Introduction

For thousands of years, fats and oils such as sesame, mustard seeds and copra have been important in food preparation in India. Fats and oils are essential and important macro nutrients in our diet. Fat provides energy of 9 cal/gram and serves a variety of functions in human system, such as energy storehouses, regulatory messengers, structural components of membranes etc. Fat absorbs and transports vitamin A, D, E and K which are fat soluble vitamins.

India is cultivating a wide range of oilseeds crops like groundnut, mustard seed, sesame, safflower, linseed, nigerseed, castorseed with different agro climatic conditions. Coconut is most important amongst the plantation crops. Non-conventional oils, like ricebran oil and cottonseed oil are also in extensive usage now a days.

Objectives

After going through this session you will be able to

1. Explain the sources and extraction methods of edible oil and
2. To explain the refining process of edible oil.

33.1 Production and utilization of edible fats and oils

In global production of oil seeds India contributes about 6-7%. Oil meals, oilseeds and minor oils export has increased to 7.41 million tons in the financial year 2011-12 from 6.31 million tons in the financial year 2008-09.

Since coconut, palm kernel or palm oil contains various types of fatty acids which are known as tropical oil. These oils are found in commercial production of cakes, cookies and snack foods. Tropical oil and seed oil are utilized 30% and 33% respectively. Edible tallow and industrial lard utilized about 7% each, margarine and butter utilized 6% each and 3% Olive oil and ghee utilized globally.
Fig. 1 utilization of edible fats and oils

33.2 Sources of fat and oil

The major sources for fat and oil are plant, animal and marine. Fruits and seeds are greatest source of fats and oils that is used for commercial purpose. Oils occurs in the seeds, nut, kernel, fruit bunches, bran, germ etc. of plants. Animal fats are produced from slaughter by-products of healthy slaughtered animals. Fat produced from milk is butter and ghee. Typical edible fats are ghee, beef tallow, pork lard etc. Marine fat include liver oils, and fish oils. Table 1 shows the oil bearing part of plant and oil content of different plant sources.

Table 1 Different plant sources of fat and oil

<table>
<thead>
<tr>
<th>Source</th>
<th>Part</th>
<th>% oil content</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coconut copra</td>
<td>Kernel</td>
<td>55-60</td>
</tr>
<tr>
<td>Virgin coconut</td>
<td>Kernel</td>
<td>35</td>
</tr>
<tr>
<td>Cotton seed</td>
<td>Seed</td>
<td>18</td>
</tr>
<tr>
<td>Groundnut</td>
<td>Nut</td>
<td>45</td>
</tr>
<tr>
<td>Oil palm</td>
<td>Fruit</td>
<td>21</td>
</tr>
<tr>
<td>Rape seed</td>
<td>Seed</td>
<td>40</td>
</tr>
<tr>
<td>Sesame</td>
<td>Seed</td>
<td>45</td>
</tr>
<tr>
<td>Soyabean</td>
<td>Seed</td>
<td>18</td>
</tr>
</tbody>
</table>
33.3 Processing of oil seed

The oil and fats are stored in the seeds or fruits and other parts of the plants. The oil and fats are required to be taken out by breaking the cells in which the oil is stored and removing the solid materials which are redundant. This extraction can be achieved by pressing or squeezing the seeds of fruits or dissolving the fatty substances by a solvent.

The important unit operations involving in oil processing are storage of oil seeds/fruits, cleaning, extraction, refining, filtration, packaging and storage is given in flow chart (Fig.3).

33.4 Storage of oil seeds/Fruits

The storage of oilseeds always involves some difficulties due to various causes, among which the most important are:

1. Nature of oil seed.
2. Moisture content
3. Possible fermentation.

Oil seed may be

- Very small and round( rape seed)
Large round (soy bean, peanut),
- Oval (grape seed, sunflower, safflower)
- Very small and elongated (niger seed)
- Round and downy (cotton seed)
- Granular (corn germ, rice bran)

Moisture content of the seed is a major factor in the good keeping properties of oilseeds during storage. When stored, oil bearing materials usually contain 5-7 percent moisture. Fermentation of oil seeds is one of the most serious risks involved in the storage of oilseeds. The fermentative processes are originated by enzymes always present in oilseeds.

