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The Effects Of Curing Treatment On Some Physical Properties Of Peanuts

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THE EFFECTS OF CURING TREATMENT ON SOME PHYSICAL PROPERTIES OF PEANUTS

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THE EFFECTS OF CURING TREATMENT ON SOME PHYSICAL PROPERTIES OF PEANUTS

INTRODUCTION

The undesirable tendency of peanut kernels to split and skin during the shelling operation has gained considerable prominence since the introduction and rapid acceptance of mechanical harvesting and curing methods. There have been indications that these and other physical properties of the kernels might be affected by the mode of curing.

Some preliminary tests at this station in 1957 and 1958 showed that curing freshly-harvested peanuts with $95^{\circ}F$ - 18% relative humidity air produced an average total milling damage (split kernels plus skinned kernels) of 14%, while $95^{\circ}F$ - 67% relative humidity air produced only 5% total damage. These results indicated that the rate of drying, independent of temperature, exerted a strong influence on milling quality. Flotation tests using these same peanuts revealed that most of the more rapidly dried kernels floated in water, while most of the slower dried kernels sank in water. The apparent density of peanuts was thus influenced in some manner by the rate of drying. Numerous other tests made in the course of curing research over the past several years have borne out these general observations.

The moisture content at which peanuts are shelled has also been found to affect their milling quality. Considerably more broken and skinned kernels result when the shelling moisture content is low than when it is near 9% wet basis. This adverse effect of overdrying is evident regardless of the rate at which the moisture was removed.

During the 1960 and 1961 harvesting seasons a series of tests was made to investigate further the manner and degree to which some physical properties of peanuts are affected by curing treatment. The specific objective of the 1960 tests was to measure the effects of drying rate on the milling quality of peanuts. In 1961 the scope of the investigation was enlarged to include the following objectives.

(1) To determine the effect of drying rate on the milling quality, size, and apparent density of Virginia bunch peanuts.

(2) To measure the effect of overdrying on milling quality and kernel size when the peanuts are shelled at low moisture content and when the peanuts are remoisturized before shelling.

METHODS AND EQUIPMENT

Temperature and relative humidity both affect rate of drying. The use of a range of different relative humidities at each of several temperature levels provided a convenient means of observing rate-of-drying effect independent of temperature. The converse was not so readily attainable, however, since rate of drying increases with temperature at constant relative humidity. Due to the difficulties involved in measuring the effects of curing temperature independent of rate of drying, the independent effects of curing temperature on milling quality were not determined.

In order to obtain a variety of controlled atmospheres for the tests, rooms with temperature and relative humidity control were used in conjunction with drying units such as those shown in Figure 1. The drying units were placed in the rooms which were controlled at some base condition. Then an appropriate amount of heat was added to the air forced through each of the separate drying trays to establish preselected conditions. Air was forced through each tray at the rate of 30 cubic feet per minute per square foot of tray area. The temperature of the air passing through each tray was monitored by means of a recording potentiometer and thermocouples. Since the air volume and heat input to each unit was constant, the temperature rise remained stable once established. Generally, temperatures above 100°F were not used in the tests, since higher temperatures are not recommended for peanut curing because of flavor considerations. (Teter and Givens, 1956, and Dickens, 1956)

