Food Oils and Fats: Chemistry and Technology

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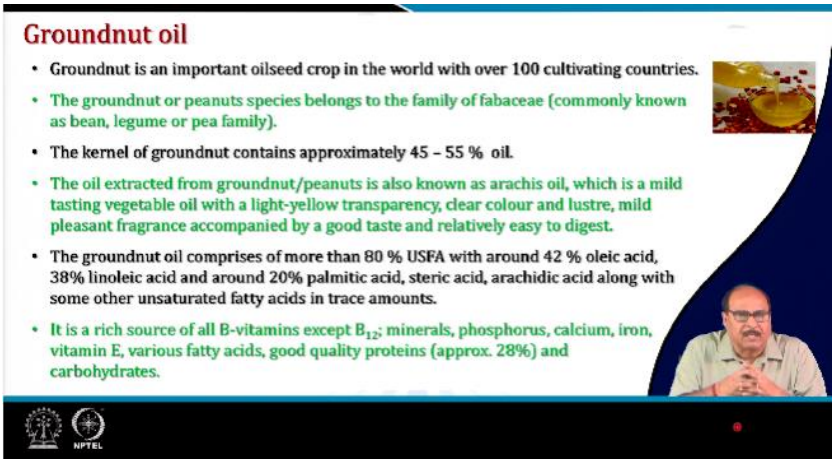
Module 09: Cooking & Frying Oils

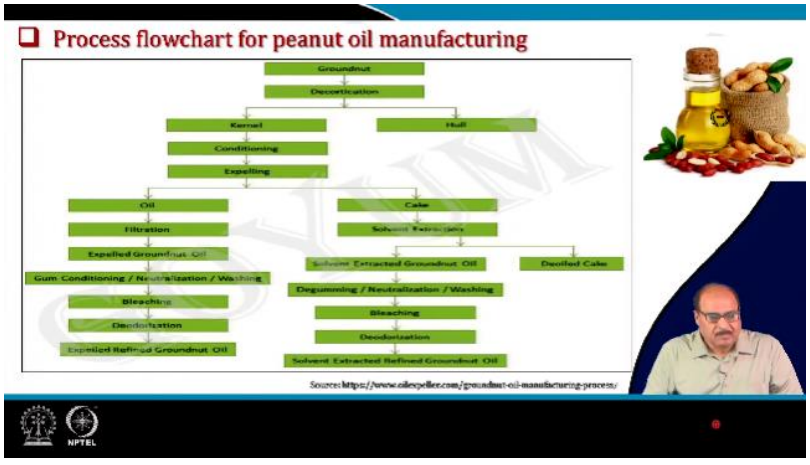
Lecture 43: Seed Oils

Hello everyone, Namaste. Now, in this 43rd lecture of the course, we will talk about seed oils.

We will discuss characteristic properties, manufacturing process, packaging and storage conditions of major seed oils that is groundnut oil, sunflower oil, mustard oil, sesame oil, soybean oil and flaxseed oil.

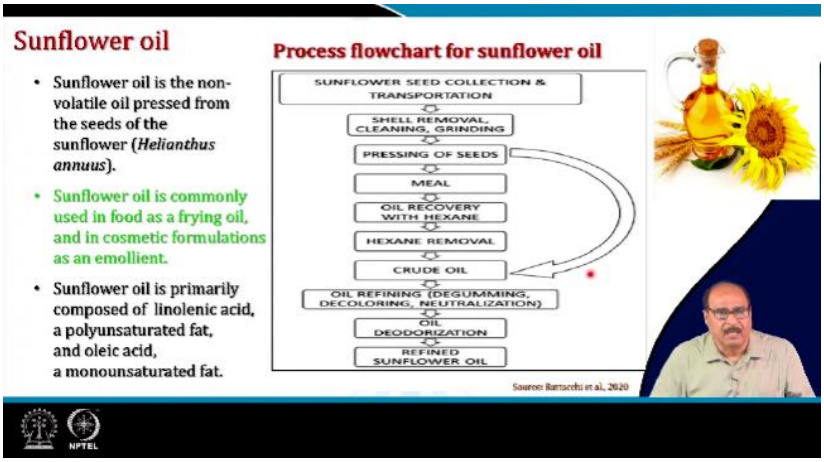


Let us start first with the groundnut oil. You know groundnut is an important oil seed crop in the world with over 100 cultivating countries. The groundnut or peanut species belong to the family *Fabaceae* commonly known as bean, legume or pea family. The kernel of groundnut contains approximately 45 to 55 percent oil. The oil extracted from the groundnut or peanut is also known as arachis oil which is a mild tasting vegetable oil with a light yellow transparency, clear color and luster. And pleasant fragrance accompanied by a good taste and relatively easy to digest. The groundnut oil comprises of more than 80 percent unsaturated fatty acids with around 42 percent oleic acid, 38 percent linoleic acid and around 20 percent palmitic, stearic, arachidic acid along with some other unsaturated fatty acids in the trace amounts. It is a rich source of all B vitamins except vitamin B_{12}. It also is a rich source of minerals, phosphorus, calcium, iron, vitamin E, various fatty acids and it contains good quality proteins approximately 28 percent protein and carbohydrates.

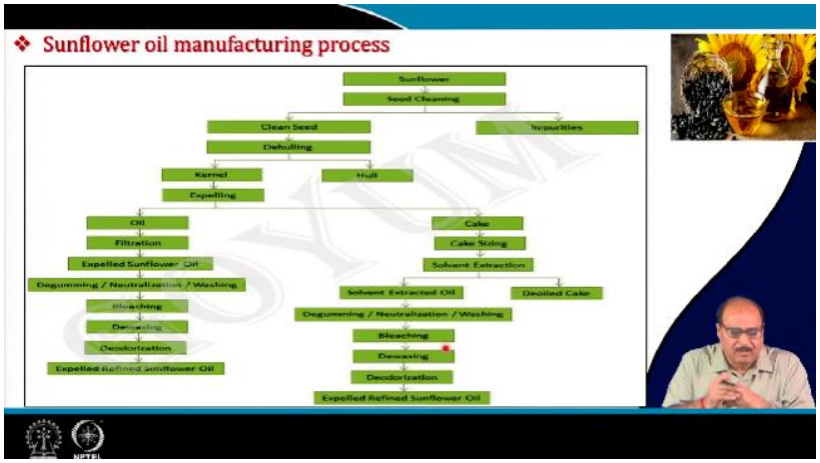


Process flow chart here for the peanut oil manufacturing normally the groundnut which is first operation is it decorticated and then the kernel is obtained and hull is obtained. The kernels are conditioned and they are expelling conditions that is from because the kernel of the groundnut is very soft. So, just by first initially simple application of pressure some