### 33.5 Cleaning and pre treatment:
Oilseeds delivered to oil mills always contain foreign bodies like chaff, dust, mud particle, iron pieces, stones. Such impurities are needed to remove from the oil seeds to increase the shelf life of oil. Cotton seeds are subjected to delinting to be removed the cotton fibres (lint) attached to them. The hull of the seeds is then removed. Dehulling is also done for sunflower and safflower seeds. In case of groundnut decortication is done.

The oil seeds which are subjected to the various processes for extraction of the oil undergoes pre treatment such as grinding, heat treatment and conditioning. The oil is contained in

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**Fig.3 Process flowchart of oil processing**
a countless number of oil bearing cells. These can be broken only by subjecting the seed to heavy pressure such as by crushing (grinding or flaking).

Heating of the oil seeds favors the extraction of the oil it contains. The increase in temperature coalesce the oil droplets and increase the rate of oil extraction. Conditioning optimizes the moisture content and temperature to which the seeds are brought in order to obtain the maximum yield of oil when it subsequently processed. Roller mills are used for breaking the seed into small particles and flakers are used to reduce the seed thickness to 0.2-0.4 mm for better extraction process. Cookers are used for heating the seed and controlling the moisture content before extraction process.

33.6 Extraction of oil:

The extraction is the first step in oilseed processing. Mechanical expellers and solvent extraction are the two major methods involving in oil extraction process. The mechanical expelling methods include ghani method, hydraulic press, expellers and solvent extraction method.

33.6.1 Ghani method

In many countries a large rotating type of system known as a ghani is used for oil extraction. Ghanis are powered by animals (Fig.4) or motors is called powerghanis (Fig. 5) although sometimes it is done manually. The mortar is firmly fixed in the ground and as the pestle rotates oil is released by friction and pressure and runs out of a small aperture at the base of the mortar. A typical one bullock ghani can process 40 kg of material/day. In the case of power ghanis either the pestle or mortar is fixed, the other rotating. Power ghanis are usually operated in pairs.
and have a typical capacity of 100 kg/day. The extraction efficiency is generally greater than animal units. An oil-rich seed such as sesame seed or groundnut yields about 5 percent less oil in a ghani than in a modern expeller, mainly because of insufficient pressure. Ghani oilcake carries about 15 percent residual fat, about twice that of screw-press.

### 33.6.2 Hydraulic press

Hydraulic press consists of series horizontal iron plates and plates are separated by 4-14 premoulded oilseed racks which is operated by hydraulic pump. This is a two stage process. In the first stage 5MPa pressure is given for 15-20 minutes and in the second stage 28 MPa pressure for 10-15 minutes is given to the oil seeds. In the first stage 80 percent of the oil is extracted and the remaining oil extracted by second press. Fig. 6 shows the schematic diagram of hydraulic press. Now days it is replaced by screw press.

![Hydraulic press diagram](Fig.6)

### 33.6.3 Screw press

Screw press can process oil bearing materials like peanuts, sunflower seeds, soy beans, rape seeds, cotton seeds, sesame seeds, coconuts/copra, etc. The screw press consists of feed hopper, screw shaft driving assembly in a horizontal cage. Oil seed fed through feed hopper. The screw shaft-driving assembly squeezes oil from oil seeds. With the constant feeding and screw shaft rotating, the space between the rings and the pressing screws edible oil flows to oil receiving plate and cakes are discharged out.
33.6.4 Solvent extraction

The extraction of oil from oilseed by dissolution of the oil in a solvent in an effective manner is called solvent extraction method. This method enables extraction of oil from a source with low oil content and residual oil after extraction is also very low. The factor which determines the effective oil extraction by a solvent are

1. Time of extraction
2. Quantity of solvent used
3. Temperature at which extraction is carried out

- The extraction time has a fundamental importance for the amount of oil recovered from oil seeds.
- The greatest amount of oil is extracted during first 30 minutes of extraction.
- An extremely long extraction time is required to obtain residual oil content below one percent.
- Every type of seed behaves differently during the extraction process.
- Amount of solvent used is important up to a seed solvent ratio of 1:18. Beyond this ratio increases in oil yield is little.

