Some Results of Storage Tests on Farmers Stock Peanuts

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ABSTRACT

Storage tests were conducted on farmers stock peanuts during three seasons. The peanuts were aerated with 1/20 and 1/10 cubic feet per minute (cfm) of air per cubic foot of peanuts when the incoming air was within certain ranges of relative humidity. The aeration was beneficial in maintaining the desired peanut moisture content level and in preserving desirable milling characteristics. Attempts to maintain a lower temperature within the peanuts were unsuccessful. Peanuts near the bin walls and in the top layers had higher average temperatures, lower final moisture content levels, lower germination, and more split kernels than peanuts stored in other locations within the bins.

All of the peanuts within a region are harvested in a relatvely short period, and most of them are stored for some time after harvesting before they are processed further. The most desirable moisture content (m.c.) level for storing peanuts is generally considered about 7 to 8 percent. At higher levels, peanuts are more susceptible to molds and their quality deteriorates faster (6). At lower levels, particularly below 6.5 percent m.c., kernels have a greater tendency to split when being shelled (1). Even though the moisture content can be as high as 10.5 percent when peanuts are placed in storage, it is not uncommon to find that the peanuts have dried to below 5 percent m.c. after several months of storage.

The purpose of the research described here was to determine whether peanut moisture content can be maintained at a desired level by using aeration, and to investigate temperature gradients of peanuts in storage and their effect on peanut quality.

Materials and Methods

Tests were conducted at the National Peanut Research Laboratory in Dawson, Georgia, beginning in the fall of 1970 for three successive seasons (Fiscal Years 1971, 1972, 1973). The tests were conducted in six, 1000-cubic foot, round metal bins, each 10 ft. in diameter and 18 ft.

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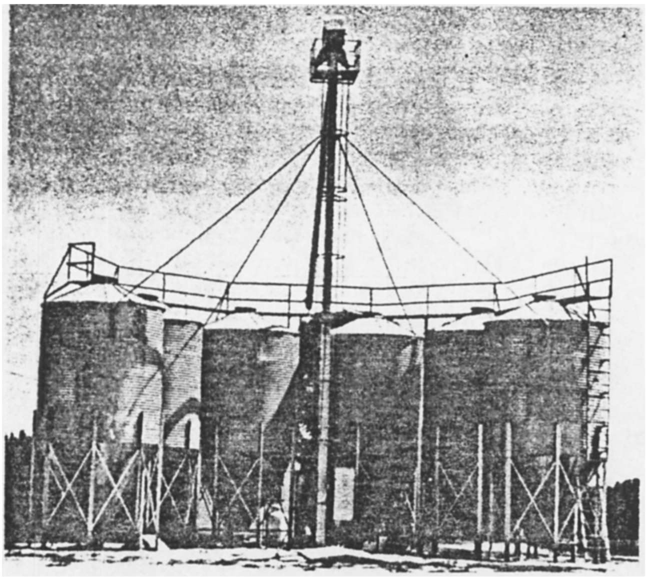

Fig 1. Storage bins.

high (Fig. 1). Spanish peanuts from each crop year were obtained from a local buyer and were treated for protection against insects with malathion, according to recommended practices (5). To ensure uniform distribution of the peanuts among the bins, the loading spout from the elevator was moved from bin to bin at 2-minute intervals until all bins were full. Each season, the tests were initiated in November and terminated the following April.

Air was pulled from the top of the bins and exhausted through the fan at the bottom of the bins. Downward airflow was used to prevent condensation that can occur when warm air from the peanuts comes in contact with the cool underside of the metal roof. The fans were controlled by electronic humidistats with lithium chloride sensing elements, placed in the headspace between the peanuts and the bin top.

In 1971, three bins of peanuts were aerated with a humidity-controlled airflow rate of 1/20 cfm/ft3, and three bins without aeration were used as control tests. Thermocouples were installed in two bins at 1, 3, 5, 9, 18, and 36 inches from both the east and west walls at mid-depth. Samples in mesh bags also were placed at 2, 6, and 10 inches and midway from the east and west walls at mid-depth.

