The Oklahoma Cooperative Extension Service
Bringing the University to You!

The Cooperative Extension Service is the largest, most successful informal educational organization in the world. It is a nationwide system funded and guided by a partnership of federal, state, and local governments that delivers information to help people help themselves through the land-grant university system.

Extension carries out programs in the broad categories of agriculture, natural resources and environment; home economics; 4-H and other youth; and community resource development. Extension staff members live and work among the people they serve to help stimulate and educate Americans to plan ahead and cope with their problems.

Some characteristics of Cooperative Extension are:

- The federal, state, and local governments cooperatively share in its financial support and program direction.
- It is administered by the land-grant university as designated by the state legislature through an Extension director.
- Extension programs are nonpolitical, objective, and based on factual information.
- It provides practical, problem-oriented education for people of all ages. It is designated to take the knowledge of the university to those persons who do not or cannot participate in the formal classroom instruction of the university.
- It utilizes research from university, government, and other sources to help people make their own decisions.
- More than a million volunteers help multiply the impact of the Extension professional staff.
- It dispenses no funds to the public.
- It is not a regulatory agency, but it does inform people of regulations and of their options in meeting them.
- Local programs are developed and carried out in full recognition of national problems and goals.
- The Extension staff educates people through personal contacts, meetings, demonstrations, and the mass media.
- Extension has the built-in flexibility to adjust its programs and subject matter to meet new needs. Activities shift from year to year as citizen groups and Extension workers close to the problems advise changes.

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Oil and Oilseed Processing I

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Oilseed Handling, Storage and Pre-treatment

Oils are essential components of all plants. However, commercial oil production facilities only utilize plants that accumulate large amounts of oil and are readily available. Currently, the largest source of commercial oils is oilseeds: the seeds of annual plants such as soybean, canola, rapeseed, cottonseed, sunflower, peanut, castor and flax. The second largest source of plant oils includes coconut, palm, olive and tung oil.

Handling and Storage

In the United States, oilseeds are shipped like any other grain, either in railroad cars or trucks, and received at elevators. Physical properties of the seeds, such as size, shape, bulk density and flowability affect the design of oilseed handling facilities. For example, canola, rapeseed, delinted cottonseed, soybean and sunflower have very good flowability. They are usually stored in vertical cell-like storage bins. Copra (dried meat or kernel of the coconut) and undelinted cottonseed do not flow well. Hence, vertical bins are not suitable for this type of seeds. Copra is stored in large flat warehouses. Storage bins can be built of stainless steel, concrete, tile or other material. Vertical bins are preferred where ambient temperature is low. Concrete bins are used at places where average outside temperature is relatively high (95-113 degrees Fahrenheit).

Proper handling and storage of oil-containing materials are very important to minimize deterioration and maintain good quality of both contained oil and meal. Whole, intact, low-moisture oilseeds (about 8-10 percent moisture) may be stored for an extended time under suitable conditions. Deterioration of oilseeds is accompanied by respiration or carbon dioxide evolution and heat generation by oxidation reactions. Sound, intact seeds may release less than 10 cubic centimeters of carbon dioxide per gram of seed per day, while damaged, high moisture seeds may release 50 cubic centimeters or more of carbon dioxide per gram of seed per day. Furthermore, heat generation by oxidation reactions may increase the temperature of stored seed, accelerating deterioration even to the point of charring the seeds.

Activity of native enzymes present in oilseeds, infestation by insects and mites along with microbial activity during storage also are important factors affecting oil and meal quality. In general, high moisture content (above 14-15 percent moisture) in seeds has an adverse effect on oil and meal quality. Oil splitting, or acid generation, may be accelerated by microbial growth (mold and/or bacterial growth) and enzyme activity in high-moisture seeds. Oil in mature seeds may contain about 0.5 percent free fatty acids. However, if seeds are damaged mechanically or by frost or become wet during harvest, handling and storage, then the acidity of oil can be much higher.

Sprouting, considered a damage factor, is another important issue during storage of high-moisture seeds. Sprouted seeds may have lower oil and higher free fatty acid content as compared to sound seeds. Today, air dryers are essential components of modern storage facilities to maintain oilseed quality. Most oilseed storage bins are equipped with aeration ducts and ventilation blowers to cool the seeds. Since oxidation reactions are aerobic processes, a low oxygen atmosphere in storage bins helps to slow down oxidation and quality deterioration. Mature seeds can be stored longer than immature seeds because of

the lower activity of oil-splitting enzymes in mature seed. Proper storage of harvested oilseeds also may contribute to desirable changes. For example, oil extraction yields from fresh soybeans can be lower than for soybeans stored more than five months. The storage of soybeans also decreases the chlorophyll content of green beans. Chlorophyll is not desirable in edible oils and needs to be removed during the oil refining process.

