The Influence of Temperature and Moisture Content on the Germination of Peanut Seeds[1]

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ABSTRACT

Peanut seed, (cv. Hanoch and Congo) were stored both shelled and in-shell at various moisture contents and 15, 20 and 26 C, in an apparatus designed to purge air at relative humidities in equilibrium with the moisture contents of the seed. Storage lasted nearly 6 months and during this period the moisture contents and germination percentages of the seed were examined periodically.

The results of germination trials showed significant differences between in-shell and shelled seed for the cv. Hanoch, but not for the cv. Congo. The calculated moisture content required to maintain 90% germination for shelled seeds stored for six months at 15 C was 8.0% for Hanoch and 7.9% for Congo. To conserve the same germination level for 6 months at 26 C, the calculated moisture contents were 7.1% for Hanoch and for Congo.

Key Words: Groundnuts, seed storage, germination, temperature, moisture content.

Peanut seeds may be stored either in-shell or shelled. A general belief is that seed are better preserved when stored in-shell than after shelling. However, the former method has two disadvantages. The first is that in-shell peanuts occupy a far greater storage volume. The second is that a larger percentage of kernels are damaged mechanically during shelling since the in-shell peanuts were stored at a low moisture content (m.c.) to prevent degradation during storage. The higher the level of broken kernels, the lower the germination percentage of the seeds (5).

Two factors known to influence the preservation of peanut seed are temperature and relative humidity (r.h.) (6, 9, 10). Molds that affect the germination power of seed are also influenced by the ambient humidity and temperatures in storage (4). However, literature on the comparative preservation of shelled and in-shell peanut seed is limited. According to Gelmond (5), to preserve peanut seed for one year at 21 C, a m.c. of 5% or less is necessary. Boswell *et al.* (3) reported on peanut seed preservation at different temperatures and relative humidities.

The objective of this investigation was to determine the influence of moisture content on the germination capacity of two peanut cultivars, Hanoch (virginia type) and Congo (valencia type), when stored both shelled and in-shell at different temperatures.

Materials and Methods

The seeds

Seeds of cv. Hanoch and Congo from the 1986 harvest, grown in southern Israel, were supplied both in-shell and shelled, and placed in 25-liter sealed drums in early November 1986. The average m.c. of Hanoch was 7.6% and that of Congo was 6.8%.

Storage conditions: The seed lots (shelled and in-shell, and according to cultivar) were divided into three groups and stored in sealed drums from November 1986 until January 1987 at three temperatures, namely, 15, 20 and 26 C. In January 1987 the seed were moistened by water addition to obtain the following kernel m.c.'s for both shelled and in-shell seed: for Hanoch 9.5% and 12.5%; and for Congo, 9.0% and 11.0%. These levels were chosen to obtain m.c.'s of each cultivar in equilibrium with air r.h. of 80 and 90%.

After moistening, the seeds were placed in and filled, 2-liter containers. On average each container held one of the following: Hanoch 1400 g shelled (1160 seeds), Hanoch 573 g in-shell (310 seeds), Congo 1420 g shelled (2840 seeds), and Congo 520 g in-shell (676 seeds). Through these, air was purged, whose r.h. had been adjusted to 80% and 90% at 15, 20 or 26 C by bubbling through wash bottles maintained at the respective temperature and containing sulfuric acid at suitable concentrations (11). Flow rate of this air at controlled r.h. was 50 mL/min. and was sufficient to prevent accumulation of carbon dioxide from seed respiration throughout the storage period. Seed at the original m.c.'s formed a third group of low m.c. seed (Hanoch: 7.6% m.c. for shelled and 8.3% m.c. for in-shell seeds; Congo, 6.8% m.c. for shelled and 7.1% m.c. for in-shell seeds), and were held during the experiment in the original 25-liter sealed drums without air purging. The seed at all m.c.'s were stored at 15, 20 and 26C for about 6 months.

