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Physical and milling properties of chickpea, *Cicer arietinum* influenced by seed characteristics

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ABSTRACT

Physical and mechanical properties of food gains is important during designing, improvement and optimization for separation and cleaning. More than 190 varieties of chickpea belonging to both *kabuli* and desi types have been released in India on the basis of yield and disease reaction, ignoring the miller's and traders' preferred processing traits. There is dearth of information about milling performance of chickpea varieties cultivated in India. The objective of this work was comparing some physical properties of two *kabuli* and two *desi* varieties of chickpea seeds (Kripa, RVKG 101 and JAKI 9218, JG 130). Although kabuli type chickpea varieties are mostly consumed as whole seed, yet they were included in the study for comparing their milling potential with desi types. Milling quality of the seeds was also found to be affected by their physical properties and varietal differences were also observed. The maximum values of seed weight, volume and bulk density among the varieties were observed in kabuli type variety Kripa. The kabuli varieties, exhibited better *dal* recovery (70.69 -71.04%) than *desi* (66.12- 66.38%) along with lesser husk content (5.32-5.77%) than desi (8-47-9.74%) due to their thinner seed coat. The *dal* recovery was positively correlated with 100-seed weight and volume but negatively correlated with true density. *Dal* recovery among *desi* varieties can be improved by reducing seed coat thickness.

KEY WORDS: PHYSICAL PROPERTIES; MILLING CHARACTERISTICS; BULK DENSITY

INTRODUCTION

Food legumes including beans and chickpea are important food crops because of their nutritional quality for supplementation of protein in vegetarian diet. They are rich sources of complex carbohydrates, proteins, vitamins and minerals (Wang *et al.*, 2010). Legumes have been considered a rich source of protein throughout the world and contain approximately three times more proteins than cereals. Chickpea (*Cicer arientum* L.) is considered as the fifth valuable food legume in terms of worldwide economical standpoint. It has been used for the preparation

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of various traditional foods such as ingredient in bakery products, imitation milk, infant food formulations and meat products (Ravi and Suvendu, 2004, Ashok Kumar *et al,* 2015*;* Jukanti, *et al* 2012). Different traditional oriental foods are prepared using chickpea flour both at household and industrial levels. Dried legume seeds generally promote slow and moderate postprandial blood glucose increase. They are also a source of high-quality protein and have been known as "a poor man's meat" (Isabel and Garmen, 2003; Rincon *et al.*, 1998; Taylor *et al*, 2016; Fabri *et al,* 2016; Carmo *et al,* 2017).

India is the largest producer (22.95 m tonnes), consumer (22.49 m tonnes) and importer (4.67 m tonnes) of pulses in the world (DES, 2017-18). It is also the largest pulses processor owing to poor pulse processing facilities in the major exporting countries like Pakistan (21.6%), UAE (10.6%), Algeria (11.6%) and Saudi Arab (9.5%) (DAC&FW 2017). Chickpea is the most important pulse crop in India accounting for nearly 40% (9.33 m tonnes) of the total pulse production (22.95 m tonnes) and 64% of total pulse export during 2017-18 (DAC&FW, 2017).

It is a good source of carbohydrates and protein which accounts for about 80% of the total dry seed mass (Geervani 1991, Chibbar *et al.* 2010) and constitutes an important component of diet of largely vegetarian Indian masses. Chickpea seed has high digestible protein and complex carbohydrate with low glycemic index and is relatively free from anti-nutritional factors (Muzquiz and Wood 2007, Wood and Grusak 2007; Riberro *et al*, 2017).

Chickpea protein complements cereal based diet with several essential amino acids.

Information on physical properties of byproducts is needed in designing and adjustment of agricultural machineries (Ghamari, 2012; Alexander *et al* 2017). The geometric properties such as size and shape are the most important physical properties considered during the separation and cleaning of grains (Nalbandi *et al.*, 2010; Meng *et al* 2010; Wood *et al*, 2017). In view of this, several studies have been conducted on the physical properties such as size, weight, volume, bulk density, true density of different crops. Because of varietal variability in chickpea seeds, understanding of physical properties of different varieties is necessary. Milling characteristics are important for *dhal* processing units where whole dhal recovery is an important factor for *dhal* processors. The dhal processing of legumes are mainly influenced by the size of the grain, the husk, the adherence of the husk to the seed and cotyledon texture properties. When there is a strong adherence of seed coat to the cotyledons, it hinders in the milling and whole dhal recovery is affected. The objective of this work was to study some physical properties of four varieties of chickpea seeds (Fig.1) to develop appropriate technologies in designing and adjustment of machines used during harvesting, separating, cleaning, handling and storing of them.

