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Peanut Storage with Different Water Content Conditions

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Abstract— *Begin a hygroscopic seed, during storage, peanuts (Arachis hypogaea, L.) can undergo physical-chemical changes and attack by pathogens, compromising commercial quality and germination potential, with water content directly related to post-harvest quality of product. The study aimed to analyze the impact of water content on peanut storage on physiological characteristics. The experiment was carried out in a completely randomized design, in a 4x2 factorial scheme, with four water contents (8, 10, 12 and 14%db) and two storage periods (6 and 12 months), with four replications. The product was stored as a complete pod, in polyethylene packaging. The water content of the husk and the seed, the electrical conductivity and the germination speed index evaluated. The data were subjected to analysis of variance and the means compared by the Tukey test, with 5% significance. Peanuts stored with a high initial water content show a decrease in seed quality. Seed germination is reduced according to the storage period. Storage with low water content, 8% db, presented better conditions for seed conservation.*

Keywords— *Arachis hypogaea, postharvest, oilseeds, sorption.*

I. INTRODUCTION

Peanuts (*Arachis hypogaea* L.) are among the main oilseeds with a high content of lipids, whose grains are marketed as a product for human consumption in natura, can be used for the extraction of oil and in medicinal products (Rodrigues et al., 2016). Due to the specific characteristics of the crop, such as high lipid content and hygroscopic properties, capable of absorbing and yielding water to the ambient air, the ambient conditions during the storage period are extremely important for the conservation of the physiological quality of the grain. There are several factors that influence the quality of the product, these must be monitored from the harvest until the end of the storage period, in order to keep the characteristics of the final product preserved for commercialization to the maximum (Amaro et al., 2019).

The chemical instability of the constituent lipids is one of the main factors that alter the final quality of the product, because the seeds maintain respiratory activity even when stored (Ely, 2018). In post-harvest, the grains undergo constant deterioration, the intensity of which is due to the joint action of climatic conditions, accelerating or delaying the process in storage. Simultaneous events in the environment that culminate in the reduction of enzyme degradation and inactivation favor the maintenance of post-harvest peanut quality. Lower water content of grains reduces metabolic activity and promotes its conservation (Erten; Cadwallader, 2017; Parkhey; Naithani; Keshavkant, 2012). Therefore, better quantitative indices (Sarto, 2019), reduce losses in grain storage (Manandhar; Milindi; Shah, 2018).

As it is a hygroscopic product, the water content and temperature at which the grain is stored, has a direct influence on the conservation of its specific characteristics, accelerating the deterioration through biochemical, physiological or metabolic reactions (Nunes et al., 2020). Low humidity and temperature provide better storage conditions by reducing the respiration rate of the grains (Amaro et al., 2019). The increase in the water content in the grain leads to an increase in the respiratory rate and provides better conditions for pathogens. On the other hand, the reduction of the water content in the grains causes loss of mass, which may cause a decrease in its final value.

During storage, the grains undergo constant interactions with the surrounding air, absorbing and yielding water to the atmosphere due to the difference in water vapor pressure between them. When the vapor pressure of the water inside the grain equals the vapor pressure of the water in the air, hygroscopic balance is achieved (Costa et al., 2015).

The choice of packaging to store the grains is of great importance, as it provides protection against the external conditions of the environment, possible attacks by insects and the handling of the product. The chosen packages can be permeable, semi-permeable and impermeable; these differ according to the rate of water vapor exchanges that they allow between the stored grain and the atmospheric air (Smaniotto et al., 2020).

Based on these considerations, the aim of this study was to analyze the effect of storage conditions on the characteristics of peanut seeds, considering different water contents in the product and storage periods.

II. MATERIAL AND METHODS

This study was conducted at the Laboratory of Medicinal Plants and Post-harvest technology belonging to the State University of Maringá (UEM), located on the headquarters campus in the municipality of Maringá, PR, Brazil. The material used in the study, peanuts in pods, obtained from a family farmer in the municipality of Campo Mourão, PR, presenting as physical characteristics: apparent specific weight of 0.547 Mg m^{-3}, real specific weight of 1.076 Mg m^{-3}, porosity of 49.09% and water content of 4.72% (db).

Aiming to analyze the effect of water content on peanut storage, it was carried out in a completely randomized design with a 4 x 2 factorial scheme, with four water contents (8, 10, 12 and 14% bs) and two storage periods (6 and 12 months), with four repetitions. The peanuts in pods were moistened in a hygroscopic process, with an increase in the relative humidity for water absorption by the product until reaching a determined water content, being stored in a polyethylene terephthalate package with a nominal capacity of 500 g.

The packages were kept in an uncontrolled temperature and relative humidity environment. At 6 and 12 months of storage, the water content of the husk and seed components was determined, using the gravimetric method, submitting the samples in an oven with forced air ventilation at 105 °C for 24 hours.

