Food Oils and Fats: Chemistry and Technology

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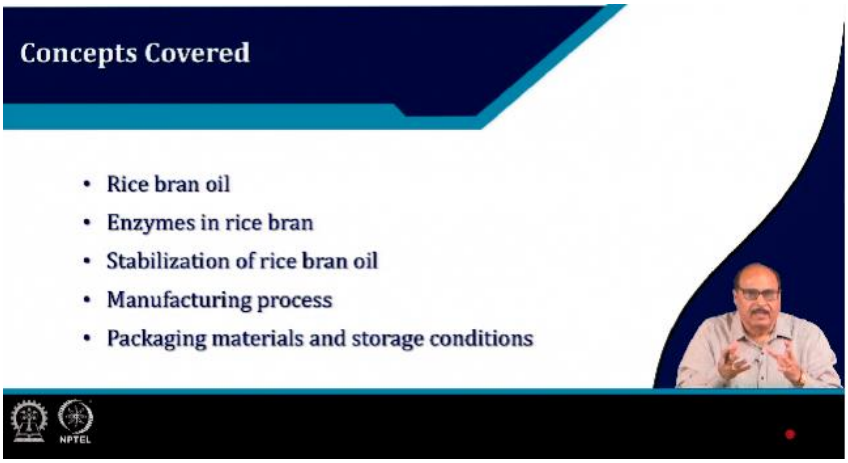
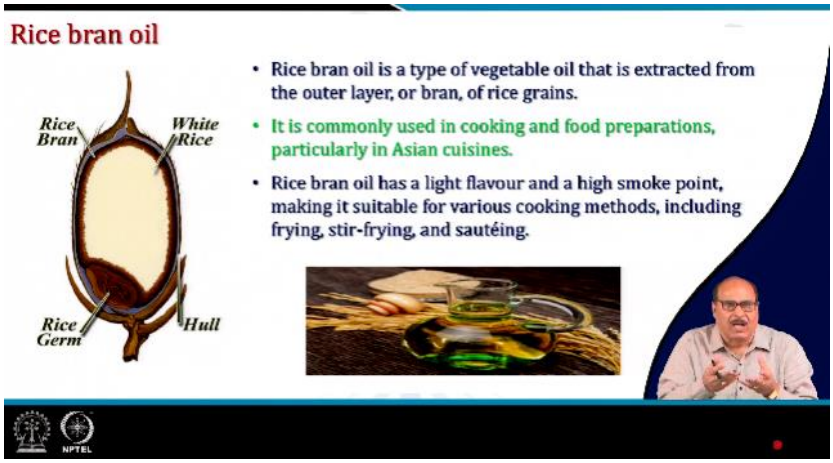
Module 09: Commercial Cooking & Frying Oils

Lecture 45: Rice Bran Oil

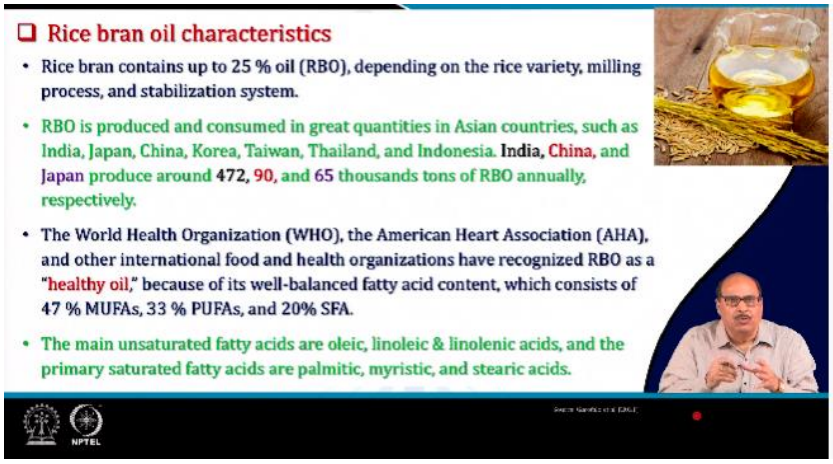
Hello everyone, Namaskar. Now, we are in the 45th lecture of the course. In this lecture today, we will talk about Rice bran oil.



We will discuss what is rice bran oil, what are its important characteristics, then enzymes present in rice bran and accordingly the stabilization of rice bran oil, manufacturing process of rice bran oil and packaging and storage conditions.

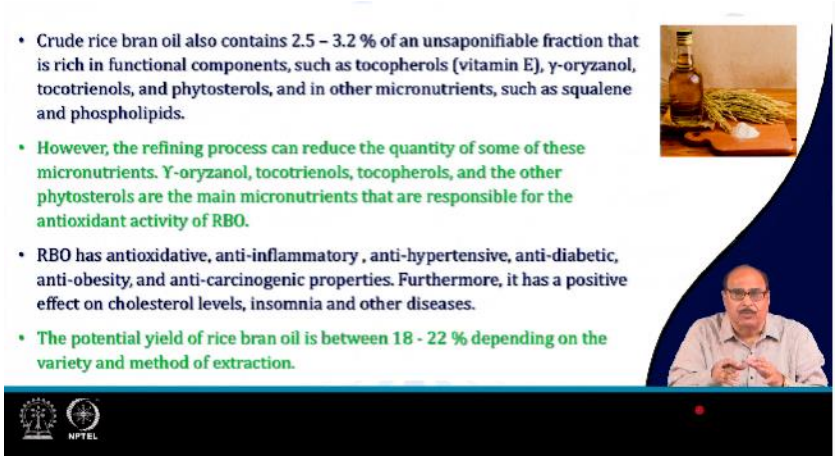


So, let us see what rice bran oil is. Rice contains an starchy endosperm in the end which is covered by a layer that is called rice bran layer and then finally, it is further protected by a that is hull or husk called Paddy husk and it contains a germ rice germ. So, basically that is between husk and starchy endosperm there is a bran layer. So, this bran oil rice bran oil is basically the oil that is extracted from the outer layer or bran of the rice grains. It is commonly used in cooking and food preparations particularly in Asian cousins it is a very popular oil. Rice bran oil has a light flavor and a high smoke point which makes it suitable for various cooking methods including frying stir frying and sauteing.

