PULSES

Basic Pulse Milling Techniques

Milling refers to the particle size reduction step which involves both dehulling and splitting, in addition to flour milling.

Dehulling *(Decortication)*

- Removal of seed coat
- Hulls of pulses, especially peas and lentils, contain high antinutrients (lipids which tend to cause off flavor and odor) and most of insoluble fiber (Wood and Malcolmson, 2011).
- Beans and chickpeas are more difficult to dehull than peas and lentils, resulting in few dehulled or split beans commercially available

Splitting

- Loosening and cleavage of cotyledons

FLOUR MILLING OR GRINDING

Milling of pulses into flour is a traditional food practice around the world, primarily in Southeast Asian countries. Obtaining consistent and ideal particle size distribution has been a challenge for the pulse milling industry. A big challenge in pulse milling is obtaining flour with consistent, uniform particle size. Pulses tend to become sticky when milled into flour, increasing a tendency to stick to the passage of equipment. Presence of seed coat or hull greatly affects the milling properties, such as particle size distribution, screening, flow rate and milling yield.

FOUR MILLING TECHNIQUES

There are four principal techniques used to bring about the size reduction necessary for processing. These are impact milling, attrition milling, knife milling and direct pressure milling.

- **Impact Milling** involves use of a hard object to strike a wide area of the particle to fracture it. A rotating assembly then uses blunt or hammer-type blades, such as with hammer mills, pin mills, cage mills, universal mills, and turbo mills. The impact technique is recommended for pulse milling applications due to particle size variability. An impact mill, such as a hammer mill, is often used to produce whole flour. The mill employs a steel durum containing either a vertical or horizontal rotating shaft fitted with hammer bars, with which the particle size is reduced until the particles are able to exit through a metal screen (Wood and Malcomson, 2011).
- **Attrition Milling** relies on a horizontal rotating vessel filled with a size-reduction solution. Treated to grinding media, the materials tend to be turned into free flowing, spherical particles. This method, which includes the ball mill, can reduce 1,000-micron (20-mesh) particles of friable materials down to less than 1 micron.
- **Knife Milling** involves a sharp blade which applies high, head-on shear force to a large particle, cutting it to a predetermined size, while also minimizing fines. A rotating assembly of sharp knives or blades is used to cut the particles. Examples like knife cutters, dicing mills and guillotine mills can reduce two-inch or larger chunks or slabs of material, including elastic or heat-sensitive materials, to 250 to 1,200 microns.
- **Direct-Pressure Milling** occurs when a particle is crushed or pinched between two hardened surfaces. This can involve two rotating bars or one rotating bar and a stationary plate and can typically reduce one inch or larger chunks of friable materials down to 800 to 1,000 microns. Examples include roll mills, cracking mills and oscillator mills.

PROCESS FEATURES

The rotor speed, feed rate, screen size, screen type and moisture content of peas all affect pea milling quality. Rotor speed is the primary factor and can significantly impact the milling process.

- **Feed Throat:** The feed throat introduces material into the milling chamber. A gravity feed throat delivers material tangentially to the rotation of the blades.
- **Blade profile:** The type, quantity, and shape of a milling blade helps determine the degree of reduction achieved. The blade profile offers the flexibility of a knife on one side and an impact tool on the other, with the former being used for gentle granulation and latter for more aggressive reduction.
- **Feed Rate:** Milling is most effective if the product is fed uniformly into the feed throat using a variable feed system (15 to 60 rpm). It should be noted that high feed rates increase energy consumption.
- **Rotor Speed:** The rotor speed affects particle size distribution and, as a general rule, with all other variables remaining constant, the faster the rotor speed, the finer the grind. Rotor speeds of 3000 to 7200 rpm are used with flat blades in fine-grinding applications, such as with coarse and fine pea flour and other legume flours, while speeds of 1000 to 3000 rpm are used with sharp blades in coarse grinding applications.
- **Screen:** The screens can be round or rectangular, with screen thickness and the total open surface area of the screen affecting the comminuting (pulverizing) operation. The diameter of the screen holes doesn't necessarily designate the particle size of the finished product, as impacted particles follow a tangential trajectory from the blades and approach the screen at a shallow angle. The higher the rotor speed, the smaller the angle under which the particle approaches the screen, and the smaller the screen openings appear to the particle.