Moisture content

Peanut seed moisture content was determined on 5 g samples, ground in a mill fitted with a #20 mesh sieve, and dried in a forced air oven at 130 C for 4 h (1). Samples with high m.c. were pre-dried before grinding. Seed m.c. (wet basis) was determined at three stages: before moistening, after about 3 months' storage, and after about 6 months' storage. Each m.c. result was the average of two separate replicates.

Seed germination level

Germination was determined according to standard methods of ISTA (2), and were carried out by the Seed Testing Laboratory of the ARO at Bet Dagan. Germination levels were determined at the same time periods as those for m.c. determinations. Each germination percentage result was the average of four separate replicates.

Data analysis

Multiple regression analysis was performed to express seed germination in relation to time, temperature and m.c. In addition, a factorial analysis of variance was carried out using Duncan's multiple range test for each level of equilibrium relative humidity, temperature, time, and shelled and in-shell peanuts, the dependent variable being germination.

Results and Discussion

Average m.c.'s of shelled and in-shell peanut seed with storage time at three temperatures are given in Table 1. In-shell seed m.c. was determined on the shelled seed. The ranges of equilibrium r.h. given in Table 1 were calculated according to findings on the equilibrium m.c. of seed of cultivars Hanoch and Congo (8). From the data in Table 1 it can be seen that the calculated ranges of e.m.c. at the highest r.h. (90%) planned for this experiment were not obtained. The reason for this was probably due mainly to slight misadjustment of the experimental apparatus at the higher r.h. level. However, at the medium r.h. (80%), e.m.c. results were close to the experimental design, while at the lowest r.h. (70%) the seeds of Hanoch were at a higher m.c. than those of Congo from the start of the experi-

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ment, and both groups of seed maintained their m.c. over the entire storage period, with only minor fluctuations.

Table 1. Average moisture contents* of in-shell and shelled seeds of two peanut cultivars stored for 6 months at three ranges of equilibrium relative humidities.

Cultivar	Range of equilibrium relative humidity %	Moisture content (%) After 3 months shelled	in-shell	After 6 months shelled	in-shell
	71 - 76	7.6	8.3	7.4	8.2
Hanoch	79 - 83	8.9	10.3	9.6	9.1
	85 - 89	10.7	11.7	12.7	10.9
	68 - 72	6.8	7.1	6.5	6.8
Congo	78 - 81	8.2	8.8	8.5	8.2
	84 - 86	9.9	10.3	10.4	10.2

* At three experimental temperatures.

The influence of temperature and r.h. on germination levels of Hanoch are given in Fig. 1. At a r.h. of 71-76%, and at 15 and 20 C, in-shell seed preserved a germination level above 90% for 83 days, whereas at r.h.'s of 79-83% and above, there was a gradual reduction in germination in proportion to storage temperature and humidity. At 15 C, germination was high in comparison with that at higher temperatures. From Fig. 1, the storage of in-shell seed resulted in higher germination levels than storage of shelled seed, except for the case where storage was at the high m.c. at 20 C for 3 months (Fig. 1B). The results of storage at the lowest r.h. (71%-76%), especially at 26 C, revealed only small differences in germination level between in-shell and shelled seeds.

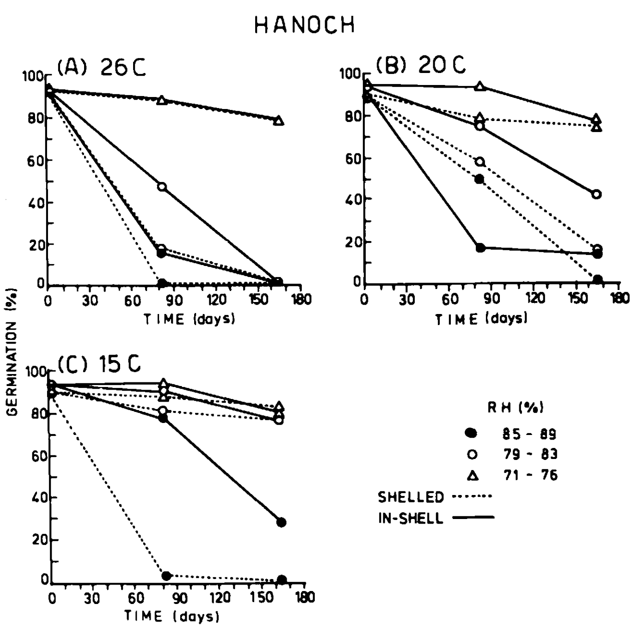

Fig. 1. Effect of relative humidity and temperature on germination of shelled and in-shell peanut seeds, cv. Hanoch.