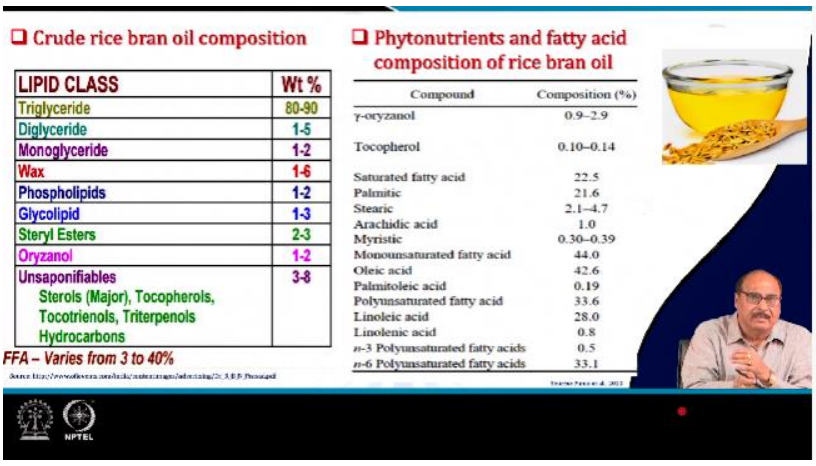


Let us see the characteristics of the rice bran oil. It contains up to 25 percent depending on the of course, variety of the rice milling process and stabilization system that is the bran contains approximately 25 percent oil. Rice bran oil is produced and consumed in great quantities in Asian countries such as India Japan China Korea Taiwan Thailand and Indonesia. India and China Japan they produce around 472,90 and 65,000 tons of rice bran oil annually respectively that is India produces 472,000 tons of rice bran oil annually you can say. The world health organizations the American heart association and other international food and health organizations have recognized rice bran oil as a healthy oil because of its well-balanced fatty acid content which consists of around 47 percent

MUFA, 33 percent PUFA and around 20 percent saturated fatty acids. The main unsaturated fatty acids in rice bran oil are oleic linoleic and linolenic acids and the primary saturated fatty acids include palmitic, myristic and stearic acid.

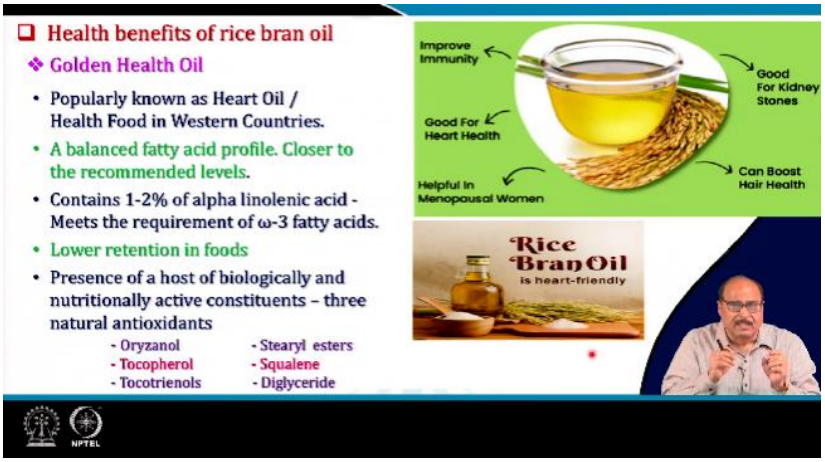


Crude rice bran oil contains around 2.5 to 3.2 percent of an unsaponifiable fraction that is rich in functional components such as tocopherol popularly known as vitamin E, gamma-original, tocotrienols and phytosterols and in it is also rich in other micronutrients such as squalene and phospholipids. However, the refining process which is subjected to crude rice bran oil can reduce the quantity of some of these micronutrient and health promoting components. Γ-oryzanol, tocotrienols, tocopherols and other phytosterols are the main micronutrients that are responsible for the antioxidant activity of rice bran oil. Rice bran oil has antioxidant, anti-inflammatory, anti-hypertensive, anti-diabetic, anti-obesity and anti-carcinogenic properties. Furthermore, it has a positive effect on cholesterol levels, insomnia and other diseases. The potential yield of rice bran oil is between 18 to 22 percent depending on the variety of the priority and method of extraction.

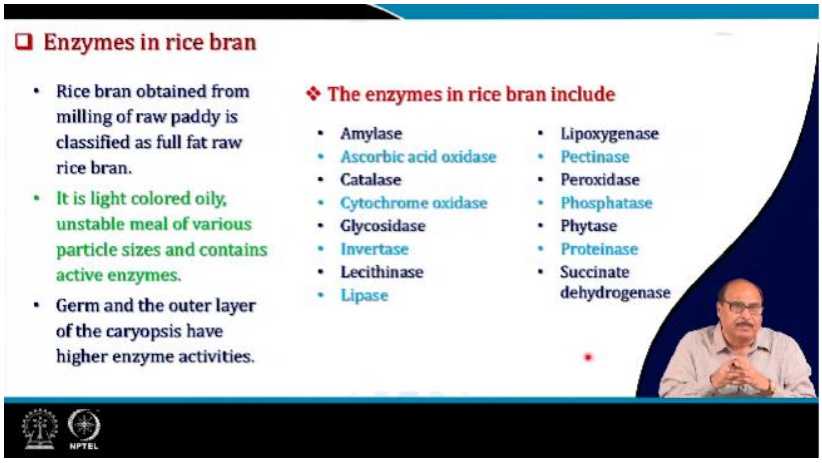


The crude rice bran oil in general contains as I told you about 80 to 90 percent triglycerides and it contains a sterile ester 2 to 3 percent and unsaponifiable matter 3 to 8

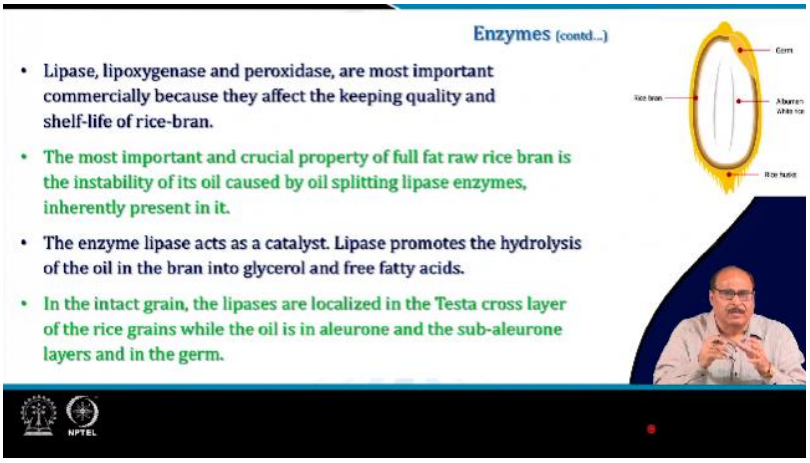
percent. The free fatty acid content depending upon the storage and whether rice bran has been stabilized or not stabilized and other conditions, it may vary from 3 to 40 percent as high as 40 percent. So, the phytonutrients and fatty acid composition of the rice bran oil include that is gamma-original, it contains around 0.9 to 2.9 percent, tocopherol 0. 1 to 0.14 percent. In fact, stearic acid is 2.1 to 4.7 percent, saturated fatty acid 22 percent and monounsaturated 44 percent, oleic 42, linoleic is 28 percent. That omega 3 polyunsaturated fatty acid are 0. 5 percent and omega 6 polyunsaturated fatty acids are around 33 percent in the rice bran oil.