MATERIAL AND METHODS

Four released varieties of chickpea (kabuli and desi) were procured from Department of Plant Breeding and Genetics, R.A.K. College of Agriculture, Sehore, Madhya Pradesh. Grains of all the varieties were thoroughly cleaned and stored in airtight containers before analyzing.: Bengal Gram or Gram- in Hindi Chana are the local names and scientifically called chickpea has the botanical name *Cicer arietinum* (L.). Broadly, chickpea is categorized into two type- Desi and kabuli. Desi chana has dark seed, rough (puckered) seed coat while kabuli type is smooth and light coloured seed coat. Adherence of seed coat to the cotyledons in desi type is tight while it is loose in kabuli. Kabuli chickpeas are mainly used for table purpose as a whole grain while desi type is mainly used for making dhal. The scientific names of both type is same-*Cicer arietinum*.

All the observations were taken in triplicates and mean values are used for further analysis. The various physical properties like 100-grain weight, 100-grain volume and bulk density were determined by standard method and true

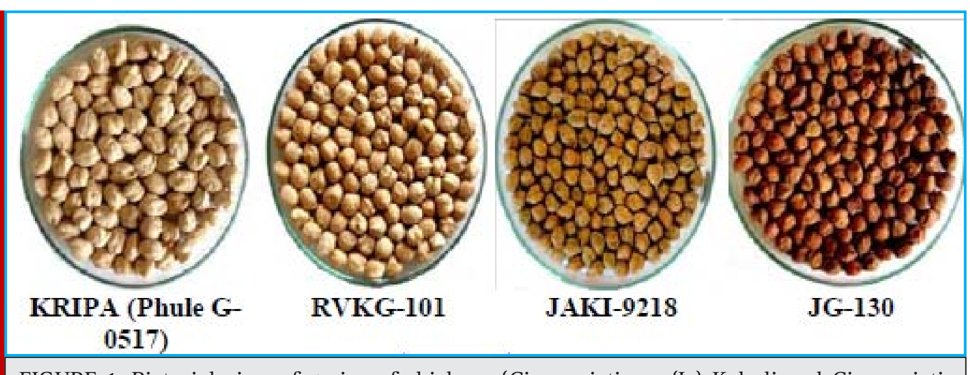

FIGURE 1. Pictorial view of grains of chickpea (*Cicer arietinum* (L.)-Kabuli and *Cicer arietinum* (L.)-Desi) varieties

Table 1. Physical characteristics of seeds of gram varieties				
Variety	100 Seed weight (g)	100 Seed volume (ml)	Bulk density (g/ml)	True density (g/ml)
Kripa	56.74	70.67	0.80	0.83
RVKG 101	45.88	61.67	0.74	0.80
JAKI 9218	24.79	32.67	0.75	1.33
JG 130	25.62	33.33	0.76	0.87
Mean	38.26	49.58	0.77	0.96
SEm	0.45	1.24	0.019	0.022
C.D.5%	1.57	4.31	0.066	0.077

density by Bhattacharaya *et al.*, (1977). One kg of grain was milled in CFTRI Dhal making machine and the splits, broken grains and husk were weighed separately to estimate the Dhal recovery of grains (Agrawal and Singh 2003).

Three measurements were taken on each analysis and the results were expressed as the mean of those values ± standard deviation. Significance was tested using the Duncan's Multiple Range Test at 5% level of probability.

RESULTS AND DISCUSSION

Seed weight, seed volume, bulk density and true density characteristics differed significantly among the varieties except bulk density (Table 1 and Fig. 2). 100 seed weight ranged from 24.79 to 56.74 g; seed volume from 32.67 to 70.67 ml and both physical properties were observed highest in kabuli gram variety Kripa (Phule G-0517). All the varieties under evaluation have more or less parallel bulk density ranging from 0.75 to 0.80 ml. Highest true density was observed in desi variety of gram *i.e.* JAKI 9218 (1.33 g/ml) followed by JG 130 (0.87 g/ml) and least in kabuli gram variety RVKG 101 (0.80 g/ml). It revealed that the particles of the desi variety of gram have been densely packed. Agrawal & Singh (2003) reported that 100 seed weight varied from 23.12 to 25.15 g in chickpea varieties.

