b) Listing of feed materials

The main raw materials processed by the EU Proteinmeal and Oil Industry are rape seeds, soybeans, sunflower seeds, crude palm oil, crude palm kernel oil and crude coconut oil.

Crushing of these oilseeds and beans delivers the following feed materials:
- rape seed and sunflower seed expeller
- soya (bean), sunflower seed and rape seed meal
- soya (bean) and sunflower seed hulls
- vegetable oils (crude degummed soya (bean) -, rape seed - and sunflower seed oil)

Soya (beans) and sunflower seeds may be dehulled, resulting in meal with a low fibre and hence high protein content (“hi-pro” versus “low-pro” meal).

Refining of oils delivers:
- refined vegetable oils (refined rape seed -, soya (bean)-, sunflower seed -, palm-, palm kernel - and coconut oil)
- rape -, soy -, sun -, palm -, palm kernel -, coconut acid oils
- soy -, rape -, sun -, palm -, palm kernel - and coconut fatty acid distillates
- soy -, rape -, sun, palm, palm kernel and coconut deodistillates

Downstream processing of oils delivers:
- hydrogenated oils
- interesterified oils
- fatty acids from splitting
- fractionated vegetable oils and fats (oleins and stearins)
- glycerine

Other oilseeds processed include linseed, sesame seeds, maize germs and poppy seeds. Other oils processed include shea, illipe, safflower seed and groundnut oil.

c) Overview of main processes

1) OILSEED CRUSHING

1.1. Cleaning, Drying and Preparation of the seeds/beans
As a first step the seed/bean is cleaned and dried. Foreign material, such as stones, glass and metal is taken out by sieving and magnets and is disposed of outside the feed chain.

Drying is performed whilst avoiding contact with combustion gasses unless natural gas is used.

Some oilseeds, like soybeans and sunflower seeds, may be dehulled after cleaning. After dehulling, the meal has a lower crude fibre content, and hence a higher protein content. The soya hulls can also be used for feeding purposes, as such or in pelletized form.

1.2. Crushing and Heating
Seeds with high oil content, such as rape seeds and sunflower seeds are usually mechanically pressed after a preheating step. The pressed cake contains up to eighteen percent of oil and is further treated in the extractor. In some cases the pressed cake undergoes deep expelling. This brings oil levels down to below ten percent and results in an expeller sold for feed purposes. Soybeans have a
relatively low oil content. They are thermally treated, mechanically crushed into raw materials/flakes that are further extracted. Sometimes the oil-containing raw material is pressed without heating; such oils are known as cold-pressed oils. Since cold pressing does not extract all the oil, it is practiced only in the production of a few special edible oils, e.g. olive oil. During storage of crude oil, solid sediments may aggregate at the bottom of the tank. Such sediments can only be removed by a special cleaning company. There is no reason to question the safety of these sediments. However, these are not sold for feed purposes.

1.3. Solvent extraction
Solvent extraction separates the oil from the seeds/beans. The pre-processed seeds/beans are treated in a multistage counter-current process with solvent until the remaining oil content is reduced to the lowest possible level. Hexane is commonly used as extraction solvent. The miscella is a mixture of oil and solvent. It is separated by distillation into its two components, oil and solvent. The solvent is recycled for re-use in the extraction process.

1.4. Desolventising and toasting
The hexane-containing meal is treated in the desolventiser toaster with the help of indirect heating and steam. The desolventising toasting process serves three purposes. Firstly, to recover the solvent from the meal, secondly to increase the nutritional value of the meal e.g. by reducing the content of glucosinolates or trypsin inhibitors, and thirdly to minimise the risk of biological contamination.

1.5. Drying, cooling, storage
To obtain a stable and transportable feed material that is fit for storage, the meal is subsequently dried and cooled. In general, oilseed meals are stored in silos. The packing in bags is limited to exceptional cases. In order to avoid the sticking of the meals to the wall of the silo, it is common practice that an anti-caking agent (such as mineral clay) is added). This is particularly necessary when the silos reach considerable heights. The anti-caking agents used are those permitted by EU feed legislation.