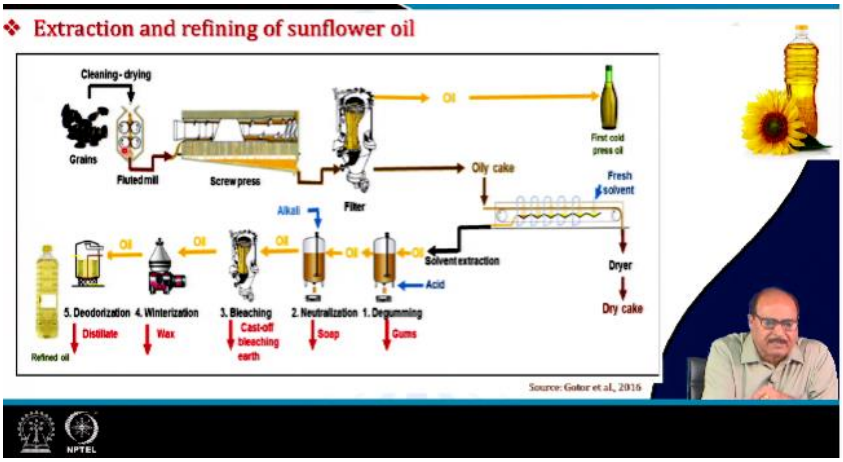
significant quantity of oil is released. So, that is done by expelling the oil is obtained and the oil is then subjected to filtration, that is you get expelled ground nut oil and conditioning gum conditioning, neutralization, washing, bleaching, deodorization or other refining process that which we discussed earlier. I have dealt with all those operations that what are how the ground nut can be decorticated in any general process. So, after expelling the cake which is obtained that this cake is further subjected to solvent extraction and after solvent extraction it is passed into the normal neutralization, bleaching, degumming and deodorization operations and the de-oiled cake which is obtained was processed for removal of the solvent and other process which we already discussed in earlier lectures in this course. And the cake that is the ground nut cake after the proper removal of solvent residual, it can be used for its protein quality and carbon quality. It is very good and it can be used for many food product developments.



Then we talk about sunflower oil, sunflower oil is the non-volatile oil pressed from the seeds of the sunflower. Sunflower oil is commonly used in food as a frying oil and in cosmetic formulation as an emollient sunflower oil is primarily composed of linolenic acid which is a polyunsaturated fat and it also contains oleic acid that is the monounsaturated fat. So, here again the process flow chart for the sunflower manufacturer the sunflower seeds are collected and then its removal of the cells etc. The cleaning, grinding using a standard post harvest operations. Then the seed is obtained and the seed is pressed like ground nut here sunflower seed also is a very soft. So, just it is pressed oil is obtained the crude oil and the meal is then the meal is again it is subjected to solvent extraction. So, remainder a part of the oil is obtained by pressing and a part is obtained by the solvent extraction. So, generally there is three pressed solvent extraction and then the crude oil which is obtained either by both the methods. They are filtered refined like refining treatment like degumming, decolorization, neutralization etc then deodorization and finally, the packaging these oils are packaged.

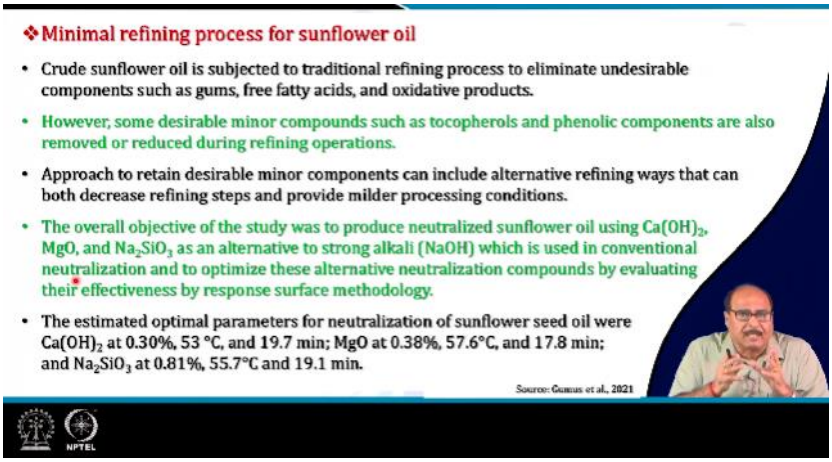


So, this is the process flow chart sunflower oil seed cleaning. So, clean seed dehulled then kernel is obtained and the hulls are blown off. The kernel the dehulled kernels they are used now expeller expelling like screw spelling are just simple by mechanical pressing the oil is obtained and it is subjected to crude oil it is refined and you get the refined sunflower oil. The cake which is obtained the cake is then again it is sized or flagged and it is subjected to solvent extraction treatment using the standard operating protocol. You got this all process in general process parameter and their effect on the quality. So, de-oiled cake is obtained and it is further utilized for the poor product manufacture.

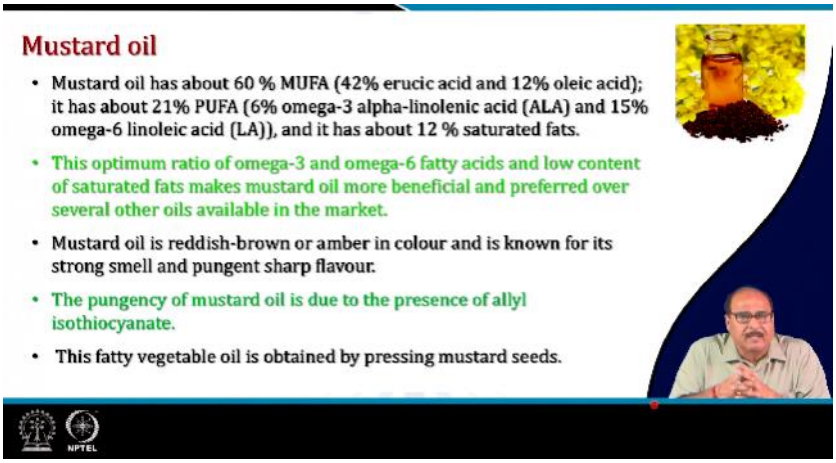


So, extraction and refining of sunflower oil schematic presentation you see here the grains, the sunflower grains are obtained. Then it is passed to the fluted mill screw press where is from the screw press it is the oil is obtained and oil it is filtered and first cold press sunflower oil can also be it is also available in the market as a cold press sunflower oil. Then this oil cake which is after a screw spelling the oil cake which is obtained it is passed to the solvent extraction. Dry cake after and after the solvent extraction this now degumming, neutralization, bleaching, mineralization, deodorization and refined

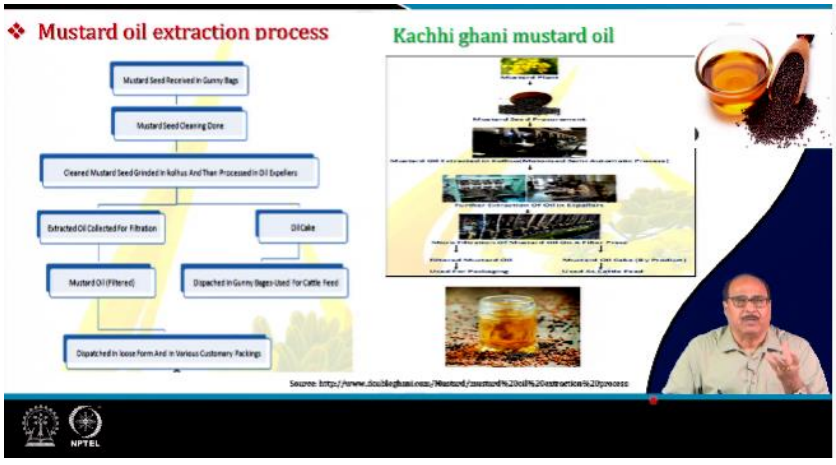
sunflower oil. So, this gives complete process flow chart for the sunflower oil manufacturing.



