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Research Article

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Determination of the Physical Properties of Grains of *Lens culinaris* L

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Abstract As the production increases, there is a growing need in the grain processing industries, for more homogeneous products and with a lower percentage of impurities; for this, engineering has been improving the beneficiation processes through studies of the physical properties of the grains. The objective of this study was to determine the physical properties of lentil grains from two different brands. The research was carried out at the Laboratory of Processing and Storage of Agricultural Products of the Federal University of Campina Grande, Brazil. The moisture content (%),water activity (a_w), mass of 1000 grains (g), actual specific mass (g/cm^{-3}), apparent specific mass (g/cm^{-3}), a (length,mm^2), b (width, mm^2), c (thickness, mm^2), angle of repose (%), porosity (%) and volume (cm^{-3}). The lentils of the two brands presented low water content and intermediate activity, the A and B marks presented the same value for the 1000 grain weight, the B mark presented the highest value for the angle of rest and the marks A and B presented same value for physical property volume, mark B presented higher values for length and width and mark A for thickness.

Keywords physical characterization, legumes, lentils, agricultural products

Introduction

Lentil belongs to the Leguminosae family, being an important source of complex carbohydrates, protein, dietary fiber and some vitamins and minerals [1, 2]. According to Faris et al. [3] lentil is a grain that has stimulated the world's interest due to its chemical-nutritional composition, being an important source of compounds derived from primary and secondary metabolisms, such as proteins and fibers [4,5]. The nutritional composition of lentils of national origin was verified by Padovani et al. [6], it presented about 64% of carbohydrates, 23% of proteins, 17% of dietary fiber and 0.8% of lipids, however, studies on the physical properties of lentils are scarce.

In Brazil the national consumption of lentils is supplied by imports. Although there is good acceptance of this grain, its national production is small. Although lentils are a nutritionally rich grain and high antioxidant activity, their use in the world food supply is still low, due to the high preparation time and economic-energy expenditure [7]. The use of lentil in feed is limited in the West due to the lack of concrete data on processing techniques and grain based products [8].

Admitting the particularity of each product, not only in relation to its physical characteristics, but also by its chemical composition. The physical characterization needs defined criteria taking into account the existing variability, since the lentil grains have quite distinct dimensions in comparison to their grains [9]. The knowledge about the physical properties is of fundamental importance to minimize the costs of production for greater competitiveness and maintenance of product quality. Information such as: size, volume, porosity and specific mass, among others, are essential tools in the study involving physical properties of grains [10].

Knowledge of the physical properties of agricultural products is not restricted to engineering, and information may be of great use in other branches of science or technology related to physical behavior and processing of fruits and vegetables in general. The main applications of this knowledge are for the adequate design of machines used in the processing and better characterization of the product [11]. The physical properties of the grains are relevant characteristics in the optimization of the industrial processes and the development of new projects and equipment used in the post-harvest operations [12].

Considering the above, the knowledge about the physical properties of the lentil has several benefits, especially when attention is focused on the processing and storage of this grain. In this way, the objective was to determine the physical properties of lentil grains of two different brands.

Material and Methods

Search Location

The research was carried out at the Laboratory of Processing and Storage of Agricultural Products of the Federal University of Campina Grande, located in the city of Campina Grande, Paraiba, Brazil.

Raw material

The lentils of two different brands A and B were purchased commercially in the city of Campina Grande, Brazil.

Physical properties

Moisture content (%): The grain water content of the two brands (A and B) was determined by the greenhouse gravimetric method at 105 ± 1 °C for 24 hours in three replicates [13].

Water activity: was determined using the Aqualab device, Decagon® brand at 25 °C.

Mass of 1000 grains (g): using a scale with a resolution of 0.01 g, in eight repetitions, weighed the mass of the products whose results were adjusted to 1000 [13].

*Actual specific mass (g/cm^{-3}):*quantified by the ratio between mass and volume of each grain [14].

*Specific apparent mass (g/cm^{-3}):*determined using a digital scale with becker use, with capacity of 150 mL [14].

*Circularity (%):*determined using digital caliper Almeida et al. [14].

*Porosity (%):*performed in function of the apparent and actual specific masses, according to the equation described by Mohsenin [15].

*Volume (cm^{-3}):*rated second Mohsenin [15].