In 1972 and 1973, an airflow rate of 1/10 cfm/ft3 was used. Two bins of peanuts had humidity-controlled aeration, as before, and two bins without aeration were used as control tests. The remaining two bins of peanuts had aeration controlled by both relative humidity and temperature. Thermocouples were placed at 3-foot intervals in a vertical plane in one bin of each treatment, and samples of peanuts in mesh bags were placed at four levels, 1 ft. from the circumference of the bins.

At the termination of the tests, samples of peanuts for quality evaluations were collected from the top and bottom layers (levels) and from random locations in the bins. Depending on the year, either five or six 900-lb lots were taken from each bin for shelling evaluation in the Pilot Shelling Plant.

Results

The effect of aeration on split kernel outturn and on moisture content level of peanuts in the 1971 tests is shown in Figure 2. Peanuts that were aerated were consistently higher (an average of 0.6 percent higher) in moisture content than the nonaerated peanuts. Aerated peanuts were consistently lower in split kernels (averaging 2.1 per-

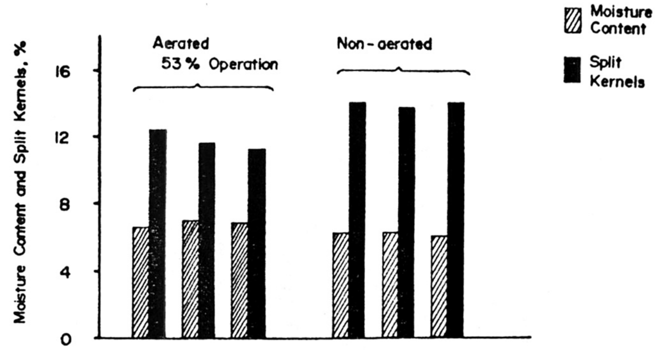

Fig. 2. The effect of aeration of farmers stock peanuts on moisture content and split kernels, FY 1971.

cent lower) than the nonaerated peanuts. The differences were both highly significant. The difference in splitting is attributed to the difference in mosture content level of the peanuts.

These data showed that the moisture content level can be controlled favorably with aeration, and that milling quality was maintained at a level higher than that of the nonaerated peanuts. However, some of the data indicated that the fans were not operated in the optimum manner. The controls were set to operate the fans between 50 and 75 percent r.h. (relative humidity). This setting resulted in a total of 53 percent operation. Early in the storage season, more aeration occurred during periods when the relative humidity was near the high limit of the operating range rather than when relative humidity was near the low limit. Later in the storage season, the weather was much warmer, the humidity was lower, and the aeration fans operated more near the lower limits of the operating range. Also, the equilibrium moisture content of peanuts is affected considerably by temperature (Fig. 3). For example,

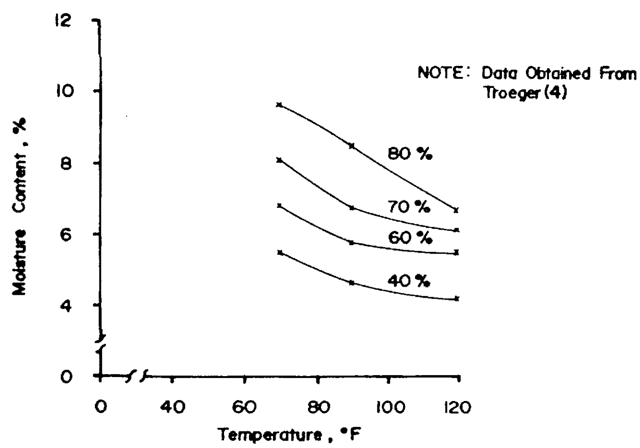

Fig. 3. Moisture content versus temperature at various relative humidities.