Now, because this sunflower oil it has a very good quality of the polyunsaturated fatty acids then. So, there are certain effort to control or the minimize the damages to these free fatty acid rather. So, there are some researchers are already working they have reported that minimal refining process for sunflower oil which results into obviously, the minimum changes in the quality characteristics particularly MUFA:PUFA ratio and other things help well. So, crude salt flower oil is in this case subjected to that some changes that the refining process traditional refining process is little bit change. So, here approach here is to retain the desirable minor component otherwise in the traditional process this tocopherols and other antioxidants etc that they are also removed. So, in the minimal refining process the change which is suggested here the approach here is to retain the desirable compounds alright. Overall that is a study had been reported where it was conducted to produce neutralized sunflower oil using calcium hydroxide, magnesium oxide or sodium silicate as an alternative to strong alkalis like NOH and this is used in NOH is used in the conventional neutralization process. So, this people researchers have tried to replace this conventional alkali refining with the magnesium oxide, calcium hydroxide or sodium silicate etc, and evaluated their effectiveness by response surface methodology or other statistical method. And the estimated optimal parameters for neutralizations are reported for the sunflower seed oil were reported as the calcium hydroxide at the 0.3 percent, concentration 53°C and 19.7 minutes magnesium hydroxide 0.3, 8% concentration 57°C and 17.8 minutes. Similarly, sodium silicate at 0. 81 percent concentration 55.7°C temperature and 19.1 minute. These are the optimum conditions and these conditions are reported to better retain the desirable components in the sunflower oil in comparison to the conventional process.

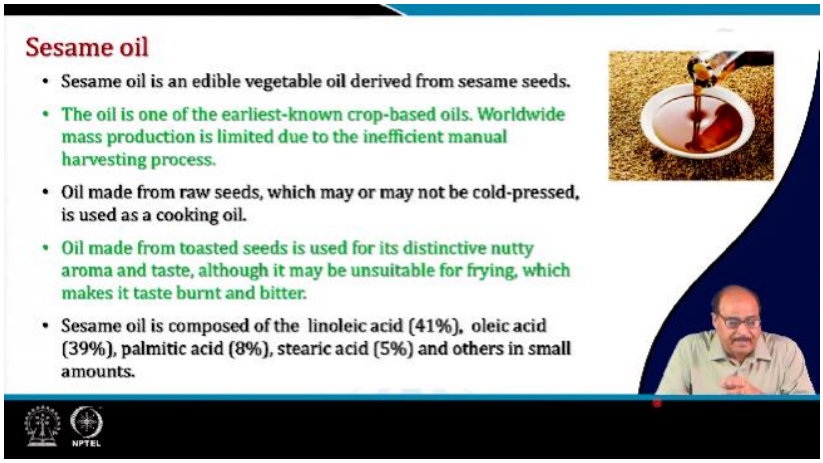


Mustard oil has about 60 percent monounsaturated fatty acid including 42 percent erucic acid and 12 percent oleic acid. It has about 21 percent PUPA like 6 percent omega-3 alpha-linolenic acid and 15% omega-6 linoleic acid and it has about 12 percent saturated fats. This optimum ratio of omega-3 and omega-6 fatty acids and low content of saturated fats make mustard oil more beneficial and preferred over several other oils available in the market. Even also the mustard oil is reddish brown or amber in color and it is known for its strong smell and pungent sharp flavor. The pungency of the mustard oil is due to the presence of allyl isothiocyanate in it and many fact that is the consumers they like this pungent flavor and taste of the mustard oil. And accordingly there are in the market even the mustard oil double filter mustard oil is many or even Kachi Ghani mustard oil is just after filtration. Otherwise in the refining process there is characteristic flavor is lost. So, this fatty vegetable oil is obtained by pressing the mustard seeds.

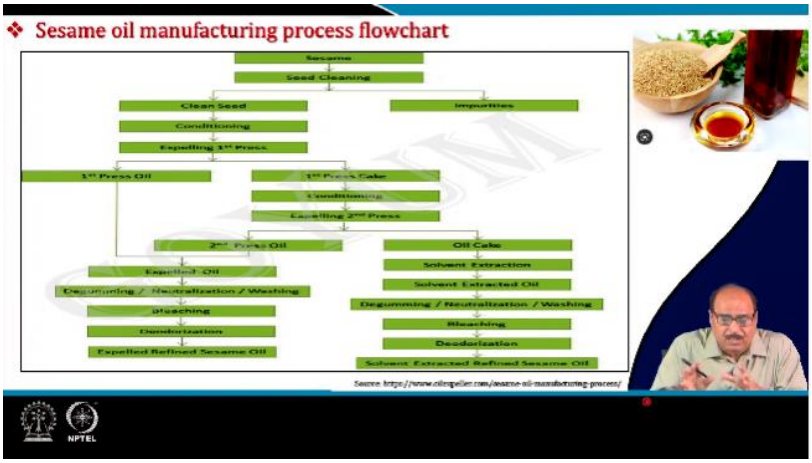


The mustard seeds also are very there is a soft in nature and very small. So, just by simple pressing, the oil can be extracted. So, the mustard seed it is taken and then it is a obviously, cleaning and one precaution is to be taken into the mustard seed that is the moisture content is controlled between may be less than 9 percent or approximately 9 to 12 percent. If the moisture content goes beyond this then during when it is crushed then

