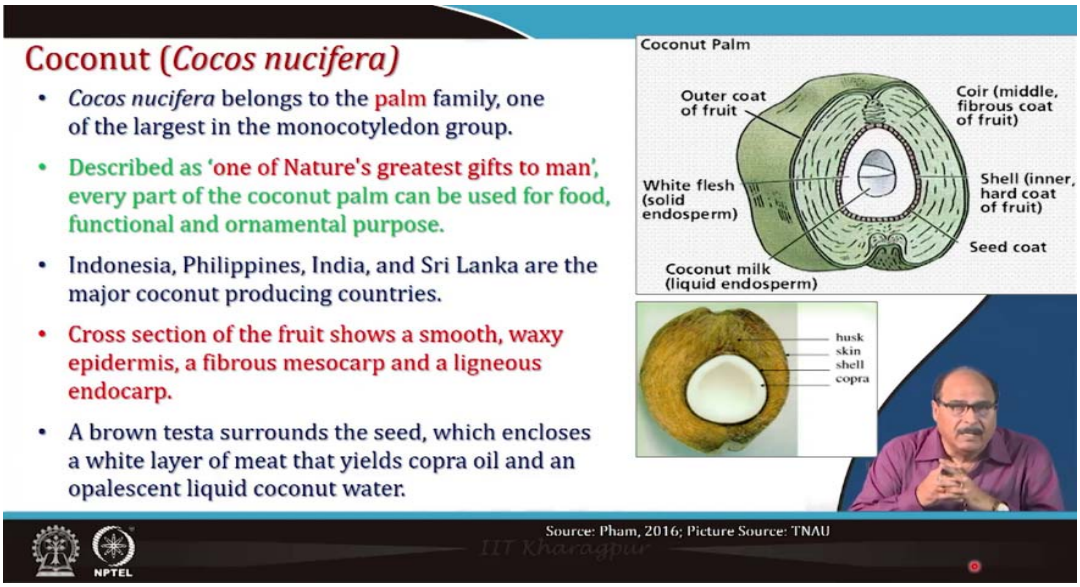
Concepts covered



The concepts that will be covered in today's lecture include coconut processing steps like cleaning, dehusking, waxing, nut splitting et cetera. Traditional and novel value-added products made from coconut like, coconut milk and desiccated coconut, coconut water, tender coconut.

And we will also discuss something about coconut industry in India: its strength, constraints and what are the various possibilities. And finally, we will discuss the cashew nut processing, which is another very very important product.

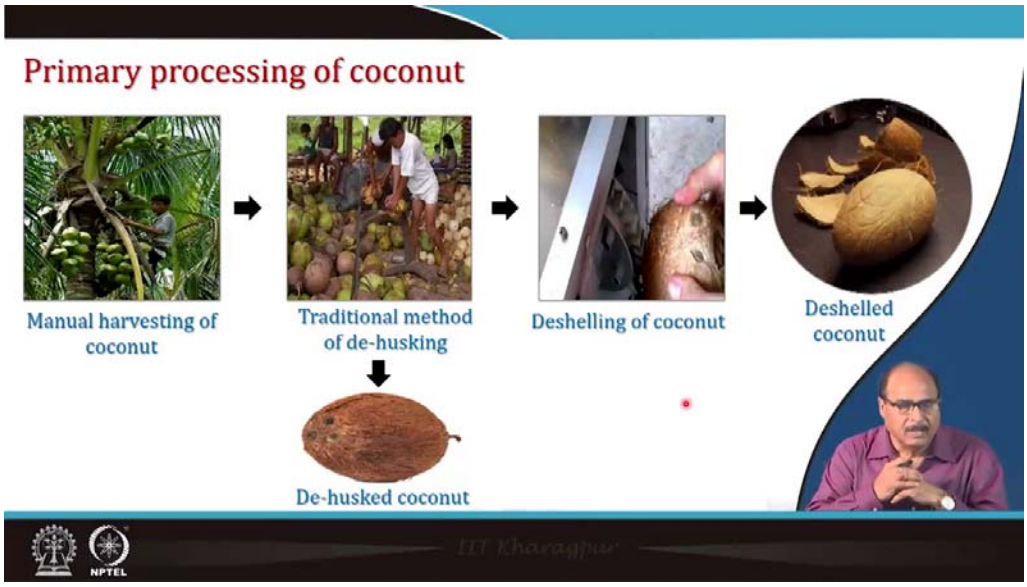
Coconut (*Cocos nucifera*)



Coconut (*Cocos nucifera*). It belongs to the palm family, which is one of the largest in the monocotyledon group. Coconut is described as one of the nature's greatest gift to man. Every part of the coconut palm can be used for food, functional materials and ornamental purposes. Indonesia, Philippines, India and Sri Lanka are the major coconut producing countries in the world.

If you look at the cross section of the coconut fruit, you will see that it has a smooth, waxy epidermis, a fibrous mesocarp and a ligneous endocarp. A brown testa, surrounds the seed which encloses a white layer of the meat that yields copra oil and an opalescent liquid coconut water.

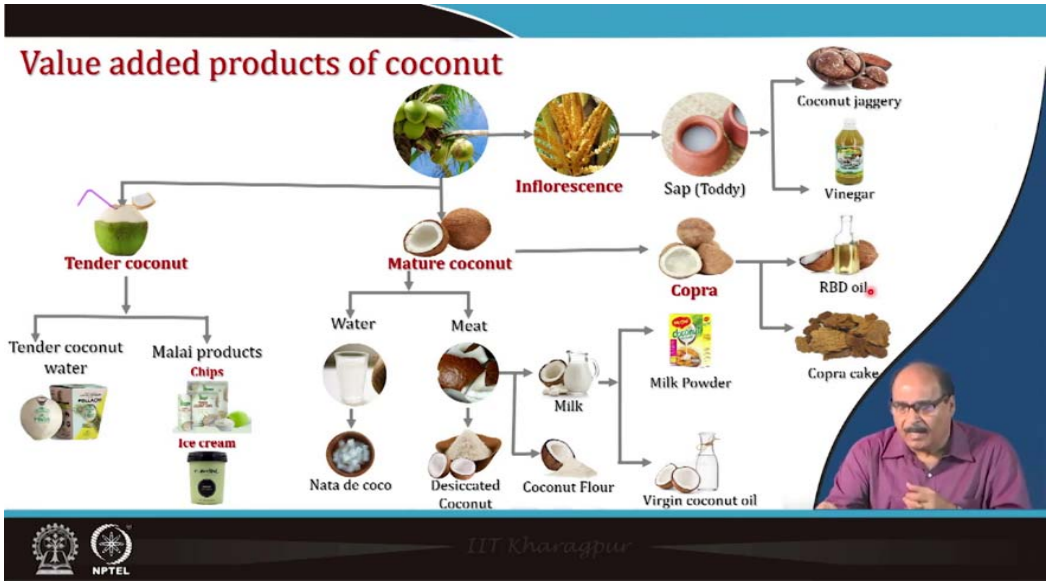
Primary Processing of Coconut



So, the processing of coconut primary processing. You can see that the matured, coconut are harvested manually by the palm tree or coconut tree using hand implements. The farmers, they have to, they have to raise the tree or plant and then manually, they cut this coconut, tender coconut. Then it is taken and subjected to traditional method of dehusking.

That is again, either manually or with a manual hand operated equipment et cetera, they dehusk, remove the outer husk, and then the dehusked coconut is shelled, that is put to net deshelling operation where the fibrous part, outer is removed and hard covering, its content, this is also removed manually, and one gets the deshelled coconut as you can see here in the figure. But this is a very tedious operation.

Value added products of coconut



So, various value added products of coconut include, the tender coconut is taken from the coconut palm tree, and the inflorescence, and this inflorescence which give the sap, that is you see that manually they put some container, earthen pot et cetera where the sap is collected. And this sap is a very, very good natural beverage. It contains a lot of micronutrients, et cetera and health beneficial components.

But the major problem with the sap is that as soon as sun rays fall on it, its alcoholic fermentation takes place and this sap is converted into Toddy, that is the alcoholic beverage. Otherwise this, what the farmers, they do, early morning they go, they collect this sap and this is used for the preparation of coconut jaggery or even, it is used for the fermentation and preparation of vinegar.

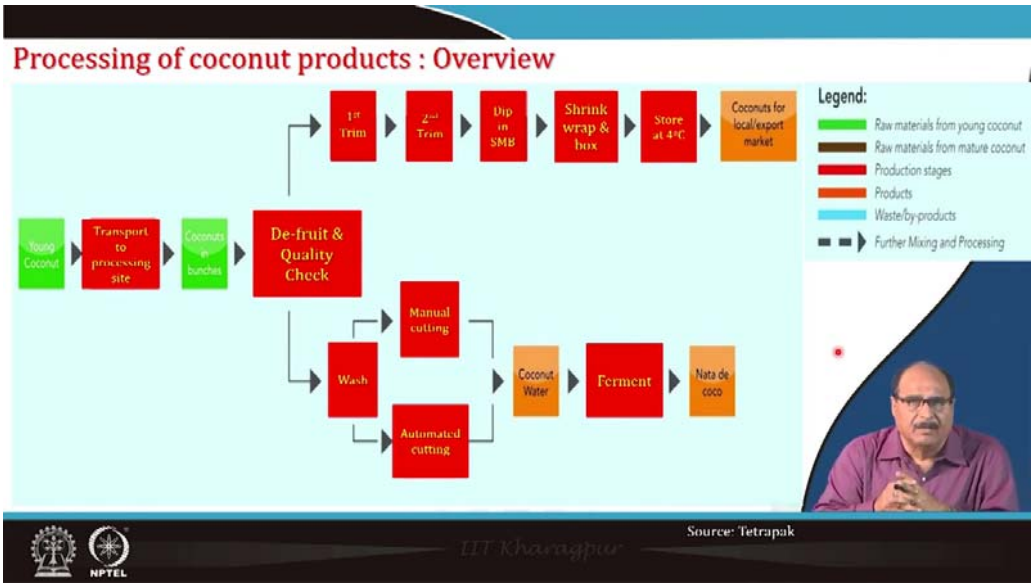
Next is that this coconut, once after a tender coconut is obtained from the plant and this tender coconut is used for making tender coconut water, and then the outer, that is the *malai* portion, or the white meat, soft meat which is there inside the coconut, it is used for either making chips are also used in the ice cream products et cetera, for mixing.

