PHYSICAL PROPERTIES OF CREOLE BEAN GRAINS

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During storage, the bean drying is the process most commonly used to ensure quality and stability, reducing the biological activity and possible physical and chemical changes. Reducing the water content of the beans decreases the size of the grains and influences directly on its physical properties during the drying process. Thus, the correct determination of the physical properties is of fundamental importance in optimizing industrial processes, aerodynamic studies, design and sizing of equipment used in harvesting and post-harvest operations (Resende et al., 2005). The objective of this study was to measure in Creole beans forms, the grain sizes (sphericity and volume) and their densities, grown in mesoregion of North of Minas Gerais State, Brazil.

This work was developed in the Biotechnology Laboratory of the Universidade Federal de Minas Gerais, Montes Claros-MG, Brazil. Ten Creole bean (*Phaseolus vulgaris* L.) accesses were studied. The bean accesses were collected manually with a water content of about 0.92 (b.s.). Drying was carried out at constant temperature of 40°C. Reducing the water content over drying was followed by gravimetric (weight loss), determining the initial moisture level of the grain until the final water content of 0.13 (b.s.), using analytical balance accurate to 0.01g . The grain water content was determined by the oven-drying method at 105 ± 1°C to constant weight. The shape and size of grains analyzed by means of spherical shape and volume from measurements of 30 grains of each access (Moshsenin, 1986). The data on the characteristics and dimensions orthogonal axes (Figure 1) were obtained using a digital caliper with an accuracy of 0.01mm.

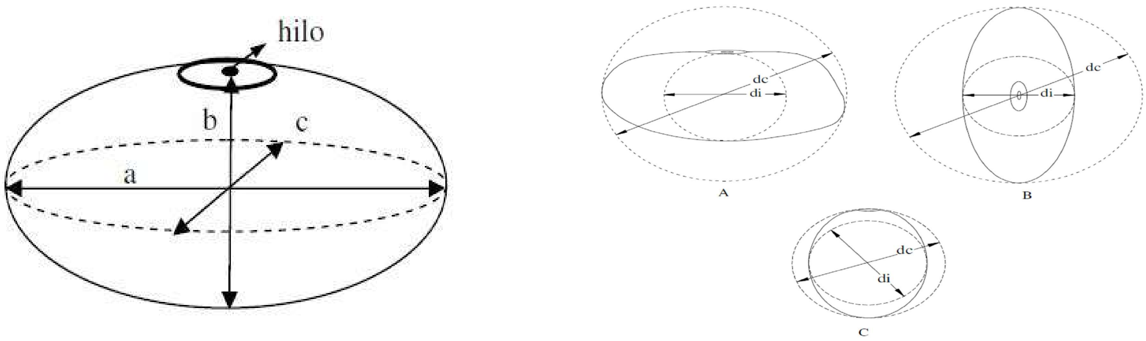

Figure 1. Schematic bean grain design considering the oblate spheroid shape with its characteristic dimensions: (a) major axis of grain (mm); (b) Average grain axis (mm); (c) the grain minor axis (mm); (di) diameter of the largest inscribed circle (mm); (dc) diameter of the smallest circumscribed circle (mm); (A) major axis; (B) median axis; (C) minor axis.

The density (g/cm^3) was determined by dividing the sample weight by volume (Ferreira et al. 2002). Statistical analyzes were performed in a completely randomized design (CRD), and the mean ( ), the variance (σ^2) and the analysis of variance (ANOVA) were determined by the GENES program (Cruz, 2001).

The analysis of variance of the physical properties of sphericity, volume and density were all significant (Table 1). Thus, it is apparent that the analyzed Creole beans exhibit variations of its characteristic dimensions (Table 2). This is observed for most biological products, which, during drying, contract up irregularly in the various directions, as noted by Correa et al. (2002). The volumetric changes of the products due to dehydration are reported to be the main causes of changes in the physical properties of agricultural grains (Sokhansanj & Lang, 1996). Zogzas et al. (1994) observed that the plant products shrinkage during drying is not solely a function of water content, but also dependent on the process conditions and product geometry. In this work, it can be seen that the characteristic dimensions of the grains decrease with decreasing water content. The grain sphericity also reduced during the drying process, whereas circularity did not show a tendency to set their values to reduce the water content. Moreover, the surface/volume ratio of the grains increased by reducing the water content during the drying process (Table 2). Despite the theoretical basis for the knowledge of the shrinkage process involved complex mechanical and material deformation laws (Towner, 1987). There is an increasing tendency for the bean breeding programs intensify their work in relation to the physical properties of the grains.

Table 1. Summary analysis of variance on the sphericity, volume and density in grain Creole bean accesses cultivated in mesoregion of North of Minas Gerais State, Brazil.

ANOVA		DF	SS	MS	F	P value	F critical
Sphericity	Accesses	9	27,785.4616	308.2735	149.7538	1.6181E-103	1.9122
	Residue	29	5,978.5415	20.6156			
	Total	29	33,764.0031				
Volume	Accesses	9	41,877.8110	4,654.6457	49.6429	1.1275E-53	1.9123
	Residue	29	27,884.6250	93.3435			
	Total	29	69,762.4360				
Density	Accesses	9	0.2740	0.030449289	16.2184	2.9625E-09	2.2106
	Residue	29	0.0563	0.001877451			
	Total	29	0.3303				

ANOVA: Analysis of variance; DF: Degree of freedom; SS: Sum squared; MS: Mean squared.

Table 2. Means (μ) and variances (σ^2) of units and water absorption capabilities in Creole bean accesses cultivated in mesoregion of North of Minas Gerais State, Brazil.

Creole bean accesses	Measurements					
	Sphericity (%)		Volume (mm^3)		Density (g/cm^3)	
	μ	σ^2	μ	σ^2	μ	σ^2
Curiango	68.1401	6.0258	113.7088	62.4484	1.2200	0.0004
Penquinha	64.4329	11.3016	107.4405	42.6366	1.1899	0.0009
Meia Corda	86.4798	62.8349	177.4813	19.4447	1.0861	0.0028
Roxo	82.7521	27.7154	164.9587	51.2726	1.1568	0.0011
Olho de Pombo	74.2842	11.0413	203.8478	22.3590	1.2881	0.0005
Cores	65.8439	19.3919	127.4270	52.0175	1.2412	0.0005
Branco	72.6522	6.6235	222.1668	11.6740	1.3508	0.0011
Mulatinho	89.5283	21.1343	228.8581	13.2107	1.3343	0.0001
Fava Branca	60.6864	9.0797	436.2075	14.8561	1.2843	0.0001
Fava Cores	64.3607	31.0078	455.1603	58.5153	1.3422	0.0110

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