A difficulty encountered in 1960 was that the 16-inch layers of

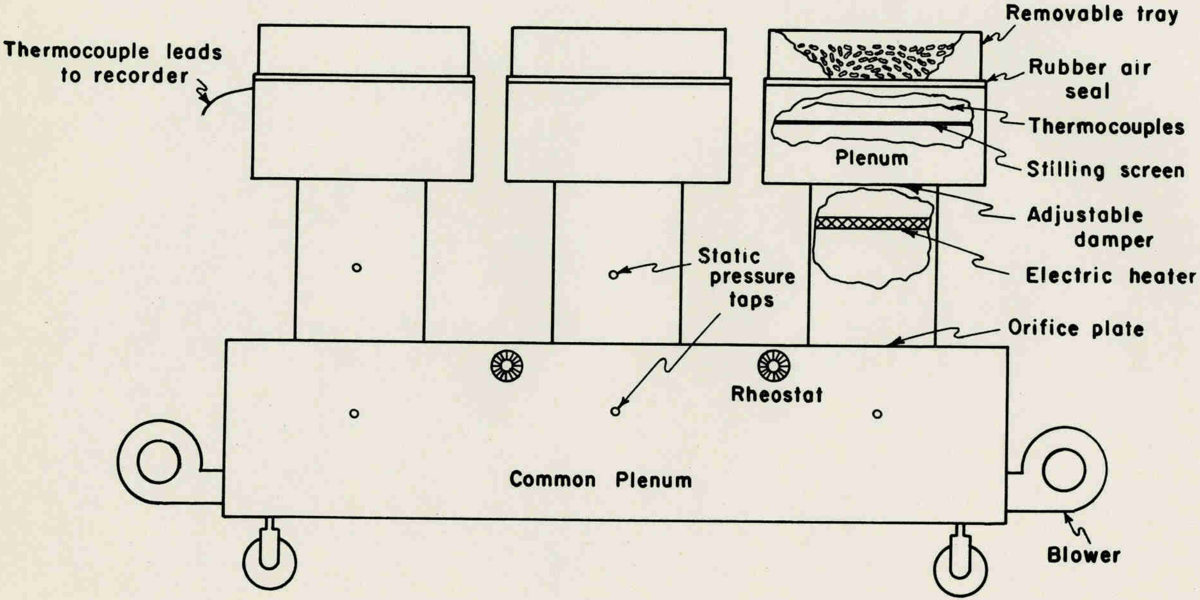

Figure 1. Schematic drawing of drying apparatus.

peanuts placed in the drying trays exceeded the limit for thin-layer drying, so that all the peanuts in a given sample were not subjected to the same psychrometric conditions. This was evidenced by a considerable difference in the final moisture content between the top and bottom of the layer. In 1961 the area of the trays was increased to permit a reduction in the depth of the layers to 3 inches, which eliminated the problem.

The shelling tests to measure milling quality were made on a small sample sheller of the type used by the Federal-State Inspection Service (Dickens, 1962). A vibrating screen of the official type was used to determine the size of the kernels.

Density determinations were made with a Jolly spring balance. The spring extension caused by a sample of kernels was measured when the sample was suspended in air and then in water at a know temperature. The average apparent density of the sample was calculated by the relation:

$$Pp = \frac{Pwx'}{x' - x}$$

where

Pp= apparent density of kernels, gm/cc

Pw= density of water, gm/cc

x'= spring extension caused by peanuts in air, cm

x'= spring extension caused by peanuts in water, cm

The buoyant force of the air on the peanuts was considered to be negligible.

EXPERIMENTAL PROCEDURE

Peanuts of the Virginia bunch type, variety NC-2, were harvested at or near peak maturity, washed and surface-dried, and placed in the various drying trays. The trays were removed from the drying units and weighed periodically to ascertain the rate of drying. In 1960, the drying process was continued until the more rapidly-drying samples reached equilibrium, at which time all samples were removed and stored. In 1961, one-third of each sample was removed and sealed in glass jars when the moisture content reached 9%. The remaining two-thirds of the sample was overdried either to approximately 5% moisture, or to equilibrium, and removed. Half of this overdried portion was sealed in glass jars, and the remainder was placed in an atmosphere which restored the moisture content to approximately 9%.

Shelling tests, screening tests, and density measurements were made after all of the drying runs had been completed. In 1960, three 1000 gram samples were shelled and screened from each treatment. In 1961, three 500 gram samples from each treatment were shelled and screened. The density measurements were made on 100 grams of kernels ranging between 21 1/2/64 and 24/64 inches in diameter. No density measurements were made on the 1960 samples.

RESULTS AND DISCUSSION

Drying Rate

Rate of drying curves for the hulls and kernels of unshelled peanuts at six different curing conditions are plotted in Figures 2 through 7. It is shown that even under moderate curing conditions the hulls lost water quite rapidly down to approximately 15% moisture content. The kernel moisture was transmitted through the hulls, and consequently the drying of the kernels lagged behind that of the hulls until the relative hygroscopic equilibrium properties of the two materials became overriding. Between 11% and 17% moisture wet basis the kernel moisture became and remained less than the hull moisture for all drying conditions shown.

Milling Quality

Because of the differences in procedure between the 1960 and 1961 tests, the results cannot readily be combined. Therefore, the data are presented separately. The same general trends are evident in both, but some are more pronounced in one test or another.

In Table 1, the 1960 data are arranged to show the effect of drying rate on milling quality at several different temperatures. It is apparent that for any given temperature the amount of shelling damage increased as the drying rate increased (relative humidity decreased). Table 2 summarizes the shelling data for the 1961 samples. This table is arranged to show the effect of different relative humidities on

