Core Course 8

TECHNOLOGY OF CEREALS, PULSES AND OILSEEDS

UNIT 2 TECHNOLOGY OF PULSES

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Introduction:

Legumes, or pulses, are flowering plants in the *Leguminosae* family. The term pulse has a more direct lineage. It derives from puls or porridge, a cooked bean dish which the ancient Romans were fond of eating. Pulses are the cheapest and rich source of protein. They are considered as lifeline for vast vegetarian population of India. Apart from being the good source of protein, pulses also contain substantial quantity of minerals, vitamins, crude fiber etc. Amino acid composition of pulses is complementary to that of cereals. In India, pulses are the second major source of dietary protein after cereals.

Legumes go through several processes before they are ready to be used as an ingredient in food preparations. These processes can include cleaning, drying, sorting, splitting, milling, and fractionating. During milling, dal is split into smaller sizes which renders it convenient for cooking. Traditional methods for processing of pulses were labour intensive, time consuming and incurred losses. Modern technologies for processing of pulses have replaced old age methods and thus avoid losses and saves time. Depending on the pulse and its intended use, other steps like dehulling (decorticating), roasting, and grinding may be included as well. By-products of pulse plants are an excellent fuel and feed.

This episode deals with the following important sub headings.

- ✓ Milling of Pulses
- ✓ Home scale milling
- ✓ Cottage scale milling
- ✓ Commercial scale milling

- ✓ Advances in Milling Technology

1. Milling of Pulses

Pulses are mostly consumed in the form of dehusked splits, commonly known as dal. The outer layer of the grain (husk) is attached to the protein and starch bearing cotyledons of the pulse grains **(Figure 1)**. In some grains bonding will be very strong. The strongness is due to the presence of a layer of gums in between the husk and the cotyledons. These types of pulses are known as difficult-to-mill pulses (urdbean, mungbean and pigeonpea). In other grains, this bonding is comparatively weaker. These grains can be milled easily and are categorized as easy-to-mill pulses. (chickpea, pea, lathyrus).

The process of removal of husk from the cotyledons is called dehusking. The entire process of dehusking and subsequent splitting of cotyledons, its cleaning, polishing and grading is known as milling.

Dehusking helps in improving product appearance, texture, quality, palatability and digestibility. The significant amount of avoidable loss at different stages of milling occurs. The losses may vary from 10-15%. Loss depends upon the type and quality of grain milled, the process and machinery used for milling and other factors. It is, therefore, important to look at different aspects of milling. Proper process and machinery should be used to obtain maximum recovery of good quality dal from the grain.

Milling of pulses involves two major steps:

i. loosening of husk
ii. removal of husk and splitting into cotyledons

Pre-milling treatments is given to almost all kinds of pulses, which helps in easy removal of husk. The processes and equipments for loosening of husk, separation of husk from cotyledons and its splitting differs. They differ from crop to crop, cultivar to cultivar and place to place. Dehusking is an age-old practice. Dehusking was first originated at home, and later developed into a cottage industry. Now it has grown into a large-scale organized industry. The four different types of milling of pulses are home scale milling, cottage scale milling, commercial scale milling and traditional milling.

2. Home scale milling

Home scale milling involves mixing of grains with water. The grains are sun dried followed by pounding for dehusking. Dehusking is carried out by using a mortar and pestle and drying in the sun for few hours. Sun- drying after water application helps to loosen the husk from the cotyledons. In mortars, dehusking is achieved due to shearing action between pestle and grains, and abrasive effect between the grains. Once the pounding is done for several minutes, the husk gets detached from the grains. Winnowing separates husk and split cotyledons. Cotyledons are separated from the whole dehusked and unhusked grains by manual sieving. The whole grains are again pounded for further dehusking and splitting **(Figure 2)**. This technique of dehusking is adopted when small quantity (upto 5kg) of pulses is to be dehusked. Dal yield by this process is quite low (50-60%). Breakage and chipping of the edges of cotyledons will be more.

