RESEARCH ARTICLE

PHYSICAL PROPERTIES ANALYSIS IN KIDNEY BEANS (*PHASEOLUS VULGARIS* L.)

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Abstract: Physical properties of Rajma (*Phaseolus vulgaris* L.) seeds were investigated and their application was also discussed. Four varieties of the kidney beans were locally collected from Garhwal region of Uttarakhand for determination of physical properties. Sample of one thousand seeds of each varieties of Rajma was taken for conducting the study. The physical parameters viz moisture content, dimensions (length, width, thickness), diameter, sphericity, surface area, volume, shape factor, bulk density, true density, porosity(%) and angle of response for different germplasm of Rajma *i.e.* PRG-4, PRG-20, PRG-2, PRG-5 and PRG-1 was taken for conducting the study. Our results showed that the germplasm PRG-5 had maximum moisture, dimensions, surface area and volume, maximum spericity and bulk density for PRG-2, maximum shape factor for PRG-4, maximum porosity (%) for PRG-1 and angle of response PRG-1.

Keywords: Rajma, Physical properties, Garhwal region, Uttarakhand.

INTRODUCTION

Rajma (*Phaseolus vulgaris* L.) or kidney beans are very popular all over the world because of its health benefits as well as their savory texture. Rajma is termed as "King of Nutrition". Brazil and Mexico is the top producer of the rajma (Broughton *et al.*, 2003).

The importance of bean to diets in the developing world is reflected in the fact that for developing countries only 13% of production is exported. The two major exporters are China and Myanmar (Gepts *et al.*, 2008). In north India red kidney beans are popularly known as "Rajma". Mostly it is grown in the northern and southern part of India. Kidney beans are also called as "Common bean", "Haircot bean", "Navy bean" or "Snap bean" (www.agrifarming.in). In comparison with other food crops, rajma has one of the widest ranges of variation in growth habits, seed characteristics (size, shape, and colour), maturation times and adaptation (Jones 1999). Common bean is a rich source of dietary proteins, complex carbohydrate, dietary fibers and minerals, such as iron and zinc, and certain vitamins. Bean production is more than twice that of chickpea, which is the second most important grain legume. When developmental status is considered further, it is seen that developing countries produce 86% of worldwide production of beans. Rajma has high content of lysine which is a good complement other than cereal crops like rice or corn which are deficient in this amino acid. It contains some antinutritional factors such as phytates, protease and amylase inhibitors, lectins and polyphenols (tannins), reduce the activity of some enzymes and the absorption of metabolites (Diaz-Batalla *et al.*, 2006; Paul Gepts, *et al.*, 2001; Batista *et al.*, 2010).

The objective of this study is to determine the engineering (physical and mechanical) properties of five locally available varieties of Rajma grown in Tehri Garhwal District of Uttarakhand, to establish a convenient reference data for their mechanization and processing. The knowledge of the engineering properties is useful for both engineers and food scientists; plant and animal breeders and it is also important in data collection in the design of machines, structures, processes and controls; and in determining the efficiency of a machine or an operation.

MATERIALS AND METHOD

The investigation was carried out at the Department of Agricultural Engineering, College of Forestry Ranichauri, Veer Chandra Singh Garhwali Uttarakhand University of Horticulture and Forestry, Tehri Garhwal (India). The present study was conducted to evaluate the some physical properties of kidney bean (rajma). The genotypes were collected from Dargi and Ranichauri villages of Tehri Garhwal district of Uttarakhand. Hundred seeds of each sample of five local varieties (germplasm) were used in this study. The seeds were cleaned up manually to remove all foreign matters such as chaff, dust and stones *etc*. These germplasm were stored in dry and cool place in ambient condition until further study. The procedures for determination of physical properties of kidney bean are discussed below:

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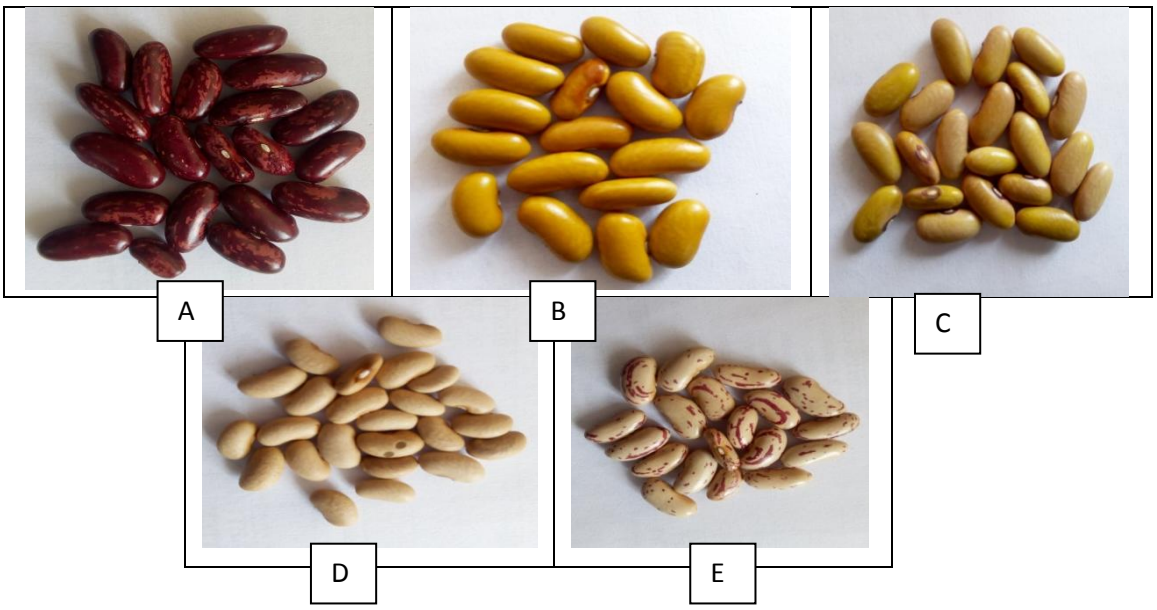

Figure 1: PRG-4, PRG-20, PRG-2, PRG-5 and PRG-1

Physical Properties

Size of the seed

For estimating the size, 50 random seeds of each species were collected. The size of rajma seeds was determined in the terms of Arithmetic mean diameter (AMD), Geometric mean diameter (GMD), Square mean diameter (SMD), Equivalent diameter (EQD) of the given kidney beans are calculated with the help of vernier caliper having a least count of 0.02 mm. the size is determined by the relationship given by (Mohsenin, 1978)

$$AMD = L+W+T \quad \ldots(1)$$

$$GMD = (LWT)^{\frac{1}{3}} \quad \ldots(2)$$

$$SMD = LW + WT + TL)^{\frac{1}{2}} \quad \ldots(3)$$

$$EQD = \frac{AMD + GMD + SMD}{3} \quad \ldots(4)$$

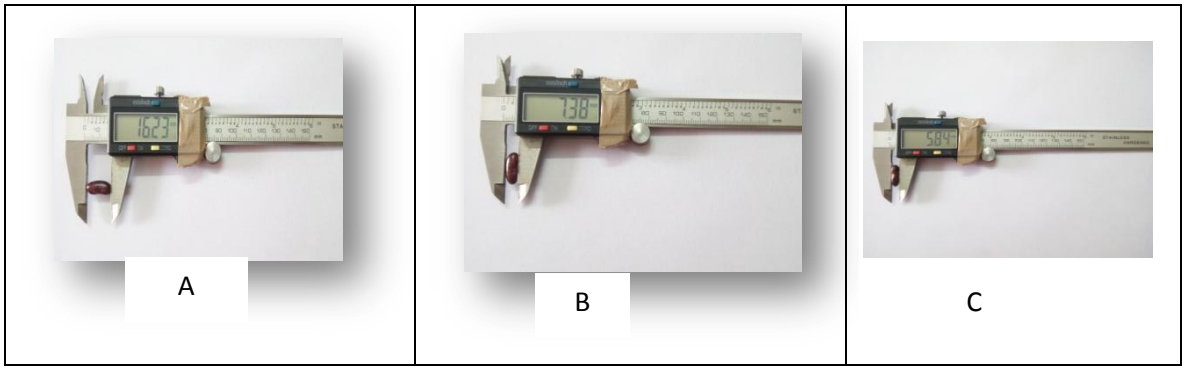

Fig 2. Measurements (a) Length, (b) width and (c) thickness

Moisture content

Moisture content of the corm was determined by oven dry method. Three samples of corm were taken and kept in oven at 105° for 24 hours. Thereafter, samples were taken out and their dry weight was determined using electronic balance. The moisture content was calculated by the following relationship (**Singh and Singh, 2015 and Singh and Chandra 2014**).

$$Mc = \frac{W_{w-W_d}}{W_d} \times 100 \quad \ldots(5)$$

Where,

M_c = Moisture content (dry basis).