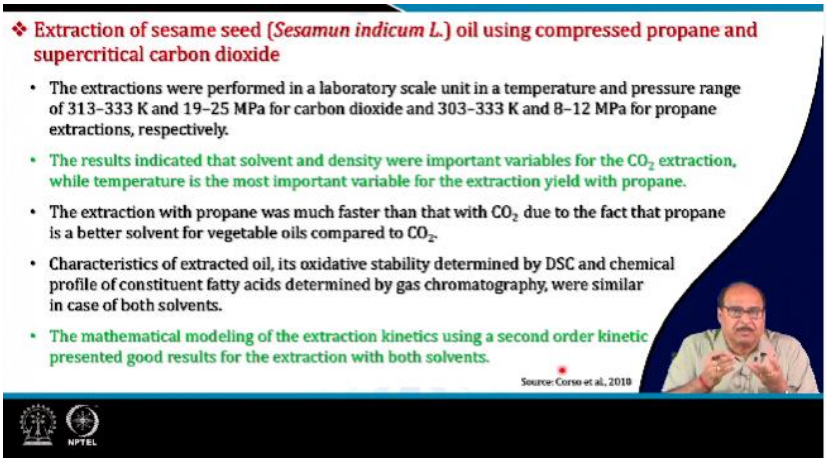
this moisture may cause the activation of the enzymes etc. And this enzymes may convert this itocyanates etcetera into hydrocyanic acids that results some water toxicity in the particularly cake. And that is the reason why the mustard oil seed cake is a normally not good for human feed because of this conversion. So, if this care is taken that this it ensured that the proper moisture content and or some heat treatment is given so that the enzymes are inactivated before the seeds are cracked etcetera ok. So, the it is a then crushed mustard oil it is crushed in kool hoos are processed oil is very popular in India here that Khadi and village industries commissions they are have they use that kachig ghani oil they are available in the market. And also this the kachig ghani normally in the earlier classes we have discussed detail how it is operated that is the bullocks etcetera is used to operate this machine that is a solar monitor in the villages and the kbic ghani's are there where this bullock power animal power is replaced with the electrical motor power and, but this kachig ghani oil oils are considered to be very good.



Then sesame oil it is again an edible oil that is edible vegetable oil derived from sesame seeds. The oil is one of the earliest known crop based oil worldwide mass production is limited due to the inefficient manual harvesting practices ok. Oil that is made from the raw seeds which may or may not be cold press and it is used as a cooking oil. Oil made from the toasted seeds toasted sesame seed is used for a distinct to nutty aroma and taste because during toasting operation typical taste is developed and which is transferred to oil although it may be unstable for frying which makes the taste burnt and bitter. Sesame oil is composed of the linoleic acid there are 41 percent, oleic acid 39 percent, palmitic acid 8 percent, stearic acid 5 percent and other acid in small quantity.

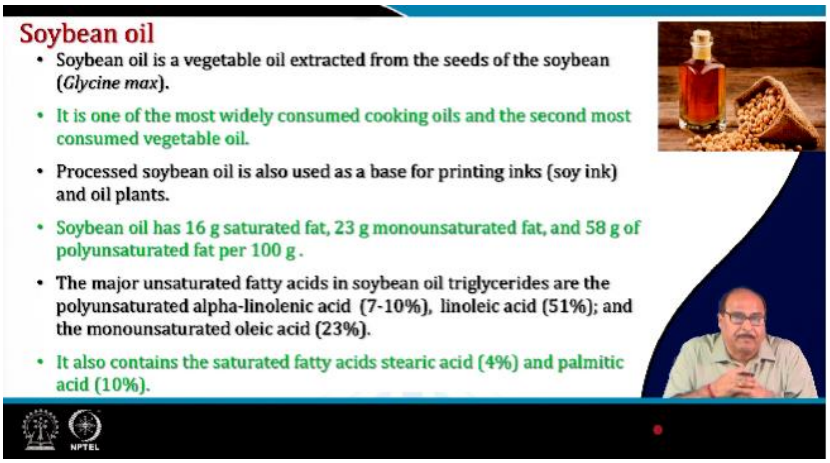


Like other cases here also sesame oil is again a soft seed ok. So, post harvest operation subjected after that is harvested from the field then seed cleaning, then clean seed is taken it is conditioned and then subjected to first press expelling ok. So, first press oil is obtained and then the cake is obtained then again it is conditioned and subjected to second press expelling. So, first press expressed oil and second press expressed oil are taken these are the expressed oil and then degum, neutralization, bleaching etcetera all the standard refining operation it is subjected to and you get expelled refined sesame oil. And then now the cake which is obtained upper first pressing or second pressing later on this cake is subjected to again solvent extraction to improve the efficiency of oil to recover most of the oil from this cake is further subjected to solvent extraction process and the solvent extracted oil is a send for the refining, degum refining at the standard protocol and you get the solvent extracted refined sesame oil ok.

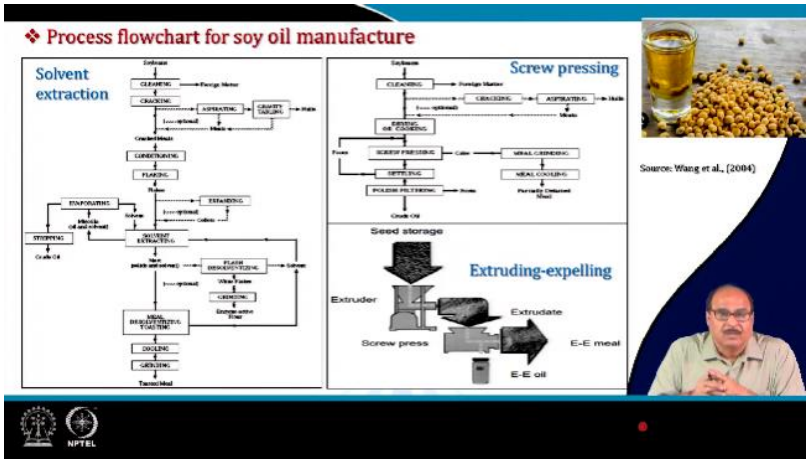


Then again this because of this specific characteristic qualities extraction of sesame seed oil using this compressed propane and supercritical carbon dioxide that is it people have worked ok and they have reported that is the in the solvent and the supercritical although the supercritical carbon dioxide in earlier we discussed that in the extract solvent extraction that is it is an emerging process that is can be used for almost all oil. So, for

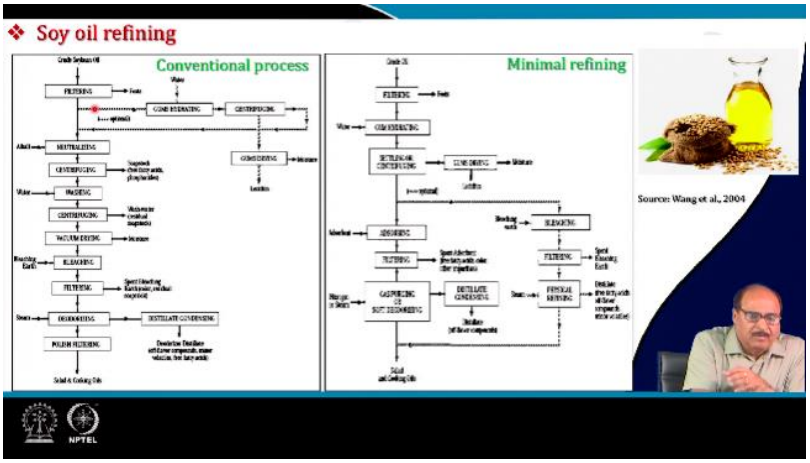
the sesame oil the extractions were performed in a laboratory scale unit in a temperature and pressure range of 313 to 333 K and 19 to 25 mega Pascal and carbon dioxide for carbon dioxide and 303 to 333 K and 8 to 12 mega Pascal for propane extractions respectively. And the results of the study which was reported by Corosso et al it indicated that the solvent and density were the important variables for the carbon dioxide extraction while temperature was the most important variable for the extraction yield with the propane. The extraction with propane was much faster than that with the carbon dioxide due to the fact that propane is a better solvent for vegetable oil compared to carbon dioxide. Economics of extracted oil its oxidative stability determined by the DSC and other chemical methods ok or profile of the chemical profile of the constituents by THH determined by the GC were similar in case of however, both the solvent whether it was carbon dioxide or it was propane. The mathematical modeling of the extraction kinetics using the second order kinetic presented good results for the extraction of this sesame oil with both the solvents.