3. Cottage scale milling

Traditionally, villagers use the hand operated wooden or stone chakki/sheller when comparatively large quantities of pulses are to be dehusked. The technique is similar to those of the home-scale methods. Prior to milling pre-conditioning of grains is carried out. Pre- conditioning is done by two ways. (i) By prolonged sun drying until the hulls are loosened. (ii) Through application of water followed by several hours of sun drying and tempering. The heating of the grains in pan with or without sand along with vigorous stirring is also in practice. The duration of treatment depends upon the variety of pulses to be milled. There are no standard dehusking techniques at the cottage level. At cottage level milling, often the husk is not completely removed and breakage is high. This reduces the consumer appeal and value of the product. The yield of dal obtained from these techniques may vary in the range of 55-70% depending upon the variety of pulse and pre-treatment used.

4. Commercial scale milling

Commercial scale milling involves processing large quantities of pulses in plants of bigger capacities. The basic milling procedure is similar. Dehusking methods vary widely from one dal mill to another dal mill and region to region.

Two methods for large scale processing of pulses are in practice.

i. **Traditional method milling,** most commonly followed by dal millers. It is almost similar to cottage level treatment in principles.
ii. **Modern method** milling has been developed at Central Food Technological Research Institute (CFTRI) which is independent of weather conditions.

4.1. Traditional milling

Traditional milling process varies from mill to mill and region to region and no standard or common process is in practice **(Figure 3)**. The sequence of operations like pre-milling treatment, conditioning, dehusking, and splitting is normally common. Large variation exists in the steps followed in milling but basic unit operations remain the same. The most frequent form in which food pulses are consumed is as the decorticated product known as dhal. From a nutritional point of view using pulses with or without milling, have several advantages and disadvantages. Separation of husk decreases nutrients but improves digestibility and/or bioaccessibility. The extent of the losses depends upon the degree of milling and the distribution pattern of nutrients in the grain. During milling the nutrient losses-particularly vitamins and minerals is very large. Therefore, it can be observed that milling has mutual effects on nutritional quality.

4.1.1. Milling process

Milling process involves cleaning ⟶ grading ⟶ pitting ⟶ treatment milling ⟶ polishing operations. The major steps involved in pulse milling are discussed below

a. Cleaning and grading

Pulses received at the mill needs to be cleaned and size graded for yielding good quality dal with higher recovery. Even during dehusking operation, pulses are subjected to sieving. This separates out husk, brokens, splits, gota (dehusked pulse) and whole (unhusked) pulses. Usually two, types of cleaners are used: reciprocating air-screen cleaners and reel screen cleaners. In reciprocating air screen cleaners air is

blown through two screens (sieves). This separates lighter material such as dust, stalk, dried leaves, husk etc.

b. Pitting

Pitting is done by using emery-coated roller. The emery coating is used for abrasive or refractory action. Whole pulses are passed through abrasive roller machine for scratching of seed. This facilitates the entry of oil/water in the grain during pre-milling treatment

c. Pre-milling treatments

The treatment is given for loosening of husk from cotyledons, which is attached through a gum layer called pre-milling treatment. Mostly pre-milling treatments are developed for difficult-to-mill pulses. Commonly adopted Pre-milling treatments are (a) water soaking, (b) oil and water application, (c) mixing of sodium bi-carbonate solution and (d) thermal applications.

For commercial milling in large capacity dal mills, oil and water treatment is commonly adopted. In household milling, water treatment is popularly used. Different methods are employed in different regions depending upon type of grain. This also varies from mill to mill.

Pre-treatments can be broadly classified into

i) wet treatment

ii) dry treatment.

i. Wet treatment

In Wet treatment method, soaking and drying are considered as effective technique to loosen the husk. This method has the advantage of facilitating dehusking and splitting the cotyledons, giving less breakage. This can be attributed to lower, dehusking percentage of grains, in water treatment process. However, it has the disadvantage of being weather dependent and labour intensive. Dal produced by this method cooks better but takes longer time to cook.

Commonly adopted red earth treatment is considered as wet method **(Figure 4)**. In this method, grains are mixed with a paste of red earth after soaking in water for about 12hours and heaping for about 16hours. The grains are spread in thin layer in drying yards for 2-4days. When dried, the red earth is removed by sieving and the

grains are then milled on power-operated stone or emery coated vertical chakki to yield dal.

ii. Dry treatment

Dry milling treatment is reported to produce dal that cooks faster, however, losses due to broken and powdering are high. In dry method, oil/water application followed by drying are important steps in processing of pulses **(Figure 5)**.

