# Some Effects of Conventional and Low-Oxygen Atmosphere Storage and Processing Methods on Florunner Peanut Seed

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ABSTRACT

Low-oxygen atmosphere methods of storing and processing peanut seed were evaluated to determine if they offered improvement over conventional methods. Florunner (runner-type) peanut seed from each of six newly harvested certified seed lots were shelled, treated with fungicide and placed in low-oxygen atmosphere containers. The containers were stored in ambient air conditions in a metal-clad warehouse from October 1981 until planted in April 1982. Controls were randomly selected from the six lots in April 1982 after conventional storage and processing. Germination, moisture content and selected grade factors were measured before and after storage to determine if changes occured. Yields were measured after the peanuts were harvested in September 1982. Germination declined in both storage conditions. At planting there was no significant difference in germination between the low-oxygen and controls in three of the seed lots. In two of the seed lots, the control was better than the low-oxygen, and in one seed lot, the low-oxygen had better germination than the control. The controls averaged 1.4% greater loss of moisture during storage and inert material was 3% higher. Yields and grades were not significantly different in peanuts harvested from the low-oxygen and control plantings within each lot, but there were differences between lots. Besides less moisture loss during storage and less inert material in the seed packages, the low-oxygen methods produced higher whole kernel outturn at shelling and the containers provided much better protection for the peanuts from insects, dirt, mold, rodents, and other forms of contamination or destruction.

Key Words: Peanuts, seed, Florunner, low-oxygen storage, yields, planting, harvest.

Maintaining the quality of peanut seed in postharvest environments is a demanding and often very difficult task. Much of the problem results from the methods used to harvest, store and process the peanuts. Damage from combining or from the equipment used in handling and processing operations, improper drying treatment, poor storage conditions, inadequate protection from dirt, mold, insects, and rodents and similar causes of quality deterioration are very difficult to control or prevent. After the peanuts are shelled, controlling quality deterioration becomes more difficult because the seed are much more sensitive to conditions and environments that cause loss of quality. Better methods and techniques are needed to improve conditions and environments that cause quality deterioration. A low-oxygen atmosphere system for handling peanut seed appears to have potential for improving conventional practices.

Several reports on the effects of storing peanut seed in closed environments are available. Bass (1) reported that materials with good moisture barrier properties provide safe storage for 3 years or longer for adequately pre-dried seeds, even in adverse temperature and relative humidity (RH) conditions without modifying the atmosphere in the container. Seed moisture content and storage temperature were apparently the most important considerations in determining longevity. Low moisture seeds (5.2%) failed to maintain good viability for longer than 2 years at 32.2 C, but at 10 C seeds with 6.8% moisture content retained good viability for 5 years. Ward (9) indicated a moisture content of 6% was required to maintain 80% germination in peanut seed stored at 35 C. Beattie (2) showed no significant drop in germination of shelled or unshelled peanuts stored for 3 years at 0, 4.4 and 23.3 C. Rodrigo (5) stated that the life span of peanuts stored in sealed containers at 25.9 C was 37 months. All of these studies agree that for safe storage of peanut seeds in a closed environment, the storage temperature and seed moisture content are factors of primary importance. Studies (Slay, unpublished data) have indicated that the type of storage environment and the oxygen levels of the environment are also important considerations. Nitrogen atmospheres maintained seed germinability better than vacuum or carbon dioxide atmospheres for 12 months of storage in ambient temperature conditions. A subsequent investigation (7) has supported this finding and has also shown that low-oxygen atmosphere methods provide better shelling outturns, quality maintenance in storage, insect protection, and seed moisture retention during storage. These and other advantages offered by low-oxygen atmosphere methods indicated the need to develop and evaluate a practical handling system. A cooperative investigation was initiated with Container Corporation of America (CCA) to develop a low-oxygen atmosphere container and handling system for peanut seeds. This paper presents the results of that study.

## Materials and Methods

A flow diagram of the procedure followed in the investigation is shown in Fig. 1. The container dimensions were primarily determined by the stacking configuration(s) required to load truck and rail carriers using forklift pallet handling methods.

