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Processing and Value Addition of Pulses

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Abstract – Cereals and food legumes are the basic ingredients of Indian diets, especially, for the people with low-income groups. For these groups, food self-sufficiency still remains an unachieved objective. Although India is now self-sufficient in the production of cereals but it has yet to depend on import in case of pulses to meet the domestic requirements. This is not always or only because of the inefficiency of the local production systems but due to post harvests losses also. The extent of post-harvest losses in case of pulses is estimated to be in the range of 25-30%. This is because pulses are required to pass through a number of unit operations before they are converted to dal. Some losses take place at every stage of processing which must be reduced. Nutritional security in India can be achieved by reducing post-production losses. In fact, production improvement must match with improvement in post-harvest operations and prevention of post-harvest losses. This paper, therefore, takes a look at different unit operations involved in processing of pulses and ways to improve the process to reduce the losses. Experiences or solutions resulting from the use of traditional methods, suitable technologies and mechanized systems are also discussed in detail. It also suggests measures to utilize the by-products for the manufacture of value added products, thereby enhancing income to the farmers. It also suggests future research thrusts in this area.

Key words: Pulse processing, unit operations, Value added products, Mini Dal Mills.

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I. INTRODUCTION

Indian diets are good combination of all essential amino-acids. Proteins present in cereal and pulses are complimentary to each other. Dal-Roti, Dal-Chawal, Idali-Sambhar etc., indicates traditional understanding about nutritional security. Pulses are consumed after dehusking and splitting called pulse milling, in form of dal. With urbanization of agro-processing industries, this age-old practice got upscaled into large capacity commercial mills. Pre-milling treatments are given to loosen the attachment of seed coat from cotyledons prior to milling. Water soaking, oil mixing and heating of grains are prevailing pre-milling treatments. Dehusking and splitting is usually performed with the help of abrasive rollers in successive passes. This causes scouring losses and yields lower dal recovery. The chain of pulse processing wholesalers, processors and retailers make higher profit than the producer, who has to sell raw grain at cheaper rates and purchase finished product at higher prices. Concept of village or farm level pulse processing will not only add income and employment opportunity to rural entrepreneurs but also strengthen the rural economy. Various research organizations have developed low capacity (75-125 kg/h) dal mills to cater the need. Mini dal mills developed by IIPR, Kanpur, CIAE, Bhopal, PKV, Akola and CFTRI, Mysore, are commonly adopted in different pockets of the country. Value added products from pulses and pulse milling by-products can further enhance the rural income.

II. PULSE MILLING

Pulse milling is the third largest food industry in India after wheat and rice. Like any other crop, pulses are consumed after minimal processing. Pulses are mostly consumed in form of deshusked splits or dal. About 80% of total pulse production in India is either consumed in form of dal or powder. Remaining 20% is utilized as whole grain or kept for seed purposes. Depending upon pulse type, variety, milling process and machineries used, there is 5% variation in milling recoveries (Mangaraj et al. 2005). Pulses are milled in about 14000 dal mills scattered throughout the country, which yield 65-70% dal recovery against potential recovery of 88-89% (Anonymous, 2015).

Dehusking of pulses is an age old practice started from domestic level in the beginning to present large capacity modern mills. The major steps involve in dehusking, either at cottage or commercial levels are same. The process includes (i) Pre-milling treatment – to loosen the seed coat, (ii) Dehusking or husk removal – to add culinary properties and (iii) Splitting – to convert dehusked whole (gota) into dal. Dehusking and splitting processes take place simultaneously in the milling units. Dehsuking is an essential process for pigeonpea, whereas other

pulses can be consumed as whole, splits with husk and dehusked splits. In most of the secondary and tertiary processed products, powder form of dehusked grains is used. Removal of husk not only reduces fiber but also improves appearance, texture, cooking quality, palatability and digestibility. Dehusked splits offer better resistance to insect activities in comparison to whole grains without any chemical application, if external infestation is prevented (Lal et al. 2008).

Presence of gummy substances between seed coat and cotyledons makes husk removal difficult during milling. According to the quality and quantity of gums present, pulses are categorized in easy-to-mill (lentil, chickpea, field pea etc.) or difficult-to-mill (pigeon pea, blackgram, greengram etc.) kind of pulses.