In this process, after cleaning and grading, grains are pitted and then mixed with about 1% oil (linseed). Then the grains are spread for sun drying in thin layer, for 2-3days. At the end of drying, 2-5% of water is sprayed, mixed thoroughly and tempered for overnight. Tempered grains are dehusked in roller machines to give dehusked grains and dal.

d. **Tempering:**

Once the pre-milling treatment is given, conditioning is done to have uniformity of treatment throughout the grain mass. This process gives time for better penetration of oil/water beneath the seed coat to dissolve gums.

e. Drying

In most of the mills in India, sun drying method is commonly practiced. Grains are spread in thin layer on pucca floor under the sun and stirred frequently with rake/feet for even drying. This operation makes process of dal milling a very lengthy requiring (2-3days). In this case, sun-dried grains require more passes and consumes more energy.

The drying time with the use of dryers ranges between 2-3hrs, which results in tremendous time saving. Dryers are used in few mills that too in rainy seasons for drying of treated grains.

f. Dehusking and splitting

Dal mills by and large use emery rollers for dehusking and splitting. In case of difficult-to-mill pulses, more than 3 passes are required for complete milling. Easy-to-mill pulses take one or two passes in emery mill in order to achieve maximum milling.

The physical, chemical and structural strength of grain coupled with the functional and mechanical characteristics of processing units jointly play an important

role. Grain properties such as hardness, load deformation behaviour, shape, size density and variety of grain etc. have considerable effect on dal yield.

The machine parameters such as roller speed, clearance, emery size etc. have vital role to play on dal recovery. As a result of milling, unhusked and dehusked whole grains, split cotyledons, broken, husk and powder are obtained. Whole grains are passed again for further dehusking and/or splitting after water treatment. Husk and powder produced during milling is generally separated with the help of aspirator and are used as cattle feed.

g. Polishing

Polishing is done to increase consumers appeal and is a form of value addition. Dal is polished in different ways, such as nylon polish, oil/water polish, leather and makhmal polish. Generally, polishing is done using soap stone, oil or water. Polishing gives uniform look and shine to each grain

5. Advances in Milling Technology

Techniques used in advance pre-milling treatments are very few. They are heat, chemical, enzyme etc., which are used at various research organizations for milling of difficult-to-mill pulses. However, oil and water treatment is most prevalent in modern dal mills. Water soaking followed by sun drying is commonly adopted at rural levels for processing of difficult-to-mill pulses. Traditionally water/oil treatments are given for loosening of husk. These traditional pre-milling techniques are labour intensive, wasteful and weather dependent. Attempts have been made by various Research and Development institutions to develop improved processes for pre-treatment of difficult-to-mill pulses. Different methods of modern technologies in milling of pulses are:

i. Pantnagar process (Chemical treatment)
ii. Pantnagar process (Enzymatic treatment)
iii. Central Institute of Agricultural Engineering (CIAE) Process
iv. CFTRI Process

i. Pantnagar process (Chemical treatment)

In Chemical treatment process, cleaned and graded difficult-to-mill grains are treated with 10percent sodium bicarbonate solution mixed in the ratio of 30:1 **(Figure**

6). These grains are then heaped for 5hours at 30°C followed by drying under the sun. The tempered and dried grains are passed through rollers. Pantnagar process utilizes traditional milling machinery. The milled product is cleaned and graded with a blower, cyclone separator and grader. It is seen that if pre-milling treatment is properly given, 91-95% dehusking is achieved in single pass having 4-5% whole grain. The husk, broken and powder are removed separately. The gota (dehusked whole grain) obtained is mixed with 2-2.5% water and kept for 4 hours for tempering. These grains are passed through splitter for dal making. About 80-90% of total sodium content is removed with husk and powder. Whereas the remaining traces of sodium in dal improves its cooking quality and storage characteristics. The dal recovery is about 80%. Advantage of this method is that it eliminates the use of oil. The problem with this method is that the chemical solution goes with the husk and this may be harmful to cattles, if used as cattle feed.

ii. Pantnagar process (Enzymatic treatment)

Milling, will be carried out on enzyme treated difficult-to-mill grains at different combination of pre-treatment parameters. The parameters considered are, moisture content of seed, incubation period and temperature. Enzymatic pre-treatment has positive effect on hulling efficiency. Hulling efficiency of untreated grains will be around 60.82%. When compared with just water treatment (73.90%), enzyme (89.68%) treated grains efficiency will be more. The enzyme treatment not only increases the hulling efficiency but also reduces the amount of powder formed. Enzyme treatment improves digestibility of dal protein and reduces cooking time.