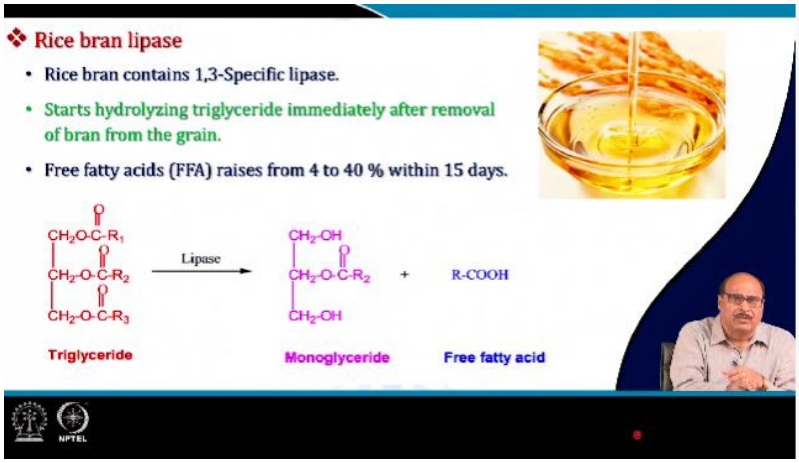
So, let us little bit elaborate the health benefits of rice bran oil like it is a popularly baby very popularly known as golden health oil that is a heart oil, heart health food in it is known as a heart oil or health food in the western country. It has a balance of fatty acid profile, it is closer to the recommended levels, it contains around 1 to 2 percent of polynomial acid that is meets the requirement of omega 3 fatty acids and it lowers the retention in foods. That is presence of a host of biologically and nutritionally activity active constituents in the rice bran include rice bran oil include oryzanol, tocopherol, tocotrienol, stearyl esters, Squalene, diglycerides, etc.



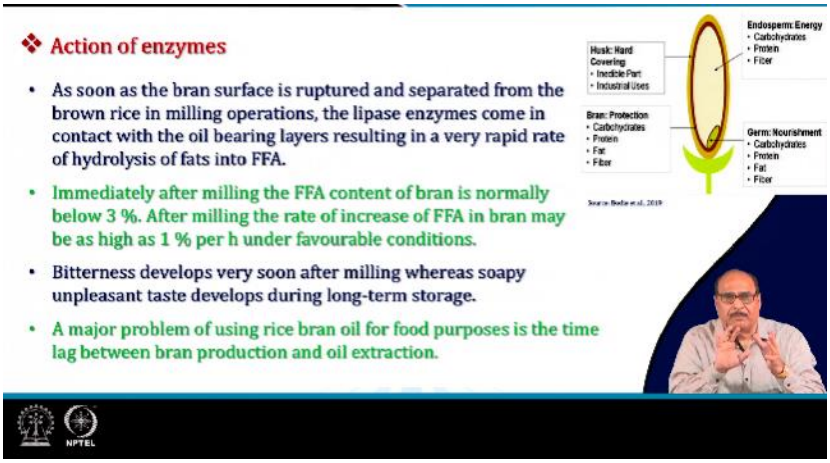
Enzymes are a very important aspect of the rice bran and particularly the rice bran oil that is in the rice bran there are several enzyme that is it contained that is a bran which is obtained from the milling of the raw paddy and is classified as full fat rice bran and it is light coloured oily unstable meal of various particle size and the it contains that is the rice bran contains many active enzymes and germ and other outer layer of the caryopsis have higher enzyme activities than the bran. So, the enzyme normally which are found in the rice bran include amylose, ascorbic acid oxidase, catalase, cytochrome oxidase, glycosidase, invertase, lecithinase, lipase, lipoxygenase, pectinase, peroxidase, phosphatase, phytase, proteinase, succinate, dehydrogenase etc. So, lot of all these enzymes many of these are very useful enzymes and some of them of course, from the rice bran oil stability point of view some are not that good ok.



Similarly, the lipase, lipoxygenase and peroxidase these are although very important commercially because they affect the keeping quality and self life of the rice bran. The most important and crucial properties of full fat raw rice bran is its instability that is that is the instability of its oil caused by oil splitting lipase enzyme ok and which is the lipase enzyme which is inherently present in it. So, it breaks that is lipase it breaks the ester linkage, it hydrolyzes the triglyceride and it increases the fatty acid content the enzyme lipase acts as a catalyst. So, in the intact grain the lipase are localized in the Testa cross layer of the rice grain while in the oil it is in the aleurone and in the sub aleurone layers in the germ.

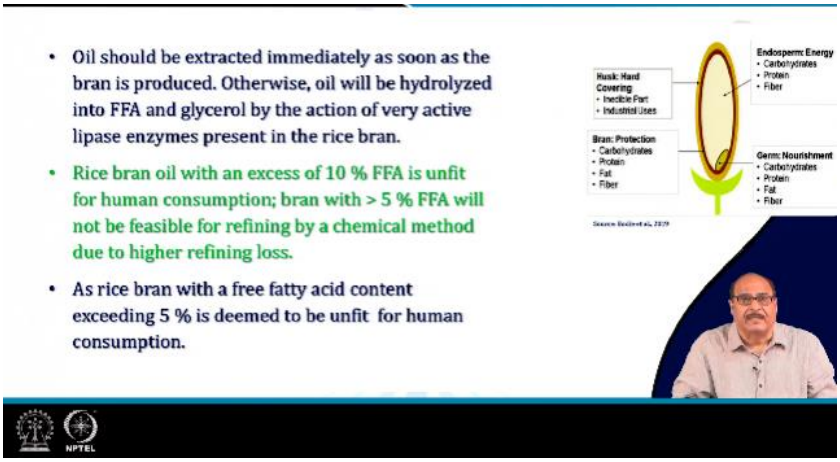


So, this rice bran oil it contains a 1,3-Specific lipase and it starts hydrolyzing that is rice lipase start hydrolyzing the triglyceride immediately after the removal of rice bran and from the grain. And the free fatty acids as I told you it may rise up to even 40 percent within 15 days 10, 15 days of course, depending upon the storage condition and whether if it is not stabilized the enzyme lipase has not been taken care of and when it hydrolyzes the triglyceride are converted into monoglyceride or triglyceride and free fatty acids are released earlier we discussed.

