

Lecture 7: CHAPTER 16

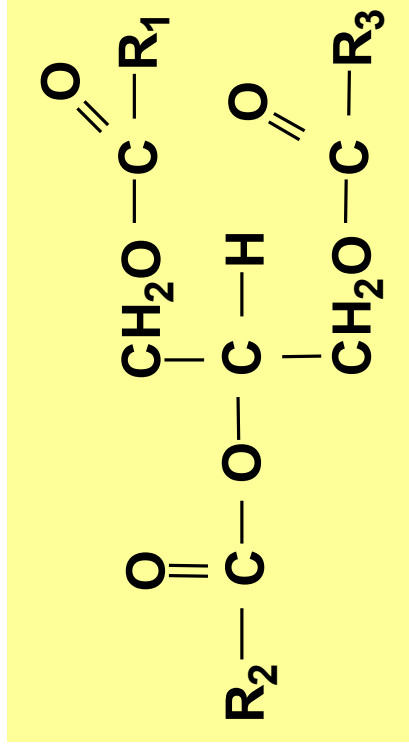
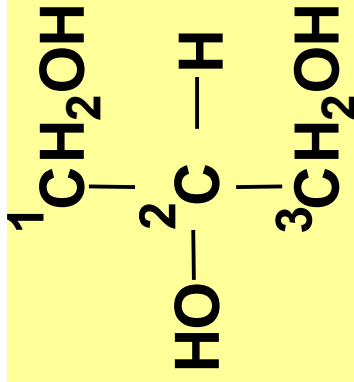
**FATS, OILS
AND RELATED PRODUCTS**

FATS, OILS AND RELATED PRODUCTS

- Fats have shortening, lubricating, emulsifying and whipping properties and high caloric value as well as being a carrier of fat-soluble vitamins.
- Fats that are liquid at room temperature are called oils.

EFFECT OF COMPOSITION ON FAT PROPERTIES

➤ Fats and oils are made up of fatty acid esters of glycerol. The structural formula of a typical triglyceride molecule of a fat is:



glycerol

$\text{R}_1 = \text{R}_2 = \text{R}_3 =$ oleic acid Triolein (olive oil)

EFFECT OF COMPOSITION ON FAT PROPERTIES

- **The structure of the fatty acids that are esterified to glycerol largely determine the properties of fats, including whether they are solid or liquid at room temperature.**
- **Short-chain fatty acids give softer fats of lower melting points than do long chain fatty acids.**
- **Fatty acids can have areas of unsaturation within their molecule due to the absence of hydrogen atoms at certain points. This is where double bonds occur in the fatty acids.**

EFFECT OF COMPOSITION ON FAT PROPERTIES

Fatty acids:

- having single C-H bonds are called SATURATED fatty acid,
- having double bonds are called UNSATURATED fatty acid.

EFFECT OF COMPOSITION ON FAT PROPERTIES

Stearic acid C18:0 $\text{CH}_3(\text{CH}_2)_{16}\text{COOH}$

ω -9 Oleic acid C18:1 (9)

$\text{CH}_3-(\text{CH}_2)_7-\text{CH}=\text{CH}-\text{CH}_2-(\text{CH}_2)_6-\text{COOH}$

ω -6 Linoleic acid C18:2 (9,12)

$\text{CH}_3-(\text{CH}_2)_4-(\text{CH}=\text{CH}-\text{CH}_2)_2-(\text{CH}_2)_6-\text{COOH}$

ω -3 Linolenic acid C18:3 (9,12,15)

$\text{CH}_3-\text{CH}_2-(\text{CH}=\text{CH}-\text{CH}_2)_3-(\text{CH}_2)_6-\text{COOH}$

EFFECT OF COMPOSITION ON FAT PROPERTIES

- **All three fatty acids are of the same length - each contains 18 C atoms. - but the degree of unsaturation is different.**
- **Stearic acid is fully saturated**
- **Oleic acid has one double bond and is missing two H atoms.**
- **Linoleic acid has two double bonds and is missing four H atoms.**

EFFECT OF COMPOSITION ON FAT PROPERTIES

- By chemical means, hydrogen can be added to an oil to saturate its fatty acids, thereby converting it to a solid. The process is termed hydrogenation and commonly converts a vegetable oil to a solid shortening.
- Unsaturated fatty acids are highly reactive with oxygen at the points of unsaturation. Hydrogenation which saturates fats, makes them more resistant to oxidation.

SOURCES OF FATS AND OILS

Fats and oils may be of vegetable, animal or marine origin.