iii. CIAE Process

In this process, cleaned and graded difficult-to-mill grains are fed in a roller mill for scratching. Once the scratching is over, then grains are cleaned to separate the husk and split grains. Whole and split grains are soaked in water at ambient temperature for 25-30minutes to produce moisture content of about 35 (% wt) and then dried to 10%moisture content. The dried grains are milled in a cylindrical abrasive mill to produce dehusked split dal. Split dal is separated from other constituents with an air-screen grain cleaner. The average recovery for difficult-to-mill pulses is 75%. This method eliminates the use of edible oil in the milling process.

iv. CFTRI Process

The technology developed at CFTRI overcomes the major problems of weather dependent nature of pulse milling industry and gives high dal yield in lesser time. The process is independent of weather conditions and eliminates the use of oil. The loosening of husk is achieved by heating of grains in hot air current followed by tempering. Removal of husk and splitting of grains is achieved by improved processing machines. This conditioning technique through heat treatment and moisture adjustment of the cleaned, size-graded grains loosens the husk, while making it fragile and brittle besides hardening the kernels. The process involves two passes in a drier with 160°C hot air, followed by tempering for 6 hours. The operation is continuous, replaces sun drying and carried out indoors. In this method yield of dal is around 80%. This method has advantages like less requirement of manpower, no need of drying yard, no requirement of edible oil etc **(Figure 7)**.

6. Conclusion:

Pulses are the cheapest and rich source of protein. Amino acid composition of pulses is complementary to that of cereals. Legumes go through several process before they are ready to be used as an ingredient in food preparations. The processes includes cleaning, drying, sorting, splitting, milling, and fractionating. Because of problems like labour intensive, time consuming and incurred losses many modern technologies is replaced to traditional milling processes. During milling, dal is split into smaller sizes which renders it convenient for cooking. Based on the bonding between the husk and cotyledons, pulses are divided into difficult-to-mill pulses and easy-to-mill pulses. The initial step of milling, dehusking, helps to remove the husk from the cotyledon and then the pulses are cleaned and split into dal. Milling processes differs from crop to crop, cultivar to cultivar and place to place. There are 4 different types of milling, they are home scale milling, cottage scale milling, commercial scale milling and traditional milling. In home scale milling, pestle and mortars are used, where as in cottage scale milling hand operated wooden or stone chakki/sheller is used. Yield obtained in home scale milling is lesser when compared

with other milling techniques. Traditional method milling includes wet and dry treatment. For the pre-treatment of pulses, Red earth is used in wet treatment, while oil is used in dry treatment. Polishing is the last step of milling, which increase the consumers appeal. Advanced milling technologies includes, Pantnagar–Chemical and Enzyme treatment, CIAE and CFTRI Process. The physical, chemical and structural strength of grain coupled with the functional and mechanical characteristics of processing units jointly play an important role in milling.

