Storing Peanuts in Trailer-Sized Containers[1]

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ABSTRACT

A containerized handling system is envisioned whereby peanuts (*Arachis hypogaea* L.) are placed in containers in the field and remain in these containers until they are shelled. This would reduce the foreign material, loose shelled kernels, and pod damage that result from handling as peanuts move through the buying point and into storage. Two naturally ventilated containers (half-trailer size) were stored in 1993. One container had a shed cover and the other an A-frame cover. In 1994 four containers were stored, two with shed covers and two with A-frame covers. One shed and one A-frame had a 1.7 m^3/min fan that operated daily between the hours of 10 a.m. and 6 p.m. Top layer peanuts were at 12% moisture content at the beginning of storage in 1993 and ranged 10 to 11% moisture content after 16 wk. In 1994, the peanuts were over-dried and top layer peanuts entered storage at 6% moisture content. After 12 wk, moisture content was 7%. No mold growth or quality degradation was observed either year. The results indicated top layer peanuts absorb or desorb very little moisture when peanut moisture content is in the range of 6 to 12% at the beginning of storage. Containers were successful for storage at the ambient conditions in Tidewater, VA during 1993 and 1994.

Key Words: *Arachis hypogaea*, peanut, storage, containers, seed quality.

A containerized handling system is envisioned whereby peanuts are placed in containers in the field and remain in these containers until they are shelled. The combine loads peanuts into "trailer size" containers in the field, and these containers are transported to the drying shed and cured. The containers are covered and stored until they are transported to and emptied at the shelling plant.

Advantages of a containerized handling concept include (a) a reduction in peanut handling prevents the introduction of additional foreign material, loose shelled kernels, and pod damage after harvest and (b) the food company receives peanuts where the cultivar, production history, harvesting procedure, curing procedure, and storage environment are known.

A disadvantage of the containerized handling system is the high initial investment to purchase and then to store the empty containers when not in use. Also, a carrier will be required to move the containers in the field and on the highway. However, peanut storage facilities could be made simpler and less expensive, which would offset the container investment cost. Other aspects such as dust control, reduced handling, improved quality or added value to the end product will enhance the economics of the container system. Some factors such as handling, trucking, etc. which are difficult to assign a dollar value will contribute to handling peanuts in large lots.

The four- and six-row peanut combines were accepted much faster than anticipated since 1991 and a self-propelled, eight-row combine was in the prototype test stage during 1995. Current systems of moving peanuts away from the combine are rapidly becoming the flow restriction in the harvesting phase of peanut production. To realize the full capacity of these larger machines, new handling systems must be developed.

Before developing new handling systems, research was undertaken to determine if peanut quality can be maintained during storage in individual containers. Depending on airflow rate and initial moisture content during drying, the difference in moisture content of peanuts between the bottom and top of a load may be as high as 3 to 4% (2). When peanuts are emptied, the high moisture peanuts are mixed with the lower moisture peanuts. This may result in mold growth or insect problems during storage. For peanuts stored in containers, the top layer will typically be around 11% moisture content (w.b.) when curing is completed (2). This research attempts to answer the question: "What happens to the top layer peanuts when a cover is attached and the container is set outside for storage?"

Materials and Methods

1993. The sides were removed from a 4.25-m drying trailer, and the drying plenum modified with structural steel to support two 2.1 x 2.4 x 1.2-m deep containers, identified as "half-trailer" size containers. The trailer, with containers in place, was filled in the field, towed to the drying shed, and cured using conventional practice (fixed 9.4 C temperature rise with 35 C maximum).

In 1993, two different designs of container covers were used in the experiment. One design, referred to as a "shed-type," had a horizontal eave vent along one side and a vertical ridge vent (Fig. 1). The second design, referred to as an "A-frame," had horizontal eave vents along both sides, and a ridge vent at the center of the roof (Fig. 2).

Both designs rely on air moving through the headspace when the wind blows across the roof, thus achieving natural ventilation. The eave vent of the shed and A-frame covers had a 0.161 m^2 of open area, and the ridge vents had 0.252 m^2 of open area. Both containers (shed and A-frame) had a nominal cross-section of 2.1 x 2.3 m = 4.8 m^2. The eave vent open area of both covers was 3.4% of container cross-sectional area and the ridge vent open area was 5.3% of container cross-sectional area. The ridge vent area was 1.5X the eave vent area.