Higher dissolving power of solvent is always associated with degradation of oil. Moreover, the solvent preferred should be safe for human consumption. Hexane is an universally accepted safe solvent. Oil seeds are extracted by means of percolation or immersion or combined percolation immersion processes. The first one is by percolation of the solvent through the seed mass so that it is sprayed over the whole mass without, filling up completely the empty spaces between the
various solid seed particles. The immersion process takes place when the seed mass is completely immersed in the solvent even if this is circulating.

In the percolation process the rate at which the solvent comes into contact with the seed granules surface is always high in that the liquid film flows rapidly over the granules by gravity.

In the immersion process the seed granules come into contact with the solvent in a static manner in that they are totally immersed in the solvent and consequently, the solvent flows slowly over the granule surface even if it is circulated rapidly. In order to obtain percolation, the seed particles must be of a certain size to allow the solvent to drain easily through the seed mass. The immersion process can be easily accomplished even if the seed has been reduced to small pieces. Immersion extractors are no longer used as the percolation equipment and the percolation immersion extractors are much more economic and easy to operate.

The extracted flakes are impregnated with solvent which is required to be removed and recovered. This operation is known as meal desolventizing and is accomplished in desolventizers. After removal of residual solvent, the oil undergoes filtration process to remove the impurities.

### 33.7 Extraction of oil from different sources.

In general, if the oil content of the oil seed is more than 20% usually mechanical method of extraction such as expellers or hydraulic press are used. If the oil content is less than 20% solvent extraction method is followed.

<table>
<thead>
<tr>
<th>Source</th>
<th>Method of extraction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soy bean</td>
<td>Solvent extraction</td>
</tr>
<tr>
<td>Rice bran</td>
<td>Solvent extraction</td>
</tr>
<tr>
<td>Germ oil</td>
<td>Solvent extraction</td>
</tr>
<tr>
<td>Groundnut</td>
<td>Expelling</td>
</tr>
<tr>
<td>Rape seed</td>
<td>Expelling</td>
</tr>
<tr>
<td>Sesame</td>
<td>Expelling</td>
</tr>
</tbody>
</table>

### 33.7.1 Palm oil processing

Unlike other oil seeds, palm oil needs pre treatment to extract oil from the fruits. The fresh fruit bunch consists of fruit entrenched in spikelet. Bunched is threshed by manual or mechanical process. Threshed fruits are sterilized using cookers which destroy oil-splitting enzymes and prevent hydrolysis. Then the fruits undergo digestion process where fruits are ruptured to
enhance the oil extraction and followed by mechanical pressing process. The oil is clarified and dried to remove the moisture.

33.8. Refining

Oil extracted from the seeds contains impurities such as mucilaginous materials and gums, colouring matters, free fatty acids, odoriferous chemicals etc. These are usually removed from the oil to produce transparent clear oil without odour, colour and free acids. The process to achieve the clean oil is called refining. Crude oil is usually refined before it is used for edible purpose. Refining process is classified as chemical or alkali refining and physical refining process.

In chemical refining process free fatty acid is saponify by an alkaline solution and dilute the resulting soaps in a water phase. These soaps are removed by separators. For small scale batch processes static separation is used but for continuous processing and large scale processes, centrifugal separation is used. In physical refining the free fatty acids (FFA) are removed from the oil under high temperature and vacuum. In physical refining process no chemical treatment is given hence it does not produce soaps and removes free fatty acids hence that this method is cost effective. The neutral oil is again undergoes bleaching, deodourization and winterization process to get refined oil.

33.8.1 Degumming:
Among the minor undesirable components to be eliminated by degumming of crude vegetable oil are oil soluble compounds, such as phospholipids. Degumming is a pretreatment which is necessary to prepare the vegetable oil. The phosphatides in the oil vary from one to another and even in the same kind of oils. Soybean oil, which is the richest in phosphotides, may contain 2.5 – 3.5 % of these compounds, whereas other unsaturated types oils may contain from 0.1% up to about 1.5%. Saturated oils like palm oil are the poorest in phospholipids (about 0.5%).