MILLING CHARACTERISTICS

Dhal recovery ranged from 66.12-71.04 per cent; Kripa registered high value (71.04%) and least was found in

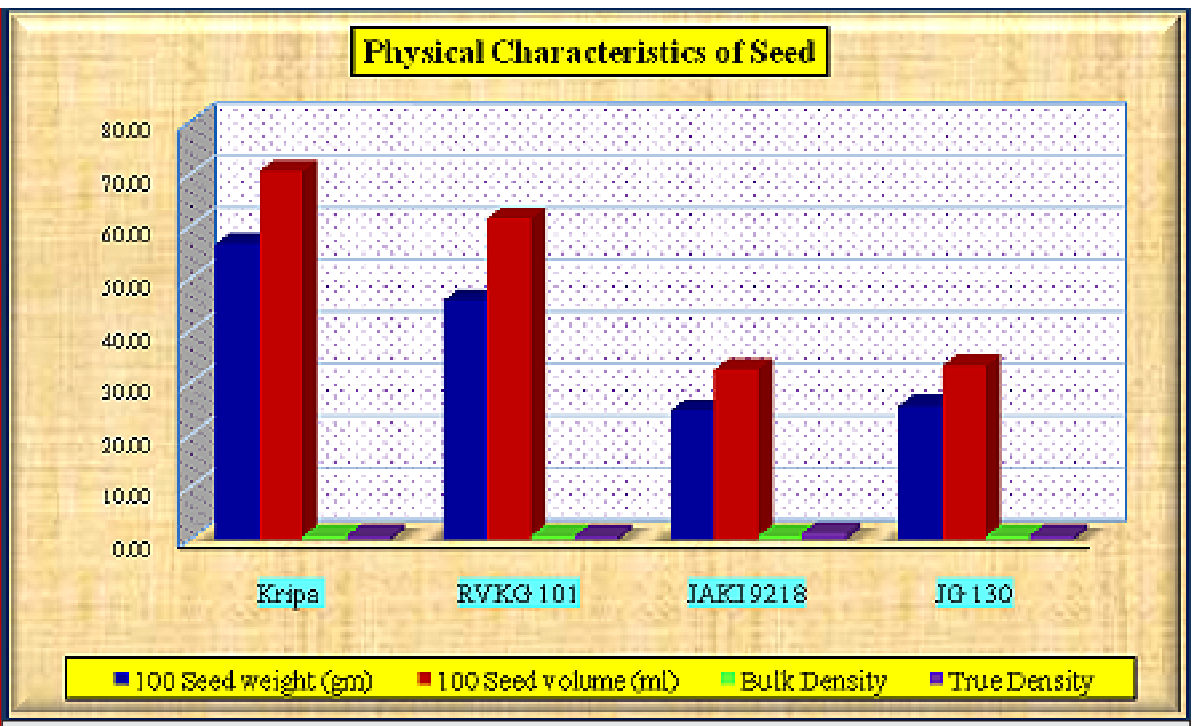

FIGURE 2. Physical characteristics of difference gram varieties

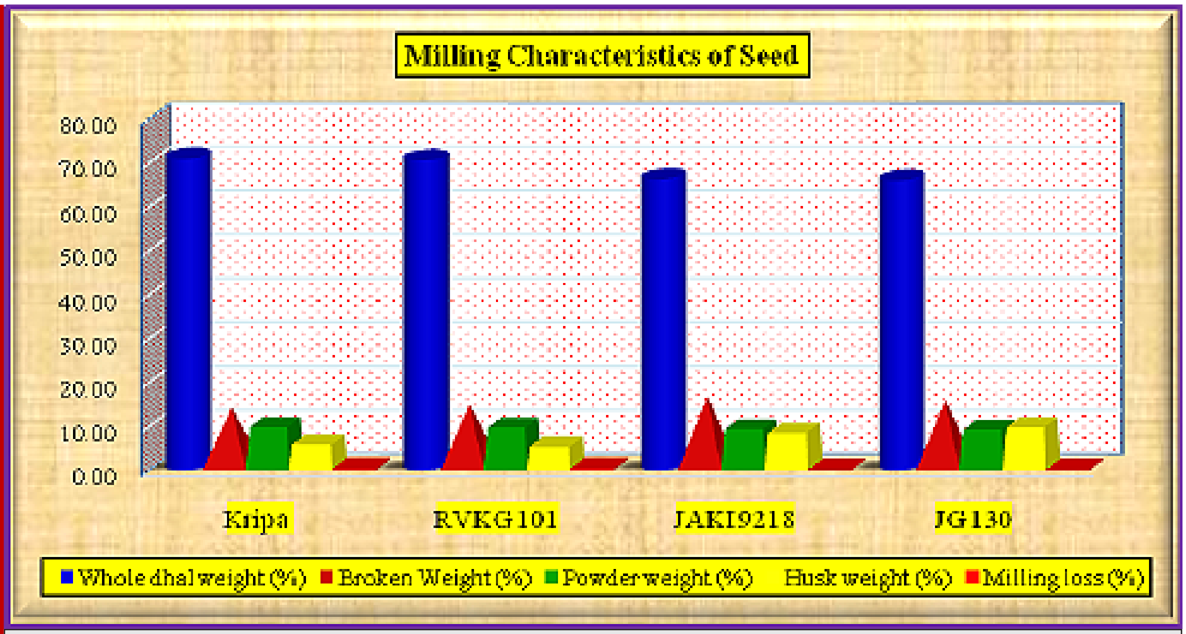

FIGURE 3. Milling Characteristics of different gram varieties

Table 2. Means of Milling Characters and cooking quality of dhal of gram varieties

Variety	Milling characters (Percent recovery- Weight basis)				
	Whole Dal	Broken Dal	Powder	Husk	Milling loss
Kripa	71.04	13.07	9.77	5.77	0.36
RVKG 101	70.69	13.93	9.66	5.32	0.40
JAKI 9218	66.38	15.72	9.32	8.47	0.11
JG 130	66.12	14.83	9.14	9.74	0.17
Mean	68.56	14.39	9.47	7.32	0.26
SEm	0.442	0.319	0.115	0.208	0.049
C.D.5%	1.530	1.106	0.399	0.720	0.172

JG 130 (66.12%) as kabuli gram have thinner testa as compared to desi and its adherence to cotyledons is also loose. Therefore, removal of testa becomes easier in kabuli gram. The brokens and powder varied from 13.07-15.72 and 9.14-9.77 per cent respectively. Amount of husk is supposed to be proportional to the thickness and mass of husk over the cotyledon. Therefore, kabuli gram varieties have lower husk recovery than desi type. The husk varied from 5.32-9.74 per cent whereas JG 130 (9.74%) recorded higher value and RVKG 101 (5.32%)

Table 3. Correlations of physical & milling characteristics in kabuli and desi gram varieties.

	100 Seed weight (g)	100 Seed volume	Bulk density	True density	Whole Dal (%)	Broken Dal (%)	Powder (%)
100 Seed Volume	0.995						
Bulk density	0.582*	0.501*					
True density	-0.634*	-0.648*	-0.288				
Whole Dal	0.971**	0.989**	0.372	-0.624*			
Broken Dal	-0.954**	-0.943**	-0.631*	0.814**	-0.899**		
Powder	0.955**	0.964**	0.419	-0.433	0.972**	-0.825**	
Milling loss	0.909**	0.941**	0.242	-0.779*	0.963**	-0.897**	0.874**

had least one. Milling loss ranged from 0.11-0.40 per cent, RVKG 101 recording higher (0.40%) values and least was found in JAKI 9218 (0.11%). There was significant difference in all the milling characteristics.