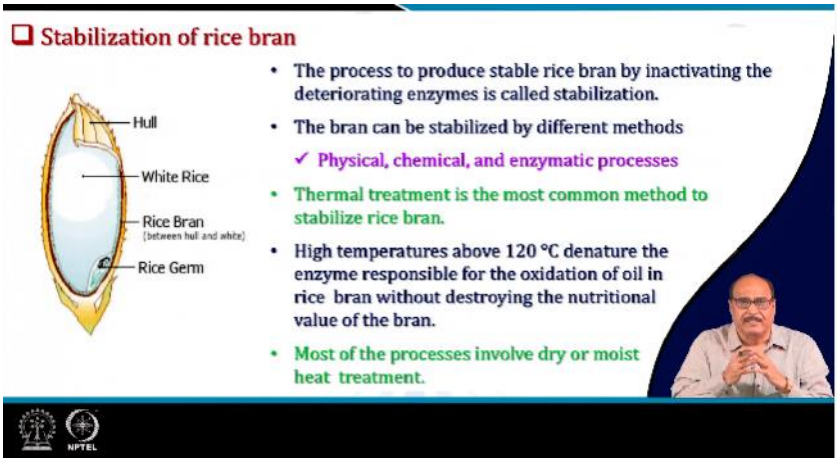


So, as I told you as soon as the bran surfaces surface is ruptured what happen that is the bran surface when it is ruptured and these enzymes are separated from the brown rice in the milling operations the lipase enzyme comes in contact with the oil wearing layers resulting in a very rapid rate of hydrolysis of the fat into FFA. And immediately after milling the FFA content of the bran may be around below 3 percent, but after milling the rate of increase of free fatty acid in the bran may be as high as 1 percent per hour under favorable conditions even that favorable condition is that is the condition which favor the activity of the enzyme. Bitterness develops very soon after milling whereas, soapy unpleasant taste develops during long term storage. So, a major problem of using rice bran oil for food purpose is the time lag between the bran production and oil extraction. If

the oil extraction has process has been delayed and the bran is kept as such before the oil extraction then these changes may take place in the bran.

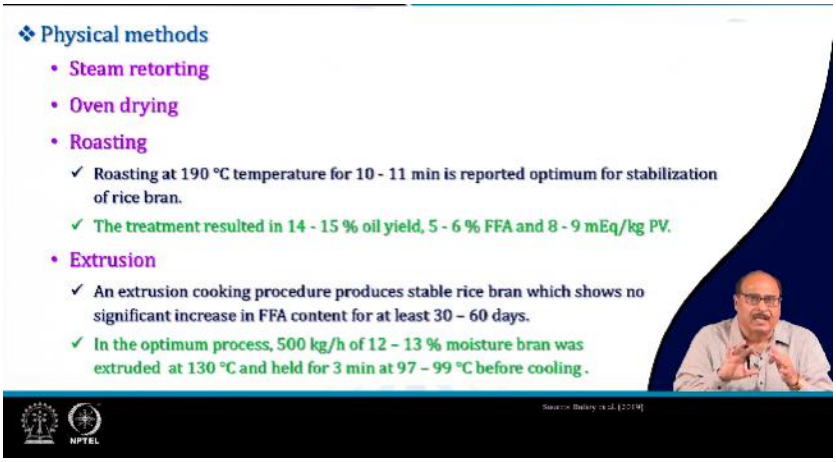


So, basically as a matter of rule the oil should be extracted immediately as soon as the bran is produced. Otherwise oil will be hydrolyzed into free fatty acid and glycerol by the action of that is enzymes and then rice bran oil will with an excess of 10 percent free fatty acids is unfit for human consumption. In fact, bran with more than 5 percent free fatty acids will not be feasible for refining by a chemical method due to the higher refining losses. As rice bran with a free fatty as such rice bran with a 5 percent free fatty acid content exceeding that is the 5 percent is the deemed to be the unfit for the human consumption etc.

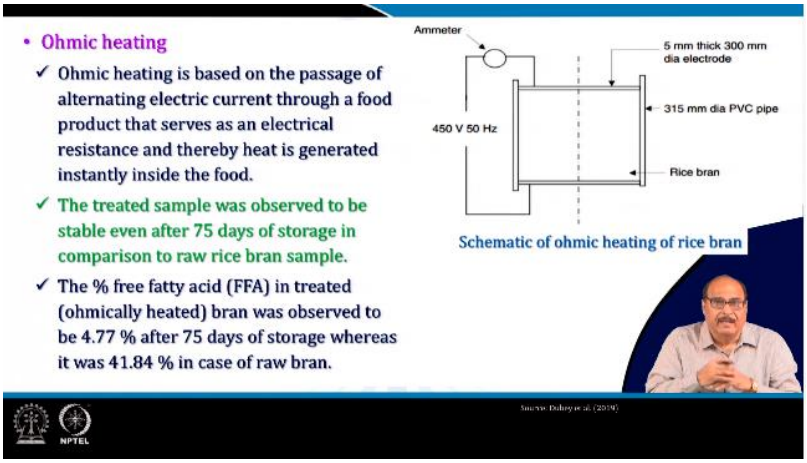


So, now so, keeping all these things stabilization of the rice bran becomes very very important. Stabilization means that is the rice bran before it is subjected to extraction of the oil it must be given some sort of treatment to inactivate this lipase or fat splitting enzymes. So, the process is basically the stabilization process it produces a stable rice bran by inactivating the deteriorative enzymes and this is called a stabilization. The bran can be stabilized by different methods like physical methods, chemical method and

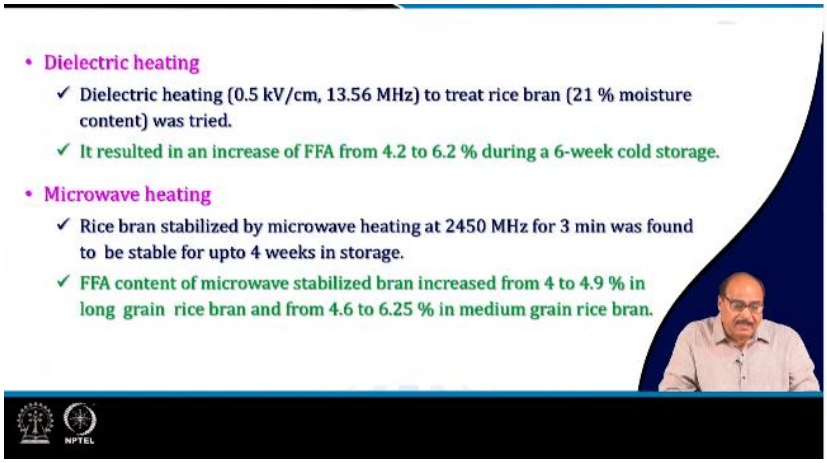
enzymatic methods. Thermal treatment is the most common method which is used to stabilize rice bran. So, in this high temperature above 120°C is bran is exposed to this and which denatures the enzyme responsible for the oxidation of oil and rice bran without destroying the nutritional value of the bran. Most of the processes involve either dry or moist heat treatment.