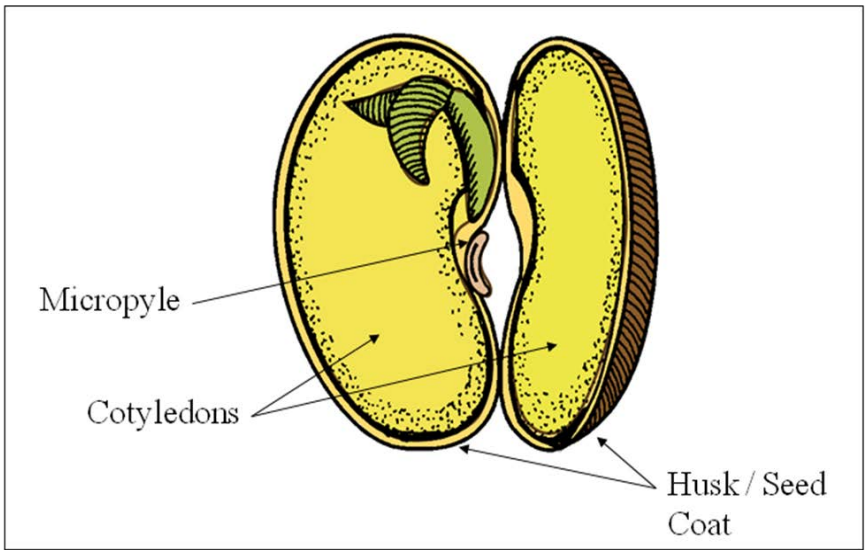


Figure 1: Pulse Grain

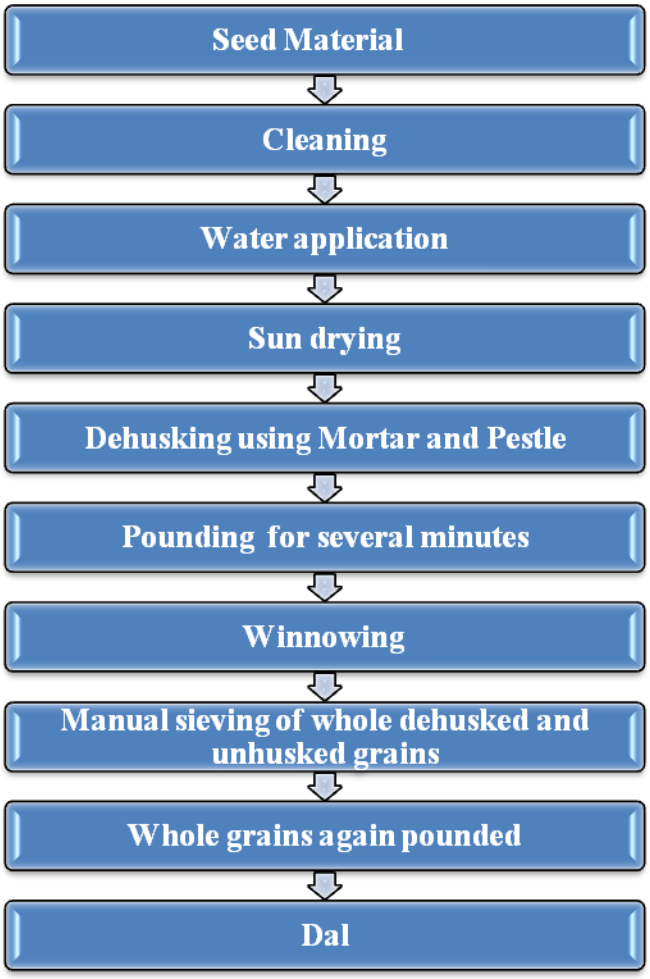
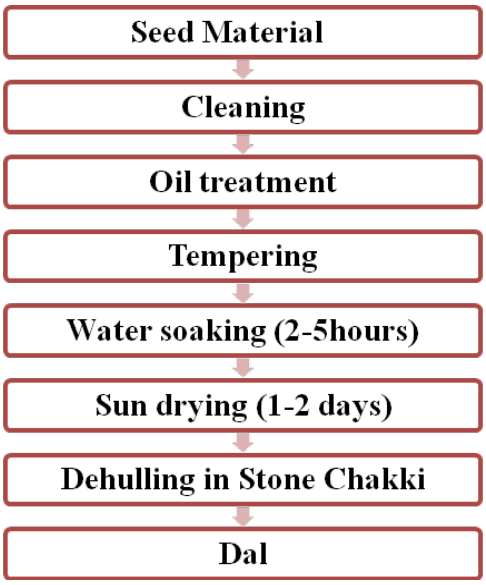
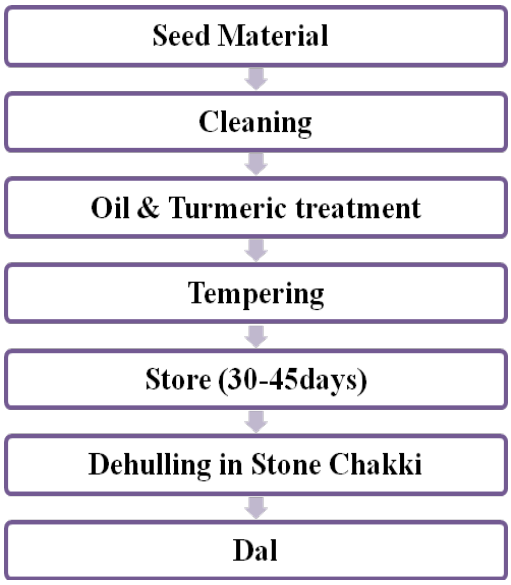