A fiberboard box 38.4 cm (15 1/8 in.) long by 19.2 cm (7 9/16 in.) wide by 44.5 cm (17 1/2 in.) high was designed to hold 22.7 kg (50 pounds) of peanut seed. Container Corporation conducted various tests to determine the type fiberboard and type finish to provide abrasion resistance, and to assure performance of the box in accordance with Department of Transportation (DOT) standards.

The plastic pouch liner selected for the investigation was a 3 mil nylon, Saran-EVA (ethyl vinyl acetate) resin structure readily obtainable from commercial sources. Oxygen permeability was rated at 10 cc/$M^2$/24 hr/atm at 20 C and 0% RH and water vapor transmission rate (WVTR) was 8 gm/$M^2$/24 hr at 40 C and 90% RH for a 1 mil thickness of the structure. Other physical and chemical property information obtained from the plastic pouch manufacturer indicated that the selected material would provide the integrity and strength to maintain the low-oxygen environment during handling and storage operations.

Two hundred and twenty seven kilogram (kg) (500 pounds) sub-lots of inshell certified Florunner (runner-type) peanut seed were collected from each of six lots of newly harvested peanut seed at the Georgia Seed Development Commission warehouse in Plains, Georgia. Each sub-lot was shelled, screened over a 0.6 cm wide (15/64 in.) slotted hole screen and treated with a commercially available fungicide. Replicated samples of each lot were sent to the State Seed Lab for germination analysis (germination tests were made by the Georgia State Seed Testing Laboratory through the courtesy and cooperation of Dr. E. E. Winstead, State Seed Analyst). Moisture content of seeds (Table 1) in each lot was determined by drying samples for 6 hr at

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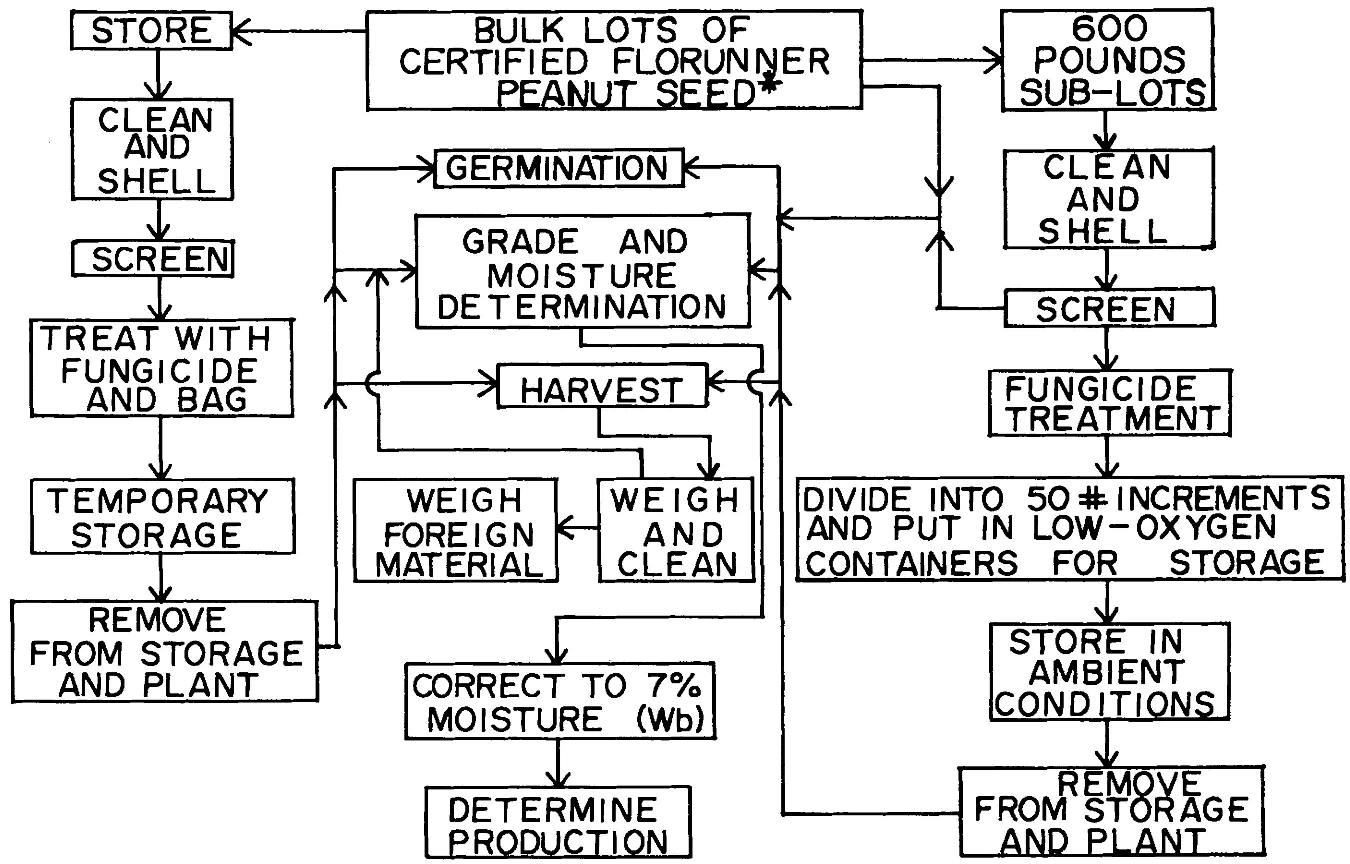