Then the mature coconut, which is obtained, the mature coconut again, it is used for making water, or then, coconut water which is converted into Nata de coco or the meaty portion is used is may be desiccated coconut, it can be dried and desiccated coconut powder, or it can be used to make coconut milk, coconut milk.

It can dried, and it makes coconut milk powder or even it can be used for extraction of oil, that is Virgin Coconut oil. Here this meat can also be desiccated coconut milk and coconut flour. So, these are one set of the product. Other set of the product may be that this copra, copra is

used for expressing, that is RBD oil or making copra cake. So, these are the different various set of products which can be used from the coconut fruit, which can be prepared from the coconut fruit.

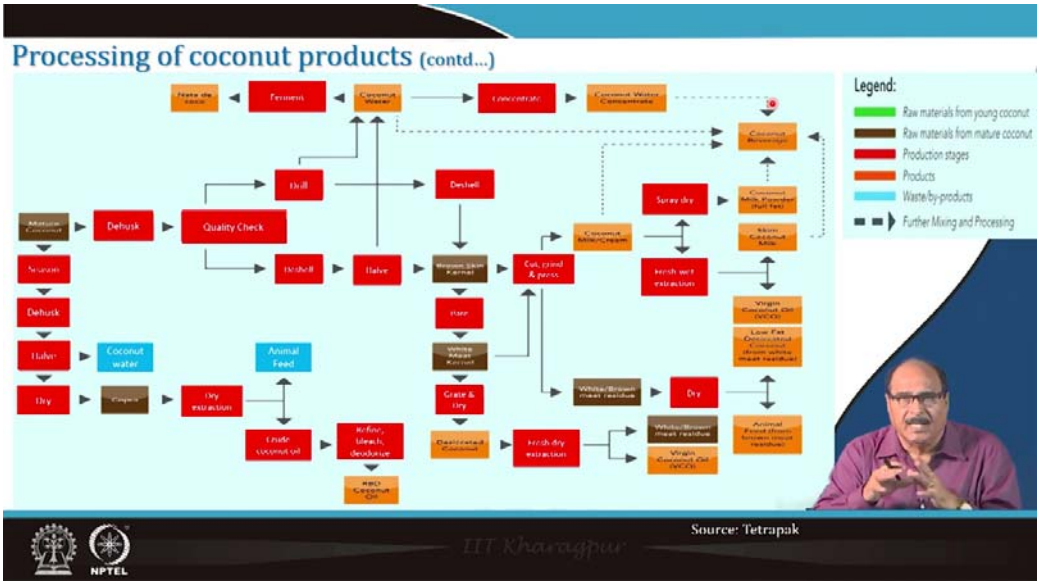
Processing of coconut products: Overview



Here, it is given a general a schematic flowchart for the making, various of processing a coconut products, an overview. That is, young coconut transported to the processing site and then coconut is used in the bunches et cetera and in the processing site, when in the industry, it comes, it is used for quality checking, the fruit quality checking.

And after it is checked for quality, then it is next sent to the processing line where first trim, second trim, dip in SMB and then shrink and wrap boxes et cetera, is that the cocoa, that is coconut root, inner material is taken and it is stored at 4 degrees Celsius. And then coconuts for local export market, it is used.

Otherwise also, what you can do that is FM portion, which is can be sent for the next operation like directly it is washed, then it is cut manually either manually it is cut or it is cut automated equipments are there, cutting equipments, and then coconut, it is pressed for coconut water and coconut water is fermented and converted into Nata de coco product. So, these are the actually in this line, three major products, coconut water, Nata de coco and coconut, whole coconut for individual used locally food or for other purpose, it is used..

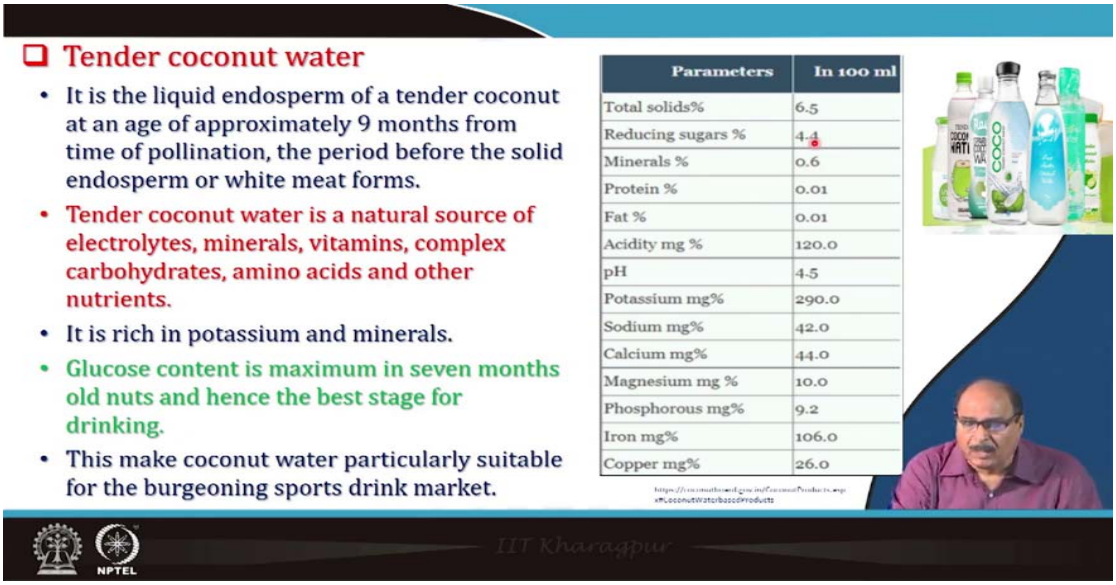


It is a little bigger scenario that is the same processing steps at a glance. It is given where the various products like Nata de coco, then coconut water, coconut water concentrate, it is subjected to concentration process, concentrated and then coconut beverage, that is water can be further mixed with other components et cetera.

It can be converted into a beverage or coconut milk powder, full fat coconut milk powder, skimmed coconut milk or virgin coconut oil or low fat desiccated coconut, it can be made from white meat residue or even virgin coconut oil or animal feed from the brown meat residue desiccated coconut or RBD oil.

So, these are the various products which are prepared from the coconut for food consumption for that animal food consumption, and their route is given here. Apart from that, this also can be like coconut water or animal feed et cetera. Some of the waste products, which also has the valuable food. Then, these are the various overview of the coconut processing is shown here.

Tender coconut water

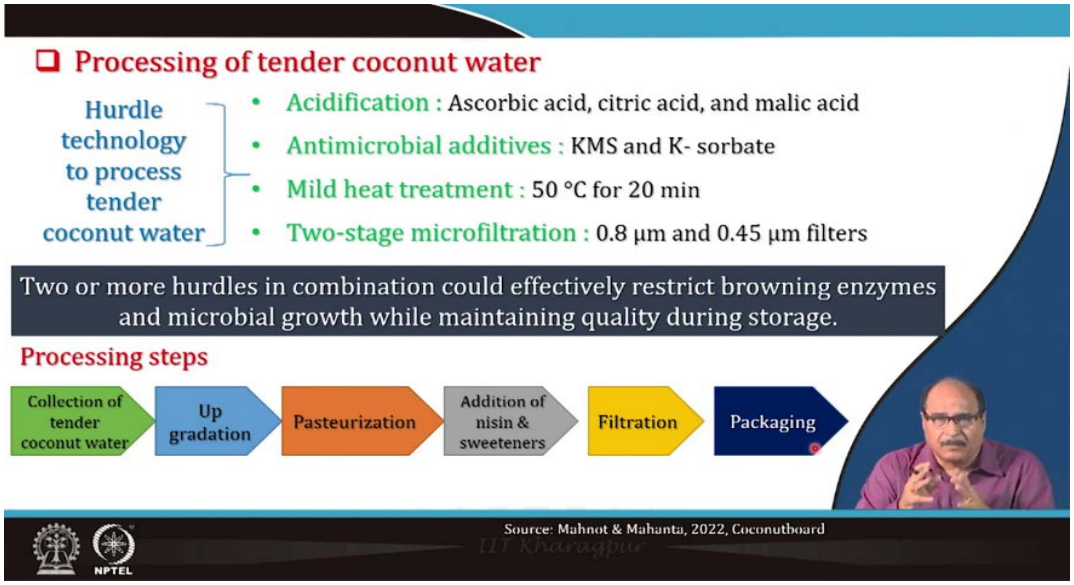


Now let us see at least a few important products, what are the tender coconut water. So, it is the liquid endosperm of a tender coconut at an age of approximately 9 months from the time of pollination, the period before the solid endosperm or white meat are formed. That is the one period which contains the liquid coconut water, tender coconut water, we say, that inside the meaty portion, in that form.

