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Effect of Pre-milling treatments and Milling mechanisms on Dehulling of Black gram

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ABSTRACT: Two methods of dehulling – plate and abrasive roller type small scale processors were employed to study the dehulling quality of black gram LBG-648. Dal yield by B-type abrasive was highest (69.45%) and the lowest (37.20%) for grinding wheel abrasive. The pitted grain treated with oil and followed by either sun or mechanical drying gave best performance in terms of dal recovery and dehusking efficiency.

Key words: Black gram, Abrassive Roller, Dehulling, Dal.

Pulses form an integral part of the Indian diet and critically supplement cereal based diets. They not only supplement protein in the diet but also improve its quality by balancing amino acid pattern in the mixed diet. India is a major producer of pulses in the world, contributing 28 % of the global production from an area of about 37 % [Masood Ali and Shiv Kumar, 2000]. Considering the production and consumption, black gram is the third leading pulse crop in Indian subcontinent accounting to 10 % of the country supply. Black gram is mostly consumed in the form of dehusked splits or rounds. Removal of the seed coat reduces roughage, improves storability and palatability for consumption in various forms. It also improves soaking, cooking quality and digestibility.

Milling of blackgram has emerged as a large scale commercial operation, from a small scale rural operation for value addition. It is estimated that about 50 % of the black gram processing is still carried out on a cottage industry level by the farmers in rural areas using traditional methods. Several small millers process 100 to 500 kg of pulses per day either for trade purpose or by custom hiring basis. The milling technology of black gram processing at small scale mill involves splitting of cotyledons using suitable roller or plate type mill. The split product is winnowed to remove powder and husk. Separation of brokens and unsplit grain are carried out by sieving. Some times the millers use soaked and sun dried grain for easy splitting of the cotyledons. The whole operation is labour intensive and time consuming. Not only that with the commercialization of technology complete dehusked black gram dal is entering into the market, due to which the traditional pulse processors are loosing ground. The complete dehusked black gram reduces water and manual energy requirement in further processing. Hence, there is a great demand from the traditional pulse processors to upgrade their existing milling machinery to obtain dehusked black gram dal , which prompted this study of machine and treatment parameters to optimize dehusking process of black gram. In the present study, five treatments and two types of milling mechanisms were used for dehulling performance evaluation of black gram cultivar LBG – 648. The important physical properties of grain are presented in Table 1.

Table 1. Physical properties of black gram LBG-648 cultivar used in the study

1000 grain weight	45.02 g
Moisture content	8.00 % (db)
Bulk density	0.87 g / cm3
Dimensions	
Length	5.01 mm
Width	3.45 mm
Theoretical dal yield	87.8 %

Materials and Methods

The raw black gram cultivar obtained from Agricultural Research Station, ANGRAU, were cleaned and passed through a 4.5mm sieve. The grain retained on 4.0mm sieve was used

Preparation of samples : The grain was pitted for 20 seconds in the respective milling mechanisms and pretreatments were applied.

i) Edible oil application to unhusked dal @ 0.3 % for 48 h and 16 h sun drying(T1)

ii) Edible oil application @ 0.3 % to pitted grain for 48 h and 16 h sun drying followed by water application @ 5 % for 24 h(T2)

iii) Soaking of raw grain in water for 3 h and 24 h sun drying(T3)

iv) Edible oil application to pitted grain @ 0.3 % for 72 h and 16 h sun drying(T4)

v) Edible oil application to pitted grain @ 0.3 % for 24 h and 3 h mechanical drying at 75^{0}c followed by water application @ 5 % for 24 h(T5).

The pre-treatments were selected based on a study of up gradation and evaluation of mini dal mills conducted by CRIDA (CRIDA Annual Report, 2002 – 2003).

Equipment : In the present experiment plate and roller type mill models representing the small scale processors were used (Table2). In the roller mill two types of emery grades (surface roughness) were considered.