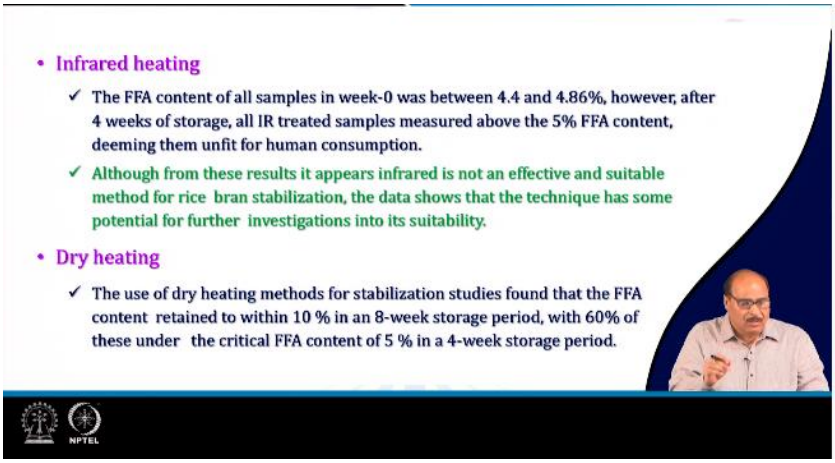
So, the physical method that is of applying the heat treatment like it may be simple steam retorting or pressure cooking or autoclaving of the rice bran or even oven drying more than 100°C temperature can be used here in the oven air drying. But of course, that is here that is the it may the accordingly depending upon the time the process and temperature heat penetration characteristics it may take some time in the process for the complete inactivation of the enzymes. So, the roasting normally at 190°C temperature for 10 to 12, 10 to 11 minute is reported optimum for stabilization of rice bran and the treatment this treatment results in about 14 to 15 percent oil yield which contains 5 to 6 percent free fatty acid and 8 to 9 milli equivalent per kg of peroxides. Extrusion is considered to be another good process for stabilization of the rice bran that is extrusion cooking it produces a stabilized bran which shows no significant increase in free fatty acid content for at least 30 to 60 days of storage under standard conditions. In the optimum process that is 500 kg per hour of 12 to 13 percent moisture bran was extruded at 130°C and held for 3 minute at 97 to 99°C before cooling and it causes the enzyme inactivation.



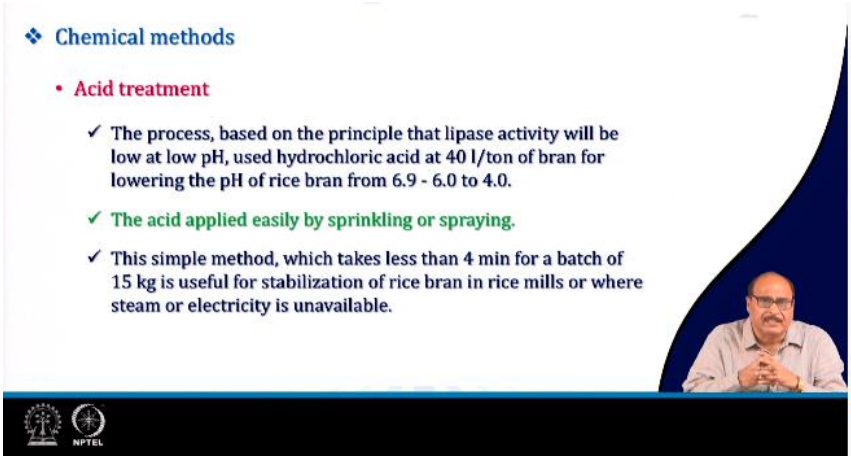
Then ohmic heating is again another important method that is here that is between two electrodes that material is kept and electric through that the electric current is passed through the food and that generates heat. So, the treated sample is observed to be stable even after 75 days of storage in comparison to raw rice bran samples. The percent free fatty acid in treated that is (ohmically heated) rice bran was observed to be about 4.7 percent after 75 days of storage whereas, it was around 42 percent in case of raw rice bran. So, you can see the difference.



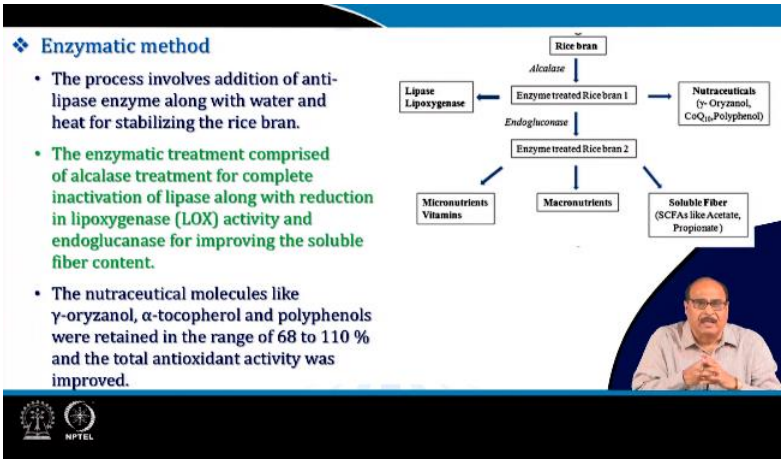
Then dielectric heating or microwave heating they can also be used for stabilization of the rice bran for example, dielectric heating that 0.5 kV per centimeter or 13.56 MHz is used to treat the rice bran containing around 21 percent moisture content and it resulted in an increase in the free fatty acids from 4.2 to 6.2 percent during a 6 weeks cold storage ok. So, it means that there is a significant reduction in the life age activity. Similarly the rice bran was stabilized by microwave heating at 2450MHz for 3 minutes and it was found to be stable that is bran was found to be stable up to 4 weeks in storage. FFA content of microwave stabilized bran increased from 4 to 4.9 percent in long rice bran as well as from 4.6 to 6.25% in medium grain rice bran.



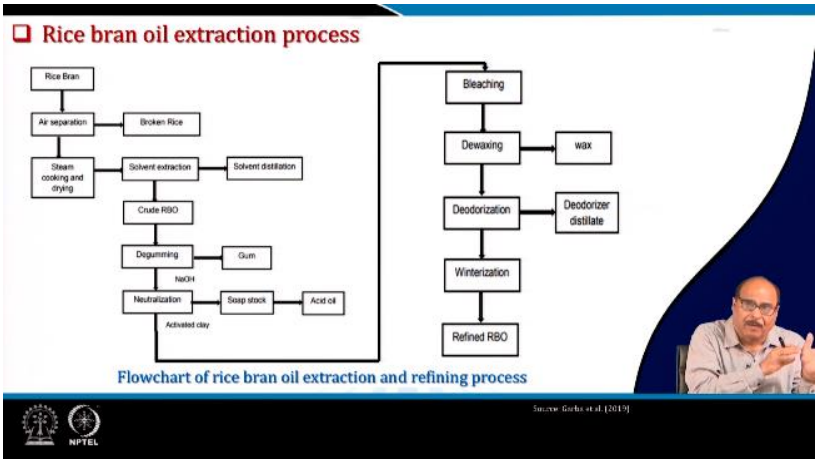
Infrared heating that is the FFA content of the samples that is in week 0 was between 4.4 and 4.86 percent. However the infrared heated sample after 4 weeks of storage the that is the it was the FFA was measured about 5%, deeming them unfit for the human consumption ok. So, although from the results it appears that infrared is not an effective and suitable method for rice bran stabilization. The data shows that the technique has some potential for further investigation into its suitability and the people are working on it and I hope that is the process standardization can be done to treat the rice bran. Dry heating that is use of dry heating method for stabilization studies found that FFA content retained between 10 percent and 8 weeks long storage period. The 60% of these under the critical FFA content of 5 percent in a 4 weeks long storage period.