2) Refining
Crude oils obtained by pressing and/or extraction are sometimes used directly for food and feed purposes. In most cases, however, the crude oils are refined. Crude oil refining entails the removal of gums or crude lecithins and that of free fatty acids (FFA) from the oil to get a neutral taste of the edible oil while maintaining the nutritional value and ensuring the quality and stability of the product.

2.1 Degumming: chemical and physical refining
Degumming is the first step of refining and involves the removal of the gums/crude lecithins from the oil. To that effect, the crude oil is treated with water, enzymes or food grade acid at elevated temperatures. The hydrated gums are removed at the end of this step or after neutralisation. Gums are a raw material for the production of lecithins.

2.2. Neutralisation: chemical refining
FFAs are responsible for oil acidity. Chemical refining is the traditional method of oil refining and involves a neutralisation step of these FFA’s in the crude oil.
During neutralisation, the oil is treated with a food grade alkali solution (caustic soda) that reacts with the FFA to form soap stock.

The soap stock - together with the precipitated gums, if still present- is separated from the oil by centrifugation. Typically, soap stocks contain 40% water and 60% fatty matter (FFA, triglycerides). In facilities that both crush oilseeds and refine the seed oils (integrated crushing and refining), the soap and gums can be added back to the meal or expellers at inclusion levels of around 1.5%. Soap stock can also be sold to the market as feed material under the denomination “soap stock” or can be split by means of an acid into acid oils. The production of gums and soap stock in integrated crushing refining is a process of continuously removing the gums and free fatty acids from the oils and continuously adding these as gums or soap stock to the meal or expellers. The components in the soap stock are part of the natural composition of seeds or beans. This means that only natural components separated from the seeds and beans are returned back into the crushing process. Whether integrated crushing refining plants add soap stocks back to the meal or expellers is determined by the design of the facility. It is not subject to daily management decisions. In their meeting on 17 and 18 January 2013, the Standing Committee on the Food Chain and Animal Health, section Animal Nutrition confirmed the feed material status of meals and expellers to which soap stocks have been added in integrated crushing and refining plants.

2.3. Bleaching: chemical and physical refining

The purpose of bleaching (or decolorising) is to reduce the levels of pigments such as carotenoids and chlorophyll, but this treatment also further removes residues of phosphatides, soaps, traces of metals, oxidation products, and proteins. These trace components interfere with further processing. They reduce the quality of the final product and are removed by adsorption with activated clay or silica. In integrated crushing / refining plants the used bleaching earth may be brought back into the meal. Bleaching earth originating from stand-alone refining plants and / or hardening plants, the latter which can contain nickel is excluded from recycling into feed and is disposed of outside the feed chain. If heavy polycyclic aromatic hydrocarbons are present in crude oil, activated carbon shall be used for their removal. The bleaching clay containing activated carbon is disposed of outside the feed sector.

2.4. Winterisation: optionally both chemical and physical refining

During winterisation waxes are crystallised and removed in a filtering process to avoid clouding of the liquid fraction at cooler temperatures. The filter cake that remains after the filtering process consists of oil, waxes and filter aid. The filter cake can be recycled to the toaster and added to the meal (in an integrated crushing/refining plant) or sold as such as a feed material (refining stand alone). The term winterisation was originally applied decades ago when cottonseed oil was subjected to winter temperatures to accomplish this process. Winterisation processes using temperature to control crystallisation are carried out on sunflower and maize oil. This process is also referred to as dewaxing.

2.5. Deodorisation: chemical refining

Deodorisation is a vacuum steam distillation process that removes the relatively volatile components that give rise to undesirable flavours, colours and odours in fats and oils. This is feasible because of the great differences in volatility between these undesirable substances and the triglycerides. The purpose of deodorisation is to remove odours, off-flavours and other Volatile components such as pesticides and light polycyclic aromatic
hydrocarbons by stripping Careful execution of this process will also improve the stability and the colour of the oil, whilst preserving the nutritional value. Depending on the residence time in the deodoriser, the process is carried out under vacuum (0.5 – 8 mbar) and at temperatures between 180° - 270°C, and using a stripping medium, such as steam or nitrogen, since the substances responsible for odours and flavours are usually volatile. Conditions are adapted within these ranges as appropriate to ensure the removal of specific substances. Further removal of the proteins is achieved at this step.

