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Pretreatment of Pigeonpea Grain for Improvement of Dehulling Characteristics

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ABSTRACT: Pulses are good source of protein for vegetarians and also even cheap. Pulses are rich in lysine. However, pigeon pea in pulses generally difficult to mill therefore different pretreatment was adopted to acquire maximum dehulling recovery. Soybean oil-based pretreatment with different concentration of 1%, 1.5%, 2%, 2.5%, and 3%is adopted for research purpose. It was observed that increase in oil concentration reduced the milling efficiency, reduced the hulling recovery, increase broken percentage, reduced the dal recovery. Maximum milling recovery obtained at 2%.

Keywords: dehulling recovery, Pulses, Soybean.

INDRODUCTION

Pulses are indispensible part of human diet and occupy an important position in world food and nutrient economy. Pulses are good source of protein for vegetarians and also even cheap. Pulses are rich in lysine whereas cereal proteins are rich in sulphur containing amino acids. Protein content of different pulses varies from 20-30% and amino acid of pulse protein is complementary to a veal protein (Vishwakarma *et al.*, 2018). Pulses pull nitrogen from air into the soil, improving soil and agronomic system. In India, about 80% of total pulses production is consumed in form of dal or powder & remaining 20% as the whole seed & other form.

Historically, India is the largest producer and consumer of pulses around the world. According to Directorate of Economics and Statistics, the pulses production in India on 2018-19 was 23.40 Million Tonnes; area under production was 29.03 Million Hectare, and yield of pulses was 806 kg/hectare out of which pigeon pea production was 3.59 MT and yield was 751 kg/hectare.

In Indian subcontinent more than 75% of the pulses are marketed and consumed as dehulled split, which is commonly termed as dhal or dal in India (Vishwakarma *et al.*, 2018). Dehulling is thus considered as one of the important operations in the milling of pulses and one of the old-age technologies generated throughout the time. However, the yield of dehusked and splitted pulses in traditional mills is 50-70% in comparison to 80-89% maximum recovery potential of split (Sinha and Jha 2017). Thus, modern technology with predetermined pre-treatment of pigeon pea required to get maximum recovery of dal and very less losses. Pre-treatment plays an important role in removing husk from the cotydedon thus improving dal recovery. Several studies showed that husk of the grain adhered to cotyledons due to presence of calcatomonus disaccharide, glucoronai acid and glycol protein. For adherence of husk to the cotyledon, arabinogalactan type polysaccharide was found responsible, which is a gummy and hydroscopic in nature (Hiregouda *et al.*, 2014).

Due to presence of this carbohydrate dehulling of pigeon pea becomes difficult. Generally, there are two approaches to remove hulls, namely wet and dry milling. Throughout the Indian subcontinent the dry method of milling is used because the quality of splits obtained from the wet milling is poor. During dehulling noticeable amount of cotyledon material and germ are removed, which result in considerable losses. There is excessive loss of pulse cotyledon and embryos in the form of broken and powdered grains (5 to 15%). In large-scale processing of pigeon pea, the loss of cotyledon in term of powder and broken grains can be as high as 12.8% and 4.4%, respectively. The various method of dehulling also affects the formation of broken and powdered particles and in case of pigeon pea it varies from between 9 to 24.6% for broken and 5.5 to 6.1% for powder.

It is, therefore, necessary to improve the traditional methods of pulses milling to increase the total yield of dehusked and split pulses and reduce the losses.

MATERIAL AND METHOD

In the proposed study, it is planned to split the pigeon pea to prepare 'dhal' from CFTRI Type dhal Mill with a capacity of 100 kg/hr. was used. The pigeon pea dhal (pulses) was procured from market.

Arhar pulse was cleaned and passed through Grader sieve in Screen Cleaner cum Grader to get uniform size Arhar grains. The treated grains were first pitted then milled at a constant moisture content of 10 percent. Universal moisture meter is used to determined moisture content of pigeon pea. Sample of 10 kg each were subjected to milling which was done in CFTRI Dal Mill.

The milled samples were collected in one lot and separated in different fractions by sieving. The fractions were husk, dal, gota and broken kernels. All these fractions were weighed accurately with the help of electronic balance and put in tabular form. These pre-treatments helped to compare milling effectiveness of treatments given to Arhar.

Milling Efficiency Calculations

To calculate the efficiency of milling: The efficiency of milling will be maximum (100%) when all Arhar pulses are dehusked and only Gota (dehusked but not splittedArhar kernel) is obtained. The milling will be of inferior quality with reduction in Gota recovery.