W_w = Weight of materials before oven drying.

W_d = Weight of material after oven drying.

Thousand seed weight

Three samples, each germplasm comprising of one hundred corms were taken. The weight of each seed was determined using electronic balance having a least count of 0.1g. The average of all three samples was taken to determine the average weight of rajma seeds.

Coefficient of static friction (μ)

The coefficient of static friction was measured for all the five different kidney beans species by inclined

plane method. The kidney beans have been kept on a horizontal surface and the slope is being increased gradually. The angle at which kidney beans started sliding was recorded, and the coefficient of static friction will be computed by using the following relationship as given below,

$$\mu = \tan(Ø) \quad \ldots (6)$$

Bulk density, true density and Porosity

The Bulk density, true density and Porosity were measured by the toluene displacement method. The procedure was replicated three times and the average bulk density of the seed was calculated the equation given below **(Mohsenin, 1970.)**

$$\text{B.D. } (\rho) \frac{w}{v} \quad \ldots (7)$$

Where,

ρ = Bulk density, g/cc

W = weight of the corm, g

V = Volume of the sample, cc

$$\text{Porosity } (\varepsilon) = \frac{1-\rho}{\rho} \times 100 \quad \ldots (8)$$

Results and Conclusion: Table 1 given below showed the mean and standard errors of phyisical parameters viz moisture content, dimensions (length, width, thickness), diameter, sphericity, surface area, volume, shape factor, bulk density, true density, porosity(%) and angle of response for different verities of Rajma i.e. PRG-4, PRG-20, PRG-2, PRG-5 and PRG-1. In this study 100 samples for each germplasm have been taken for conducting this study. The length, width and thickness had been measured in mm, surface area in mm^2, volume in mm^3, density in gm/mm^3 and angle of response was measured in degree.

Table 1. Physical parameters for different verities (PRG-4, PRG-20, PRG-2, PRG-5 and PRG-1) of Rajma

ITEMS→ MEASUREMENT↓	***PRG-4***	***PRG-20***	***PRG-2***	***PRG-5***	***PRG-1***
MOISTURE CONTENT	8.81±0.525	13.66±0.719	15.84±2.899	18.93±0.306	9.12±0.480
DIMENSIONS (Length)(mm)	1.216±0.545	0.841±0.173	1.044±0.465	1.318±0.694	1.109±0.788
(Width) (mm)	0.617±0.020	0.467±0.018	0.609±0.005	0.669±0.093	0.608±0.044
(Thickness) (mm)	0.466±0.065	0.320±0.059	0.478±0.085	0.488±0.059	0.428±0.087
DIAMETER (GMD) (mm)	0.704±0.056	0.501±0.092	0.672±0.045	0.754±0.008	0.660±0.012
SPHERICITY	0.578±0.054	0.595±0.089	0.643±0.076	0.572±0.036	0.595±0.065
SURFACE AREA(mm^2)	1.892±0.073	0.942±0.008	1.625±0.032	2.186±0.011	1.636±0.064
VOLUME(mm^3)	0.222±0.009	0.078±0.008	0.182±0.084	0.274±0.099	0.237±0.068
SHAPE FACTOR	0.190±0.094	0.177±0.086	0.183±0.099	0.187±0.090	0.189±0.099
BULK DENSITY	0.205	0.1667	0.23	0.1992	0.091
TRUE DENSITY	1.345	1.358	1.276	1.444	1.229
POROSITY (%)	84.75	87.72	81.97	86.20	92.59
ANGLE OF REPOSE	23.215±2.589	23.019±2.24	23.109±1.459	23.25±1.67	23.8±1.2