So, tender coconut water is obviously a very, very good source, natural source of electrolyte minerals, vitamins, complex carbohydrates, amino acids, and many other micronutrients. It is rich in potassium and other minerals, you can see here in this figure, that is given, it has around 106 milligram percent of the iron per 100 ml.

A glucose content is maximum in seven months old nuts and hence, it is best stage for the drinking. This makes coconut water particularly suitable for burgeoning sports drink market because the coconut water, it is a protein also, very less, but fat content, maybe 0.01 percent, mineral, 0.6, it reducing sugar 4.4 percent, total solids 6.5 percent and potassium, sodium, calcium, magnesium, phosphorus, or iron, copper these are present in the significant quantity in the tender coconut water.

Processing of tender coconut water



So, for processing of tender coconut water, because obviously once it is taken out of the coconut, tender coconut that it is very, very highly perishable. It will be immediately, that oxidized and acted upon by the micro organism et cetera. So, care has to be, it has to be properly processed and maybe packaged to improve, to help retain its color and its valuable components and also to extend its shell life.

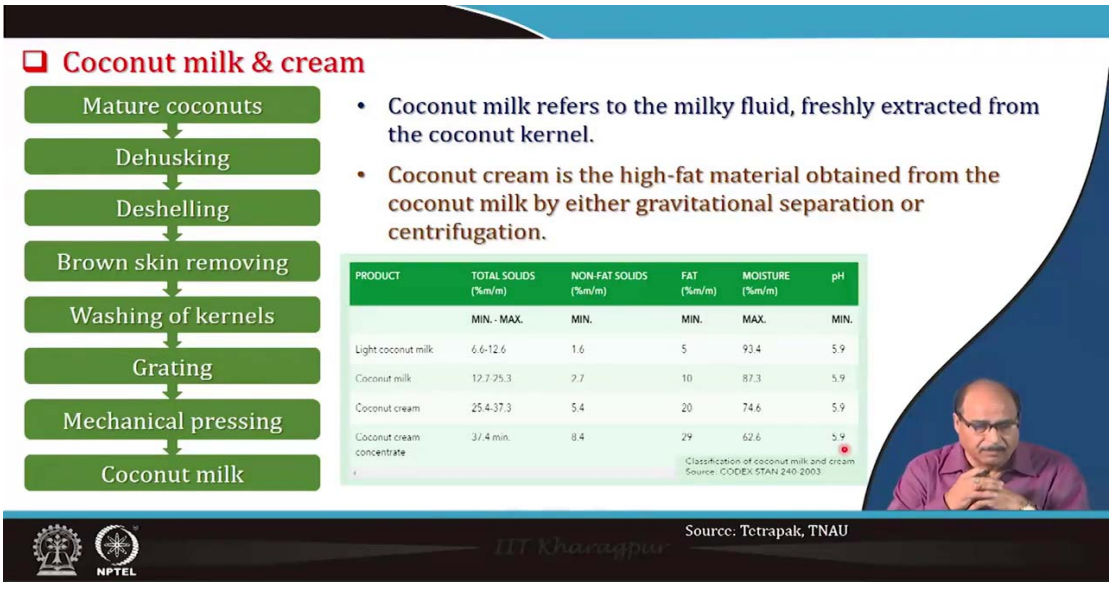
So, Hurdle technology concept is used. There are two or more hurdles in combination, could effectively restrict browning enzymes and microbial growth while maintaining the quality during storage because these contents, enzymes and other thing, its flavor immediately oxidizes, enzymatic browning et cetera takes place.

So, maybe acidification, where ascorbic acid, citric acid, malic acid or addition of antimicrobial additive like potassium metabisulfite or potassium sorbate, then mild heat treatment, may be 50 degrees Celsius temperature for about 20 minutes or so, or two stage microfiltration, that is, using 0.8 micron and 0.45 micron membranes, and this helps.

And then microfiltration and finally, packaging in the proper container laminates et cetera. So, that will extend its shelf life. So, the processing steps include collection of tender coconut water upgradation, then pasteurization, addition of some antimicrobial natural, antimicrobial like nisin et cetera, at some time they add a sweeteners also, then filtration, and finally, packaging.

And in the market, this tender coconut water processed and packaged, are available in different forms which you can see in this figure.

Coconut milk and cream



Then, coconut milk and cream. Coconut milk refers to the milky fluid that is obtained from freshly extracted from the coconut kernel. Coconut cream is the high fat material obtained from the coconut milk by either gravitational suppression or centrifugation. So, that is the, after the brown skin is removed, it is washed, the kernel, grating and by mechanical pressing, coconut milk is obtained.

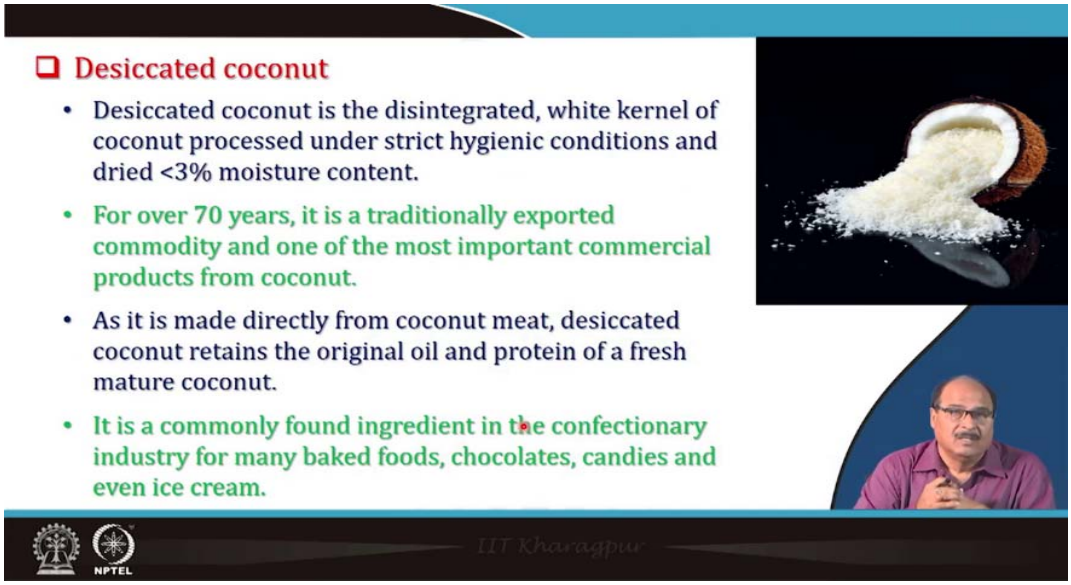
And the depending upon the total solids content, non-fat solids, fat content and pH et cetera, that is, pH in all the case may be 5.9, but there are total solids and non-fat solids and fat, these

differences, that are the difference. And it makes light coconut milk, coconut milk, coconut cream and coconut cream concentrate.

Like in the total solids content in the light coconut milk should be minimum 6.6 and maximum 12.6. Coconut milk should contain minimum 12.7 percent, mass by mass, their total solids and maximum 25.3. So similarly, even coconut cream 25.4 minimum and 37.3 Maximum.

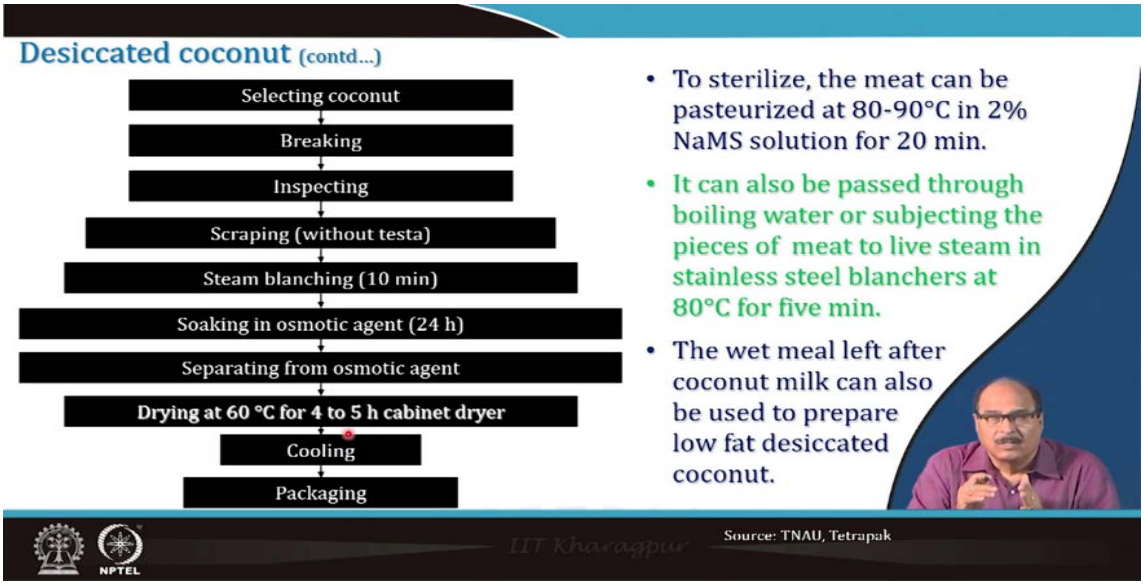
Coconut cream concentrate that 37.4 percent of mass bypass minimum. So, similarly the non-fat solids also, the light coconut milk about 1.6 percent, coconut milk 2.7, coconut cream 5.4 and coconut cream concentrate, 8.4 percent . So, based on this, various grades of coconut milk is produced by the industry.