Four thermocouples (ANSI Type T) were placed in a

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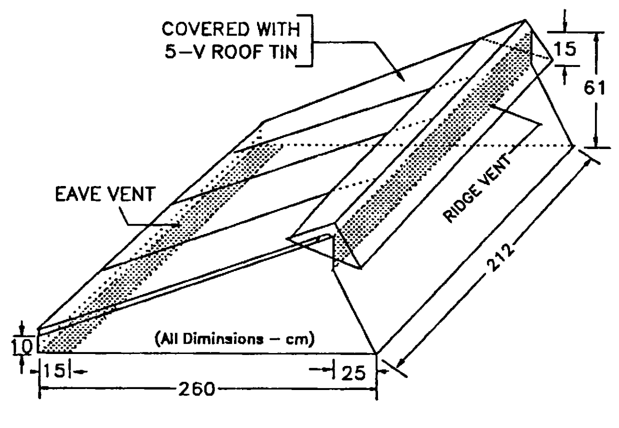

Fig. 1. Shed cover for half-trailer container.

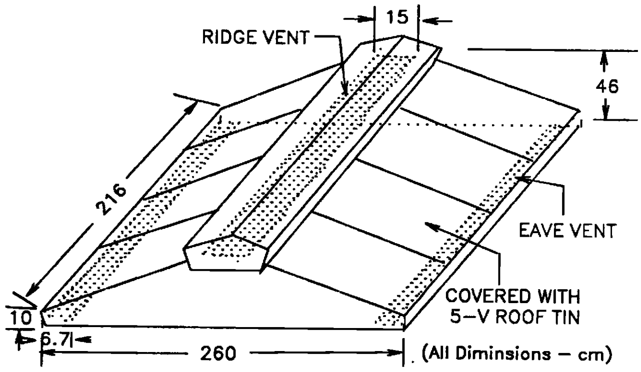

Fig. 2. A-frame cover for half-trailer container.

vertical line at the center of each container. The first was 2.5 cm above the drying floor, the second was 55 cm above the floor (center of peanut mass), the third was just below the peanut surface, and the fourth was in the center of the headspace. A humidity sensor (Rolfes Company, Model 584) was placed in the center of the headspace and in the center of the peanut mass. Temperature and humidity were recorded at 4-hr intervals over a 16-wk storage period. These readings were used to calculate the equilibrium moisture content using the equation presented by Beasley and Dickens (1).

Moisture content samples were taken from the top layer of both containers at 2, 4, 8 and 16 wk. Top layer peanuts were visually examined by a plant pathologist to identify mold growth.

1994. Peanuts were stored in two shed covered and two A-frame covered containers. The two containers constructed in 1994 were identical to the two containers used in 1993, except they were mechanically ventilated by mounting a 1.7 m^3/min fan in the center of the headspace. The fan outlet was pointed toward the ridge vent. Data collection was the same as in 1993 for the 16-wk storage period.

Results and Discussion

1993. The top layer peanuts in the containers were approximately 12% moisture content when placed in storage. Drying of the top layer was negligible and the moisture content was 10 to 11% at the end of 16 wk of storage. This result was unexpected. Based on past research, peanuts stored in open-top trailers parked under a drying shed typically equilibrate at 7% moisture content for winter ambient conditions in Virginia. In bulk warehouses, the entire peanut mass typically equilibrates to 7% moisture content over a 5-mo storage (3).

Headspace temperature in both the shed and A-frame covered containers was almost equal to ambient, indicating that some natural ventilation occurred. Equilibrium moisture content (EMC), based on headspace conditions (Fig. 3), was slightly lower for the A-frame covered container than the shed covered container during a typical fall day (14 Nov. 1993). For a typical winter day (14 Jan. 1994), EMC for the A-frame covered container was slightly lower during the daytime morning hours and approximately equal to the shed covered container for the daytime evening hours (not shown).

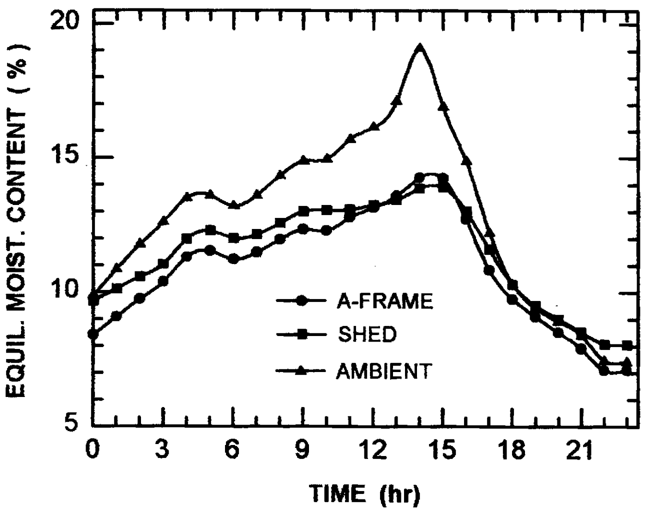

Fig. 3. Headspace and ambient equilibrium moisture content for containers with a shed and A-frame type cover (14 Nov. 1993).