**Fig. 1. Flow chart of experimental procedure.**

135 C in a forced-air oven. The peanuts in each lot were divided into 22.7 kg quantities and placed in laminated-type plastic pouches inside fiberboard boxes. The low-oxygen treatment consisted of an initial 88 KPa (26 in/Hg) vacuum with a nitrogen ($N_2$) gas backflush to 34 KPa (10 in/Hg) vacuum. Oxygen content in the package was 2.7%. The low-oxygen containers were stored in a metal-clad type storage building in ambient temperature conditions which ranged from -7 C to +30 C with a mean of 12 C for the storage period. The storage period was from October 20, 1981, to April 17, 1982, the following year for a total of 178 days of storage. The seeds were planted immediately after removal from storage.

Controls were 22.7 kg (50-pound) bags of peanuts from the same six seed lots which had been bulk stored as farmers stock peanuts at the State Seed Facility in Plains, Georgia. The control peanut lots were removed from storage, shelled and processed in March 1982. The storage, shelling and processing methods used and the time frame within which they occurred were essentially the same procedures used by all peanut seed processors in the southeast. The bags of processed seeds were stored in a metal-clad building in ambient temperature (15 to 28 C) conditions for approximately 2 weeks before they were planted. A split-plot planting design was used with a seeding rate of 124 kg (272 pounds) per ha. At planting each treatment and control was divided through the Federal-State shelled stock divider to collect samples for determining the percent germination, sound mature kernels (SMK), bald kernels (BK), split kernels (SK), and inert material.

Approximately 0.5 ha (1 1/4 acres) of each treatment and control was planted for a total of 6 ha (15 acres). A conventional four row planter was used to plant alternate twin rows of treatments and controls to make a normal windrow at digging. The peanuts were grown on the farm of a private producer and received the same treatment as peanuts growing in adjacent fields. The peanuts were grown on non-irrigated land using conventional growing practices. The peanuts were dug and windrow dried for approximately 48 hrs before combining. The peanuts were harvested on September 11, 1982, after 147 growing days. All harvesting was done with the same digger and combine and peanuts in each treatment and control were harvested separately and weighed. The peanuts were then cleaned and both foreign material and peanuts were reweighed to check against lossses. A sampling device on the cleaner collected peanuts for grade and moisture analysis determinations. The grade samples were artificially dried to 10% moisture wet basis (wb) and official Federal-State grading procedures were used to make the grade analysis. Moisture determinations were made by drying the samples for 6 hrs at 135 C in a forced air oven. All kernal and hull data were corrected to 7% moisture (wb) for reporting results. Statistical treatment consisted of AOV with significance determined at the 0.05 level. All values shown in the tables are the mean of three replications.