Figure 2: Home Scale Milling

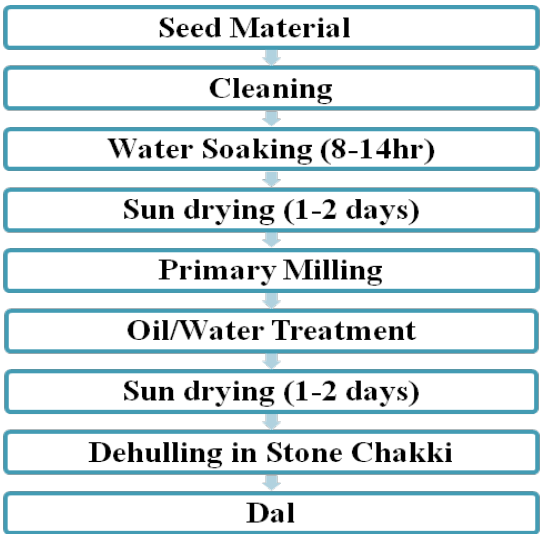
Source: Lal, R.R. and Verma, Prasoon (2007) Post Harvest Management of Pulses, Indian Institute of Pulses Research, Kanpur.



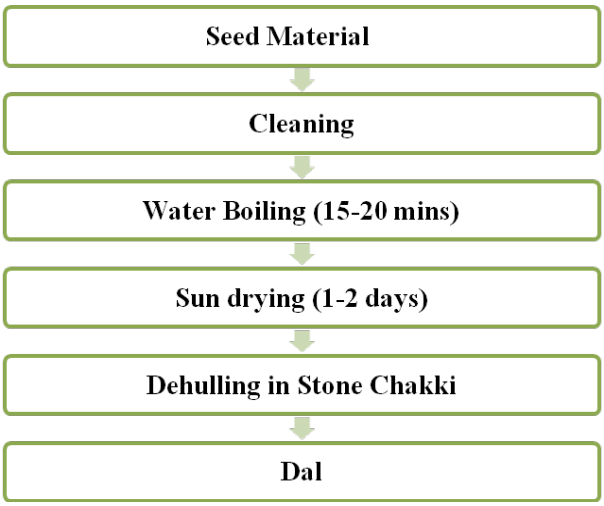
a. UP, MP and Karnataka



b. AP and Maharashtra



c. MP and Maharashtra



d. UP and MP

Figure 3: Traditional methods of Dehulling Difficult-to-mill Pulses in various Indian States

Source: Lal, R.R. and Verma, Prasoon (2007) Post Harvest Management of Pulses, Indian Institute of Pulses Research, Kanpur.

Figure 4: Wet Treatment of Pulses

Figure 5: Dry Treatment of Pulses

Source: Lal, R.R. and Verma, Prasoon (2007) Post Harvest Management of Pulses, Indian Institute of Pulses Research, Kanpur.