2.6 Distillation: physical refining
Physical refining removes the FFAs by distillation; the boiling point of the FFA is lower than that of the triglyceride oil. FFA from physical refining are referred to as fatty acid distillates. Stand-alone refineries, ie those that source crude oils and hence don’t crush oilseeds often apply physical refining to tropical oils such as palm oil, palm kernel oil and coconut oil. Integrated crushing and refining plants may also apply physical refining to seed oils such as rape seed, sunflower seed and soybean oil. Physical refining does not involve a neutralisation step of the crude oil and hence no soap stock production.

3) Modifications on Oils and fats

3.1. Hydrogenation
During hydrogenation hydrogen reacts with the points of unsaturation in the fatty acids. The purpose of hydrogenation is to obtain oils and fats with specific melting profiles or oxidative stability by reducing unsaturated double bonds in the oil or fat. Hydrogenation is accomplished by reacting oil with hydrogen gas and in the presence of heat and metal catalysts, e.g. nickel.

3.2. Interesterification
A better melting profile of oil/fat system can also be achieved via interesterification, which is defined as the interchange of fatty acids from different fats/oils on the glycerol backbone. There are two types of interesterification processes: chemical and enzymatic. Chemical interesterification in the presence of basic catalysts, e.g. sodium methoxide, results in non-selective or random rearrangements of fatty acids. Interesterification using immobilised lipases is more commonly done in the industry due to its selective modification of position of fatty acids in the triglycerides. After interesterification, the output product is bleached (if necessary) and (re-) deodorised.

3.3 Fractionation
The chain length of a triglyceride defines its melting point. Fractionation entails controlled crystallization. Solids are removed by means of solvents or winterization or pressing. Pressing happens with hydraulic pressure or vacuum filtration. Fractionation is used to produce specialty fats from palm and palm kernel oil.

3.4 Splitting
Splitting by means of water under high pressure of the ester bonds of triglycerides renders fatty acids and glycerol molecules. The glycerol is separated with the water.
The flow charts below represent the following main processes applied:
- Crushing of oilseeds
- Chemical refining of oil
- Physical refining of oil
- Downstream processing of refined oil
Flow chart Refining Physical Refining

Crude Oil

Degumming

Crude degummed oil (2,20.3) c

Bleaching

Winterisation

Filter aid

Distillation

Refined oil

Fatty acid distillate

Acids

Active coal (optional)

bleaching earth

Bleaching earth

Filter aid

To solvent extraction a

Crude lecithins (wet gums) (2,21.1) c

To desolventising toasting a

To desolventising toaster a

used bleaching earth b

Filter aid

* Typical flow chart: the order of the process steps may vary amongst production plants

b Used bleaching earth with active coal is not fed back to meal at integrated crushing and refining and is disposed of outside of the feed chain

c The number refers to that in the Catalogue of Feed Materials - Commission Regulation 68/2013

d These page numbers refer to safety evaluations in this appendix

EFISC Code – Sector reference document on the manufacturing of safe feed materials from oilseed crushing and vegetable oil refining

11
Flow chart downstream processing

Crude, Refined or Processed oil

Hydrogenation

Hydrogenated oil (2.20.1)¹

Interesterification

Chemical/enzymatic

Interesterified oil

Spitting + fractional distillation

Fatty acids from spitting (11.6.4.1 from crude oil, 13.6.7.4 from refined oil)²

Glycerine (11.8.1, 13.8.2)²

Clein

Stearin

to refining (potentially)

¹ The number refers to that in the Catalogue of Feed Materials - Commission Regulation 88/2013