Similar results were obtained for cv. Congo (Fig. 2). Germination levels above 90% for this cultivar were recorded at low (68-72%) and medium (78-81%) r.h.'s, at 20 and 15 C for the entire storage period of about 6 months. As with the other cultivar, differences between germination levels of in-shell and shelled seeds for this cultivar were small, especially at the low and medium r.h.'s.

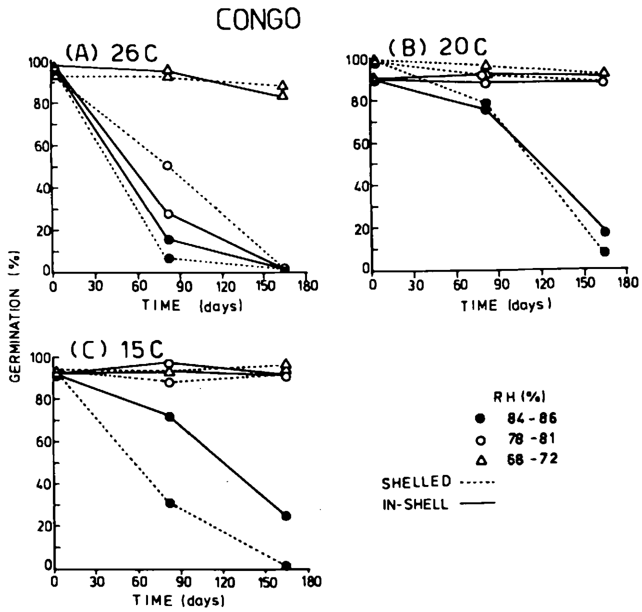

Fig. 2. Effect of relative humidity and temperature on germination of shelled and in-shell peanut seeds, cv. Congo.

Detailed information on the influence of different r.h.'s at two temperatures on germination levels of peanut seed was given in a study by Boswell *et al.* (3). Their findings showed that at r.h.'s of 66% and 78% and at 26.7 C, germination dropped over 110 days from 83% to 43% and 0%, respectively. In this study, the germination of both cultivars at 26 C and medium r.h. (79-83%) dropped to 0% over 165 days (Figs. 1A, 2A). In contrast, at 20 and 26 C, and low r.h. (71-76%), the germination level of cv. Hanoch was 88% after 6 months, and that of cv. Congo was even higher.

Several models have been developed to express the relation between moisture, germination and period of viability (7, 9). Hukill (7) developed the concept of physiological age index. However, the approach in this study was to provide guidelines for the seed industry to indicate at what level of m.c. peanut seed should be stored to obtain a desired germination level, when the variables of temperature and time are known. Therefore, to express the influence of temperature and seed m.c. on germination in relation to time, multiple linear regression analysis was carried out. The analysis for in-shell and shelled seeds of both cultivars are given in Table 2. This shows that the in-shell seeds of both cultivars had lower correlation coefficients than those of the shelled seeds.

Table 2. Results of multiple regression analysis to express seed moisture content (dependent variable) and germination in relation to time and temperature for in-shell and shelled peanuts of two cultivars.