(i) In milling, the second best by product after Gota is dal (dehusked and splitted cotyledons) in market, dal obtained from Gota is considered to be Grade-I OR premium dal and fetches maximum market value. Dal obtained directly during milling is termed as Grade-II dal and fetches about 10-15% less market price as compared to Gota dal.

(ii) Dal with husk: During milling, some pulse grains are splitted in two cotyledons without removal of husk. This is simply not desirable. Miller go for softer operation while increasing the milling passes to minimize such unhusked dal. The less is the quality of splited dal husked better is the milling operation.

(iii) Brokens: broken content should be less to get better milling operation or milling index. Formation of kernels powder also includes in the kernels powder. Millers too desire to get minimum fraction of powder.

Considering the above fact, listed indices were required to calculate to get the overall milling index, dal recovery index, broken percentage and recovery of the hull. Here, the difficulty was felt while differentiating between the Gota and dal content of the milled sample to obtain the meaningful milling index. The value of dal was reduced w.r.t Gota dal as per the comparative difference in market price of Gota dal (Grade-I) and dal (Grade-II).

Formula of the milling efficiency:

$$\eta_{milling} = \eta_{hulling} \times \eta_{wk} \times 100$$

$$\eta_{hulling} = \frac{n_1 - n_2}{n_1} \;\&\; \eta_{wk} = \frac{k_2 - k_1}{(k_2 - k_1) + (d_2 - d_1) + (m_2 - m_1)}$$

Where:

$\eta_{milling}$ = Milling Efficiency of Dal Mill;

$\eta_{hulling}$ = Hulling Efficiency of Dal Mill;

η_{wk} = milling index

n_1, n_2 = amount of unhulled grain before and after Milling;

k_1, k_2 = amount of whole grains before and after Hulling;

d_1, d_2 = contents of broken kernels before and after Hulling;

m_1, m_2 = weight of mealy waste before and after Hulling;

Broken percentage:

$$\text{Broken (\%)} = \frac{\text{weight of broken after milling}}{\text{weight of whole grains after milling}} \times 100$$

Dal recovery percentage:

$$\text{Dal recovery (\%)} = \frac{\text{weight of dal after milling}}{\text{weight of whole grains after milling}} \times 100$$

Husk percentage:

$$\text{Husk (\%)} = \frac{\text{weight of husk after milling}}{\text{weight of whole grains after milling}} \times 100$$

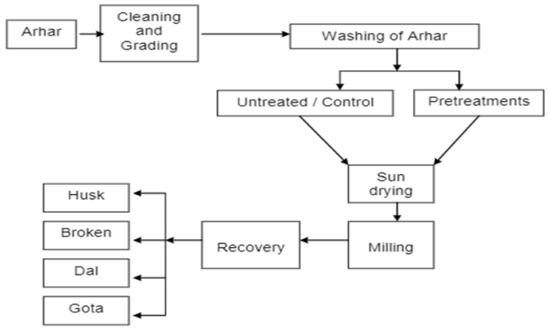

Fig. 1. Flow diagram showing the process of milling.

Fig 2. showing CFTRI Dal Mill.

RESULT AND DISCUSSION

Effect of Oil Application Rate on Milling Efficiency. As shown in Fig. 3 the relationship between oil application rate and milling efficiency followed a pattern of second order polynomial which increases from 78.1% milling efficiency for 1.0% oil application rate and attains a maximum value at 84% at 2% of oil application rate after that, the milling efficiency starts decreasing with increase in oil application rate. The effect of oil application rate on milling efficiency is given by a second order polynomial equation:

$y = -5.685x^2 + 20.88x + 62.38$

The significant relationship between the oil application rate and milling efficiency is endorsed by a good coefficient of determination, *i.e.*, $R^2 = 0.736$

During the experiment, it was noted that beyond 1.8%

of oil application rate, the losses in terms of broken percentage and mealy waste starts increasing, which results in decrease in milling efficiency.

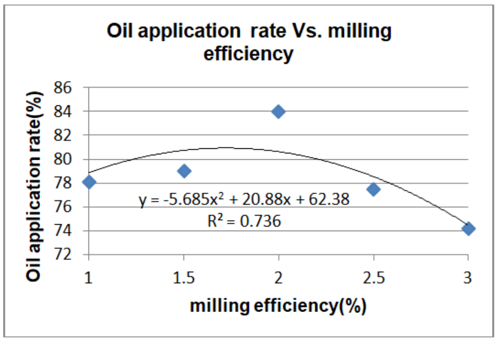

Fig. 3. Showing effect of oil application rate on milling efficiency.