Preparation of Seeds for Oil Extraction

Unit operations for preparation of seeds for oil extraction vary slightly depending on the physical properties and oil content (Figure 1). However, most oilseeds go through the process of cleaning, drying dehulling, size reduction, flaking cooking and tempering.

Cleaning

Oilseeds need to be cleaned to remove plant stems, sticks, leaves and foreign material before storage. Such material may decompose and cause heating in stored seed mass diminishing oil and meal quality. Foreign materials in seeds are typically separated out by a combination of rotating or vibrating coarse screens, reels and aspiration. This process is commonly referred to as scalping. Buhler, Carter-Day, and Kice Metal Products are some of the suppliers of scalping equipment.

Sand and dirt also are removed by fine screening. Rotex and Buhler are well known suppliers of such screens. Magnetic devices remove metal contaminants from seeds. Plate magnets, drum magnets or electromagnets installed over conveyor belts are commonly used. Some oilseeds such as peanuts may contain stones which are similar in size to the seeds. Hence, they cannot be separated by screening. Seeds need to be separated from stones by gravity. Special "destoners" are available to remove stones and mud balls. Companies such as Buhler and Triple S Dynamics are popular suppliers of such equipment.

Seed Drying

The moisture content of oilseeds often needs to be reduced to minimize degradation in storage and to improve the effectiveness of downstream processing. For example, soybeans are often received at 13 percent moisture and need to be dried to 10 percent moisture to facilitate efficient hull removal. Large, vertical, open-flame grain dryers can be used for oilseeds as well. These dryers have multiple columns of oilseeds which slowly migrate downward. The upper portion of the column is used for drying and lower section is for cooling.

Dehulling

The amount of hull on oilseeds varies significantly. The percentage of hulls for cotton seed, sunflower seeds and soybean are 45, 25 and 7 percent, respectively. Hulls and shells of oilseeds do not contain a significant amount of oil (less than 1 percent). Most oilseeds need to be separated from their outer husk or shell prior to oil extraction. Dehulling also is referred to as shelling or decorticating. Dehulling increases oil production efficiency, capacity of the extraction equipment and reduces wear in the expeller as the husks are abrasive. If not removed, hulls reduce the total oil yield by absorbing or retaining oil in the pressed cake. Furthermore, wax and color compounds present in the hulls end up in the extracted oil. These compounds are not desirable in edible oils and need to be removed during the refining process. Dehulling reduces fiber and increases protein content of the meal.

There are numerous dehuller designs to choose from depending upon the types of seeds. Knife, disk and impact type dehullers are widely used. For example an impact dehuller, which is commonly used for sunflower seeds, consists of a rotating blade that drives seeds into a hard material outside the diameter of the blades. The force of impact causes the hulls to break. Then, seeds are separated by using shaking conveyor belts, multiple sifting screens or vacuum. Dehulling efficiency of a system often is measured by the residual fiber content in the meal and the residual oil content in the hulls. The industry standards for soybeans are less than 3.5 percent fiber content remaining in the meal and less than 1.5 percent oil content remaining in the hull. Suppliers of dehulling equipment include Buhler, Crown Iron Works, De Smet, Kice Industries, Inc., Rotex and Carter Day.