So, the chemical methods of bran stabilization include number one acid treatment that the this process is based on the principle that lipase activity will be low at low pH. So, if the process used hydrochloric acid at 40 liter per ton of bran for lowering the pH of rice bran from 6.9-6.0 to 4.0 and this becomes unfavorable medium becomes unfavorable for the activity of lipase. So, the acid is applied easily by either sprinkling or by spraying and this simple method which takes less than 4 minute for a batch of 15 kg is useful for stabilization of rice bran in rice mills or where steam or electricity is not available easily.

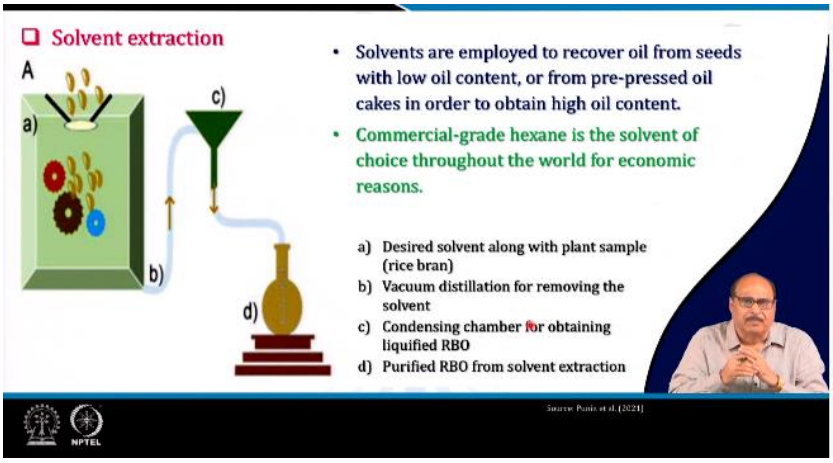


Then enzymatic method is another potential method this process involves the addition of anti-lipase enzymes along with water and heat for stabilizing the rice bran. The enzymatic treatment comprised of alcalase treatment for complete inactivation of lipase along with reduction in lipoxygenase activity and endoglucanase for improving the soluble fiber content. The nutraceutical molecules like γ-oryzanol, α-tocopherol and polyphenols were retained in the range of 68 to 110% and the total antioxidant activity was improved by enzyme stabilized rice bran.

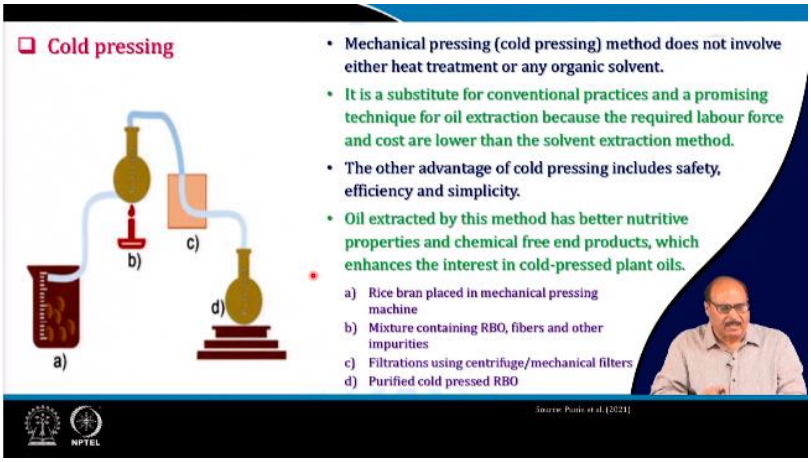


So, after this stabilization obviously, the rice bran after the milling the bran is collected bran is immediately it is an enzyme treated or stabilized lipase it is treated either by enzyme or by heat or by acid etcetera chemical whatever method is there. So, after the rice bran is stabilized enzymes are inactivated then it is subjected to the extraction process and the extraction is done as usual like in any material rice bran air suppressor broken rice, steam by cooking then it is normally there is solvent extraction because the bran is a very hard particles and pressing etcetera may not work here. So, it is subjected to the solvent extraction process and the miscella is obtained and miscella oil is separated by the solvent distillation. Then by this process crude rice bran oil is obtained and this crude rice bran oil again is subjected to refining treatment as discussed in the earlier

classes standard processes. So, therefore, the process parameter may little bit vary depending upon the content like various impurities present in the oil like in the degumming, neutralization, bleaching, dewaxing, deodorization and finally, winterization. So, these are the crude rice bran is passed through all these operations and finally, the refined rice bran oil is obtained.

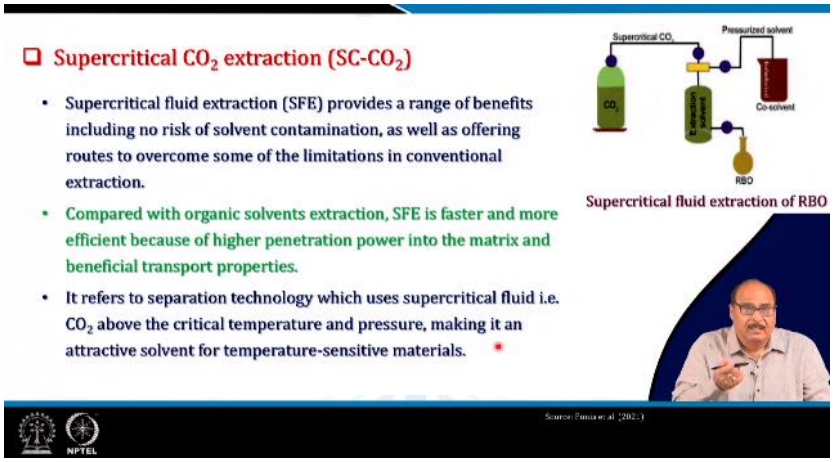


Now, let me particularly for the specific some parameter for the rice bran that solvent extraction. So, commercial grade solvent which is used in the solvent extraction of rice bran oil is a hexane. And as you see that there is a setup in the extracted desired solvent along with the plant sample rice bran is kept and it is done in the vacuum distillation for the removing of the solvent after the from the miscella and then condensing chamber it is passed through the condensing chamber for obtaining the liquefied rice bran oil. So, the purified rice bran oil is extracted from the after the solvent extraction it is after collected. So, this is just schematic representation.