Effect of Oil Application Rate on Dal Recovery. As shown in Fig. 4 the relationship between oil application rate and dal recovery followed a pattern of second order polynomial which increases from little more than 51% dal recovery for 1.0% oil application rate and attains a maximum value of a little more than 64% at about 2.0 % of oil application rate after that, the dal recovery starts decreasing with increase in oil application rate. The effect of oil application rate on dal recovery is given by a second order polynomial equation:

$$y = -14.13x^2 + 55.43x + 10.97$$

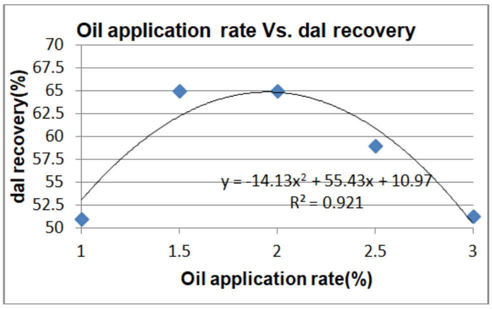

Fig. 4. Showing effect of oil application rate on dal recovery (%).

The significant relationship between the oil application rate and dal recovery is endorsed by a good coefficient of determination, *i.e.*, $R^2 = 0.921$

During the experiment, it was observed that beyond the oil application rate of 2.0% the losses in terms of broken percentage and mealy waste starts increasing, which results in decrease in dal recovery, after 2.0% of oil application rate.

It is because it was observed that addition of more than 2.0% oil increases slippage between rubbing surface and pulses kernels due to which splitting mainly takes place due to increased pressure between cylinder and concave which causes increase in breakage.

Effect of Oil Application Rate on Broken Percentage (%). As shown in Fig. 5 the relationship between oil application rate and broken (%) followed a pattern of second order polynomial which decrease from a little more than 16% broken for 1% oil application rate to a little more than 8% broken for 2% of oil application rate after that, the broken percentage starts increasing with increase in oil application rate. The effect of oil application rate on broken percentage is given by a second order polynomial equation:

$$y = 7.714x^2 - 26.25x + 32.4$$

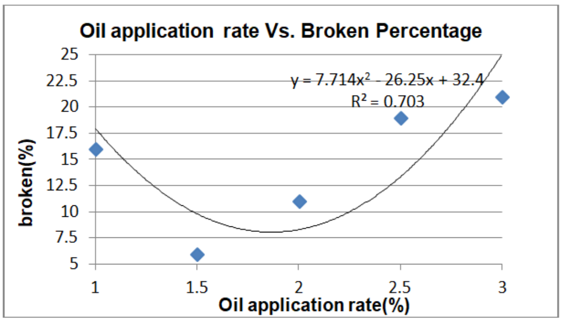

Fig. 5. Showing effect of oil application rate on broken (%).

The significant relationship between the oil application rate and broken percentage is endorsed by a coefficient of determination, *i.e.*, $R^2 = 0.703$

During the experiment, it was observed that beyond 2% of oil application rate, due to increase pressure treatment for longer periods, the breakage in whole splits pulses starts increasing.

Effect of Oil Application Rate on Hull Recovery (%). As shown in Fig. 6 the relationship between oil application rate and hull recovery followed a pattern of second order polynomial which increases from little more than 10% for 1% oil application rate and attains a maximum value of a little more than 20% for oil application rate of 2%. Therefore, hull recovery starts decreasing with increase in oil application rate. Fig. 6 showing effect of oil application rate on hull recovery (%)

The significant relationship between the oil application rate and hull recovery is endorsed by a coefficient of determination, *i.e.*, $R^2 = 0.824$

During the experiment, it was noted that increase in oil application rate, help to improve the dehulling of pulses. However, a higher value of oil application rate, *i.e.* more than 2% causes severe scratching of hulls, thereby resulting in minor decrease in hull content after 2% oil application rate.

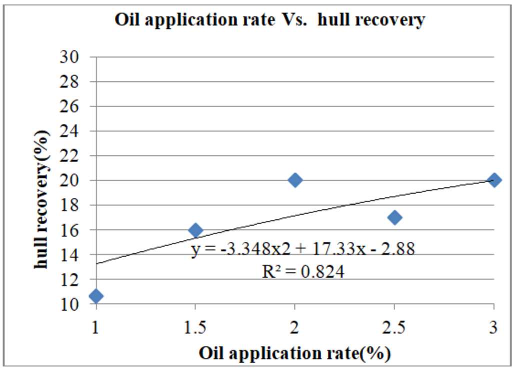

Fig. 6. Showing effect of oil application rate on hull recovery (%).

With increase in oil application rate hull recovery reduced as due to increase in oil application rate causes slippage and reduces rubbing force between emery and kernel which is responsible for dehulling of pulses. Therefore, by addition of more oil greater than 2.5% causes decrease in hull recovery.

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