- **Vegetable fats - solid fat cocoa butter and the liquid oils corn oil, sunflower oil, soybean oil, cottonseed oil, peanut oil, olive oil, canola oil, and many more.**
- **Animal fats - lard from hogs, tallow from beef, butterfat from milk.**
- **Fish oils - cod liver oil, oil from menhaden, and whale oil.**

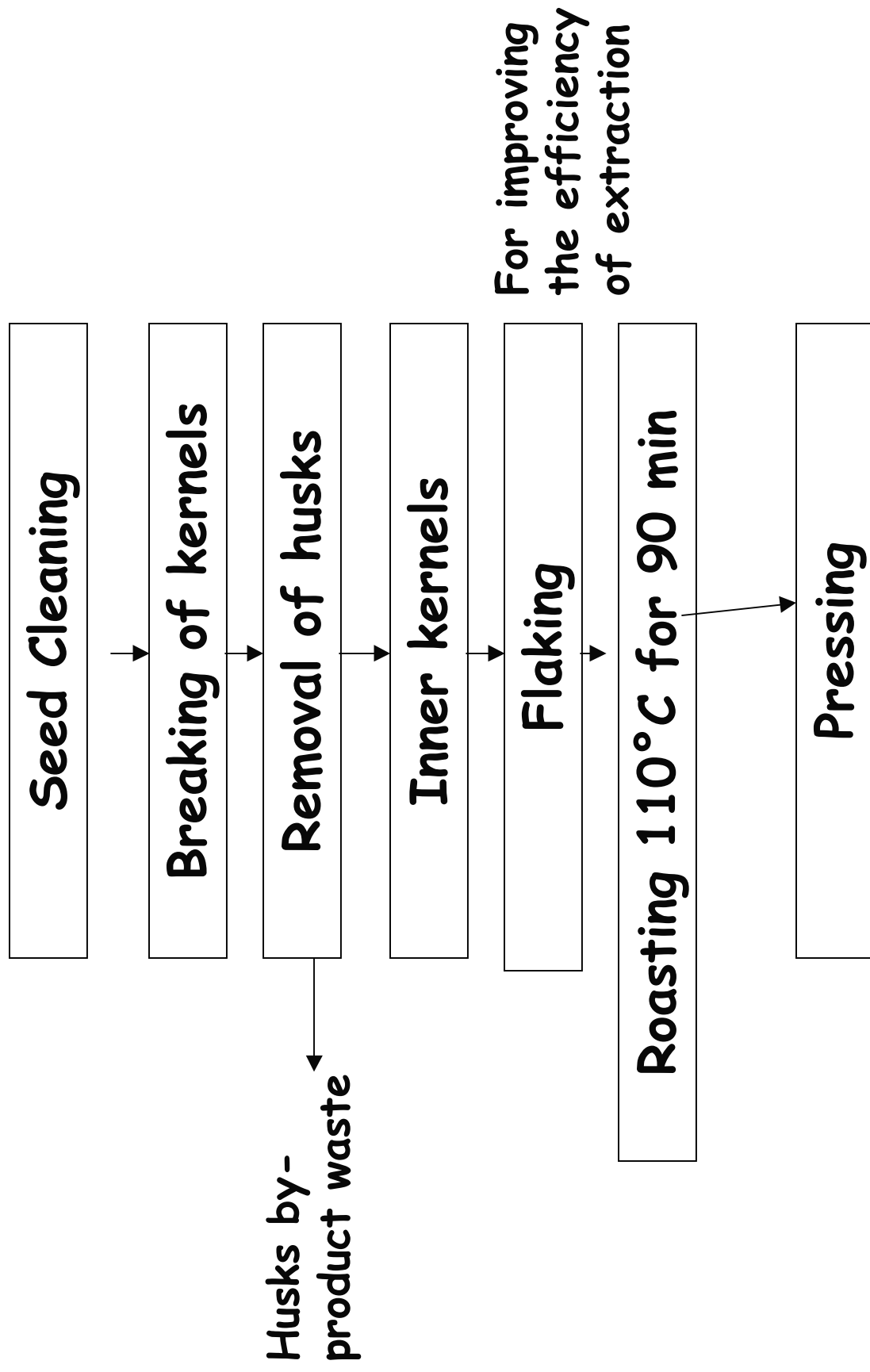
SOURCES OF FATS AND OILS

- Because fats vary widely in price, and often can be made interchangeable or nearly so, it is important that deception be prevented and consumers indeed get what they choose to purchase.
- There are federal standards of identity for foods, labeling requirements for nonstandardized foods and analytical tests to distinguish between certain fats to prevent adulteration.