Desiccated coconut



Then desiccated coconut, another important product of the coconut industry, which is used in various, every preparations and even various milk based or such other, for like, making Laddoo or many other products. Desiccated coconut is the disintegrated, as you can see here in the picture, white kernel of the coconut processed under strict hygienic conditions. And it is dried to around less than 3 percent moisture content.

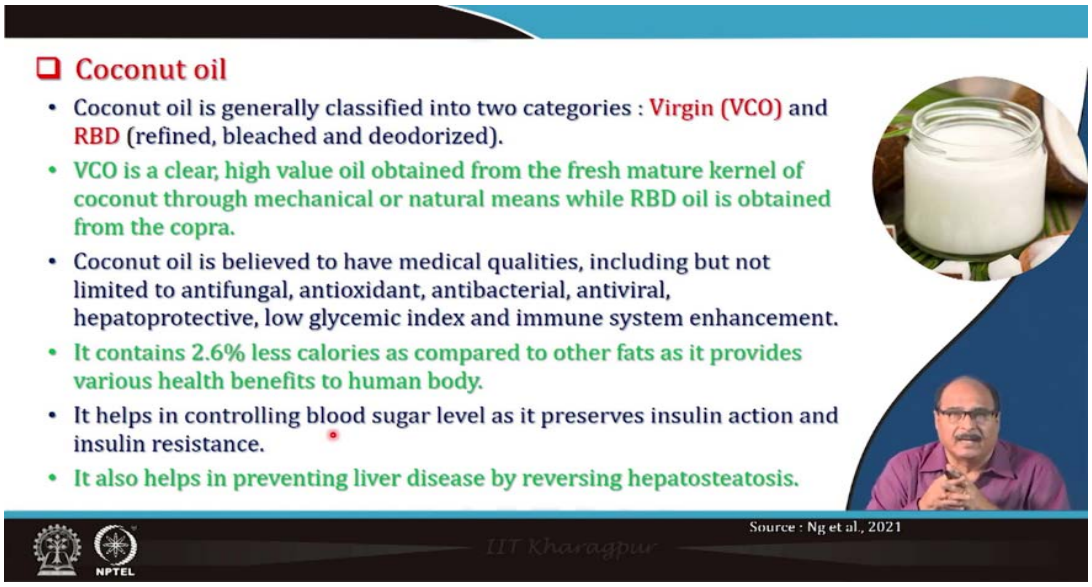
And for over 70 years, as I told you, it is traditionally exported commodity and one of the most important commercial products from coconut. As it is made directly from the coconut meat, desiccated coconut retains the original oil and the protein of fresh mature coconut. It is a commercially found ingredient in the confectionery industry and many baked food, in chocolate, candies or even ice cream or in many dairy foods.



For making desiccated coconut, see that coconut breaking, inspecting, scraping, steam blanching for 10 minutes, followed by soaking in osmotic agent for 24 hours, then separating from osmotic agent and finally, it is dried at 60 degrees Celsius for 4 to 5 hours in a cabinet dryer or in a mechanical drier, cooling and packaging.

So to sterilize, the meat can be pasteurized at around 80 to 90 degrees Celsius in 2 percent sodium metabisulfite solution for 20 minutes. It can also be passed through boiling water or subjecting to, subjecting the pieces to meat to live steam in a stainless steel blancher at around 80 degrees Celsius for 5 minutes. The wet meal left after coconut milk can also be used to prepare low fat desiccated coconut.

Coconut oil



Then coconut oil, another very, very important product, valuable product of the coconut. It is generally classified into two categories, one is the virgin coconut oil commonly known as VCO or refined, bleached and deodorized coconut oil, commonly known as RBD oil. So VCO is a clear, high value oil obtained from the fresh mature kernel of coconut through mechanical or natural means.

Whereas the RBD coconut oil is obtained from the copra. So, that is the major difference. That is, VCO is obtained from the kernel of the coconut whereas the RBD is obtained from copra. Coconut oil is believed to have medical qualities including but not limited to antifungal, antioxidant, antibacterial, antiviral, hepatoprotective, low glycemic index and immune system enhancement.

It contains around 2.6 to 3 percent less calories as compared to other fats as it provides various health benefits to human body. It helps in controlling blood sugar level as it preserves insulin action and insulin resistance. It also helps in preventing liver diseases by reversing Hepatosteatosis.

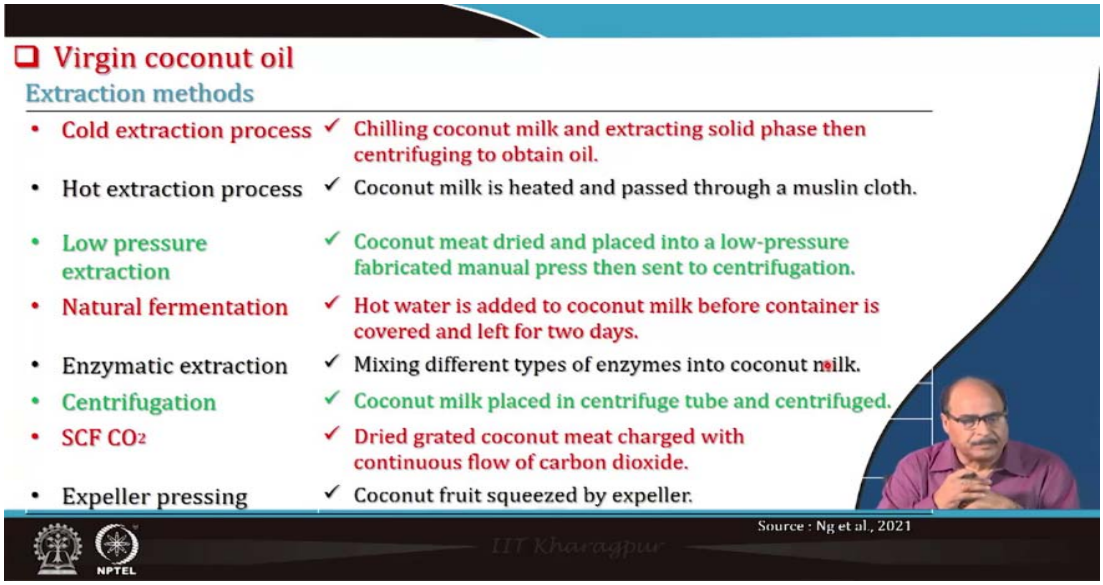
Coconut oil: Traditional method

In the traditional method, the coconut oil is extracted from copra, that is, copra can be obtained by separating the coconut meat from the whole coconut shell, followed by sun drying and smoke drying for about 6 to 8 days, as you can see here in the picture, that is the copra is obtained.

And then this Copra is chopped to a small size and cooked by heating the small pieces of copra in a cooker for about 30 minute. And then this copra was in the expeller and such other pressers

is used and it is squeezed out from the copra by an expeller, and then filtered by a filter press to get the clear oil.

Virgin coconut oil



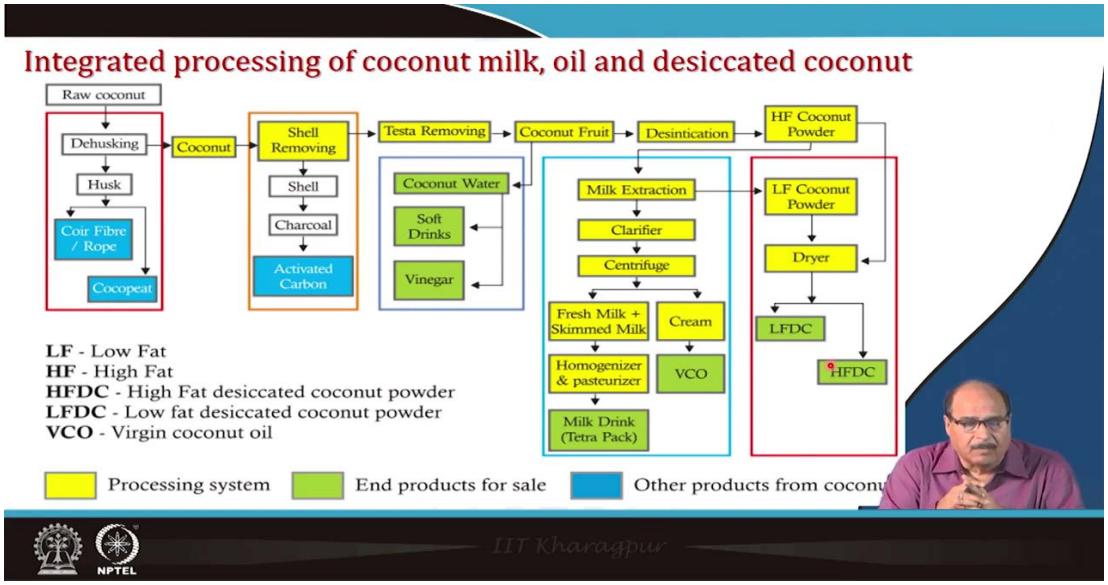
So, various other extraction methods, (like) can be used for the getting the Virgin Coconut oil like cold extraction process, where the chilled coconut milk is used and extracted, solid phase then centrifuge to obtain oil. In the hot extraction process, coconut milk is heated and then passed through a muslin cloth, pressed through a muslin cloth.

Then low pressure extraction. In this process, coconut meat is dried and placed into a low pressure fabricated manual press, and then sent to the centrifugal cell to separate oil. In the natural fermentation method, hot water is added to the coconut milk, before container is converted and left for two days.

And then oil will separate it and oil is used. Enzymatic extraction can also be used, it mixes different types of enzymes into the coconut milk and which separate the oil. Centrifugation process. Coconut milk is placed in centrifuge and it is centrifuged, the oil is separated, virgin oil is obtained.