To determine the electrical conductivity, 25 seeds were randomly separated, after weighing, placed in a polyethylene cup, 75 mL capacity, adding 50 mL of distilled water and kept in a BOD (Biochemical Oxygen Demand) chamber for 24 hours. After the incubation period, the reading were performed with a digital conductivity meter. In the germination test, 50 seeds were placed on a paper roll, being kept in a germination chamber at 25 °C, with a count of the number of seeds germinated at 5 and 10 days (Brasil, 2009), with four replicates per treatment.

Exploratory data analysis were carried out, with determination of the correlation between analyzed variables. The data subjected to analysis of variance, the percentage of germination; germination speed index and electrical conductivity subjected to regression analysis. For analysis of the storage period, the means compared by the Tukey test ($p<0.05$), using the Sisvar software (Ferreira, 2019).

III. RESULTS AND DISCUSION

In physiological maturation, there is maximum germinative potential and vigour, whose potential decrease occurs over time, with a degree of deterioration depending on the management at harvest and post-harvest (Jesus et al., 2020). The storage of peanut seeds in the pods allows adequate storage over time, maintaining the physiological characteristics for the physical protection of the product (Oliveira et al., 2020).

The initial water content in the peanut showed a significant effect ($p <0.05$) on the physiological qualities of the stored product, especially after a longer storage period (Table I).

TABLE I. Physiological characteristics of peanut seeds with different water content, being stored for a period of six and twelve months.

Water content (%db)	Temp	Water content (%db)		EC[1]	Germination (%)		GSI[2]
		Seed	Shell	(μS cm^{-1}g^{-1})	5	7	
8	6	4.47 a	6.88 a	72.64 b	70 a	86 a	26.29 a
	12	4.19 a	13.38 b	55.78 a	64 a	72 b	23.09 b
10	6	5.41 a	9.07 a	86.65 a	34 a	46 a	13.37 a
	12	6.49 b	11.58 b	101.34 b	30 a	32 b	10.57 b
12	6	6.64 a	11.82 a	92.35 a	14 a	24 a	6.23 a
	12	6.67 a	12.94 b	138.54 b	6 b	8 b	2.34 b
14	6	8.07 a	12.30 a	217.92 a	0 a	2 a	0.29 a
	12	12.26 b	13.79 b	414.24 b	0 a	0 a	0.00 a
CV (%)		33.18	23.06	80.70	98.57	93.02	95.72

[1] Electrical conductivity; [2]Germination Speed Index.
* Values followed by different letters differ by the Tukey test, with a 5% significance level, for the storage time.

In grain storage, adequate water content is essential to preserve product quality, reducing metabolic activity and maintaining reserves (Wenneck et al., 2020; Amaro et al., 2019; Pereira and Damaceno, 2020). In the six-month storage period, the water content values of the peanut seeds stored under the same conditions reveal more marked reductions in moisture compared to the water content of the seed at twelve months.

For all water contents (8, 10, 12 and 14% db), the moisture content of the peanut shell decreased in the first six months, while at twelve months moisture gains were observed, except for the 14% bs treatment, where the shells had a water content of 13.79% bs at the end of storage (Table I). This can be associated with equilibrium conditions depending on the temperature and relative humidity of the environment, which through the vapor pressure acts on the uncontrolled storage system. In addition, the polyethylene terephthalate packaging provides airtightness, but without thermal insulation capacity, temperature indexes accompany the ambient conditions, also influencing the characteristics of the raw material. In cartamo seeds, plastic packaging showed better quality preservation, mainly up to four months of storage (Menegaes et al., 2020).

The percentage of germination and the initial water content of the seeds were inversely proportional for both periods, of 6 and 12 months of storage, with those stored with an initial water content of 8% reaching values above 80% of germination. At 6 months, decreasing according to the storage period and water content, reaching a zero germination percentage for 14% of initial moisture (Fig. 1).

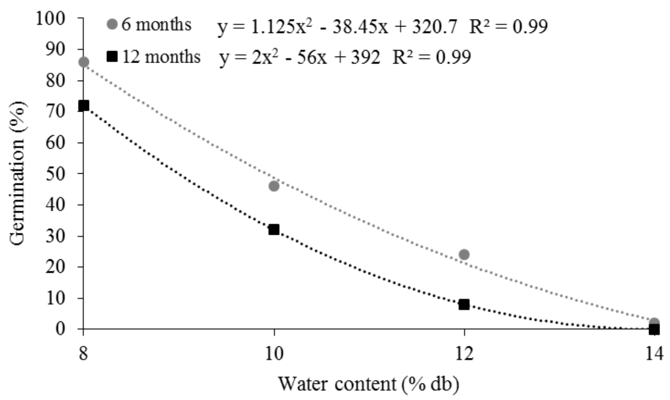

Fig. 1. Percentage of germination of peanut seeds stored in different moisture conditions of the product at 6 and 12 months of storage.

In the study, peanuts stored with a water content of 10% db or higher, showed germination lower than 50% at 6 and 12 months (Table I), with an increase of 2% db resulting in a decrease greater than 53%. Similar to this, studies using canola seeds showed zero germination percentage when stored with a water content of 14% with 135 days of storage (Haeberlin et al., 2020). Likewise, the germination speed index values were higher, in both periods, for seeds with a water content of 8%, decreasing according to the increase in initial moisture for storage (Fig. 2).