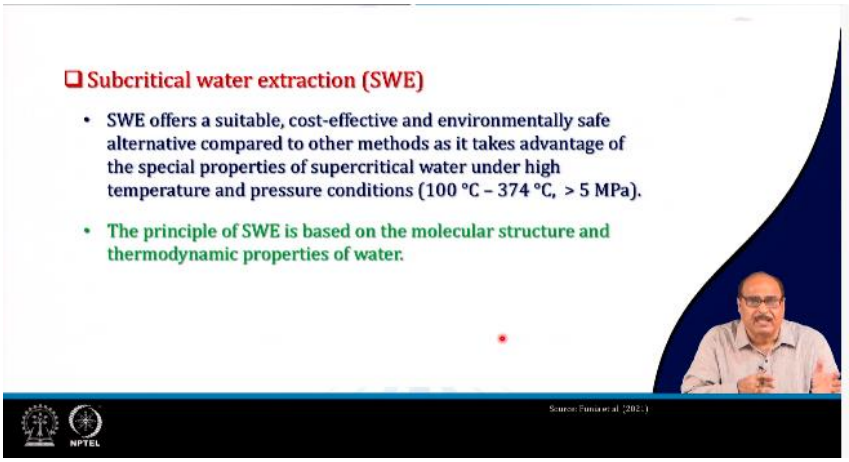


Then cold pressing of course, that is as I told you although it is very difficult, but sometime mechanical pressing there is a screw spelling etcetera there is the opposite does not involve either heat treatment or any organic solvent, but it is a substitute for

conventional practices and promising technique for oil extraction because it requires a labour force and cost are lower. But however, in the rice bran oil it may not very it may not be very useful, but if at all it can be tried rice bran is placed in the mechanical pressing machine then mixture containing rice bran oil fibers and other impurities are obtained then filtration is done using centrifuge mechanical filter and purified cold rice bran oil is obtained, but the efficiency yield will be comparatively low here. Of course, if this rice bran is given some pretreatments like PEA or another thing ultrasonic fabrication etc then this cold pressing may work.

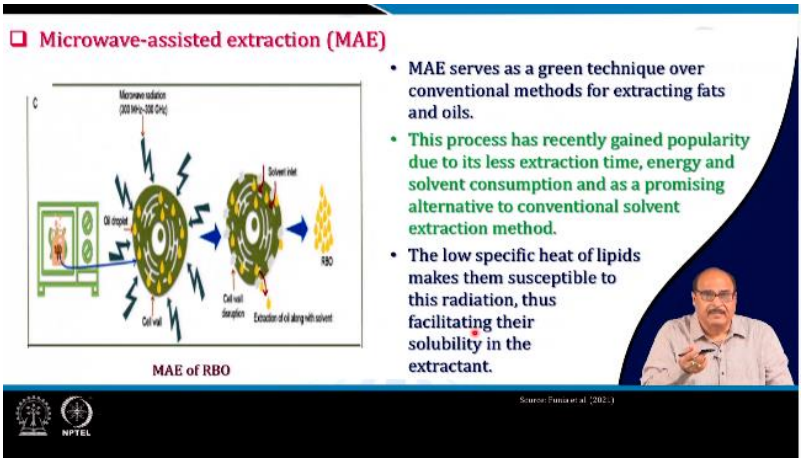


Then supercritical carbon dioxide extraction in earlier classes we have discussed in detail the supercritical extraction principle. So, I will compare with other organic solvent supercritical fluid extraction which is faster and more efficient because of higher penetration power into the matrix and it is beneficial transport property. So, it refers to separation technology which uses which uses supercritical fluid as a carbon dioxide and above the critical pressure and temperature.

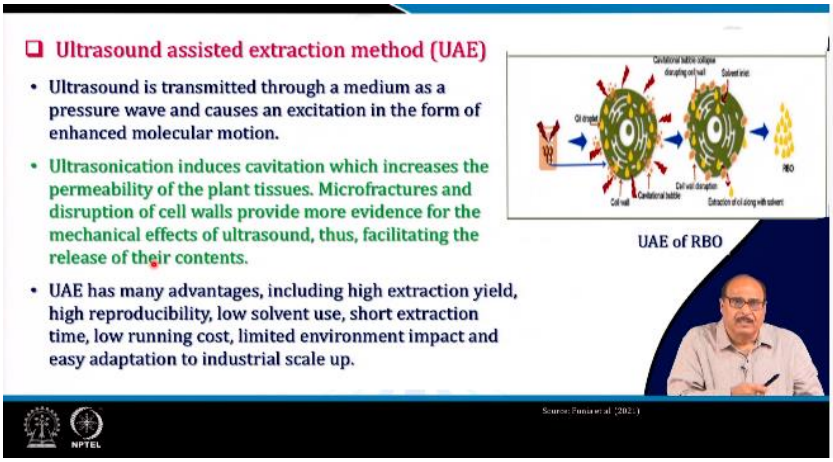


So, also another potential technology is the subcritical water extraction (SWE). It offers a cost effective and environmentally safe alternative compared to other methods as it takes

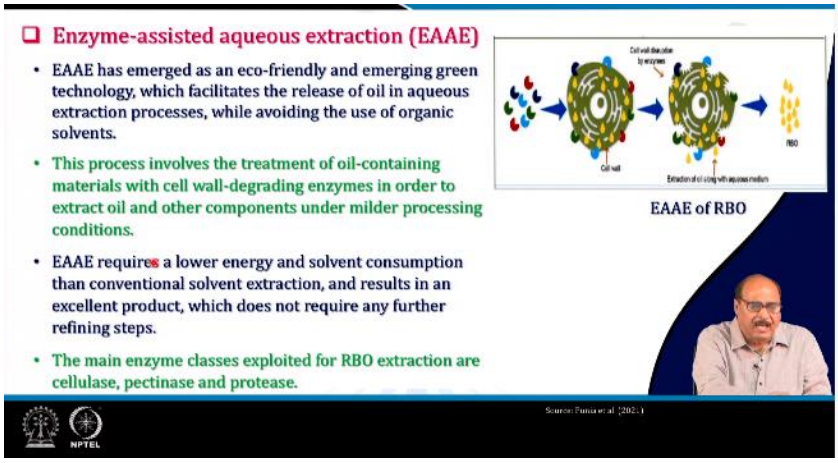
advantage of the special properties of the supercritical water under high temperature and pressure conditions that is the conditions are 100°C temperature to 374°C and pressure more than 5MPa. And the principle of supercritical water extraction is based on the a principle of subcritical water extraction is based on the molecular structure and thermodynamic properties of the water.