Supercritical fluid carbon dioxide. In this process, dried and graded coconut meat is charged with continuous flow of supercritical carbon dioxide and liquid carbon dioxide and which extracts the oil. Expeller pressing, very commonly used method where coconut fruit is squeezed by the expelling machine, squeeze expelling machines.

Integrated processing of coconut milk, oil and desiccated coconut

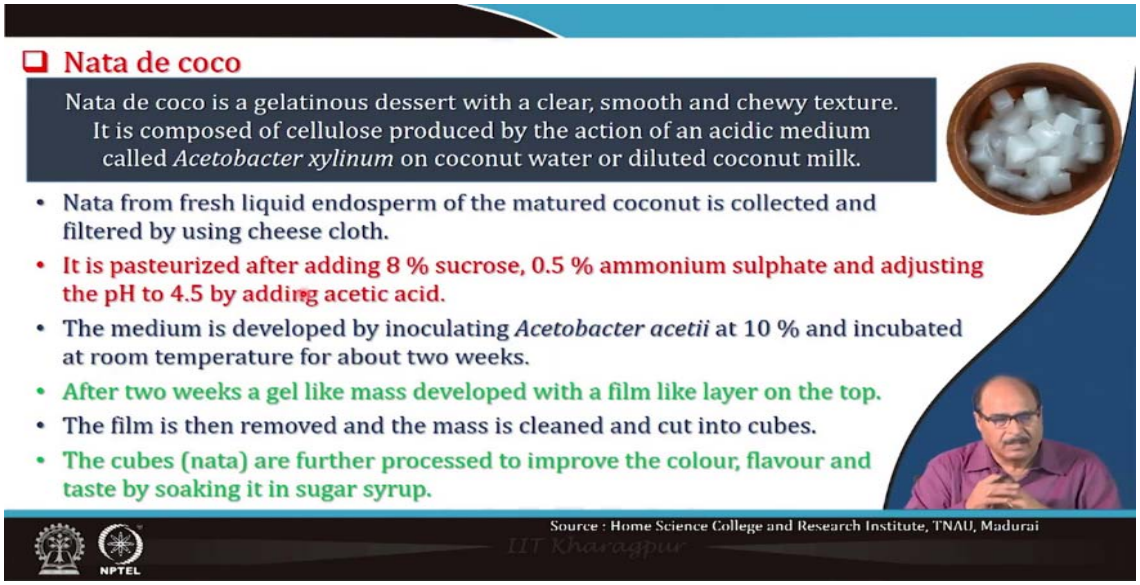


So, here an integrated processing line for coconut for manufacturing coconut milk, coconut oil both virgin oil and RBD oil and then desiccated coconut. So, you see the raw material is dehusked and the husk can be used for coir fiber/ rope and cocopeat making. So after dehusking the coconut obtained, it is subjected to shell removing and this shell can be used for making activated charcoal et cetera.

Then deshelled material, coconut, then it is subjected to testa removing where coconut fruit is obtained. This coconut fruit is may be, converted into coconut water. That is, it can be used in soft drinks or coconut. And then again, coconut fruit is desiccated and after that HF coconut powder, and it is a coconut powder, it can be used for milk extraction, clarifier, centrifugation, and finally virgin coconut oil or milk drink that is the tetra pack, they are using this, or even HF coconut powder, that is milk extraction.

This milk can be concentrated earlier of coconut powder then dryer then LFDC or HFDC that this high fat desiccated coconut powder or low fat desiccated coconut powder. So, basically in this process you will see HFDC, LFDC, VCO, milk drink, vinegar, soft drink, coconut water, these are the various types of product. So, in the integrated unit, all these. And yellow line shows the processing system. And this green line shows the end products for sale.

Nata de coco

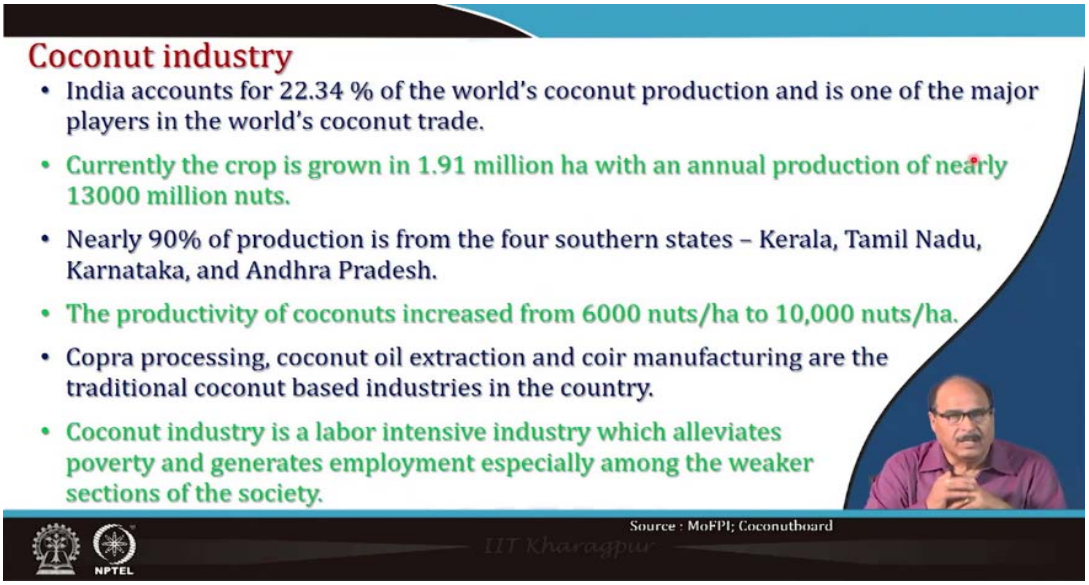


Then, Nata de coco. That Nata de coco is a gelatinous desert with a clear smooth and chewy texture. It is composed of cellulose produced by the action of acidic medium called *Acetobacter xylinum* on coconut water or diluted coconut milk. See here, in the picture that is the Nata de coco, these cubes.

Nata from the fresh liquid endosperm of the matured coconut is collected and filtered by using cheese cloth. It is then pasteurized after adding 8 percent sucrose, about 0.5 percent ammonium sulphate and adjusting the pH to a level of 4.5 by adding acetic acid. The medium is developed by inoculating *Acetobacter acetii* at 10 percent, and incubated at room temperature for about two weeks.

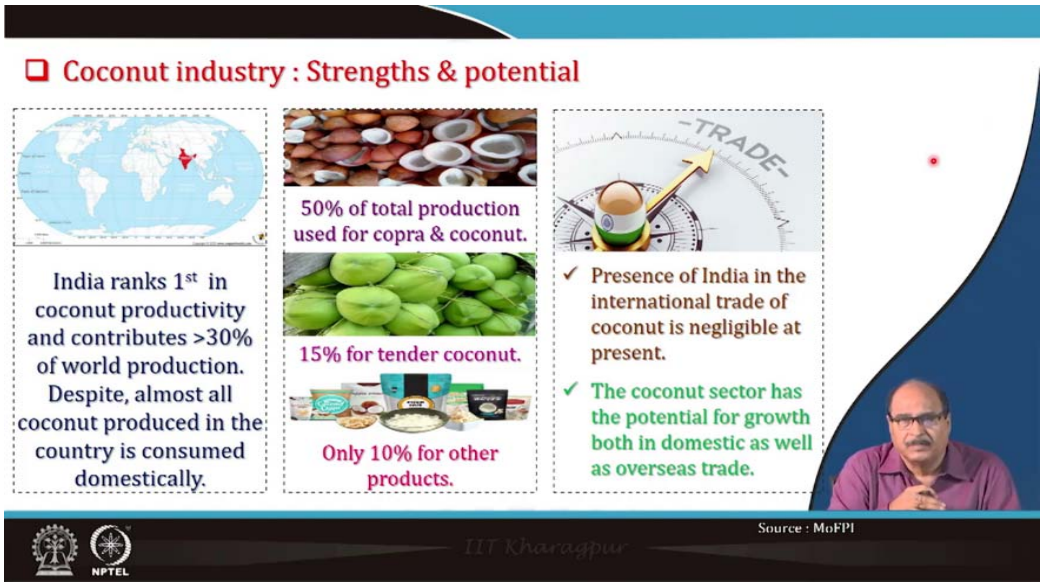
After two weeks, a gel like mass is developed with film like layer on the top. This film is then removed and the mass is cleaned and cut into cubes. And these cubes, which are known as Nata are further processed to improve the color, flavor and taste by soaking it in the sugar syrup.

Coconut Industry



Now, let us see coconut industry. In fact, India accounts for about 22.34 percent of the total world's coconut production. And it is one of the major player in the world coconut market. Coconut, currently the crop grown is 1.91 million hectare with an annual production of nearly 13,000 million tonnes. But nearly 90 percent of the total production is only mainly from the southern part, southern states, Kerala, Tamil Nadu, Karnataka, Andhra. Coconut industry, however, is a very, very labor intensive industry. It alleviates poverty and generates employment, especially among the weaker section of the society.