Bindu & Kasturiba (2017) reported that husk varied between 8.45-10.07 per cent and *dhal* recovery between 76.55-78.55 per cent. Less than 10 per cent of the grains were collected as brokens which is unavoidable in milling of pulses. In general bold-seeded varieties produced slightly higher per cent of powder than small-seeded varieties. Other reported a dal yield ranging from 83.1-87.8% in kabuli types and 61.3-82.6% in desi chickpea types (Shrivastava *et. al.,* 2017).

Correlation of Physical and Milling Characteristics

The whole dhal recovery is higher where 100 seed weight and 100 seed volume is more but it also caused more milling loss as well as more powder. It was also evidenced from positive correlation of 100 seed weight with powder and milling loss. It is also observed that true density has negative correlation with whole dhal recovery, powder and milling loss signifying the vice-versa relationship amongst them while, broken dhal is positively correlated with the true density (Table 3). Therefore they should have been the balanced of 100 seed weight and true density to minimize the milling losses, broken dhal to recover maximum whole dhal. 100 seed weight and true density also contributed to affect the milling properties of chickpea (Deshpande *et al.,* 1993, Nimbalkar 2000; Ravi and Harte, 2017; Alexander *et al*, 2017).

CONCLUSION

Kabuli gram (Kripa) had significantly higher seed weight of 56.74 $\pm$ 1.57 followed by RVKG 101 (45.90 $\pm$ 1.57). Desi gram had average 100 seed weight, 100 seed volume (70.67 ml), while, JAKI 9218 occupies only 32.63 ml volume. Among the varieties used in the study kabuli gram variety Kripa had the highest dhal recovery of 71.04% in overall kabuli gram have higher dhal recovery than desi gram. The milling recovery of whole dhal was also found higher in kabuli gram varieties than that of desi ones, most preferable by the millers.

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