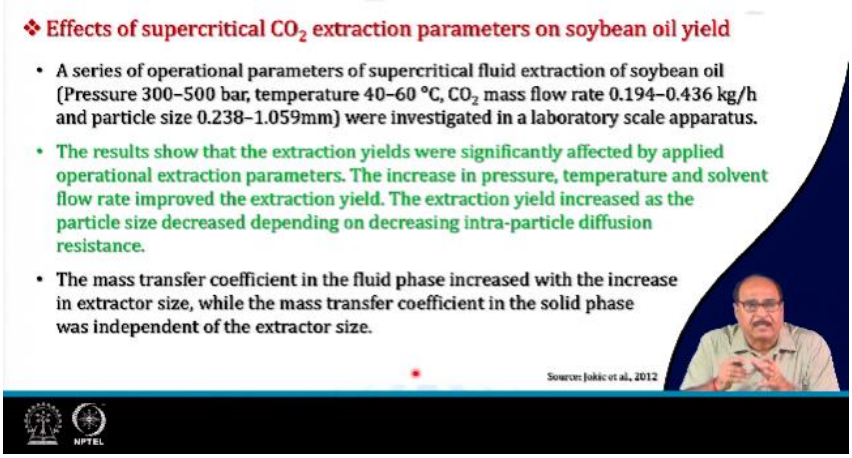
Now soybean oil another very good very important oil soybean oil is a vegetable oil extracted from the seeds of the soybean it is glycine max. It is one of the most widely consumed cooking oil and is the second most consumed vegetable oil you can say worldwide. The second order soybean oil is also used as a base for printing ink like soybean and oil plants. Soybean oil has 16 gram saturated fat, 23 gram monounsaturated fat and 58 grams of polyunsaturated fat per 100 gram. The major unsaturated fatty acids in soybean oil triglycerides are the polyunsaturated alpha linolenic acid it is around 7 to 10 percent, linolenic acid 51 percent and monounsaturated oleic acid is 23 percent. It also contains the saturated fatty acids, stearic acid like 4 percent and palmitic acid 10 percent.



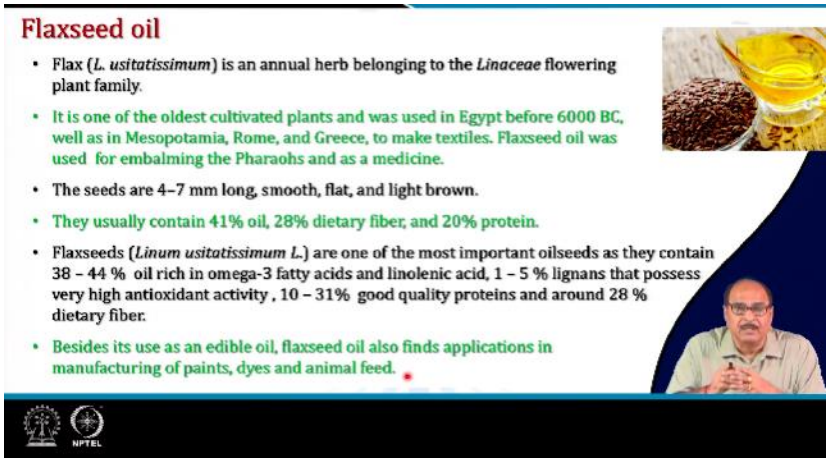
Process flow chart for the soybean oil soybean oil manufacture that is the soybean seeds they are taken there is three method like screw pressing, solvent extraction or even extruder expelling. This can also be used for the obtaining for obtaining oil from the soybean it contains around 20 percent oil or so. So, soybean seeds are cleaned, fallen matter are removed then it is cracked dehulled and the hulls are blown off and after that seeds are dehulled the cotyledons of soybeans are conditioned flagged and then these flags are subjected to the solvent extraction process ok. Of course, the flag the conditions to have to more pore and then the rest is that is after the solvent extraction you get that the steam says is a paraded distilled you get solvent extracted oil crude oil and then that is the crude oil is subjected to the and the meal which is obtained it is meal solvent that is group stage meal etcetera. And then the crude oil obviously, it is sent to further standard refining protocol. For the screw spilling that is the soybeans are cleaned soybean cotyledons that is a dried it are cooked and then it is sent to the that is moisture content is adjusted ok. And it is conditioned and then it is sent to the screw spilling and here the settling and polish filter. So, get the crude oil and the meal which is obtained it is a then partially de-fatted meal then it is again sent to the solvent extraction process. And the extrude along the seed it is passed through extruder in a extruder barrel seeds are work on and some of the oil is collected and then remaining is through solvent extraction. So, normally prepress solvent extraction is used ok.



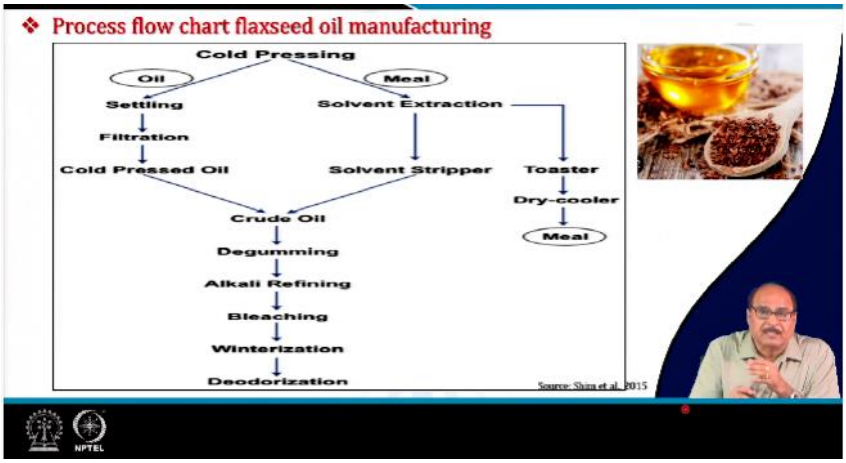
The process flow chart of oil refining is given, here the oil is subjected to filtering then gums are removed and then they are used for lecithin production. And then this de-gum material is an alkali neutralization, centrifugation to remove the soap stock then it is washed centrifuged vacuum drying to remove any traces of moisture etcetera from it. And then subjected to bleaching where bleaching earth is used filtered deodorization that is the steam physical refining you can say then distillate which is obtained by during deodorization. Then it is used for making flavor component minor volatile fatty acids etcetera are removed and then the polishing filter subject it is that is you have been oil which is obtained after filtration it is used as a salad or cooking oil. And also there are some reports that reporter has suggested there is a some minor changes in the traditional process there is a minimal refining that is the after filtering gum hydrating settling or centrifuging then gums are removed. And then it is a some adsorbent or added or bleaching filtering physical refining or adsorbent filtering then gum gas purging or soft deodorization. So, there is some process parameter that is so, that the changes which may take place originally in the traditional refining process they can be minimized. So, it is also this oil is also used in salad and cooking oils.