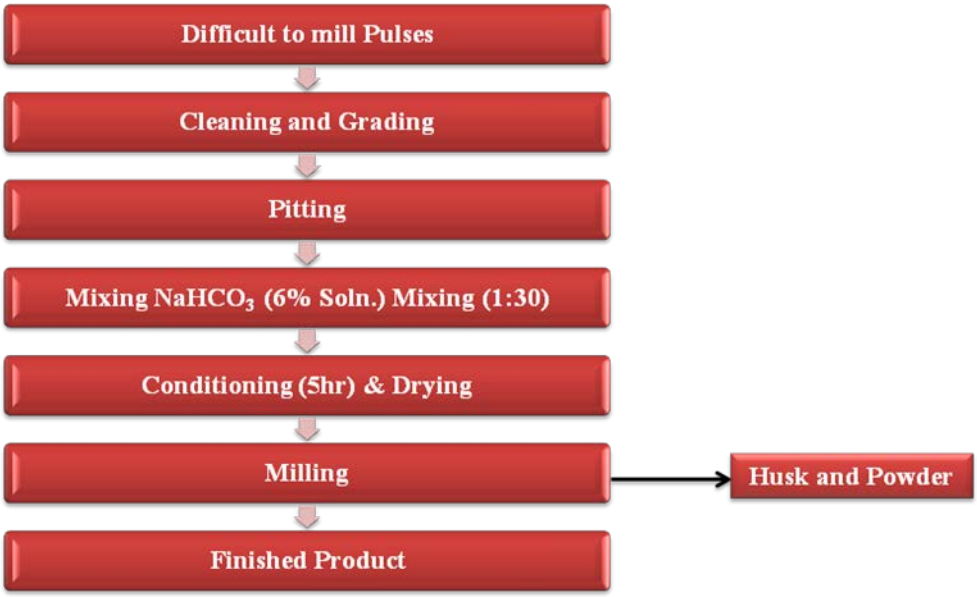


Figure 6: Pantnagar Sodium bi-carbonate Treatment

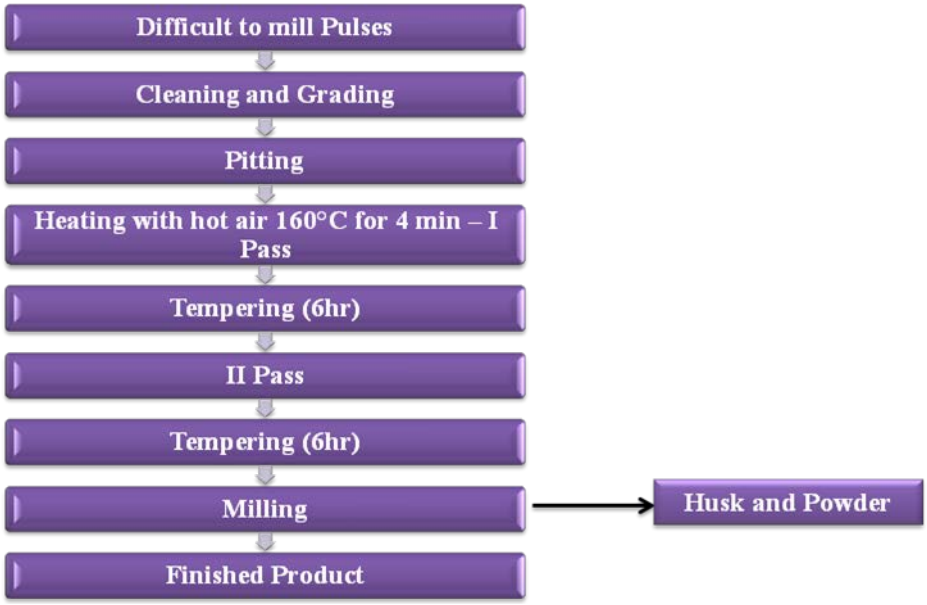
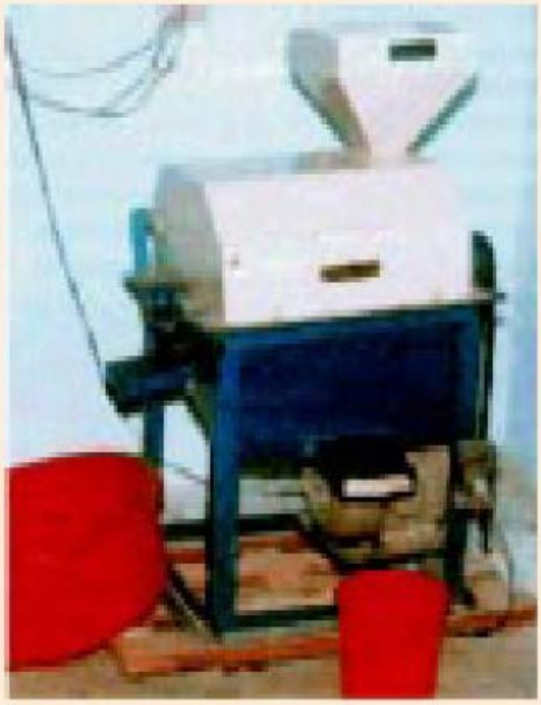


Figure 7: CFTRI Process–Thermal Treatment

Source: Lal, R.R. and Verma, Prasoon (2007) Post Harvest Management of Pulses, Indian Institute of Pulses Research, Kanpur.



CIAE Mini Dal Mill

CFTRI Mini Dal Mill