Coconut Industry: Strengths and Potential

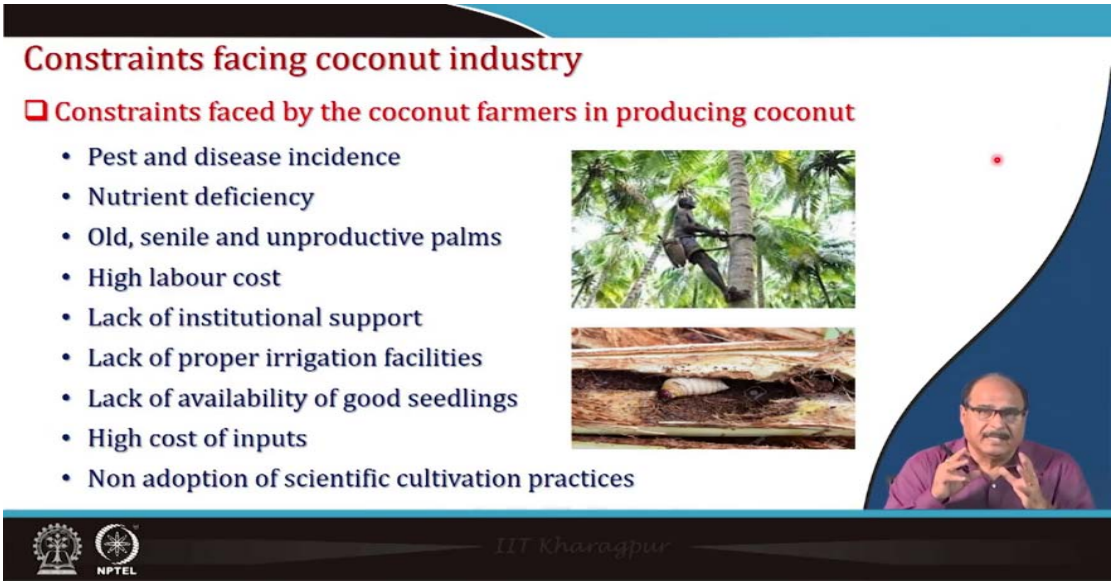


So, strengths and potentials of coconut industry that as I told you, India ranks first in the coconut productivity and contributes more than 30 percent of the world production. Despite all, almost all the coconut produced in the country is consumed domestically. So, there is a big

potential to boost export, export of the coconut. 50 percent of the total coconut production is used for copra and coconut, 15 percent for tender coconut, and only 10 percent for other products. Presence of India in the international trade of the coconut is negligible at present. The coconut sector has the potential for growth both in the domestic as well as in the overseas trades.

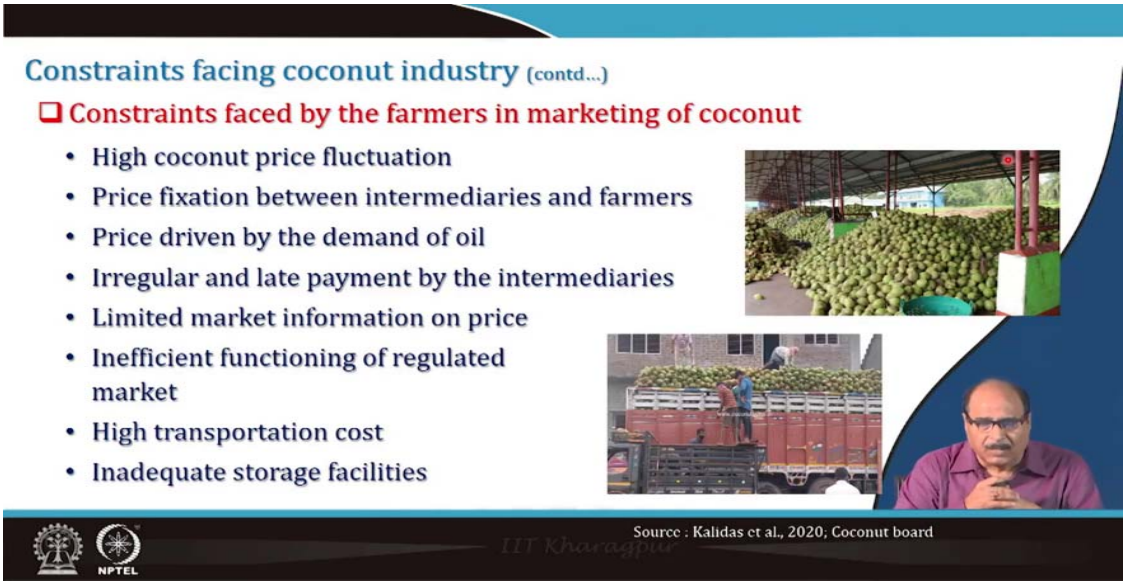
Constraints facing coconut industry

Constraints faced by the coconut farmers in producing coconut



But there are certain constraints faced by the coconut processing industry both by the farmers as well as, the transport, marketing like pest and disease incidents, nutrient deficiency, high labor cost, lack of institutional support or lack of availability of the good seedlings or non-adoption of the scientific cultivation practices. These are some of the major constraints facing the farmers.

Constraints faced by the farmers in marketing of coconut

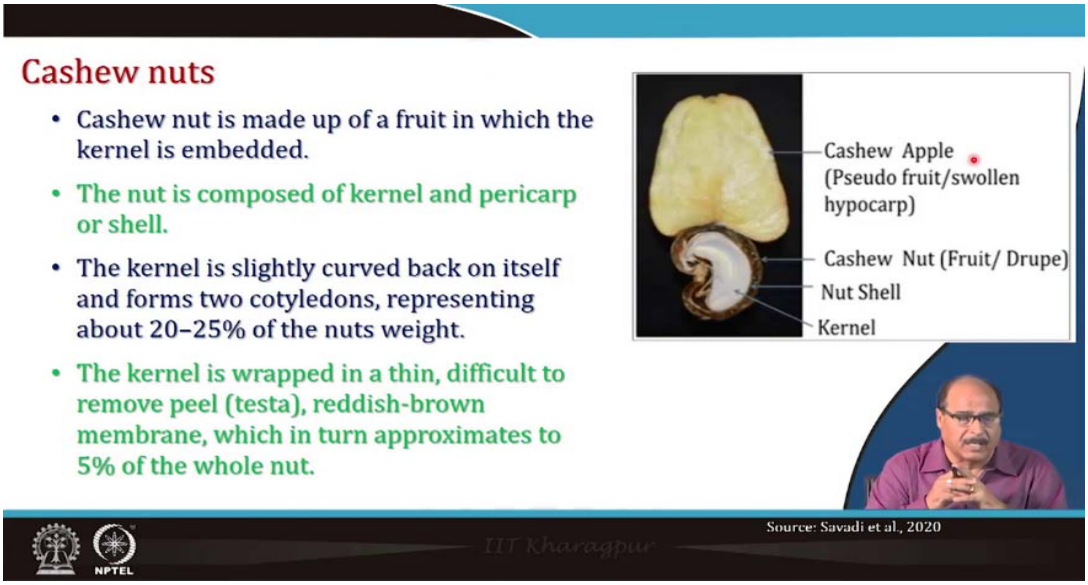


And then, that is a constraints faced by the farmers in marketing a coconut, like high prices coconut price fluctuation, price driven by the demand of the oil, limited market information on price or inefficient functioning of the regulated market, high transport cost or inadequate storage facility, et cetera.

Constraints faced by processors

Even the constraints faced by the processors like low capacity utilization, high price fluctuation, inconsistent supply of raw material, lack of institutional support with respect to promotion of coconut or lack of institutional support with respect to credit, et cetera. So, these are the some of the constraints. And I think this is a, coconut industry is a very, this is a very important crop, and every possible effort should be done to boost its export as well as processing and value added product promotion.

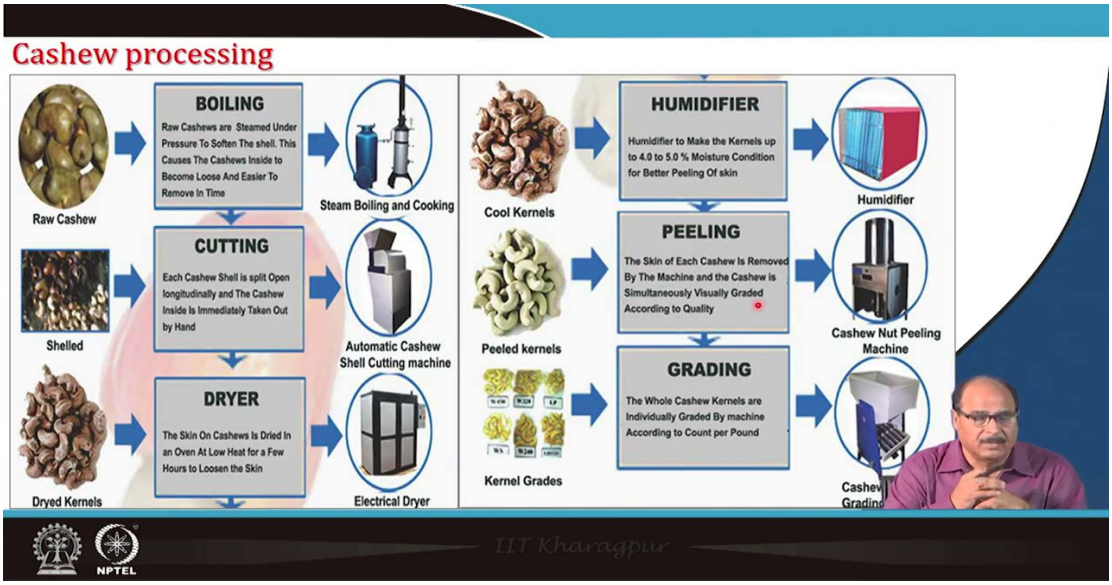
Cashew nuts



So, now let us discuss the another important commercial crop, that is the cashewnut, the cashewnut processing. Cashewnut is made up of a fruit in which the kernel is embedded. You can see here in the figure, the nut is composed of kernel and pericarp or shell. The kernel is slightly curved back on itself and forms two cotyledons. Here, this is the kernel. That is a kernel, two cotyledons, about 20 to 50 percent of the nuts weight

The kernel is wrapped in a thin, difficult to remove peel which is called testa, reddish-brown membrane, which in turn is approximate to about 5 percent of the whole nut. So, in actual processing, that is, so it is two parts, that is, one is the cashew apple and the other is nuts. And both, the cashew apple is the the pseudo fruit or a swollen hypocarp. And both, these both components are important part.