COMPARING TYPES OF PULSE MILLING:

Different milling processes produce different ranges of particle size. According to research conducted at the Canadian International Grains Institute, pin mills and roller mills produce the most uniform and finest particle size flour while stone and hammer mills produce flour with largest and least uniform particle size (Maskus et al, 2016). Particle size differences were dependant on the processing method as simultaneously milling hulls and cotyledons to the same particle size was difficult on most of the mills tested. Only pin milling enabled the simultaneous particle size reduction to the same particle size (Maskus 2016). Such differences cause functionality differences. For example, fine fraction of pulse flour prepared by hammer mill had a lower initial gelatinization temperature compared to more coarsely milled counterpart.

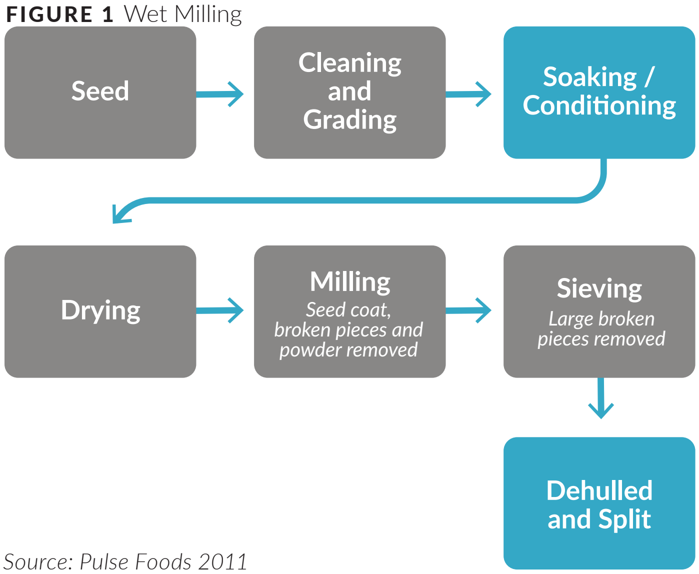
PRE-TREATMENTS & DRYING METHODS

Tempering: Softens cotyledons and reduces starch damage.

Roasting with dry heat for 6-8 minutes @ 104-105 C: Stabilizes flour, partially gelatinizing the starch, denaturing the protein, and inactivating enzymes to increase product shelf life.

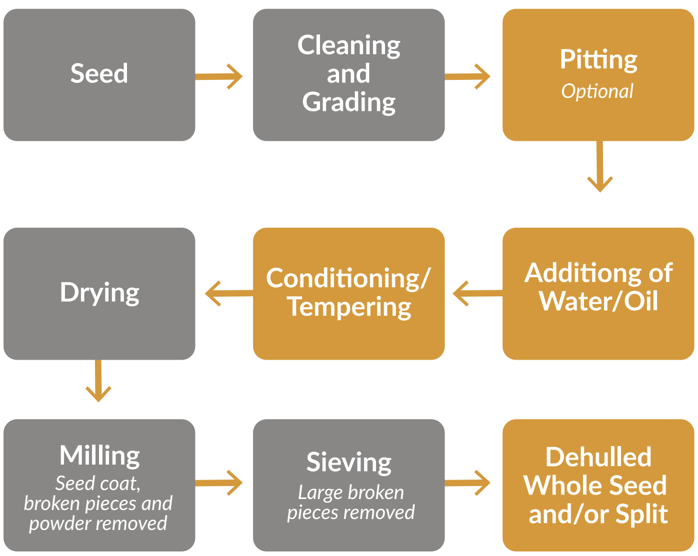
Source: Canadian International Grains Institute

FIGURE 1 Wet Milling



Source: Pulse Foods 2011

FIGURE 2 Dry Milling



Source: Pulse Foods 2011

Additional Resources

Pulse Foods: Processing, quality and Nutraceutical Applications Edited by Brijes K. Tiwari. Food Science and Technology, International Series. Academy Press. 2011

Advancing Pulse Flour Processing and Applications. Technical Papers: Pulses. Canadian International Grains Institute https://cigi.ca/pulses/

Pulse Canada www.pulsecanada.com

USA Dry Pea and Lentil Council Technical Manual www.usapulses.com

Northern Crops Institute www.northern-crops.com

Pulse Processing. Industry Solutions Resources.Buhler. www.buhlergroup.com

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For more information, contact: **USA Dry Pea and Lentil Council/ American Pulse Association**

info@usapulses.com | 208-882-3023 | *www.usapulses.com*