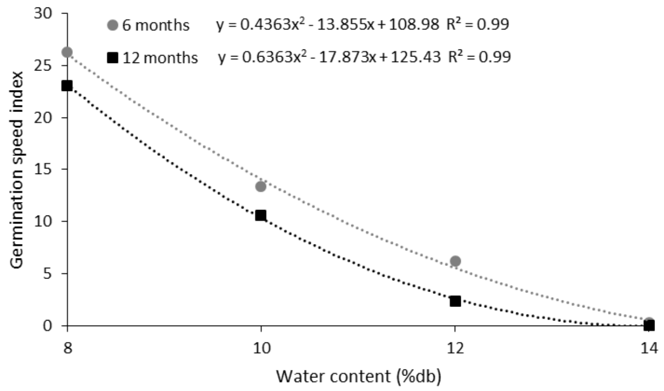

Fig. 2. Germination Speed Index of peanut seeds stored under different water content conditions at 6 and 12 months of storage.

Under conditions of water content above the recommended, the structures of the membrane are compromised and the development of pathogens is favored (Saath et al., 2010; Smaniotto et al., 2020; Barbosa et al., 2012), generating consequences on the germinative potential. Storage under conditions of temperature of 20°C and relative humidity of 50% or higher, does not allow maintaining the viability of peanuts for seeds over a period of more than six months, due to the development of fungi (Diniz et al., 2012).

Simultaneous events in the environment that culminate in the reduction of enzyme degradation and inactivation favor the maintenance of post-harvest peanut quality (Fig. 3). However, interactions and speed of reactions in the process are a function of the joint action with the water content (Marcos-Filho, 2015). In this scenario, the conditions of temperature and relative humidity of the environment and water content of seeds that minimize metabolic activity favor their conservation (Erten; Cadwallader, 2017; Parkhey; Naithani; Keshavkant, 2012).

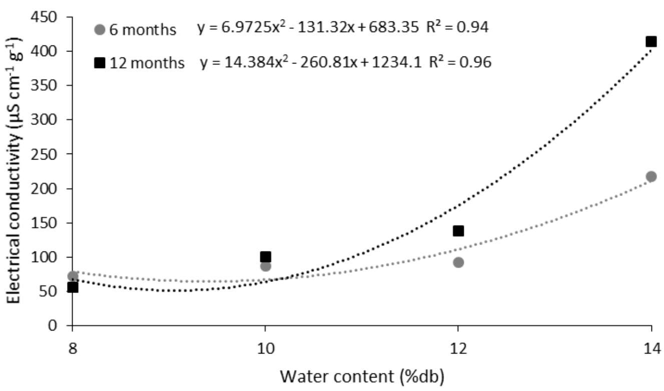

Fig. 3. Electrical conductivity in peanut seeds stored with different water contents at 6 and 12 months of storage.

Damage to the seed structure can be measured through electrical conductivity (Saath et al., 2010), with significant differences, only for the content of 14% db in the period of 6 months. Significant increments at 12 months for higher levels at 8% db, a consequence of the high water activity that favors deterioration by the action of microorganisms, also reducing the physiological potential (Table II).

High humidity conditions during storage favors the presence of pathogens that cause the product to deteriorate, such as the presence of insects or the growth of fungi, which have their growth and metabolic activities determined by atmospheric conditions. This reduction in the physiological quality of the product influences the moment of its commercialization (Barbosa et al., 2014). Keeping the water content of the product low, helps to reduce respiratory rates, consequently the oxidative activities of the seed, favoring the maintenance of product quality during storage.

TABLE III. Correlation of the variables analyzed in the storage of peanut seeds.

	WC seed	WC shell	EC	G 5° day	G 7° day	GSI
WC seed	1.00	-	-	-	-	-
WC shell	-0.02	1.00	-	-	-	-
EC	-0.39	0.48	1.00	-	-	-
G 5° day	-0.31	-0.58	-0.67	1.00	-	-
G 7° day	-0.29	-0.64	-0.69	0.99	1.00	-
GSI	-0.30	-0.61	-0.68	0.99	0.99	1.00

*WC=Water Content; EC=Electrical Conductivity; G=Germination; GSI= Germination Speed Index.

Injuries to the integrity of the seed membranes affect the germination potential of the seed, whose negative correlation between electrical conductivity and germination varied between -0.67 and -0.69 (Table II), showing an inverse behavior between the variables. The germinative potential of the seeds reduced over time, considering respiration and the biochemical reactions involved even in low activity. However, practices such as storage with low humidity are essential to minimize losses and preserve the characteristics of the product. In addition, the peanut post-harvest sector needs constant development, considering the need to maintain product health, whether for consumption or sowing.

IV. Conclusion

Increasing the initial water content reduces the germinative potential of peanut seeds. The germination percentage of the seeds reduced with the storage time. Polyethylene terephthalate packaging with 8% water content showed better results for preserving the potential of peanut seeds.

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