		Hanoch		Congo	
Coefficients		shelled	in-shell	shelled	in-shell
Correlation	R^2	0.75	0.48	0.71	0.56
Significance		0.001	0.05	0.001	0.05
Intercept	a	13.0892	13.1063	11.1394	11.7564
Log time (days)	b	-0.0099	-0.0176	0.2502	0.3163
Temperature (C)	c	-0.0811	-0.0842	-0.0684	-0.0971
% germination	d	-0.0436	-0.0299	-0.0312	-0.0299

From the data in Table 2, Figs. 3 and 4 were prepared to express the influence on germination of temperature and m.c.. Fig. 3 shows the results of in-shell and shelled seed storage for cv. Hanoch. To maintain the same level of germination, in-shell seed can be stored at higher m.c.'s than shelled seed. Factorial analysis showed that germination levels of in-shell seed differ significantly (P≥0.05) from those obtained for shelled seed. These differences were particularly significant at the higher temperature and m.c. levels. Figure 4 for germination of cv. Congo, shows similar results to those in Fig. 3, though differences are less pronounced.

A comparison of Figs. 3 and 4 shows that to maintain the same germination level of shelled seed of Hanoch and Congo for 6 months, the same m.c. is required. For example, to maintain 95% germination at 15 C, 7.7% m.c. is required for both cultivars, while at 26 C 6.8%

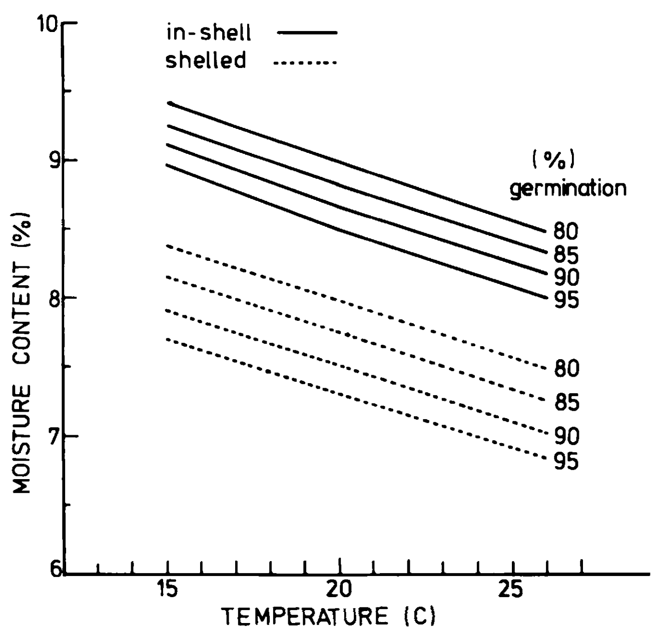

Fig. 3. Calculated germination percentages as influenced by temperature and moisture content at the end of 6 months of storage of shelled and in-shell peanuts, cv. Hanoch.

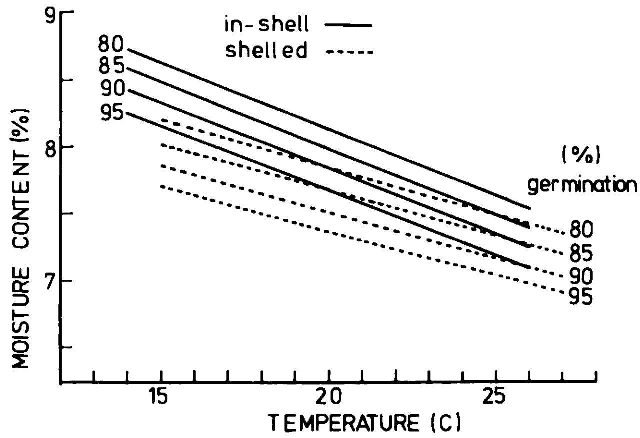

Fig. 4. Calculated germination percentages as influenced by temperature and moisture content at the end of 6 months of storage of shelled and in-shell peanuts, cv. Congo.

and 7.0% m.c. are required for Hanoch and Congo respectively.

The above results indicate the advantage of storing peanut seeds in-shell for cv. Hanoch cultivar but to a lesser extent for Congo. From the findings on shelled seed (Figs. 3 and 4), the m.c. levels required to maintain different levels of germination over time periods up to 6 months can be calculated. To maintain 90% germination at 15 C, the calculated m.c. is 8.0% for Hanoch and 7.9% for Congo, whereas to maintain the same germination level at 26 C, a m.c. of 7.1% is required for the two cultivars.

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