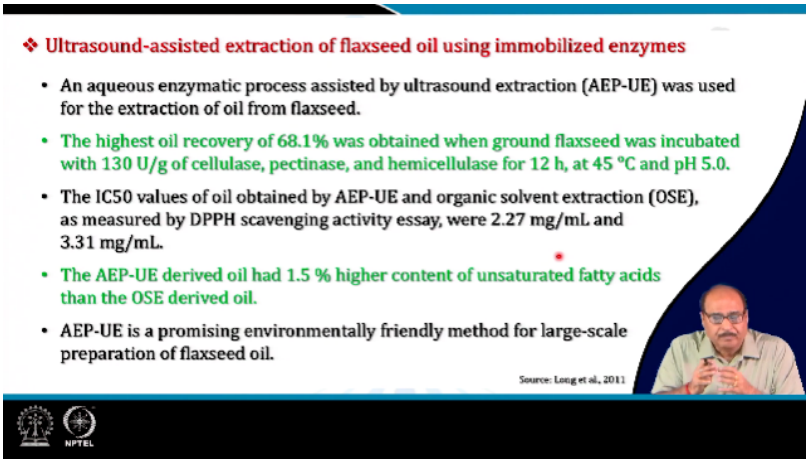
Also let us briefly discuss the effect of supercritical carbon dioxide extraction parameter on the soybean oil yield. There is a series of operational parameters of supercritical fluid extraction of soybean oil like pressure in the 300 to 500 bar, temperature in 40 to 60°C, carbon dioxide mass flow rate 0.1942-0.436 kg per hour and particle size may be 0.238-1.059 mm were investigated in the laboratory scale apparatus. The results show that the extraction yields were significantly affected by the applied operational extraction parameters. The increase in pressure, temperature and solvent flow rate improved the extraction yield. The extraction yield increased as the particle size decreased depending upon decreasing intra particle diffusion resistance. The mass transfer coefficient in the fluid phase increased with the increase in extractor size, while the mass transfer coefficient in the solid phase was independent of the extractor size.



Then flaxseed oil, the flaxseed is an annual herb belonging to the *Linaceae* flowering family. It is one of the oldest cultivated plant and was used in Egypt before 6000 BC. Oil in Mesopotamia, Rome and Greece to make textiles. Flaxseed oil was used for in a embramine and ferrous as a medicine. The seeds are 4 to 7 millimeter long, smooth, flat and light brown. They usually contain 41 percent oil, 28 percent or so dietary fiber and approximately 20 percent protein. Flaxseed are one of the most important oil seeds as they contain about 38 to 44 percent oil rich in omega 3 fatty acids and linolenic acids. 1 to 5 percent lignans that possesses very high antioxidant activity, 10 to 31 percent good quality protein and around 28 percent dietary fiber are there. Besides its use as an essential oil flaxseed oil also finds applications in manufacturing of paints, dyes and animal feeds.

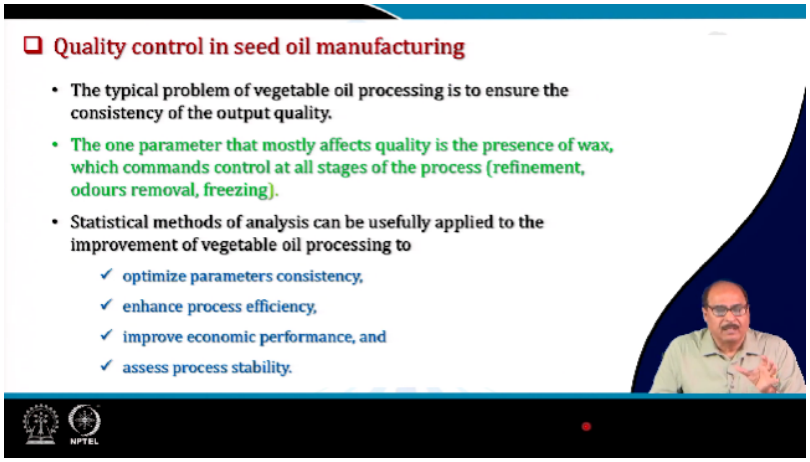


So, this is the process flow chart for flaxseed oil. This is also flaxseed also is comparatively a soft seed. So, it is majority of the oil is extracted by cold pressing. So, it is just cold pressing treatment oil settling, filtering and cold pressed oil and then the meal which is obtained it is solvent extraction. So, solvent is triple. So, you get cold press oil or solvent extractor oil the crude oil it is sent to the refining treatment degumming, alkali refining, bleaching, militarization and deodorization and the meal is toaster, dry cooler and then the de-oiled meal is obtained.

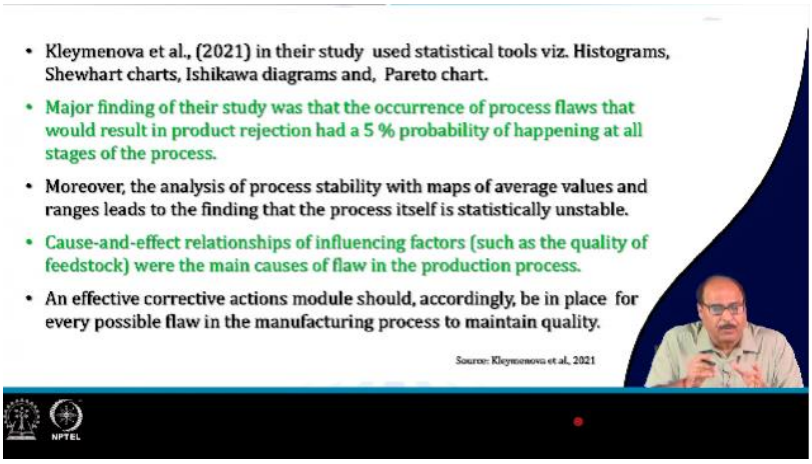


Then ultrasound assisted extraction of flaxseed oil using immobilized enzyme that is another study which was reported by some researcher and Herrer and aqueous enzymatic process assisted by ultrasound extraction that is AEP-UE was used for the extraction of oil from flaxseed. And the highest oil recovery was 68 percent which is obtained when the ground flaxseeds was incubated with 130 unit per gram of cellulose, pectinase and hemicellulose for 12 hour at 45°C and the pH was maintained at 5. The IC50 values of the oil obtained by AEP-UE and organic solvent measure methods were measured as by DPPH scavenging assay and these were 2.27 mg per ml for AEP-UE and 3.31 mg per ml for OSE methods. The AEP-UE derived oil had 1.5 percent higher content of unsaturated fatty acids compared to the OSE derived oil that is organic solvent extraction derived oil.