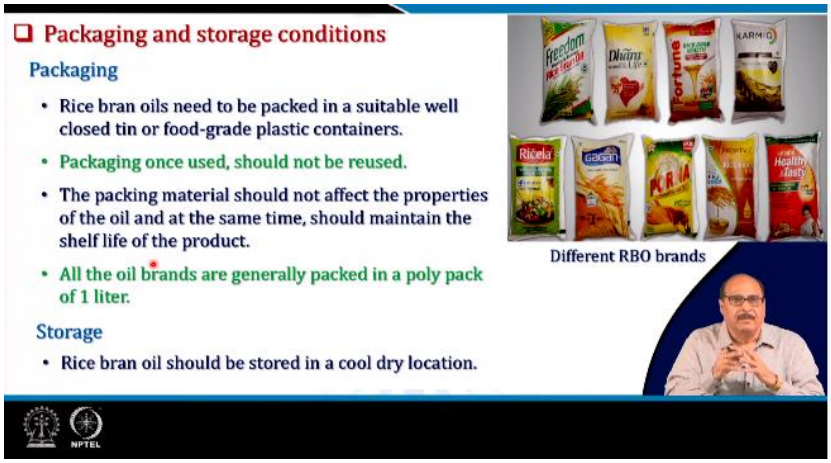
Microwave treatment is a green technique over the conventional methods for extracting the fats. And this process particularly has in recently gained popularity due to its less extraction time energy and solvent consumption as a promising alternative for the conventional solvent solution. So, in this case that is the through there is a suitable microwave generation source and in this cavity microwave the rice brands they are exposed to microwave and these microwaves because of the there is a some it causes the breakage of the cell wall due to the molecular movement inside material when the microwaves penetrates into it. Then try to align to the oppositely charged poles and then it causes the fraction and rupture and this causes low specific heat of liquids makes it them susceptible to this radiation and thus it facilitates the solubility in the extractant because of this there is the movement of the material becomes better.



Similarly same principle works on the ultrasound assisted extraction method for. So, as I told you after giving this ultrasound extraction treatment or microwave treatment or even other such treatment that is here it increases the pore size and like ultrasound treatment the ultrasonication it induces cavitation and increases the permeability of the plant tissues. So, micro fractures and are created and disruptions of cell wall are there and which provide more evidence for the mechanical effects of ultrasound thus facilitating the release of their content that is the it has an ultrasound has many advantages including high extraction yield, high reproducibility, low solvent use, short extraction time and low running cost because of the creation of pores etc. And then the material extraction remove that is an easy flow and yield increase to ultrasound assisted bran or even microwave treated bran etc or even PF pulse electric field treated brans they can be then subjected to either solvent extraction or also mechanical extraction.

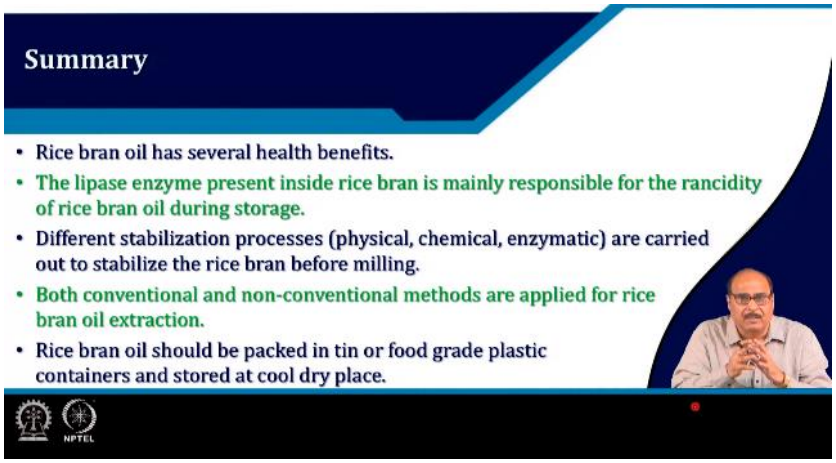


Then there is another enzyme assisted aqueous extraction as well this is also a good promising technology because enzymes this is the it has emerged an eco-friendly and emerging green technology which facilitates the release of oil in the aqueous extraction process while avoiding the use of any organic solvents. And the principle is seen here that there are certain cell wall degrade the enzymes are used and these enzymes when it is given mixture of enzymes when this bran is exposed to this then cell wall that is a which is cover the oil droplets etc they are broken and it releases this cell that is oil and its extraction becomes easier. The main enzymes which are used here are cellulose, pectinase and proteases.

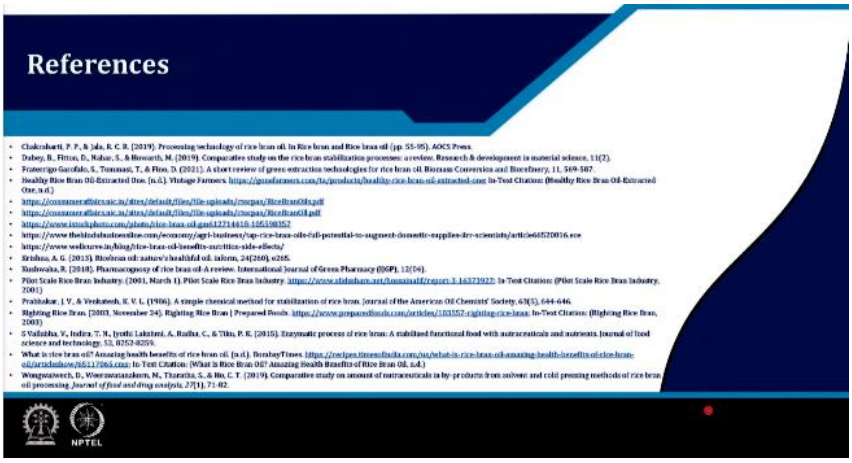


Then finally, packaging and storage condition that is rice bran oil needs to be packaged in suitable well closed tin or food grade plastic material packaging once used should not be reused and the packaging material should not affect the properties of the oil and at the same time it should maintain the shelf life of the product. All the oil brands are generally packaged in a poly pack of 1 litre nowadays these are becoming very popular in the Indian market as well as in the international market that is poly pack of 1 litre consumer packs. Rice bran oil should be stored in a cool dry location.

These are some of the pictures of the some of the common popular brands of Indian brands of rice bran oil.



So, finally, I will summarize this lecture by saying that yes rice bran oil has several health benefits it is a golden health oils. However the lipase enzyme present inside the bran they may cause problem in the bran as well as in the oil they and they may reduce the shelf life ok. And therefore, it needs to be stabilized inactivated that is inactivated life as activity need to be controlled to extend the shelf life of the bran as well as keeping quality of the oil. So, different stabilization process like physical chemical enzymatic process is carried out due to stabilize the rice bran before milling and both conventional and non-conventional method are applied for rice bran oil extraction ok. In the non-conventional method like PF, microwave and this enzyme treatment enzyme extraction etcetera that may be helpful in getting the better oil recovery better oil quality ok. Rice bran oil should be packaged in tin or food grade plastic containers and they should be stored in cool dry place.



So, these are the references that were used to prepare this lecture with this. Thank you very much for your patience here.