peanuts stored at 80 percent r.h. and at 70° F. are in equilibrium with the air when their moisture content is 9.65 percent m.c.; whereas, at 80 percent r.h. and at 120°F. they are in equilibrium at 6.65 percent m.c., i.e., increasing the peanut temperature at a constant relative humidity results in a lower equilibrium moisture content. The peanuts probably had maintained their moisture during the early part of the storage season but were beginning to dry near the end of the tests. This conclusion was further supported by the data shown in Figure 4. The top layer of aerated pea-

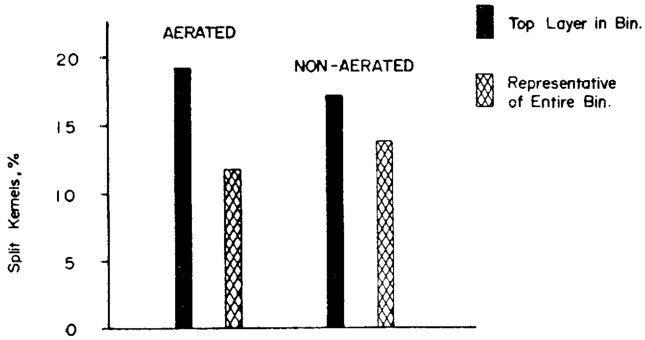

Fig. 4. The effect of aeration and location in bin on split kernels, FY 1971.

nuts had a considerably higher percentage of split kernels than representative samples for the entire bin, and somewhat higher percentage of split kernels than the top layer in the nonaerated bin. The high percentage of split kernel outturn from the top layer suggests that a drying front was beginning to move down through the aerated peanuts. These results indicate that as the weather becomes warmer, the operating range of relative humidity should be higher in order to maintain the desired moisture content level.

For aerated peanuts, the effect of the peanut's location in the bin on its moisture content, split kernels, and temperature is shown in Figure 5.

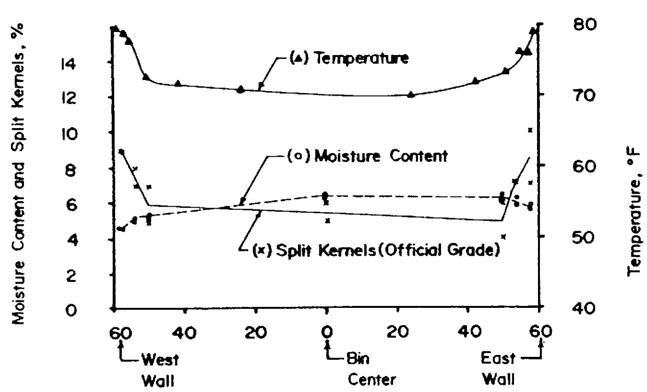

Fig. 5. The effect of location in bin of farmers stock peanuts on moisture content, split kernels and temperature (Bin number 3, FY 1971).

These data were obtained at the end of the tests from samples of peanuts in mesh bags and from thermocouples that were placed in a horizontal plane across the bin at mid-depth. There was a sharp drop in moisture content near the edge of the bin, which resulted in an increase in split kernels. The increase in the amount of split kernels probably would have been much more dramatic if the peanuts had been shelled in a commercial-type sheller. The official grade sheller used for these evaluations has a more gentle shelling action and is not as sensitive in showing the effect of moisture content level on the outturn of split kernels (3).

Apparently, the decrease in moisture content level and the corresponding increase in split kernels near the bin walls were directly related to temperature. A 10-degree difference in temperature at a constant absolute air moisture content level would have a significant effect on moisture content. For example, if air at 60° F. and at 70 percent r.h. is heated 10° F., the relative humidity is decreased to 50 percent. This condition would lower the kernel moisture content level more than 2 percent (4).