*Angle of repose (º):*determined according to the Almeida et al. [14].

*Length (a), width (b) and thickness (c) (mm^2):*with the aid of a digital caliper with a resolution of 0.01 mm, measurements were made on the dimensions of the grains [15].

Statistical Analysis

The results were submitted to analysis of variance (ANOVA), Tukey test of means comparison at the 5% level of significance, with the aid of the statistical program Assistat 7.7 [16].

Results and Discussion

The lentils of the two brands showed low water content and similar water activity, showing no statistical difference between the brands. Cajamarca et al. [17] when working with the chemical properties of brown and gold flaxseed observed for water content in the seed 6.98% in golden flaxseed and 7.60% in brown flaxseed. According to Farias et al. [18] the water content of the agricultural products is an important factor that determines the porosity variation of the grains, because grains with higher water contents present a higher surface tension than dry grains. Oliveira [19] classified as products of intermediate moisture those with aw between 0.6 and 0.85 and products with low humidity are those with aw values up to 0.6. We can classify the grains of both brands as intermediate moisture.

The A and B marks had the same value for the mass of 1000 grains, so there was no statistical difference. The mass of 1000 grains is important for calculating seeding density, number of seeds per package and for purity analysis [13]. Coradi et al. [20] when evaluating the physical properties of sunflower seeds after drying observed that temperatures of 65 and 75 °C were the most influential in weight reduction.

The grains of the brand A presented higher value for the actual specific mass, which differed statistically from the mark B. The specific mass is a physical characteristic frequently used to evaluate the quality of a grain mass, so that usually the larger its magnitude, and the quality of the product, and is frequently used in the commercialization of some products such as wheat, dug and flour [21]. Similar behavior occurred for the apparent specific mass, where the A mark presented a statistical difference of the B mark, being the mark A, which presented the highest average.

Table 1: Physical properties of lentil seeds from different brands.

Physical properties	Mark A	Mark B
Moisture content(%)	10.50a	10.70a
Water activity (a_w)	0.57a	0.58a
Mass of 1000 grains (g)	0.07a	0.07a
Actual specific mass (g/cm^{-3})	1.56a	1.43b
Specific apparent mass (g/cm^{-3})	0.79a	0.72b
Circularity (%)	95.07a	89.89b
Porosity (%)	49.48a	49.87a
Volume (cm^{-3})	0.11a	0.11a
Angle of repose (°)	20.67b	27.33a
a (length, mm^2)	5.86b	6.61a
b (width, mm^2)	5.58b	5.94a
c (thickness, mm^2)	1.30a	2.40b

Note: Letter superscripts equal in the same line do not present significant difference at the 5% probability level.

The A mark, for the physical property circularity, presented statistical difference, being the one that presented higher value for this parameter. Goneli et al. [10] working with castor bean fruits, also observed similar results, in which circularity and sphericity showed small variations in their values.

The lentil grains of the two brands showed no statistical difference for the physical property porosity. When evaluating the physical properties of castor bean seeds, Farias et al. [18], obtained 42.5% for the parameter porosity, being lower than the one verified in this research with lentil grains. The B mark presented a higher value for the rest angle, differing statistically from the mark A. According to Elias [22], the rest angle is that formed between the grain mass surface and the horizontal plane, when discharged on a flat surface. Some grains tend to occupy the largest possible area, forming a small angle of rest, while others do not. Silva et al. [23] when determining the angle of repose of the sunflower seeds of different localities, obtained values ranging from 25.33 to 25.67.

The marks A and B presented same value for the physical property volume, that is, both did not differ statistically among themselves. Volumetric changes of the products, due to their dehydration, are reported as being the main causes of changes in the main physical properties of agricultural products [24,25]. The theoretical bases for the knowledge of the volumetric contraction process involve complex mechanical and material deformation laws [25].

As to the length and width, the B mark presented higher values, differing from the A mark, since the thickness occurred the inverse, the mark A presented statistical difference of the B, being the one that presented the highest average. The use of seeds sorted by size facilitates the operation of seeders in seed distribution, making it possible to obtain suitable populations in the field. In addition, Santos et al. [26] reported that size classification improved their sanitary quality. Size and shape are genetically defined specific characteristics of each product, which may also be influenced by the environment during and after the formation period [27]. These data can be used for sizing the size and shape of seeds and sieves in equipment for sorting and sorting. The shape of the product is influenced by the reduction of the water content, because in addition to causing the reduction in seed size, it directly influences the physical properties [28].