III. UNIT OPERATIONS IN COMMERCIAL PULSE MILLING PROCESS

Essentially milling process involves cleaning, grading, pitting, treatment, milling and polishing operations. Each unit operation requires specific machinery to perform the individual task. Usually pre-milling treatments and processes were developed for the toughest-to-mill pulse grains, i.e., pigeon pea. The major steps of pulse milling are described as under:

(a) **Cleaning and Grading:** Pre-cleaning and grading of raw material is an essential step in milling. It involves removing dust, dirt and foreign material, off-sized, immature and damaged grains and grading. At the first step, raw material is passed through cleaner-cum-grader. The quality of raw material used for milling determines the quality of end product, i.e., dal. Cleaners are used to remove impurities, foreign matter, damaged and shriveled grains. Depending upon size, shape and gravity raw material is graded to get uniform quality of raw grains. Commonly reel machines are used at commercial mills for size grading. Destoner is used to remove stones and pebbles. Lighter impurities are removed with the help of aspirators, fans or pneumatic separators.

(b) **Pitting:** This is a common practice in commercial *dal* mills using emery-coated roller. The emery coating is used for abrasive action. Whole pulses are passed through abrasive roller machine for scratching of the seeds. Cracked seed coat facilitates entry of oil/water applied to the grain during pre-milling treatment. Ideally cracks should not be visible from naked eyes, but during pitting process some dehusking and splitting takes place.

(c) **Pre-milling Treatments:** Depending upon scale of milling, wet or dry pre-milling treatment can be adopted. Wet milling is adopted at domestic or cottage scale milling whereas dry pre-treatment is commonly practiced for commercial milling.

(d) **Cottage Scale Pulse Milling (Wet Milling) :** At cottage scale, whole grain is soaked overnight or stipulated time period followed by sun drying and tempering for 2-3 days to attain 10-12% moisture level before dehusking and splitting in hand operated wooden or stone chakkies. Husk is removed by manual winnowing operation. Several other pre-treatments, viz., red earth application, iron pan roasting with or without sand, oil smearing, boiling etc., are being practiced in different part of the country. At cottage scale pulse milling is time consuming, weather dependent and labour intensive process. Despite pre-treatment, it is hard to achieve 100% dehusking in traditional chakkies, which decreases appearance of dal and diminishes market value. But a section of affluent market is developing preference for cottage scale unpolished dals.

(e) **Large Scale Milling (Dry Milling):** At commercial scale pulse milling efforts were made to overcome constraints of traditional cottage scale mills. Problems of drudgery, time consuming, weather dependency and improper dehusking were addressed in commercial pulse mills. To minimize soaking and drying time, oil and water application, referred as dry treatment, is quite popular in northern zone. Linseed oil is applied at the rate of 0.7% on pitted grains. Alternate day time heating under the sun and heating and cooling during nights for 3-4 days, loosens the seed coat. Thus, treated grains are milled in emery roller mills for dehsuking. But this process also depends upon weather and solar radiations for sun drying.

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(g) **Thermal Treatment:** Pulse milling pre-treatments at cottage or large scale are labourious, time consuming and weather

dependent process. A weather independent thermal process was developed by CFTRI, Mysore. The process also completely eliminates use of oil. In the process grains are subjected to high temperature (166^0C) using heated air followed by tempering in insulated bins for 6 hours to maintain the grain temperature. The process is repeated twice for proper conditioning. This is weather independent process but not being adopted due to more investment on machinery and high operational expenses.

At GBPUA&T, Pantnagar, sodium bi-carbonate, vinegar and enzyme treatments were evaluated. But none of the treatments could reach up to commercial acceptance.

(h) **Tempering:** After water soaking or oil application grains are heaped and covered with gunny bags for 12 to 18 hrs for uniform conditioning of entire grain mass. This **process** allows penetration of oil/water beneath the seed coat and helps in loosening of gummy substances.

(i) **Drying:** Sun drying of treated and tempered grains is quite common in commercial mills of Indian subcontinent. For round the year operation and reduce weather dependency electricity based mechanical dryers are being used on limited scale. Alternate sun drying in thin layer during day time (heating) and heaping in nights (cooling) for 2-3 days results into loosening of seed coat. Sun drying process is time consuming and labour intensive operation. Drying in mechanical dryers takes 2-3 hours, thus, saves both time and energy.

(j) **Dehusking and splitting:** In commercial mills after complete pre-treatment, grains are subjected to abrasive surfaces for removal of husk. The operation of dehusking and splitting is performed in emery roller mills. The emery coating, also referred as carborundum, is made of silicon carbide (carbon + crystalline alumina). The grit size of carborundum affects the dehusking efficiency. Different grit sizes are used for different kind of pulses. Most of the mills use emery rolls for dehusking and splitting. Some millers use disk sheller for splitting of dehusked grains (gota), whereas dehusking is performed in emery rollers only. Milled fractions viz. unhusked whole, dehusked whole, unhusked dal, dehusked dal and broken are separated to achieve quality product. By-product from milling industry (mixture of husk and powder) commonly goes for cattle feeding.