The aerated peanuts were generally several degrees warmer than the nonaerated peanuts because the radiant heat which builds up in the headspace air is drawn through the mass of peanuts. The average temperatures versus bin location for the aerated and nonaerated peanuts during the final 2 weeks of the tests are shown in Figure 6. The figure also shows the temperature

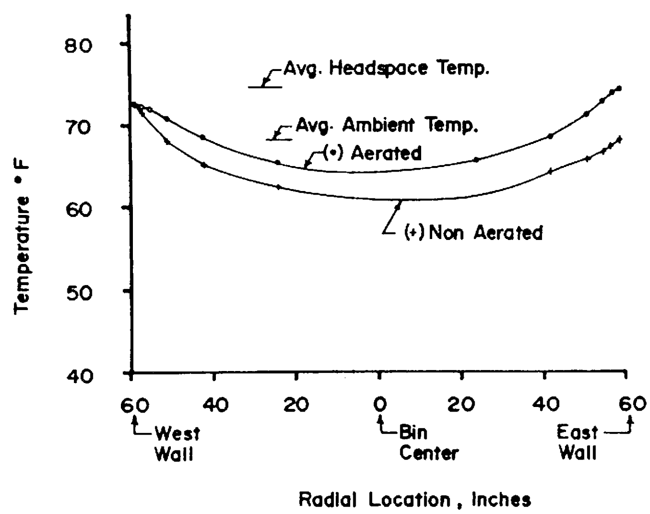

Fig. 6 Average temperature versus bin location, April 13 through April 25, 1971.

gradient throughout a cross section of the bin. Air temperatures in the headspace fluctuated widely and generally were several degrees higher than ambient air, particularly during the warmer months.

In 1972, attempts were made to control the temperature and moisture content level of the peanuts in two of the bins. A differential thermostat was connected in series with the humidistat so that it operated when the ambient temperature was at least 10° F. lower than the temperature of the peanuts in the center of the bin. Two bins of peanuts were aerated based only on relative humidity and the two control tests had no aeration. The humidistats were set to operate between 60 and 75 percent r.h.

Attempts to control both the temperature and moisture content of the peanuts were unsuccessful. Abnormally warm weather throughout the season limited the required aeration conditions to less than 1 percent of the total time. With so little aeration, these peanuts were essentially the same as the nonaerated control tests. Aeration within the 60 to 75 percent r.h. range without regard to the ambient temperature resulted in aeration for 16 percent of the total time.

The effect of the storage treatments on the moisture content and split kernel outturn of peanuts is shown in Figure 7. As in the previous year,

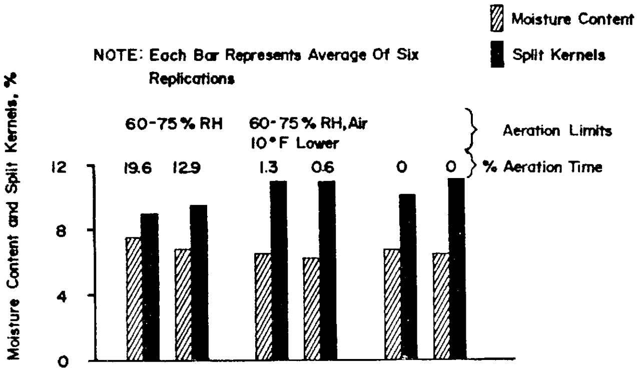

Fig. 7. The effect of aeration on moisture content and split kernels, FY 1972.

the peanuts aerated within a humidity range without regard to temperature were significantly higher in moisture content and lower in split kernels when compared with the controls, and also when compared to the tests that were limited by temperature controls. Of the two replications, the peanuts receiving more aeration also had a higher moisture content and less split kernels.

The effect of bin location (relative to the sun) on the moisture content of the peanuts is shown in Figure 8. The moisture content level was de-