Conclusion

The lentils of the two brands presented low water content and intermediate activity, the marks A and B presented the same value for the 1000 grain mass, the grains of the brand A differed statistically from the B mark in relation to the actual specific mass, the brand A showed statistical difference of the B mark, being the mark A, which presented the highest average for the apparent specific mass. The A mark, for the physical property circularity presented higher value.

The lentil grains of the two brands did not present statistical difference for the physical property porosity, the mark B presented higher value for the angle of rest and the marks A and B presented same value for the physical property volume. The B mark had higher values for length and width, whereas mark A presented statistical difference of B, being the one that presented the highest average for the thickness.

References

[1]. Iqbal, A., Khalil, I. A., Ateeq, N.,& Khan, M. S. (2006). Nutritional quality of important food legumes. Food. Chem, 97(2):331-335.

[2]. Vohra, K., & Gupta, V. K. (2012). Pharmacognostic evaluation of Lens culinaris Medikus seeds. *Asian Pacific Journal of Tropical Biomedicine*, 2(3):S1221-S1226.

[3]. Faris, M-I., Takruri, H. R.,&Issa, A. Y. (2012). Role of lentils (*Lens culinaris* L.) in human health and nutrition: a review. *Mediterranean Journal of Nutrition and Metabolism*, 6(1):3-16.

[4]. Kouvoutsakis, G., Mitsi C., Tarantilis, P. A., Polissiou, M. G.,& Pappas, C. S. (2014). Geographical differentiation of dried lentil seed (*Lens culinaris*) samples using Diffuse Reflectance Fourier Transform Infrared Spectroscopy (DRIFTS) and discriminant analysis. *Food Chemistry*, 145:1011-1014.

[5]. Zia-Ul-Haq, M., Ahmad, S., Shad, M. A., Iqbal, S., Qayum, M., Ahmad, A., Luthria, D. L., & Amarowicz, R. (2011). Compositional studies of lentil (*Lens culinaris* medik.) cultivars commonly grown in Pakistan. *Pakistan Journal of Botany*, 43:1563-1567.

[6]. Padovani, R. M., Lima, D. M., Colúmbia, F. A. B., & Rodriguez-Amaya, D. B. (2007). Comparison of proximate, mineral and vitamin composition of common Brazilian and US foods. *Journal of Food Composition and Analysis*, 20(8):733-738.

[7]. Brune, M. F. S. S., Pinto, M. O., Peluzio, M. C. G., Moreira, M. A., Barros, E. G. B. (2010). Avaliação bioquímico-nutricional de uma linhagem de soja livre do inibidor de tripsina kunitz e de lectinas. *Ciência e Tecnologia de Alimentos*, 30(3):657-63.

[8]. Hefnawy, T. H. (2011). Effect of processing methods on nutritional composition and anti-nutritional factors in lentils (*Lens culinaris*). *Annals of Agricultural Science*, 56(2):57-61.

[9]. Araújo, W. D., Goneli, A. L. D., Orlando, R. C., Martins, E.. A. S., &Hartmann Filho, C. P. (2015). Propriedades físicas dos frutos de amendoim durante a secagem. *Revista Caatinga*, 28(4):170-180.

[10]. Goneli, A. L. D., Corrêa, P. C., Magalhães, F. E. A., & Baptestini, F.M. (2011). Contração volumétrica e forma dos frutos de mamona durante a secagem. *Acta Scientiarum. Agronomy*, 33:1-8.

[11]. Araújo, W. D., Goneli, A. L. D., Souza, C. M. A. de., Gonçalves, A. A., &Vilhasanti, H. C. B. (2014). Propriedades físicas dos grãos de amendoim durante a secagem. *Revista Brasileira de Engenharia Agrícola e Ambiental*, 18(3):279-286.

[12]. Ribeiro, D. M., Corrêa, P. C., Rodrigues, D. H,&Goneli, A. L. D. (2005). Análise da variação das propriedades físicas dos grãos de soja durante o processo de secagem. *Ciência e Tecnologia de Alimentos*, 25(3):611-617.