The present result showed that PRG-5 has the maximum moisture content *i.e.* (18.93 + 0.306) whereas PRG-4 has minimum (8.81±0.525). Altuntas and Demirtola, 2007 have experimented on three different moisture percent (8.21, 11.83 and 18.01) on rajam. The present result had much higher moisture content may be better fertility of soil and atmospheric condition of hilly areas of rainfed conditions of Garhwal region of Uttarakhand. The germplasm PRG-5 had maximum length, width and thickness whereas minimum length, width and thickness had PRG-20. The Maximum sphericity was found in PRG-2 (0.643 + 0.076) and minimum sphericity for PRG-5 (0.572±0.036). The germplasm of Rajma PRG-5 (2.186 ± 0.011) has maximum surface area and minimum surface area for PRG-20(0.942±0.008). The maximum volume was found for PRG-1(0.437±0.068) and minimum volume for PRG-20(0.078±0.008). The PRG-4 had maximum shape factor and minimum shape factor for PRG-20. The maximum bulk density had been found for PRG-2 and minimum bulk density for PRG-20. The germplasm PRG-5 had maximum true density and minimum true density for PRG-2. The maximum porosity (%) was found for PRG-1 and minimum porosity for PRG-2 whereas maximum angle of response was found for PGR-1 and minimum for PRG-20. In the higher moisture content rajma that is 18.01 in rajam the length (16.766±0.31), width (8.992±0.12), sphericity (61.31±0.04) and porosity (61.114±1.9) were estimated (Altuntas and Demirtola, 2007). The Physical and functional properties of Rajma (*Phaseolus vulgaris*) was studied and found that the diameter 7.97 mm, average sphericity 57.22%, Porosity 19%, compressibility index 24.90, Hausner's ratio 1.238 (Gani, *et al.*, 2015). Therefore, this study suggests that the physical property of Rajma was better in Garhwal region of Uttarakhand, India.

REFERENCES

http://www.agrifarming.in/kidney-beans-farming. Accessed on 09/10/2017.

Jones, A. L. (1999). Phaseolus bean: post-harvest operations. Roma: FAO. Available at: <http://www.fao.org/>. Accessed on: 15 Aug. 2012.

Diaz-batalla, I., Widholm, J.M., Fahey Junior, G.C., Castano-Tostado, E. and Paredes-Lopez, O. (2006). Chemical components with health implications in wild and cultivated mexican common beans seeds (*Phaseolus vulgaris* L.). *Journal of*

Agricultural and Food Chemistry, 56 (6): 2045-2052.

Batista, K.A., Prudencio, S.H. and Fernandes, K.F. (2010). Changes in the functional properties and antinutritional factors of extruded hard-to-cook common beans (*Phaseolus vulgaris* L.). *Journal of Food Science*, 75(3): 286-290.

Gepts, P. (2001). *Phaseolus vulgaris* (Beans). In: Brenner, S.; Miller, J. H. (Ed.). Encyclopedia of genetics. Cambridge: Academic Press. 1444-1445.

Bennett, M. and Leitch, I. (2005). Angiosperm DNA C-Values database. Release 4.0 http://www.rbgkew.org.uk/cval/database1.html.

Gepts, P., Aragao, F.J.L., Barros, E., Blair, W.M. *et al.* (2008). Genomics of *Phaseolus* Beans, a Major Source of Dietary Protein and Micronutrients in the Tropics**.** P.H. Moore, R. Ming (eds.), Genomics of Tropical Crop Plants, *Springer*, 1: 113-144.

Broughton, W.J., Hernandez, G., Blair, M., Beebe, S., Gepts, P. *et al.* (2003). Beans (*Phaseolus* spp.) –model food legumes. *Plant Soil*. 252: 55–128.

Altuntas, E. and Demirtola, H. (2007). Effect of moisture content on physical properties of some grain legume seeds. *New Zealand Journal of Crop and Horticultural Science*, 35: 423-433.

Singh, P., Pandey, V., Mishra, A.C., Ahmad, R.A. and Singh, P.V. (2016). Physical and engineering properties of garlic cloves for designing planting and harvesting machinery. *Progressive Research- An international Journal*, 2: 766-769

Gani, A., Hussain, H., Ahmad, M., Baba, W.N., Gani, A., Masoodi, F.A., Wani, S.M., Shah, A., Wani, I.A. and Maqsood, S. (2015). Engineering and functional properties of four varieties of pulses and their correlative study. *Journal of Food Measurement and Characterization* 9 (3): 347-358.

Singh, P. and Singh, T.P. (2015). Assessment of Physical Properties of Gladiolus (*Gladiolus grandiflorus* L.). *Annals of plant and soil research*, 17 (2): 45-47.

Mohsenin, N.N. (1986). Physical Properties of Plant and Animal Materials. Second Edn. Gordon and Breach Science Publishers, New York.

Yogendra, S. and Chandra, S. 2014. Evaluation of physical properties of kidney beans (*Phaseolus vulgaris*). *Food Science Research Journal*,5 (2): 125-129