(k) **Polishing:** Polishing is required to give uniform appearance to milled product and increase consumer appeal. Certain fraction of milled product includes dal with husk cover. Polishers help in removal of husk from such dal. Different kinds of polishes, such as nylon polish, oil/water polish, leather and makhmal polish are applied to different kind of dals. Oil and edible colour polish is commonly adopted in commercial mills. With increasing awareness of adulteration and use of non-edible compounds, consumers are developing preference for unpolished dal.

IV. MINI DAL MILLS

Like most of the food processing industries, high capacity pulse processing plants are mostly located in cities. Whole grains are procured by middlemen at cheaper rates and value added product, dal, is sold back to villages at higher prices. Sometimes cost of finished product is double the price of raw material. In forward and backward linkages, procurement agencies, wholesaler and retailer network takes the maximum advantage. The actual grower and rural population are at loss as they have to shell out more money for processed dal and profit margin moves to urban areas. It was realized that pulse processing can be adopted among rural entrepreneurs to strengthen rural economy. Concept of small capacity mini dal mills was visualized by several research organizations. Mini dal mills developed by CFTRI, Mysore; CIAE, Bhopal, PKV, Akola and IIPR, Kanpur are popular in different pockets of the country. Mini dal mills in rural areas will reduce the expenditure made on to and fro transportation and make cheaper dal available to rural population. At small scale, it is easy to control milling losses, thus, such units give higher dal recovery. Establishment of processing units in rural catchments has potential to promote rural entrepreneurship, generate employment opportunities, enhance rural income and ultimately, prevent migration to the cities.

V. VALUE ADDED PRODUCTS OF PULSES

In India pulses are consumed in various ways and forms viz., utilized as whole, dehusked splits, milled, mixed with cereals, roasted, puffed, salted and sweetened etc. Immature pulse grains are utilized as green, roasted, boiled, fried, crushed and cooked forms. After maturity the same pulse can be consumed as dried grain, soaked, sprouted, boiled, steamed, fried, cooked as dal. Dal or sambar is prepared from dehusked cotyledons on daily basis at every household of southern India. Dehusked splits are also converted into flour to make various delicacies throughout the country. Soaking, cooking, roasting, puffing, extrusion, germination, fermentation

etc., are essential processes involved in preparation of different recipes from pulses. During pulse milling, due to abrasive dehusking in commercial mills, only 70% dal is recovered against the potential dal recovery of 85%. The by-product obtained from pulse milling utilized as cattle feed. This low protein and high fiber by-products can find edible use for human consumption. At IIPR, Kanpur efforts were made to utilize this nutritious fiber and protein rich byproduct for human use. By sieving of milling by-product about 30% of cotyledon powder is separated which can be used as powder of pulses for making various pulse based recipes or instant dal. Phenol and fiber rich husk component of sieved fractions can be find therapeutic usages.

For making biscuits 10, 20 and 30% milling by-product was incorporated in dough. The fiber and protein rich biscuits can be exploit commercial potential of milling by-product. These biscuits from pulse by-product are quite comparable with commercially available wheat fiber based biscuits. Organoleptic evaluation of the product among subjects of different age group revealed acceptability for such products. Mature age people had clear appreciation for biscuits with high fiber, whereas young people showed the preference for lower milling byproduct.

VI. FUTURE RESEARCH THRUST AREAS

(a) Improved varieties: Varieties need to be developed keeping the requirements of millers. Low gum and husk content varieties can easily be dehusked with minimal losses.

(b) Efficient pre-treatments: There is need to develop newer methods and processes for loosening the seed coat prior to milling.

(c) Freedom from weather dependence: Pulse milling is a weather dependent process. There is need to develop process and machineries which can dehusk the grains irrespective of weather conditions.

(d) Improved dehusking unit : To achieve maximum dehusking with minimum breakage and powdering improvement in machine parameters viz., emery grit size, roller-sieve clearance, diameter-length ratio etc. need to be improved.

(e) Utilization of milling byproducts: Pulse milling by-products usually go as cattle feed. However, this low protein and high fiber milling by-product has potential to be used as edible value-added products.

VII. CONCLUSION

Pulse milling is third largest food processing industry after flour and rice milling. Dehusking and splitting is an essential process as pulses are mostly consumed in from of dal. Urbanization of processing industries adversely affected the rural economy. Low price raw material is purchased by industries and high value end product is sold back. In this chain intermediaries are involved which make profit at every stage of post-harvest chain. Agro-processing technologies suitable for rural areas have potential to enhance rural income and employment opportunities. Mini dal mills and value-added products at cottage scale will not only make cheaper products available to rural population but also strengthen the rural economy.

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