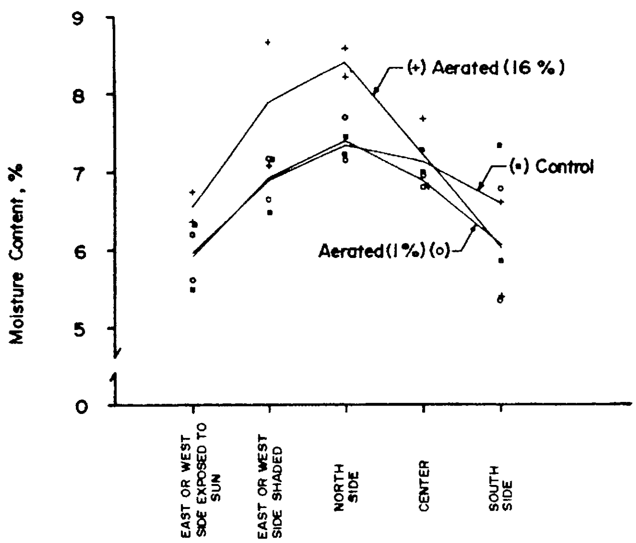

Fig. 8. The effect of bin location (relative to the sun) on moisture content, FY 1972.

termined from samples stored in mesh bags and placed 1 foot from the wall indicated. The bins were arranged in a semicircle, so that the three east bins received more radiation in the mornings (on their east wall) than the three west bins. The three west bins received more radiation in the afternoon (on their west walls). The south side of all bins was exposed to the sun most of the day, and the north side was shaded most of the day. The moisture content was influenced considerable by the sun's radiation. Note also (Fig. 8) that the aerated peanuts were consistently higher in moisture content.

In 1973, further attempts were made to lower the temperatures of the peanuts in the bins. In addition to the relative humidity controls, low temperature operation was obtained in two of the bins. Fan operation was considerably higher (averaging 17 percent) for these tests than for tests during the previous year. The two bins of peanuts that were aerated during a prescribed range of relative humidity alone averaged 24 percent operation. Two bins of peanuts were used for control tests and were not aerated.

The effect of aeration on moisture content levels and split kernel outturn of peanuts for the 1973 tests are shown in Figure 9. As in previous

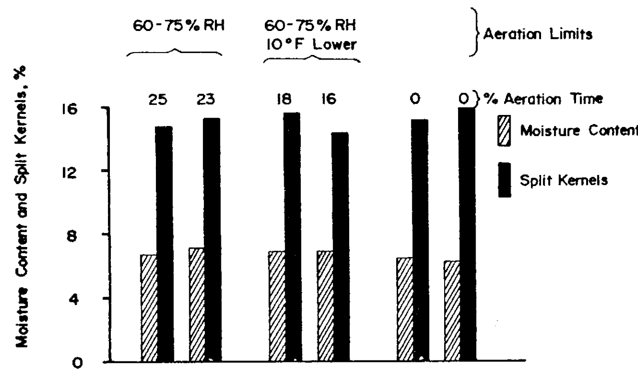

Fig. 9. The effect of aeration on moisture content and split kernels, FY 1973.

years, the moisture content level of the aerated peanuts was significantly higher than that of the controls. Although the percentage of split kernels was slightly less for the aerated peanuts, the difference was not significant. Since the difference in mosture content level was nearly as much as in previous years, the reasons why the aerated peanuts did not have better milling quality were sought. Unreported research at the National Peanut Research Laboratory (2) concerning adding moisture to peanuts before shelling with commercial-type shellers has indicated that after peanuts are dried to a level which is deleterious for shelling, restoring the moisture content is generally not effective in restoring the milling quality. The peanuts used in 1973 were dried to a low moisture content level before they were received for storage, but in previous years the peanuts had not been overdried. Table 1 summarizes the initial and final (control and aerated) percentages of moisture content and split kernel outturn for each year's tests. Peanuts used in the 1973 tests showed a decrease in splitting from about 23 percent, at the beginning of the tests, to about 17 percent, at the end of the tests. This decrease in split kernels was attributed to the increase in moisture content. However, some of this improve-

Table 1. Initial and final percentages of moisture content and split kernels.

	1971		1972		1973	
	Moisture content	Split kernels	Moisture content	Split kernels	Moisture content	Split kernels
			Percentage			
Initial	6.87	10.57	7.12	7.12	5.68	23.15
Final (control)	6.13	13.97	6.44	12.24	6.38	16.86
Final (aerated)	6.85	11.77	7.11	10.53	6.90	16.60

ment was superficial since the outturn from the final shelling contained about 4 percent more bald kernels (kernels without skins) than shown in the beginning of the tests. The bald kernels are easily split during handling, and probably should be considered as split kernels. In previous tests there was no significant difference in amount of bald kernels before and after the tests.