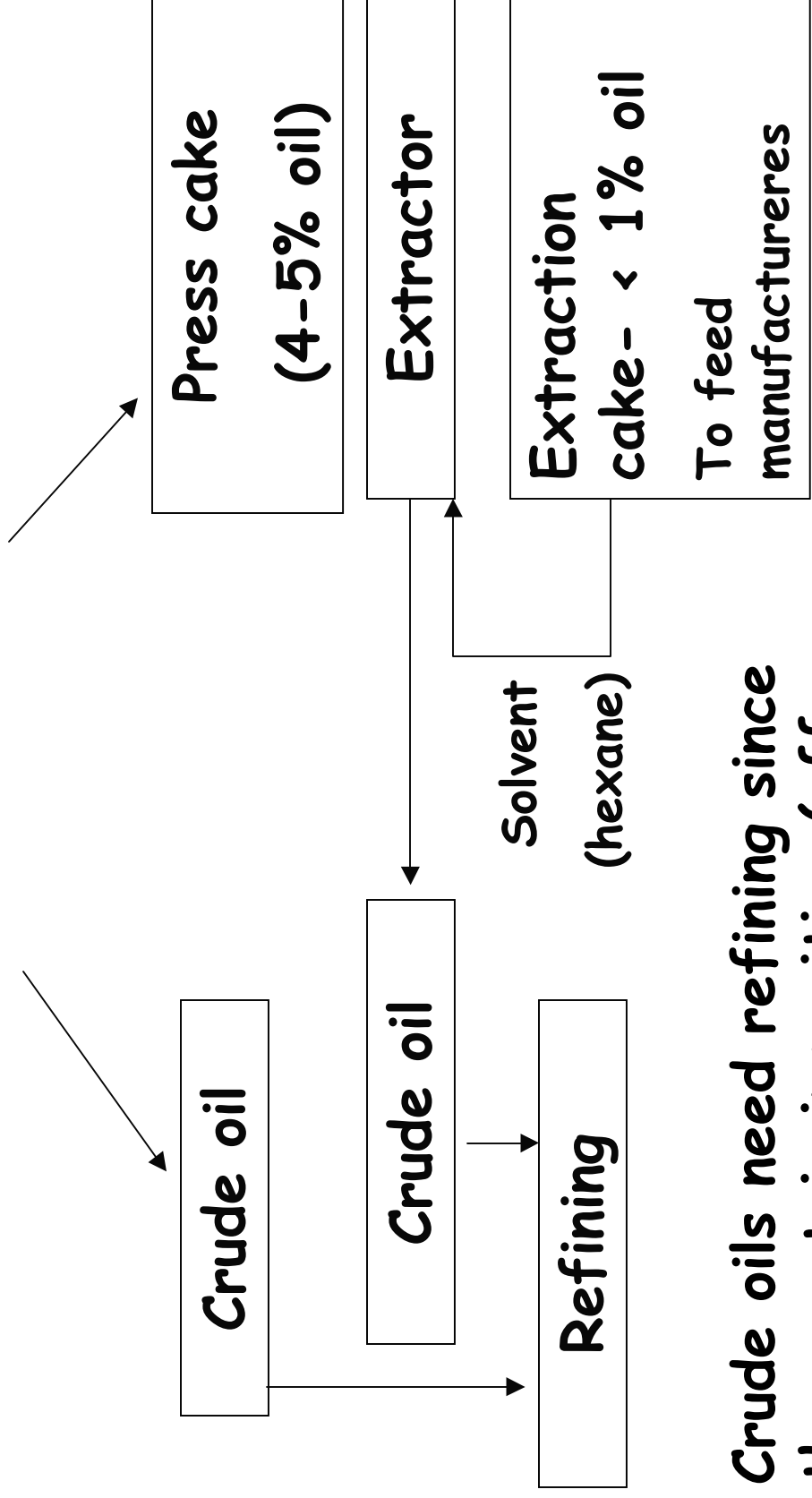
SOURCES OF FATS AND OILS

- Butter cannot be called butter if it contains any fat other than butterfat. This is also true of olive oil. Substitute cocoa and chocolate products must be appropriately labeled when they contain vegetable fats other than cocoa butter.
- Animal body fats: Meat scraps are heated in steam or water to melt fats, which then rises to top while tissues and water settle below. Fat is separated by skimming or centrifugation.