AEP-UE is a promising economically friendly method for large scale preparation of flaxseed oil.

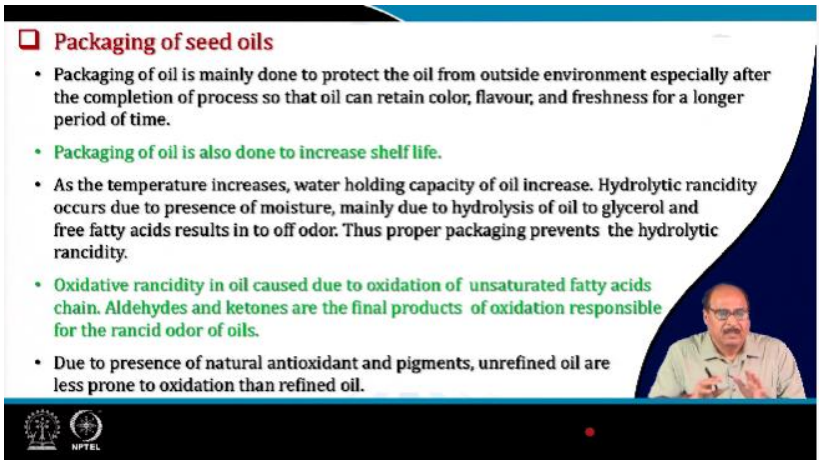


So, the quality control in seed oil manufacturing the typical problem of the vegetable oil processing is to ensure consistency of the output product quality. And one parameter that mostly affect the quality is the presence of wax which command commands control at all stages of process that is refinement, address removal, freezing etc. So, statistical methods of analysis can be used or it can be usually applied to the improvement of the vegetable oil processing to optimize parameters consistency to enhance process efficiency to improve economic performance as well as to access process stability.

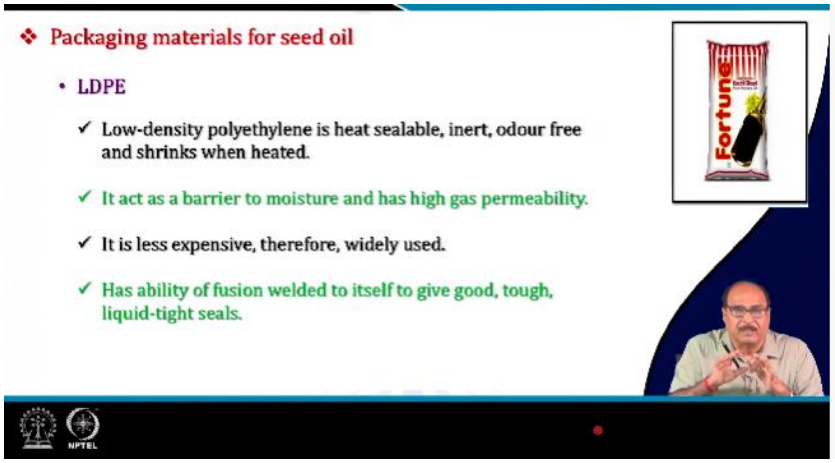


Researchers like Kleymenova et al., (2021) in their study used statistical tool like histograms, skew chart, skew diagram and Pareto chart etc and they analyzed various methods and they reported there is major finding of their study was that the occurrence of process flaws, occurrences of process flaws that would result in product rejection had a 5 percent probability of happening at all stages of the process. Moreover, the analysis of process stability with maps of averages values average values and ranges leading to the finding that the process itself is a satisfactory unstable satisfactorily unstable. So, cause

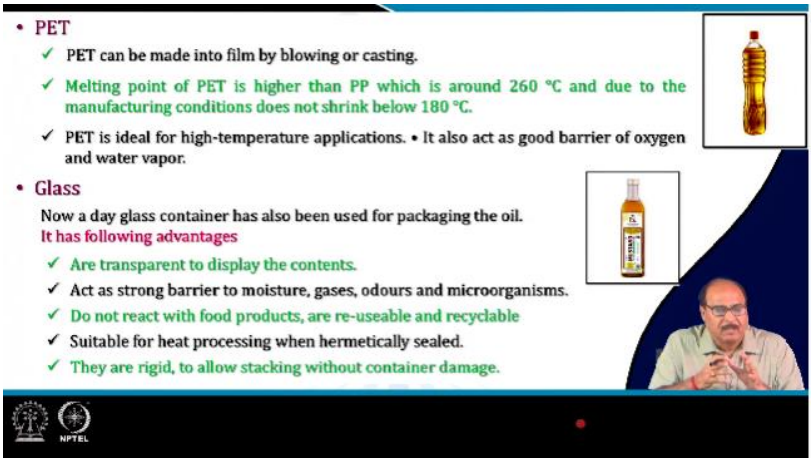
and effect relationship of influencing factors such as quality of the feedstock, where the main cause of flaw in the production process. So, an effective corrective action module should accordingly be in place for every possible flaw in the manufacturing process to maintain both the quality of the oil as well as meal.



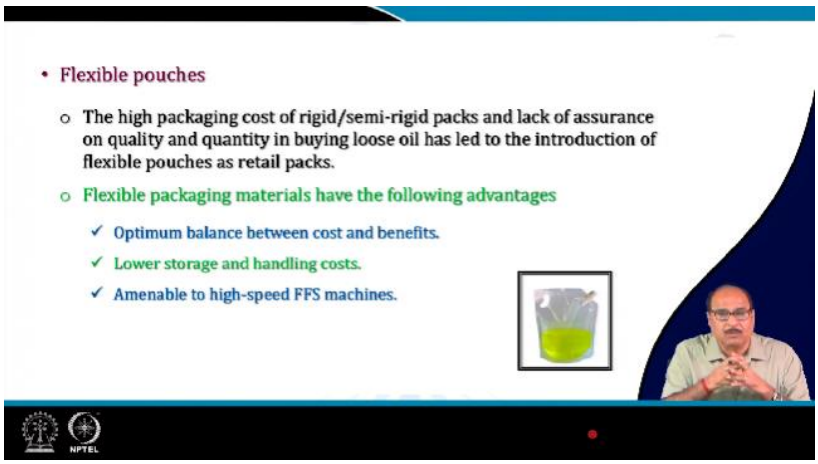
Then packaging of the seed oils, packaging oil of the oil is mainly done to protect the oil from outside environment as any food especially after the completion of the process. So, that oil can retain color, flavor, freshness for a larger period of time a packaging of oil is also done to increase its shelf life. So, as the temperature increases water holding capacity of oil increases hydrolytic reactions occur due to the presence of moisture mainly due to the hydrolysis of oil to glycerol and free fatty acids that results in off-flavor. Thus proper packaging between prevents the hydrolytic rancidity even the oxidative rancidity of oil caused due to oxidation of unsaturated fatty acids change the aldehydes and ketones are the final products of oxidation which are responsible for the rancid odor of the oil. So, this is the presence of natural antioxidants and pigment this unrefined oil are less prone to the oxidation than refined oil.