## Results

**Seed Moisture Content.** The moisture content of the peanut seed before and after storage is shown by lot in Table 1. When packaged in the low-oxygen atmosphere containers in October, the moisture content of the seeds from the six lots ranged from 6.8 to 7.3% with an average content of 7.1%. When removed from the low-oxygen atmosphere containers for planting the following April, the moisture content ranged from 6.7 to 7.3% with an average content of 6.9%.

The moisture content of the control lots when planted in April ranged from 5.5 to 5.8% moisture with an average content of 5.7%. The average moisture loss in the controls was 1.4% for the 6-month storage period.

**Germination.** The six lots of peanut seeds were selected for a wide range of germination based on initial

Table 1. Moisture content of seed lot[1].

| Lot no. | Percent seed moisture content (wb) | | |
|---|---|---|---|
| | At packaging (Oct. 26) | At planting (April 17) | |
| | | Low-oxygen | Control |
| 1 | 7.3 | 7.3 | 5.7 |
| 2 | 7.0 | 6.7 | 5.6 |
| 3 | 7.0 | 6.7 | 5.6 |
| 4 | 7.3 | 7.0 | 5.8 |
| 5 | 6.8 | 6.7 | 5.5 |
| 6 | 7.1 | 6.8 | 5.9 |

1/ The values shown for each seed lot are the mean of 3 replications. Each replication consisted of a 200 gram sample of seeds dried in a forced hot air oven for 6 hours at 135 C.

germination tests which were made at harvest. Table 2 shows the percent germination of samples collected from the six seed lots in October when storage began and from each treatment and control before planting the following April. Before storage, germination of the six seed lots ranged from 80 to 93% and averaged 88.1%. When planted, the average germination was 80.6 and 78.5% for the controls and treatments, respectively. There were no significant differences in percent germination between treatments and controls in seed lots 1, 5 and 6 at planting. In seed lots 3 and 4, the controls had significantly better germination than low-oxygen treatments, and in seed lot 2 the low-oxygen treatment had significantly better germination than the control.

**Analysis Factors.** Table 3 shows the average percent seeds and inert material content by lot as determined from samples collected from each seed package when removed from storage at the time of planting in April. In all six seed lots the SMK content of the low-oxygen containers was significantly higher than in the controls. The SMK content averaged 99.9% in the low-oxygen containers and 96.9% in the controls. In all six seed lots the total inert material content was significantly higher in the controls than in the low-oxygen containers. This was primarily the result of the higher split kernel and bald kernel content in the controls, which was visibly evident as the seeds were poured into the planter hoppers.

Previous tests indicated dormancy was not a matter of serious concern in seeds stored in low-oxygen atmospheres. However, in previous investigations several days usually elapsed between removing seeds from the low-oxygen atmospheres and making the germination test, and in this investigation the seeds were planted soon after being removed from the package. However,

Table 2. Germination[1] of peanut seed stored and processed using control and low-oxygen atmosphere methods.

| Lot no. | Percent germination 2/ before storage or processing | Percent germination 3/ at planting | |
|---|---|---|---|
| | | Low-oxygen | Control |
| 1 | 80 | 72 a 4/ | 75 a |
| 2 | 88 | 86 a | 73 b |
| 3 | 90 | 76 a | 86 b |
| 4 | 91 | 73 a | 85 b |
| 5 | 93 | 82 a | 87 a |
| 6 | 87 | 78 a | 82 a |

1/ All values are the mean of three replications.

2/ Germination test made Oct. 26.

3/ Germination test made April 17.

4/ The low-oxygen and control values for each lot are significantly different (0.05 level) if followed by different letters.

Table 3. Mean percent by weight[1] of seeds and inert material in the packages when removed from storage for planting.