Cashew Processing



So, in the case of cashew processing, there are different steps which are used for cashew processing. After this, cashew nuts are obtained from the tree, raw cashew, see how does it look like in the figure. Then, it is subjected to boiling where raw cashews are steamed under pressure to soften the shell. And this causes the cashew inside to become loose and easier to remove, it becomes easy to remove it from it. And then next operation is cutting, that is outer covering testa et cetera is removed.

Cashew shell is split open longitudinally, and the cashew inside is immediately taken out by hand or by hand implements. Then this is next subjected to drying. The skin on the cashews is dried in the oven at low heat for a few hours to loosen the skin so that the skin covering, it becomes soft, it loses out. So, dried kernels, you can see in the figure. So, these dried kernels. The next step is humidifier. Humidifier operation is done to make the kernel up to around 4 to 5 percent moisture conditioning or better peeling of the skin.

So, this humidity, drying and after drying, it in humidifier. So it improves the, it makes it better for the cleaning operation removal of the outer shells et cetera. So, after that, like the peeling operation, the skin of each cashew is removed by the machine, and the cashew is simultaneously visually graded according to the quality. So see these are peeled cashew kernels, you can see here in the figure. And these are the also, the machines that we have shown here, that is, these cashew nut peeling machines are also available in the market.

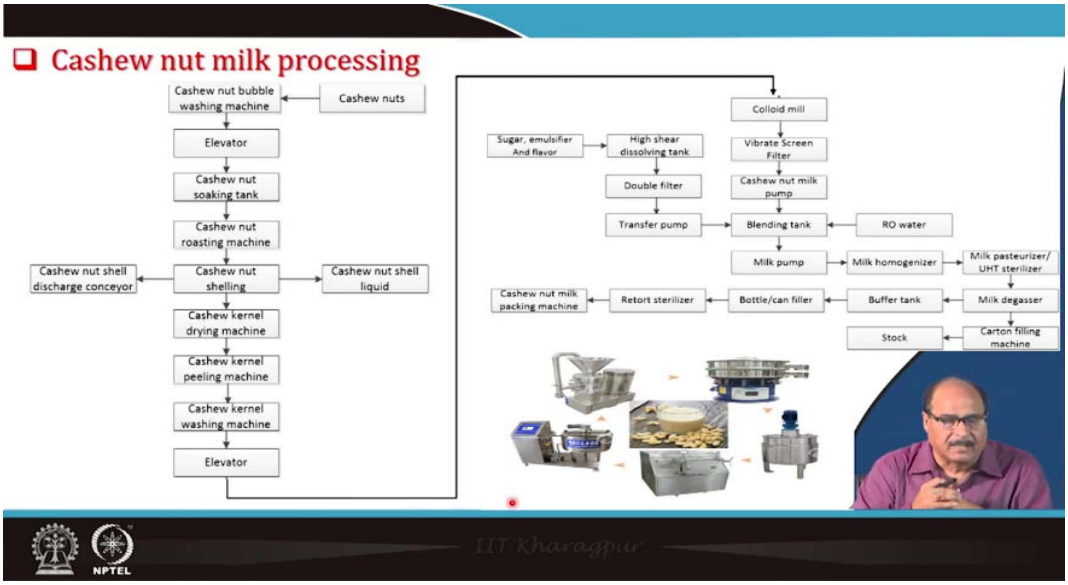
Then finally, grading. The whole cashew kernels are individually graded by machine according to the count per pound, that is per kg or what is the count of the kernel part, accordingly grade 1, grade 2, grade 3 is given, that is kernel grades. There are automatic graders machines. So,

humidifier, grading. So processing step you can see finally, steam boiling and cooking, then cashew shell cutting, electrical drying, then humidifying, cashew nut peeling and then finally, grading.

Machinery for cashew processing

The machinery required for cashew nut processing, you can see here. Raw cashew nut pre-cleaning and de-stoning and then sizing. Then the steam boiler and other cooking vessels are shown in picture. Then sheller with vibratory sieve and color sorter, and steam humidity chamber, that inside that material after drying is kept and then humid steam is used, is spread. Then finally, pneumatic peeling machine with an air compressor and optical color sorter. So, these are the common machinery which is used in the cashew processing plant.

Cashew nut milk processing

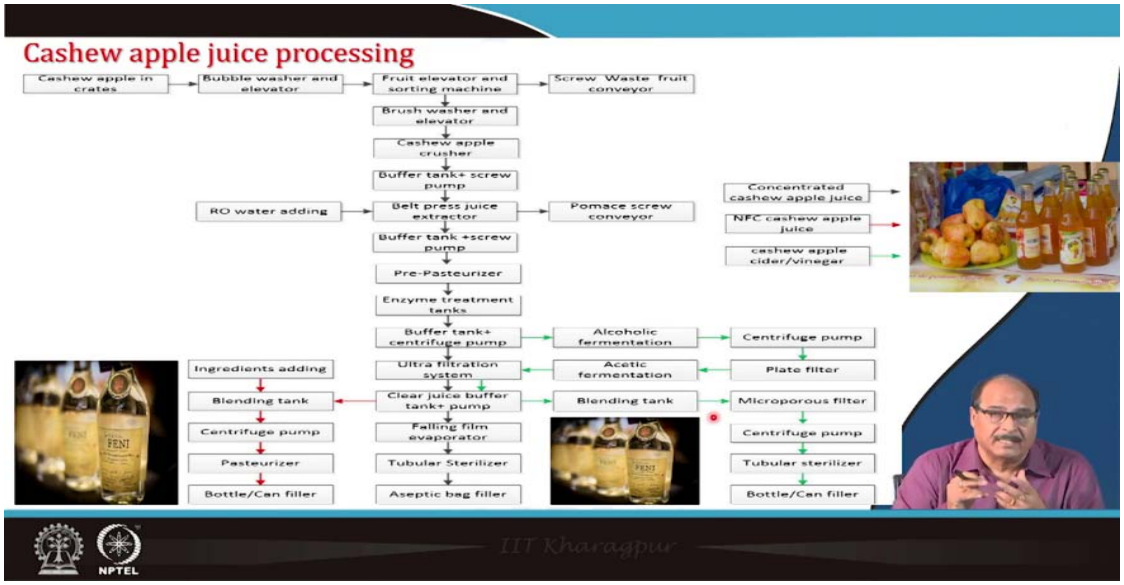


So, here it is a process flowchart which is soon the cashew nut milk processing where the cashew nut bubbles are taken, the cashew nuts, this is sent to the washing machine, elevator, then cashew nut soaking tank, cashew nut tank roasting, it is roasted and then finally the cashew nut is shelling. So shelled cashew nut, it may be here, discharged to conveyor or cashew nut, shelled cashew is made, that cashew nut liquid.

So, kernel then it is sent to drying machine, cashew kernel peeling, kernel washing and then after washed kernel, with the help of elevator, is sent to the colloid mill. In the colloid mill where it is a finely ground in the form of paste, vibrate feed is filtered, cashew nut milk pulp and the blending tank. Here this colloidally grounds milk pump is obtained in. And then sugar, emulsifier other flavors et cetera is added, it is mixed here. Even RO water. All these things are blended.

It is sent to the, through the milk pump, homogenization, and then pasteurizer, UHT sterilizer, then milk degasser. It is subjected to buffer tank, bottle can filters or retort sterilizer to get cashewnut milk, packaging. It is packed properly in the tetrapack. After milk degasser, it can also be seen for the cartoon filling machine or stock. So, these are the different steps, operation, steps involved in preparation of cashew nut milk, starting from the cashew nut, and finally you get the bottled milk, as you can see.

Cashew apple juice processing



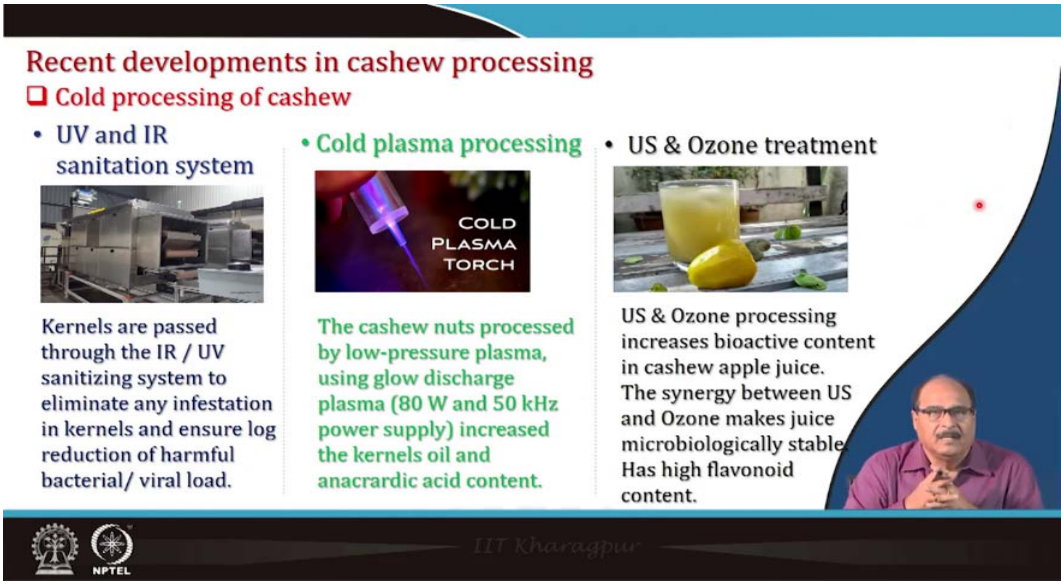
Then cashew apple juice processing, another very, very important, the cashew apple which is obtained. It is made, that is the cashew apple in crates is taken, bubble washer and elevator, it is in washed, and then after thorough washing, then the cashew apple is sent to the crusher, crushed, and then buffer tank where belt press juice extractor.