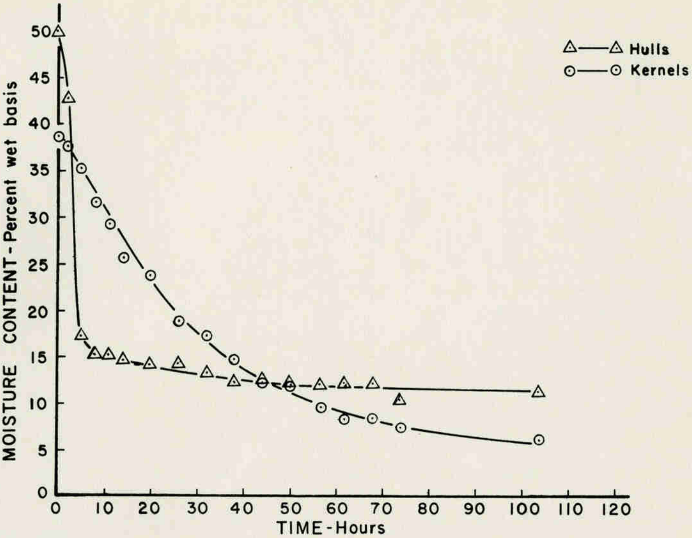

Figure 2. Drying rates for hulls and kernels of unshelled peanuts cured at 92^{o}F and 58% R.H.

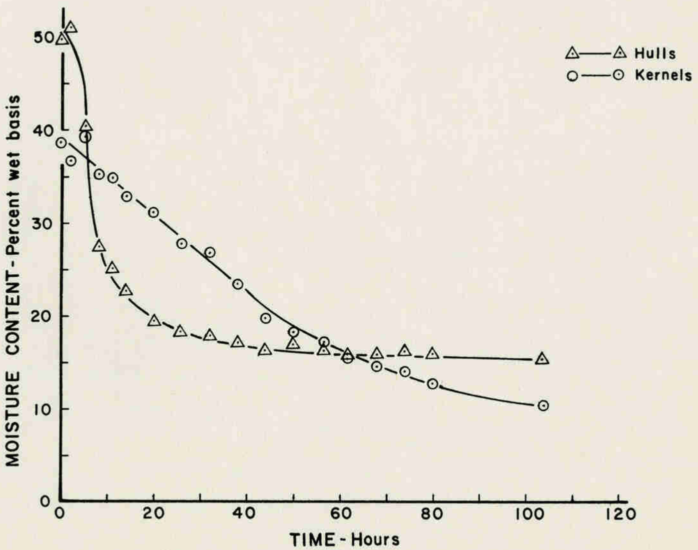

Figure 3. Drying rates for hulls and kernels of unshelled peanuts cured at 81^{o}F and 78% R.H.

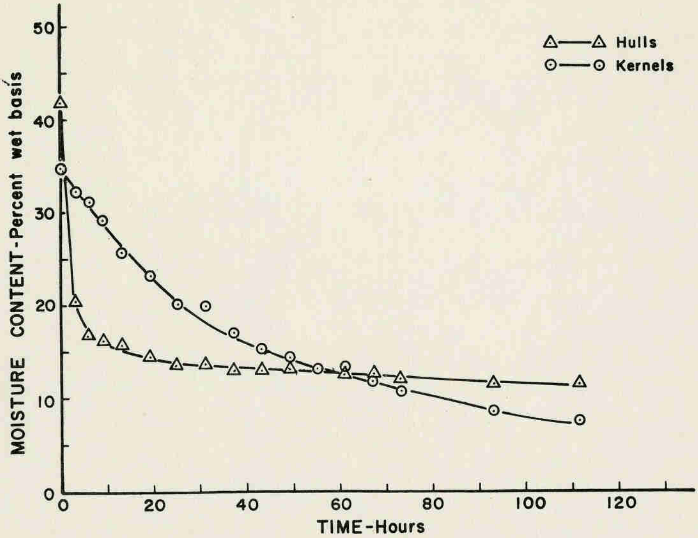

Figure 4. Drying rates for hulls and kernels of unshelled peanuts cured at 72°F and 50% R.H.

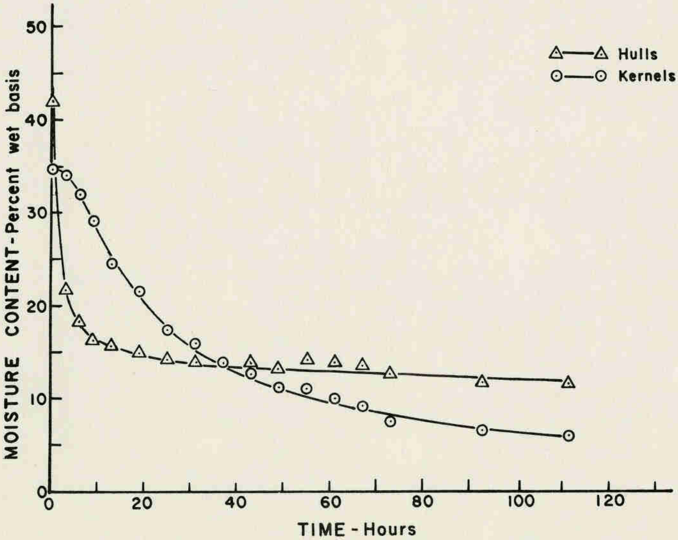

Figure 5. Drying rates for hulls and kernels of unshelled peanuts cured at 92°F and 68% R.H.