Phospholipids

Hydratable non hydratable

Hydratable phospholipids contain mainly groups of polar compounds such as choline, ethanolamine, serine and inositol. By hydration of the oil, these phospholipids are precipitated as clearly distinguished fluctuating agglomerates, which are easily eliminated by centrifugation. The non hydratable phospholipids are mainly magnesium and calcium salts of phospholipids and cannot be eliminated by simple hydration. These types of phospholipids can be eliminated by the action of strong acids, dissociation the iron from the phosphatides in the form of iron salts and these can be eliminated. This can also be done by adding water, which has the property to transform the precipitated compounds into a form enabling their separation by centrifugation.

33.8.2 Neutralization:

Any free fatty acids, phospholipids, pigments, and waxes in the extracted oil promote fat oxidation and lead to undesirable colors and odours in the final products. These impurities are removed by treating the oil with 8-24% caustic soda (sodium hydroxide) to remove free fatty acids. This method is called as chemical neutralization process. The impurities settle to the bottom and are drawn off. As a result of neutralization process, the soap is produced which are separated from the oil by either washed with water or treated with silica. The refined oils are lighter in colour, less viscous, and more susceptible to oxidation.

33.8.3 Bleaching:

Oil and fats in the raw state contain a variety of extraneous materials and impurities, besides colouring materials in colloidal suspension or in actual solution. The dissolved pigments impart an undesirable appearance to the oil from the consumer standpoint.

The primary function of the bleaching operation is to remove colloidal pigments, peroxides and secondary oxidation products and traces of residual soap and phosphatides from the refining
step. This process transforms oil from a darker appearance into a transparent clear liquid possessing better stability, shelf life and flavor. Bleaching materials such as natural fuller’s earth, activated carbon and activated clay are used in bleaching process.

The heated oil is treated with various bleaching agents. Many pigments, including chlorophyll and carotenoid, are absorbed by this process. However, few natural antioxidants and nutrients are removed along with the impurities during bleaching and this promotes fat oxidation.

33.8.4 Deodorization

Deodorization is an important process in edible fats and oil processing. A high temperature steam is applied (stripping) to remove undesirable elements by stripping process is called deodorization. Flavour, odour, stability and color are essential compounds of oil and during this process undesirable odorous compounds are removed. Deodorization is a vacuum steam distillation process in which steam is passed through such oils at very low pressure and relatively high temperature to remove remaining all substances still present after the preceding processing stage.

33.8.5 Winterization process:

Vegetable oils, like sunflower and corn contains waxes, which has to remove to get clarity of oil. So oil is crystallize at lower temperatures and result in turbidity of oil. Winterization is a final unit operation in oil seed processing. In this process deodorized oil is crystallized at lower temperature where waxes are solidified and removed from the oil by filtration. The oil produced at this last stage is called as "refined oil".

33.9 Packaging

Packaging directly influences the quality of oil by protecting the product from both oxygen and light. When oils exposed to intense artificial light and diffused daylight the shelf life of the oil is reduced. Moreover, the storage temperature, head space oxygen in the packaging volume can appreciably control quality changes during storage time.

Materials such as glass, tin-coated steel, plastics and plastics coated paperboard are used for packaging of oil and fat. Among plastics, polyethylene terephthalate (PET) is widely used due to its advantages including clarity, better mechanical properties, chemical inertness, and low oxygen permeability. Besides PET, polyethylene (PE) in the form of LDPE-coated paperboard/aluminum foil laminates, like brick-type cartons and bag-in-box pouches and polypropylene (PP) are widely used in packaging of vegetable oils.

Summary
1. Fat and oil is essential for human system. Plants, animal and marine are the major source for fat and oil. Fat and oil is classified as saturated and unsaturated fatty acids.

2. Oil seeds are pre treated before processing to enhance the shelf life of oil. The oil is extracted by mechanical method and or using solvent extraction methods.

3. The extracted oil is called crude oil and undergoes refining process for further purification.

4. The refining process involves degumming, neutralization, bleaching, deodourization and winterization process. These processes remove FFA, gum, pigments, odour, wax etc.

5. If the oil content is more than 20% expellers are used to extract the oil if the oil content is less than 20% solvent extraction method is followed.

6. Palm oil requires different pretreatments to extract oil as it is from fruit

7. Glass, tin, plastic materials are used for packaging of oil to prevent rancidity and to increase the shelf life.