So, the from the cashew apple juice is extracted and pomace et cetera pomace is there, the pomace is then sent for various, to make concentrated cashew apple juice, NFC cashew, apple juice or cashew apple cider, beverage et cetera. These are all made. This can also be made after this RO water et cetera is added. And then it is also then sent for the alcoholic fermentation, alcoholic fermentation. And with the alcoholic fermentation then acetic fermentation.

You see that in the figure, it is a feni, very, very important product which is available in the Goa. That is a, feni is a very, very popular product, very popular beverage, alcoholic beverage, beverage which is having characteristic flavour. And it is prepared from the cashew apple. Then, these are the some of the products that is various other product like cashew apple cider, vinegar, NFC cashew apple juice, concentrated cashew apple juice et cetera. These different products are made from the cashew apple.

Recent developments in cashew processing

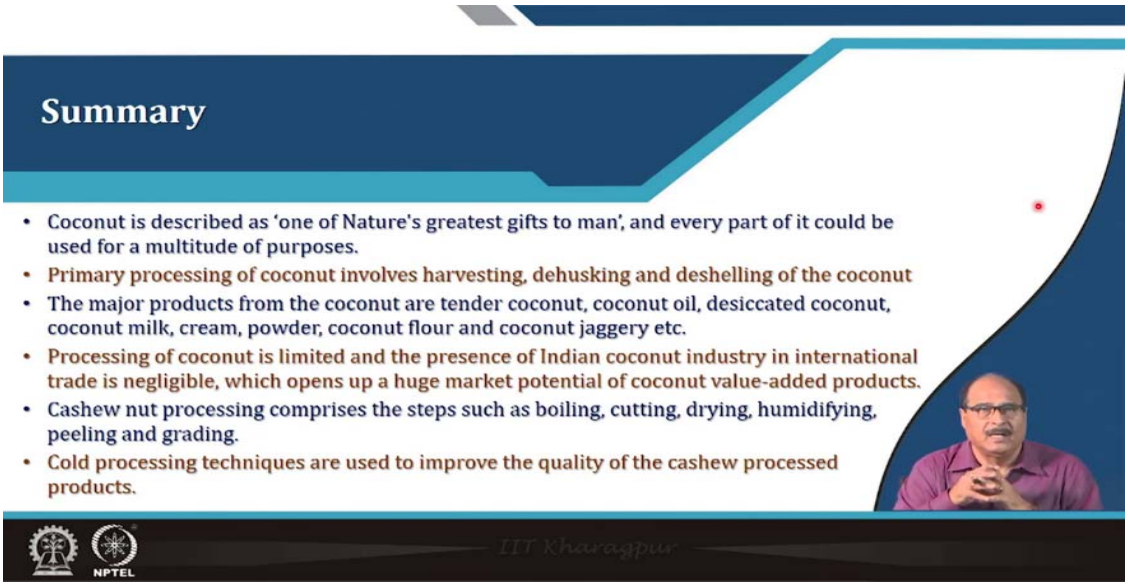
Cold processing of cashew



Then, only there are certain recent development in the cashew processing, because the cold processing of the cashew is heard, that is UV and IR sanitation system, that is kernels are passed through IR or UV sanitizing system to eliminate any infestation in kernels and ensuring log reduction of harmful bacterial viral load.

Then in cold plasma processing the cashew nuts are processed by low pressure plasma using glow discharge method, that is, which increases the kernel oil and anacrardic acid content. In the U.S. and ultrasound and ozone treatment processing, it increases the bioactive content in the cashew apple juice. The synergy between ultra sound and ozone takes place in the juice and makes the juice microbiologically stable. And it has high flavonoid content.

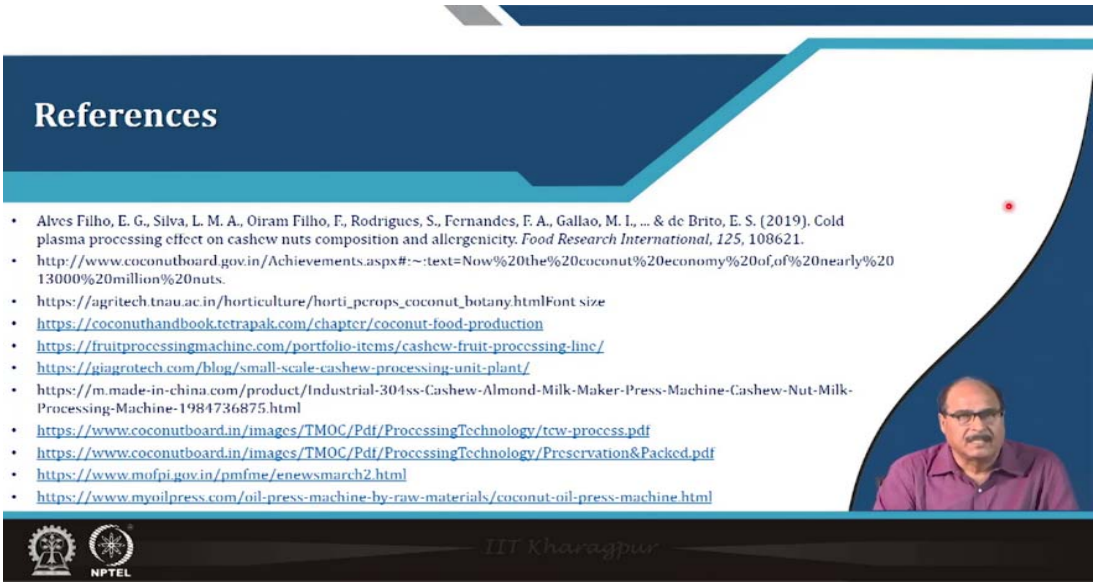
Summary

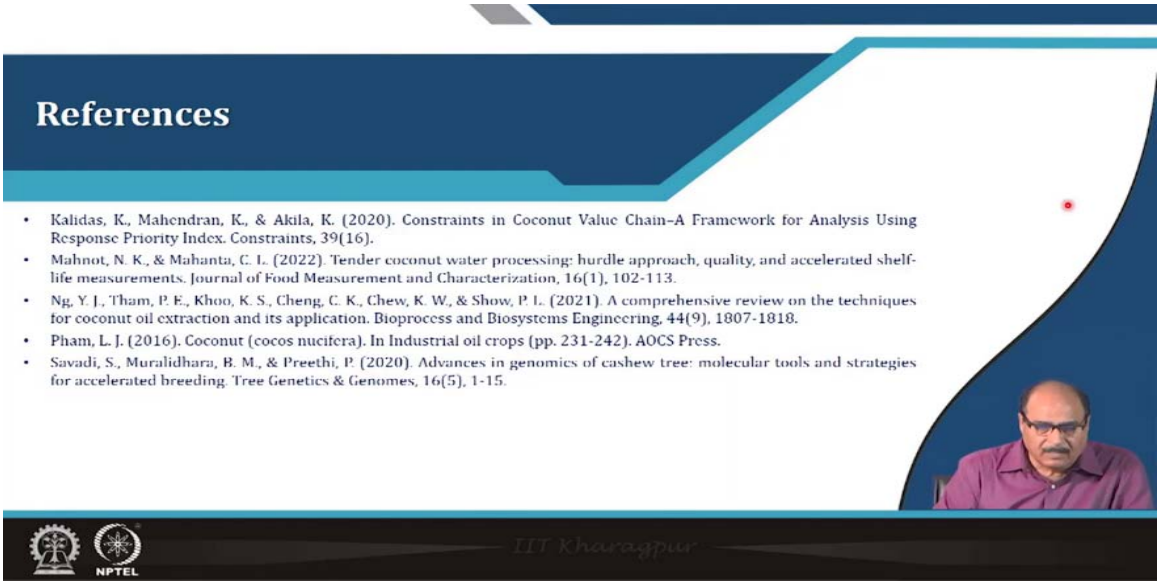


So, what I can summarize that yes, both coconut and cashew processing, these both the products are very important. The coconut is a, first this coconut is taken and then primary processing operation but however, there is a need for mechanization of the coconut industry. So, this atleast coconut pluckers are getting the harvesting the coconut foods from the long bunches of the plant, there should be some mechanical harvester, need to be developed. Some institutions are working on it, but still lot of, lot more work is to be done.

Cashewnut processing, that is, it is an important industry and various products of the cashewnut, both apple and cashewnut products are prepared. And they are available in the market. But still lot is required to be done in both these products. The coconut, as I told, that majority of the coconut is still produced in the country is used domestically and where it has a lot of potential. So, efforts should were made to boost the export of the coconut.

References





With this , I come to the end of this lecture. These are the references which have been used in this. Thank you very much for your patient hearing. Thank you.