| Lot no. | Sound mature kernels (SMK) | | Bald kernels (BK) | | Split kernels (SK) | |
|---|---|---|---|---|---|---|
| | Low-oxygen | Control | Low-oxygen | Control | Low-oxygen | Control |
| 1 | 99.8 a 2/ | 96.8 b | 0.0 a | 1.6 b | 0.2 a | 1.5 b |
| 2 | 99.9 a | 98.1 b | 0.0 a | 1.0 a | 0.1 a | 0.8 b |
| 3 | 99.8 a | 94.5 b | 0.0 a | 2.2 b | 0.2 a | 3.2 b |
| 4 | 99.9 a | 98.5 b | 0.0 a | 0.4 a | 0.1 a | 1.0 b |
| 5 | 99.7 a | 95.7 b | 0.0 a | 1.4 b | 0.3 a | 2.7 b |
| 6 | 99.9 a | 97.8 b | 0.0 a | 0.8 a | 0.1 a | 1.3 b |

| Lot no. | Inert 3/ | | Total inert 4/ | |
|---|---|---|---|---|
| | Low-oxygen | Control | Low-oxygen | Control |
| 1 | 0.0 a | 0.1 b | 0.2 a | 3.2 b |
| 2 | 0.0 a | 0.1 b | 0.1 a | 1.9 b |
| 3 | 0.0 a | 0.2 b | 0.2 a | 5.5 b |
| 4 | 0.0 a | 0.1 b | 0.1 a | 1.5 b |
| 5 | 0.0 a | 0.3 b | 0.3 a | 4.4 b |
| 6 | 0.0 a | 0.2 b | 0.1 a | 2.2 b |

1/ The low-oxygen and control values for each lot are significantly different (0.05 level) if followed by different letters.

2/ All values are the mean of 3 replications

3/ Inert foreign material.

4/ Total inert includes balds, splits and inert foreign material.

no visible difference between treatments and controls could be detected in emergence of the seedlings or throughout the growing season.

**Production.** Table 4 shows the production of farmers stock peanuts for each plot in the treatment and control plantings. The data is corrected to 7% moisture (wb).

Table 4. Farmers stock production in kilograms per hectare (kg/ha) from peanut seed stored and processed using low-oxygen atmosphere and control methods.

| | kg/ha | |
|---|---|---|
| Lot no. | Low-oxygen | Control |
| 1 | 4096 a | 4263 a |
| 2 | 4041 a | 4207 a |
| 3 | 2879 a | 2657 b |
| 4 | 3875 a | 3930 a |
| 5 | 3930 a | 3985 a |
| 6 | 2546 a | 3045 b |

1/ The low-oxygen and control values for each lot are significantly different (0.05 level) if followed by different letters.

In seed lots 1, 2, 4, and 5 there was no significant differences in production between plants from seeds stored in low-oxygen atmospheres and the controls. The plants from the control seeds in seed lot 6 had significantly higher production than the plants from the low-oxygen treatment, and the plants from the low-oxygen treatment in seed lot 3 had significantly higher production than the plants from the control. Grade factors did not show any significant differences in the hull or total kernel (TK) content between peanut samples from the low-oxygen and control plantings within a seed lot, but there were significant differences between the seed lots.

## Discussion and Conclusions

This study has demonstrated that low-oxygen atmosphere methods were effective in maintaining the quality of peanut seed during the six to seven month storage period between harvest and planting. There was some loss of germination in the peanut seed during storage, but it was comparable to losses sustained in conventionally used storge methods.

The study has also shown that low-oxygen methods offer advantages that the seed processor may find very beneficial. One advantage is the higher whole kernel outturn that results because the peanuts are shelled soon after harvest when kernel moisture is still high (3). Whole kernel outturns are also higher because the peanuts are warmer and not as easily damaged as when shelled in February or March while still cold (4) from winter storage. This appears to be a very important consideration because some seed processors now shell soon after harvest and store the seed untreated in large tote bags (one ton quantity.) Final processing is done just prior to planting time the following year. Another advantage of the low-oxygen methods is that the moisture content of peanut seed stored in the containers does not change very much; whereas, with conventional methods, the kernel moisture loss is normally 1 to 2% below the allowable marketing level of 7%. The low-oxygen methods also provide better seed purity because the seed are processed when kernel temperatures are warmer and kernel moisture contents are higher which makes them more resistant to damge from impact forces in shelling and handling operations. In addition, the low-oxygen containers provide much better protection than paper bags against adverse handling conditions (8) and from insects, rodents, mold or other forms of contamination or destruction. Some preliminary tests also indicate that up to 20% less storage space is required for the low-oxygen methods. Studies are planned to determine storage space requirements and the effects of composite gas environments on seed quality.

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