Figure 10 shows the temperature in the center of three bins and the ambient air temperature plotted versus time. The peanuts with temperature-controlled aeration were cooler than those that were aerated without regard to temperature, as anticipated; however, they were warmer than those with no aeration. The reason nonaerated peanuts were cooler than those aerated with temperature control was apparently because the temperature controls were based on the difference in temperature between the center of the bin and ambient air. The air actually entering the mass of peanuts was warmer than the ambient air due to the heat gain in the headspace. However, peanut temperatures were primarily a function of ambient temperature, regardless of treatment.

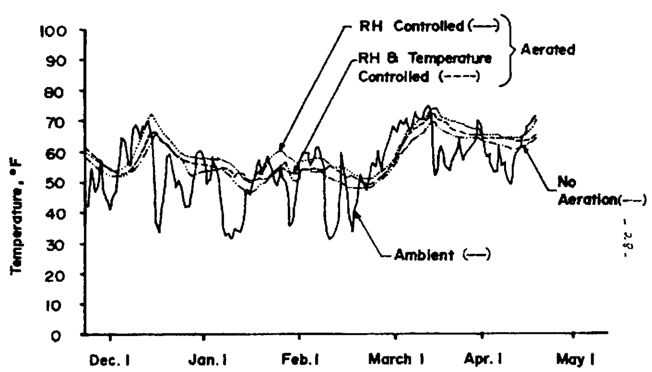

Fig. 10 Temperature in center of three bins and ambient air temperature versus time for peanuts in storage, FY 1973.

Analysis of germination data from the 3 years of testing revealed that aeration had no effect on germination. However, samples of peanuts from the top surfaces of the bins showed some adverse germination effect in peanuts that were located in the first few inches of storage. The germinability was well preserved each year, since there was no significant reduction from the germination at the beginning of the tests. The germination values generally ranged from about 85 to 95 percent.

Summary and Conclusions

Tests for 3 years showed that moisture content levels can be controlled by aeration at low airflow rates (1/20 to 1/10 cfm per cubic foot). The aeration should be accomplished during certain relative humidity levels in order to maintain a desirable moisture content level and, thus, maintain peanut milling quality. However, for optimum results, peanuts must not have been reduced below 7 percent m.c. Tests indicate that if the moisture level ever has been reduced to a level deleterious to shelling, the milling quality cannot be effectively restored.

Removing excess moisture from stored peanuts was not demonstrated in these tests. Moisture content of the peanuts at the beginning of the tests generally did not exceed desired levels. However, removing moisture from peanuts is generally considered less difficult than maintaining a given level for long periods. Moisture removal probably could be accomplished easily with aeration.

Maintaining a lower peanut temperature in storage bins with aeration did not appear feasible in the test setup used because the peanut temperature was affected directly by ambient temperature, even in the center of the bin. However, the storage bins used had a much higher ratio of wall surface to peanut volume than is found in common storage bins, and, therefore, the results do not apply directly to the larger storage bins.

Peanuts near the bin walls and in the top layers had higher temperatures, lower moisture content levels, and more split kernels than peanuts stored in other locations within the bins. This effect was even greater for locations that received more radiation from the sun. Insulating and shading the walls of the storage bin apparently would be beneficial.

Although a fan operation zone of 60 to 75 percent r.h. was used for these tests, a single operation zone is not considered suitable for all seasons. During warmer months, operation should be at a higher relative humidity than that used in cool weather in order to allow for the change in peanut equilibrium mosture content with temperature change. For most effective control, peanut moisture content levels could be monitored continuously, and the zone shifted to suit the needs of the peanuts. For example, if a series of samples indicate a decreasing trend of peanut moisture content level, the operation zone could be shifted from 60-75 percent to 65-80 percent.

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