[13]. Brasil. (2009). Ministério da Agricultura, Pecuária e Abastecimento. Secretaria de Defesa Agropecuária. Regras para análise de sementes. Brasília: MAPA, 395p.

[14]. Almeida, F. de A. C. (Org.)., Duarte, M. E. M. (Org.)., Cavalcanti-Mata, M. E. R. M. (Org.). (2006). *Tecnologia de Armazenagem em sementes*. 1. ed. Campina Grande: Marconi, 1: 382p.

[15]. Mohsenin, N. N. (1986).*Physical properties of plant and animal materials*. New York: Gordon and Breach science publishers Inc., 734p.

[16]. Silva, F. A. S., & Azevedo, C. A. V. (2016). The Assistat Software Version 7.7 and its use in the analysis of experimental data. *African Journal of Agricultural Research*., 11(39):3733-3740.

[17]. Cajamarca, F., Lancheros, A., F. Benatti, Guedes, C. B. E., & Guimarães, M. (2014). Grãos cultivados no inverno visando à produção de biodiesel. II Simpósio de Bioenergia e Biocombustíveis do Mercosul, Universidade Estadual de Londrina.

[18]. Farias, H. F. L., Camargo, F. R. T., Silva, I. L., Faria, R. C., Machado, V. S., & Devilla, I. A. (2018). *Propriedades físicas, térmicas e aerodinâmicas de grãos de mamona*. In: Anais do IV Congresso de Ensino, Pesquisa e Extensão da UEG. v. 4.

[19]. Oliveira, G. S. (2012). *Aplicação do processo de liofilização na obtenção de cajá em pó: avaliação das características físicas, físico-químicas e higroscópicas*. 83 f. Dissertação (Mestrado em Ciência e Tecnologia de Alimentos). Universidade Federal do Ceará. Fortaleza, CE.

[20]. Coradi, P. C., Helmich, J. C., Fernandes, C. H. P., & Peralta, C. C. (2015). Drying kinetics, mathematical modeling and volumetric shrinkage of sunflower seeds (*Helianthus Annuus* L.). *Engenharia Agrícola*, 30(3):319-330.

[21]. Botelho, F. M., Granella, S. J., Botelho, S. C. C., & Garcia, T. R. B. (2015). Influência da temperatura de secagem sobre as propriedades físicas dos grãos de soja. *Engenharia na agricultura*, 23(3):212-219.

[22]. Elias, M. C. (2008). *Manejo tecnológico da secagem e do armazenamento de grãos*. 1. ed. Pelotas: Editora Cópias Santa Cruz, 1, 368p.

[23]. Silva, L. P. F. R., Silva, S. N., Silva, R. C., Cândido, A. F. M., Dantas, M. C. A. M., & Gomes, P. J. (2017). *Propriedades físico-químicas das sementes de girassol oriundas de diferentes localidades*. Anais... III Encontro Nacional da Agroindústria: desafios da segurança alimentar. Armistrong Martins da Silva (org.) – Bananeiras -PB.

[24]. Couto, S. M., Magalhães, A. C., Queiroz, D. M., Bastos, I. T. (1999). Massa específica aparente e real e porosidade de grãos de café em função do teor de umidade. *Revista Engenharia Agrícola e Ambiental*, 3(1):61-68.

[25]. Towner, G. D. (1987). The tensile stress generated in claythroughdrying. *Journal Agricultural Engineering Research*, 37(4):279-289.

[26]. Santos, P. M. dos., Reis, M. S., Sediyama, T., Araújo, E. F., Cecon, P. R., & Santos, M. R dos. Influência do tamanho de sementes de soja na qualidade fisiológica e sanitária durante o armazenamento. Revista *Brasileira de Armazenamento*, 31(1):08-16.

[27]. Nunes, J. A. S., Ormond, A. T., Caneppele, C., Silva, S. L. S. da., &Job, M. T. (2014). Determinação do ângulo de repouso, volume unitário, eixos ortogonais e esfericidade de trigo. *Acta Iguazu*, 3(2): 77-86.

[28]. Resende, O., Corrêa, P. C., Goneli, A. L. D., &Cecon, P. R. (2005). Forma, tamanho e contração volumétrica do feijão (*Phaseolusvulgaris* L.) durante a secagem. *Revista Brasileira de Produtos Agroindustriais*, 7(1):15-24.