Equilibrium moisture content based on weekly average headspace temperature and humidity ranged from 10 to 12% in the shed covered container and 9 to 11% in the A-frame covered container (Fig. 4). The air exchange in the headspace of the containers was minimal and caused the top layer peanut moisture content to remain higher than open trailer storage under sheds. To reduce skin slippage at shelling, it is advantageous for the peanut moisture content to remain at 7% or slightly higher.

1994. The top layer moisture content of peanuts stored in 1994 was dried to approximately 6% prior to storage. This was dried lower than the cutoff 10% moisture content desired. After 12 wk of storage the top layer peanuts had equilibrated to 7% in all four containers (two naturally ventilated, two mechanically ventilated). Moisture content measured at the buying station ranged 7.2 to 7.5% across the four containers.

Headspace temperature in the two mechanically ventilated containers was approximately equal to tempera-

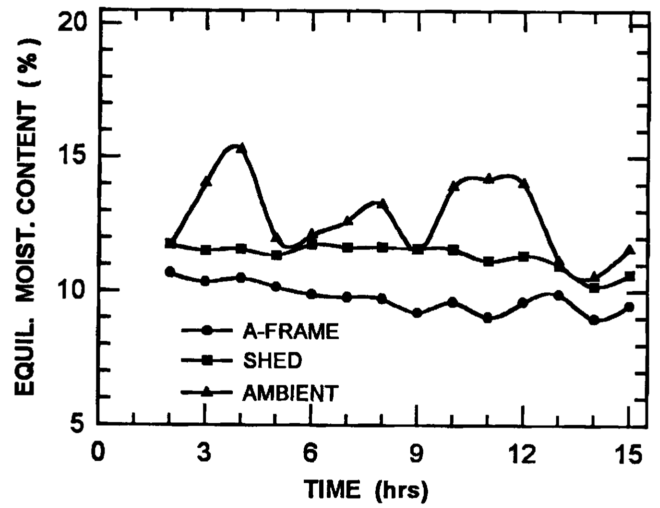

Fig. 4. Equilibrium moisture content for ambient and headspace of covered containers for the 1993 storage period.

ture in the two naturally ventilated containers. The small amount of forced air exchange from the headspace did not significantly change the storage environment.

The experiment in 1994 was planned to duplicate the storage of peanuts in 1993 with a top layer moisture content of 11% and add forced ventilation in two similar containers. Although these peanuts were dried to a lower moisture content than desired, the top layer of peanuts gained about 1% point moisture in the naturally and mechanically ventilated containers. Based on the results, the top layer peanuts absorbed or desorbed very little moisture when the moisture content was in the range of 6 to 12% at the beginning of containerized storage. Additional research is needed to define moisture variations due to maturity distribution and evaluate the effects of foreign materials on drying uniformity for better management of containers in commercial use.

The conventional drying procedure recommended turning off the fans when the moisture content of the top peanuts reach 11 to 12%. This is done because of the 3 to 4% moisture gradient between the top and bottom peanuts. Since the grade sampler collects peanuts from the top to bottom, the composite lot will be about 10%. Some peanuts in the lot will be higher than 10% but will be mixed when placed in storage. Based on the results that the top peanuts remain close to the drying cut-off moisture content when the containers are covered, it may be desirable to cut off the drying process when the top peanuts are 9 to 10% moisture content because the peanuts are not mixed with lower moisture content peanuts. This would reduce the potential for mold development.

Summary and Conclusions

Peanuts were stored outside in containers covered with a shed or A-frame type metal cover. In 1993, two units were naturally ventilated, whereas in 1994 two similar units were added and mechanically ventilated. The small 1.7 m^3/min fans were operated daily between 10 a.m. and 6 p.m.

Based on the results, it was concluded (a) the air temperature was similar in the naturally ventilated and mechanically ventilated covered containers, (b) the EMC was slightly higher in the shed covered container compared to the A-frame covered containers, (c) the A-frame cover was simpler to construct and handle, (d) the peanuts on the top layer changed about 1% in moisture content where drying was terminated in the 6 to 12% moisture range, (e) no quality degration of peanuts was observed, (f) the moisture content at grading ranged 7.2 to 7.5% for all containers, and (g) peanuts can be successfully stored outside in covered containers.

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