OILSEED PROCESSING

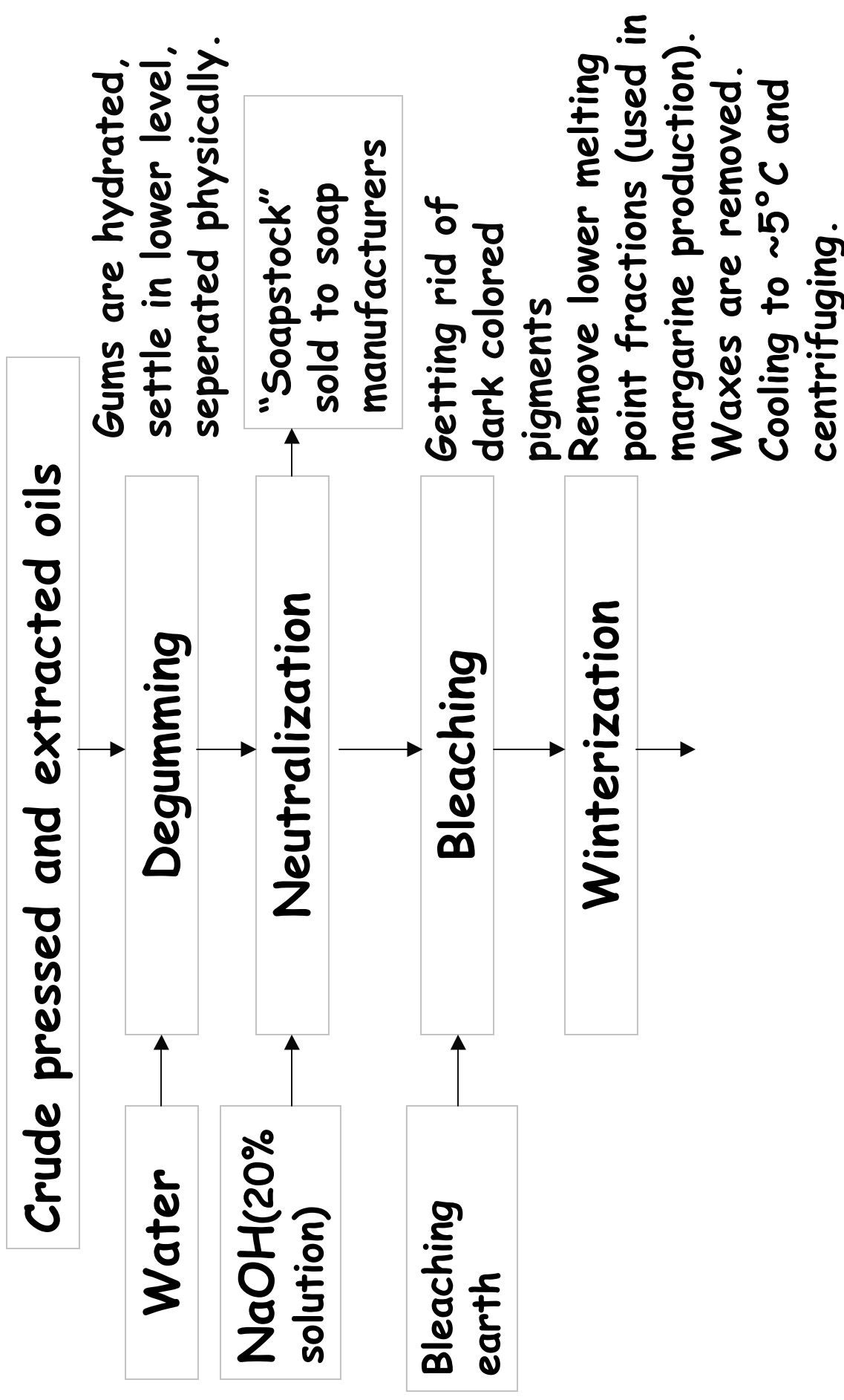


OILSEED PROCESSING

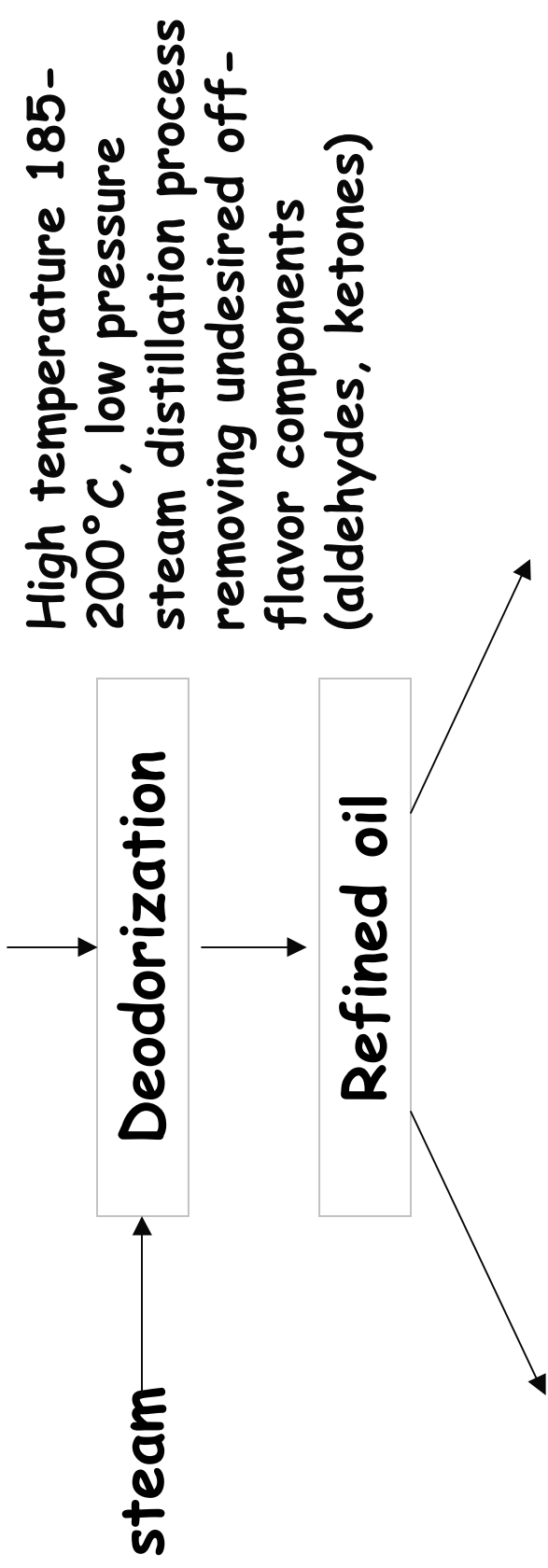


Crude oils need refining since they contain impurities (off-flavors, waxes, gums, dark pigments).

REFINING CRUDE OILS



REFINING CRUDE OILS



High temperature 185-200°C, low pressure steam distillation process removing undesired off-flavor components (aldehydes, ketones)

Neutralized, bleached and deodorized (nbd) sold to margarine producers

"liquid salad oils"

MARGARINE PRODUCTION

- **In 1870; Megés Mouries invented margarine to take the place of butter.**
- **Margarines are emulsions, combination of two immiscible phases (water+oil)**
- **Emulsifier is a substance that one half dissolves in water and the other half dissolves in oil.**
- **Example for an emulsifier: Lecithin.**

MARGARINE PRODUCTION

*Hydrogenation : Converting liquid vegetable oils to solid fats. Hydrogen is given to unsaturated fatty acids in the triglyceride molecule thus saturating them.

Industrial hydrogenation process:

- Heating the oil to 120°C under vacuum (with 0.05% nickel catalyst)
- Stirring, shutting the vacuum, admitting H_2 gas
- Cooling and stopping the flow of H_2 filtering of catalyst.