Size Reduction and Flaking

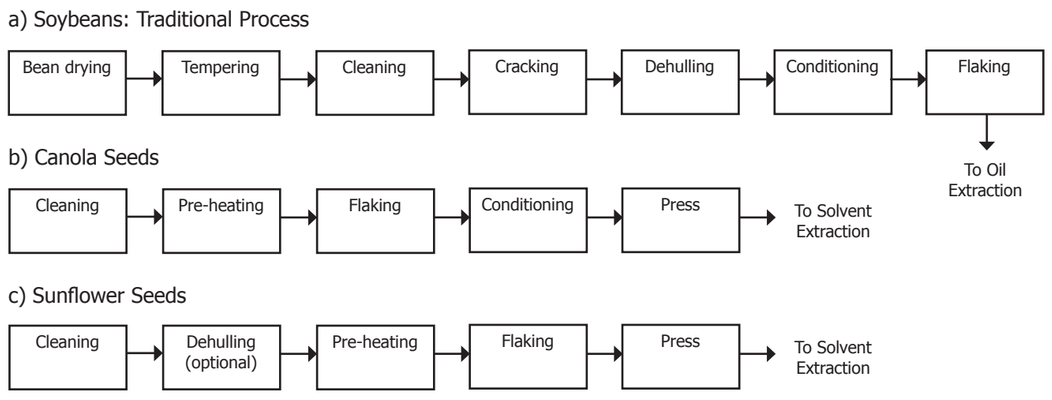
Most oilseeds are reduced in size to facilitate hull removal, heating, drying and flaking prior to oil extraction. Canola, rapeseed and corn germ do not require size reduction as they are already sufficiently small. Cracking mills are used for seed size reduction. A cracking mill consists of two sets of cylindrical corrugated rolls in series. The rolls rotate at differential speeds to break apart seed cells containing oil. High capacity cracking mills can process up to 1,000 tons per day of oilseeds. Buhler and CPM Roskamp are the primary suppliers of cracking mills.

Oilseeds also can be flaked prior to solvent extraction. Flaking ruptures seed cellular structure and reduces the distance that solvent has to travel to reach the oil in the cells. A flaking mill has two large diameter rolls turning in opposite direction and forced together by hydraulic cylinders. As the seeds are pulled through the flaking mill, they are stretched and flattened. Typical flake thickness is in the range of 0.01-0.015 inch or 0.25-0.37 mm. Flaking of oilseeds also increases surface area for increased contact between solvent and seed during the solvent extraction process. Oil from the cracked or flaked seeds should be extracted as quickly as possible (within 24 hours) to minimize meal and oil quality deterioration. Flaking mills, which can process 300 to 500 tons of seeds per day, are available. Buhler and CPM Roskamp are the major suppliers of flaking mills.

Cooking/Tempering

Oilseeds are cooked or tempered to denature proteins, release oil from the cells and inactivate enzymes. For example, rapeseed contains the enzyme myrosinase. This enzyme catalyzes hydrolysis of glucosinolates which are naturally present in rapeseed. During the hydrolysis process, undesirable compounds such as isothiocyanates and nitriles form. These compounds are soluble in oil and lower the quality of oil. Rapeseed is cooked in multistage cookers to keep the glucosinolates intact and inactivate the myrosinase. Rapeseed is preheated to 68-122 degrees Fahrenheit in less than 5 minutes and contacted with live steam at 248 degrees Fahrenheit. Since canola has much lower levels of glucosinolates than that of conventional rapeseed varieties the cooking temperature for canola is lower (less than 212 degrees Fahrenheit). Cooked seeds are immediately pressed to separate oil. Cooking also gives seeds proper elasticity for efficient pressing. Cooking at high temperature is not necessary for sunflower seeds. Cracked and dehulled soybeans are conditioned/tempered by increasing the temperature to 149 degrees Fahrenheit and adjusting the moisture by using live steam. Conditioning is done in rotating drums with an internal steam coil. Tempering improves flaking performance and extraction efficiency.

Figure 1: Unit operations for seed pre-treatment prior to extraction
(R. Carr. 1993. Oilseed Harvesting, Storage and Transportation. In: Proceedings of the World Conference on Oilseed Technology and Utilization. Editor T.H. Applewhite. AOCS Press, Champaign, IL, 1993).



Resources

Buhler Group: http://www.buhlergroup.com/19886en.asp?grp=60&org=70_60_45&lang=EN&nav=80_10

Carter-Day: http://www.carterday.com/CD.html *and* http://www.carterday.com/Media/CDIGrainCleanaing.pdf

CPM Roskamp: http://www.cpmroskamp.com/roskamp/

Crown Iron Works: http://www.crowniron.com/technologies/prep_parent.cfm

De Smet Group: http://www.desmetgroup.com/preparation.html#01

Kice Industries, Inc.: http://www.kice.com/industries/oilseedprocessing/index.html

Kice Metal Products: http://www.kice.com/products/index.html

Rotex: http://www.rotex.com/02applications/app_agriculture.aspx

Soyatech: http://www.soyatech.com/info.php?id=198&cat=8&ecat=1

Triple S Dynamics: http://www.sssdynamics.com/downloads/index.htm