So, the accordingly the packaging material should be selected proper packaging material ok. For the seed oil like LDPE it is a low density polyethylene it is a heat stealable inert odor free. It acts as a barrier to moisture and has high gas permeability it is less expensive therefore, widely used and has ability to fusion welded to itself to give good tough strength like seals.

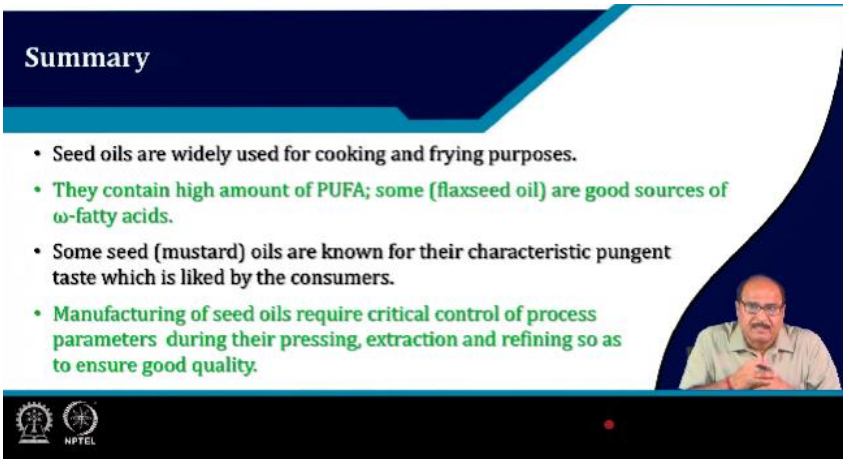


Then PET can be made into film by blowing or casting melting point of PET is higher than that of PP which is around 260°C and due to the manufacturing conditions does not shrink below 180°C. PET is ideal for high temperature applications it is also act as a good barrier of oxygen gas and water vapor. Then glass is also used for packaging of the oil now a day the glass container has been used and it has the obvious advantages like it is transparent and the product is displayed over this. It acts as a strong barrier to moisture gases, odors and microorganisms and do not react with food products and it are reusable and recyclable suitable for they are suitable for heat processing when hermetically sealed and they are rigid to allow stacking without container damage.

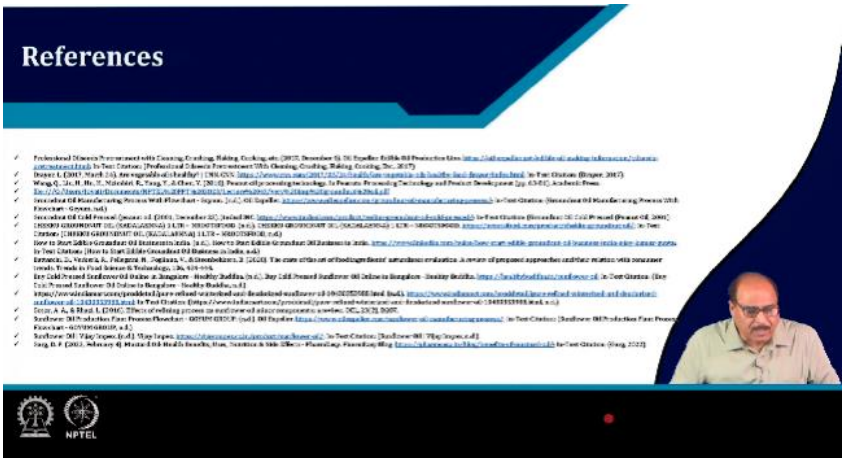


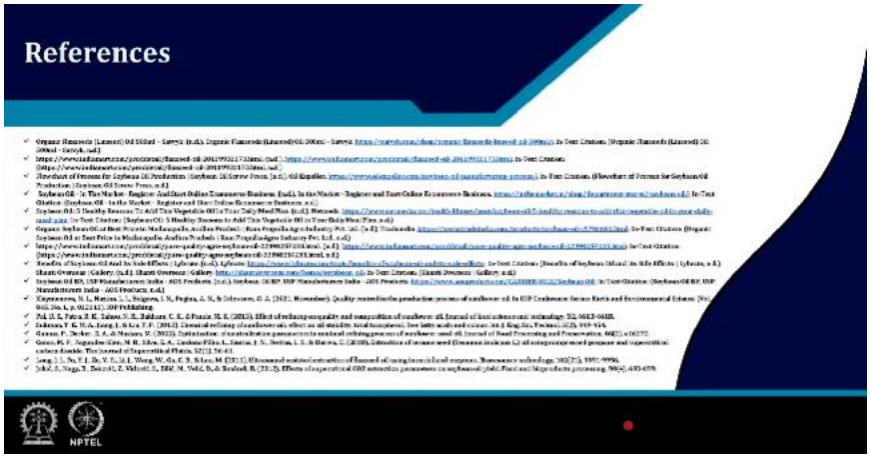
Then flexible packages also nowadays are become popular and because the high packaging cost of the rigid and semi rigid containers are and the lack of assurance of

quality and quantity in buying losses lose oil and it has led to the introduction of flexible pouches and retail packs. Flexible packaging materials have the advantages like optimum balance between cost and benefit, lower storage and handling cost it is a and these are amenable to high speed FFS machine. In fact, the FFS machine are available and you can get oil pouches now where they are available in the market from very small pouch to 1 kg, 2 kg, 100 gram and so on.



So, finally, I will summarize this lecture by saying that seed oils are widely used for cooking and frying operations. The seed oils contain high amount of polyunsaturated fatty acids and some seed oils like polyene or flax seed etcetera they are good sources of omega fatty acids, some seeds mustard oil they are known for their characteristic pungent taste which is liked by the consumers and manufacturing of seed oils require critical control of process parameters during their pressing extraction and refining so as to ensure good quality all the particularly to retain the natural antioxidants which are present there as well as to destroy any undesirable compound volatile and they should be properly packed to ensure their stability during transportation and handling. To avoid that is the packaging material should be proper it should have sufficient resistance power strength to control the oxidative rancidity, hydrolytic rancidity etc.





So, these were the references that were used in this preparing this lecture. Thank you very much for your patience here. Thank you.