Table2. Specifications of milling mechanisms

Plate type mill (M1)	Roller mills	
	B-type carborundum abrasive (M2)	A-type carborundum abrasive (M3)
Plate Size : 150 mm Dia	Roller Size : 150 mm Dia	Roller Size : 150 mm Dia
Thickness : 5 mm	Thickness : 40 mm	Thickness : 40 mm
Type : Radially Serrated		Grinding wheel abrasive
RPM : 900	RPM : 700	RPM : 700

In each experiment, four samples were milled and the brokens, dal and unmilled fractions were separated manually. The dal recovery and dehusking efficiency were calculated using the following equations. The data was analyzed statistically using analysis of variance procedure for two factors(Gomez and Gomez , 1985)

$$\text{Dehusking Efficiency, per cent} = \frac{F_p}{W\,(1-T_h)} X100$$

$$\text{Dal Recovery, per cent} = \frac{F_p}{W} X100$$

Where,

W = Sample Weight, Kg

F_p = Finished product Weight (Dehusked grain + Dehusked dal), Kg

T_h = Theoretical husk content of grain (Fraction)

Results and Discussion

Dal recovery

The theoretical yield of dehulled grain determined by the manual method is 87.8 % (Table1). This dal yield values primarily depend on the content of seed coat (husk) of the gram genotype. The experimental results for dal recovery and dehusking efficiency (average of four replications) are shown in Tables 3 and 4. The analysis of variance indicated that the main effects of each factor (T, M) and interaction of T x M are statistically significant. Average dal recovery was highest (69.45 %) in B-type roller mill followed by A-type mill (64.9 %) for pitted and mechanically dried grain at 75^{0}C (Table 3). The mean dal yield obtained with B-type carborundum roller are comparable with that of the commercial dal mills (69.45 % dal) in India, but is considerably lower than that of the improved commercial dehulling technology developed for milling of black gram. The treatment mean values revealed that the dal yield was highest (61.24 %) for B-type carborundum roller mill and the same was on par for plate and A-type carborundum roller mills with 52.415 and 52.564 % respectively. This indicated significant differences in splitting quality of black gram by the milling mechanisms.

Table 3. Effect of different treatments and milling mechanisms on dal recovery (%) of Black gram

Treatments	Machines			
	M_1	M_2	M_3	Mean
T1	49.725	54.775	37.205	**47.235**
T2	52.325	63.863	56.650	**57.613**
T3	54.050	54.838	44.713	**51.200**
T4	51.200	69.450	64.900	**61.850**
T5	54.775	63.275	59.350	**59.133**
Mean	52.415	61.240	52.564	55.406
Machines		**Treatments**		
F- test	82.85 **	F- test	70.45 **	
SEm	0.555	SEm	0.717	
CD (0.05)	1.584	CD (0.05)	2.045	
M x T				
F- test	20.80 **			
SEm	1.241			
CD (0.05)	3.542			

M_1 = Plate Mill , M_2 = B-type Carborundum roller , M_3 = A-type Grinding wheel Carborundum roller

Table 4: Effect of different treatments and milling mechanisms on dehusking efficiency (%) of Black gram.

Treatments	Machines			
	M_1	M_2	M_3	Mean
T1	93.000	98.833	97.650	**96.496**
T2	32.500	50.063	51.750	**44.771**
T3	46.400	39.250	33.425	**39.692**
T4	83.500	97.500	95.250	**92.083**
T5	66.000	96.550	96.525	**86.492**
Mean	64.360	76.440	74.920	**71.907**
Machines		**Treatments**		
F- test	71.91 **	F- test	747.10 **	
SEm	0.776	SEm	1.002	
CD (0.05)	2.214	CD (0.05)	2.858	
M x T				
F- test	25.60 **			
SEm	1.735			
CD (0.05)	4.950			

M_1 = Plate Mill , M_2 = B-type Carborundum roller , M_3 = A-type Grinding wheel Carborundum roller

Dehusking Efficiency

The treatments T_1, T_4 and T_5 showed a significant effect on dehulling (Table4). The mean dehusking efficiency of B-type carborundum roller is comparable with that of A-type roller. The value for dehusking was highest (98.833 %) for T_1 with B-type roller and the lowest (32.5%) for T_2 when dehulled in the plate mill. Large variability in dehulling quality of black gram was observed when they were hulled with different treatments. The data showed that pitting of the grain significantly enhanced dehusking efficiency mainly because the oil penetrates through the husk making it brittle. Even though the milling efficiency primarily depends on the type of machine employed for processing, other characteristics such as roughness of the plate or roller, speed of the machine and treatment imparted to the grain seem to play an important role in determining milling losses.

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