MARGARINE PRODUCTION

NBD* oil

Hydrogenation*

*NBD: Neutralised, bleached, deodorized

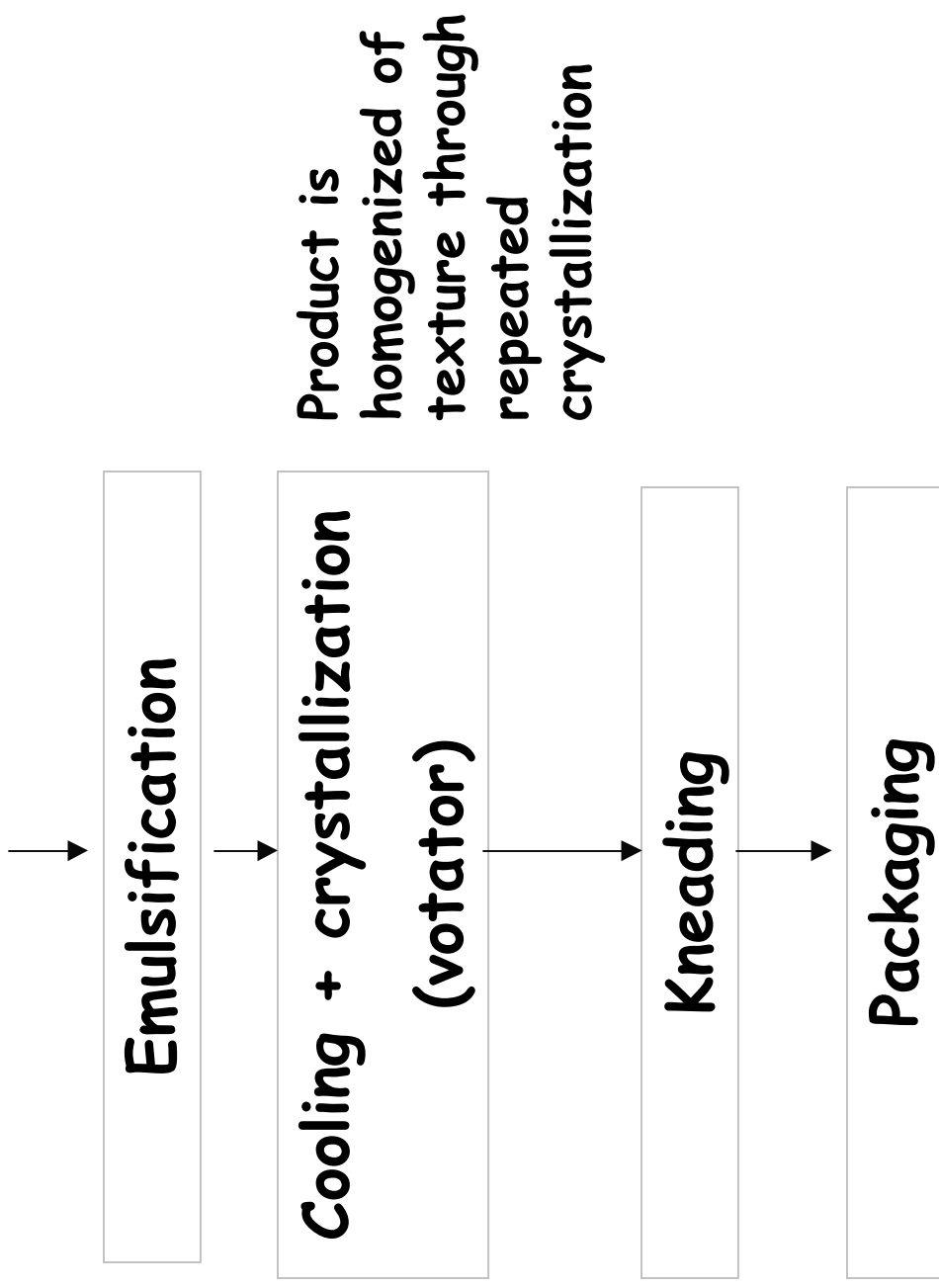
Mixing the oils and fats for fat phase.
Oil soluble additives
(β -carotene, vit A, D, emulsifiers lecithin, MDG)

Milk phase
milk
starter culture
(*Streptococcus lactis*
Streptococcus cremoris-
producing aroma)
NaCl
Preservatives

Emulsification



MARGARINE PRODUCTION



BUTTER PRODUCTION

Emulsion of water and oil

Starting material is milk(~3.5% fat content)

1) Production of cream

Specific gravity of milk fat =0.93

Specific gravity of milk =1.03

“Cream separators” are used

2) Churning process (the cream):

Mechanical agitation process at $\sim 10^{\circ}\text{C}$. Water is removed and fat content(%) is increased.

3) Washing and adding NaCl

4) Packaging

FAT SUBSTITUTES

Because of the desire to reduce the caloric and fat content of the diet and to change the types of fat in the diet, many new fat substitutes have been or are being developed.

They can generally be divided into two types:

- Those which reduce caloric content by substituting a less calorically dense substance for the fat (protein particles, carbohydrates etc.)
- Those that behave like a fat but are not readily absorbed by the body and do not provide the same calories (sugar esters, Olestra®- derivative of table sugar).

TESTS ON FATS AND OILS

Chemical tests:

Degree of unsaturation - Iodine value

Degree of oxidation (oxidative rancidity) - Peroxide value

Hydrolytic rancidity - Acid value

Average molecular weight - Saponification value

END OF LECTURE 7