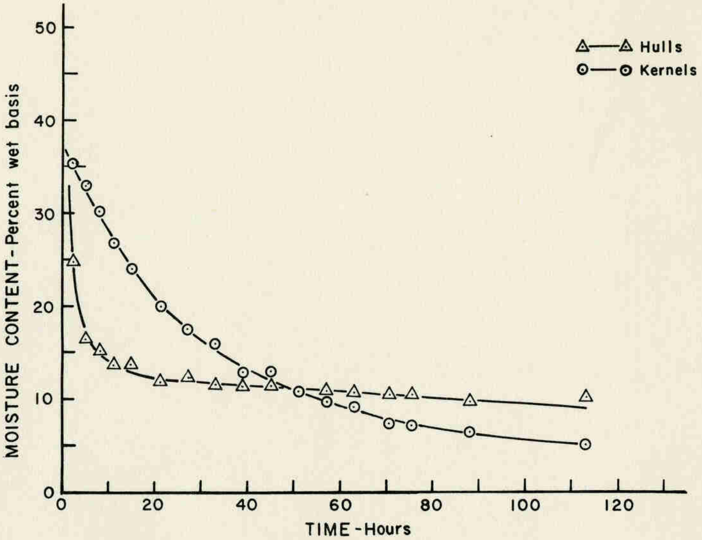

Figure 6. Drying rates for hulls and kernels of unshelled peanuts cured at 86°F and 50% R.H.

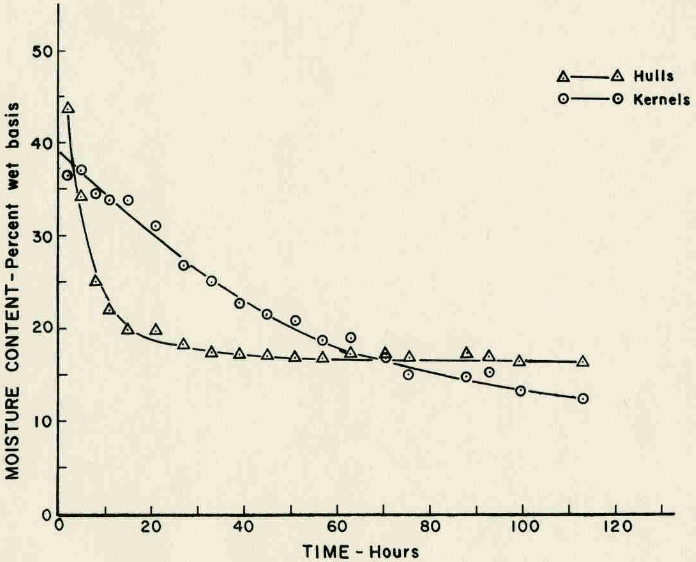

Figure 7. Drying rates for hulls and kernels of unshelled peanuts cured at 72°F and 78% R.H.

Table 1. The effect of curing relative humidity on the milling quality of peanuts (1960)[a]

Temp. °F	Relative Humidity %	Splits %	Baldface[b] %	Total Damage[c] %
75	65	1.77	.30	2.07
	79	1.62	.20	1.82
80	55	2.03	.45	2.48
	67	1.43	.18	1.61
	80	1.10	.27	1.37
85	47	2.40	.86	3.26
	57	1.83	.40	2.23
	69	1.23	.37	1.60
	80	1.38	.07	1.45
90	40	2.71	1.59	4.30
	49	1.87	.57	2.44
	59	1.47	.45	1.92
	69	1.60	.20	1.80
	81	1.32	.07	1.39
95	41	2.50	1.22	3.72
	50	2.58	.72	3.30
	59	1.73	.27	2.00
	70	1.50	.24	1.74
	82	1.47	.18	1.65
100	43	2.93	1.10	4.03
	51	2.77	.47	3.24
	60	1.92	.81	2.43
	71	1.37	.33	1.70
105	44	3.35	1.37	4.72
	52	2.73	.94	3.67
	61	1.23	.40	1.63
110	45	4.41	2.19	6.60
	53	3.00	1.35	4.35

[a]Each entry is the average of three replicated shelling tests.

[b]Baldface refers to whole peanut kernels with 25% or more of the skin removed.

[c]The shelling moisture content was 5.5 to 6% for all samples.

Table 2. The effect of curing conditions and final moisture content on the milling quality of peanuts (1961)[a]

		Dried to 9% moisture content				Overdried				Reconstituted to 9% m. c.			
Temp. °F	R. H. %	Splits %	Bald-face %	Total damage %	Shelling m. c. %w. b.	Splits %	Bald-face %	Total damage %	Shelling m. c. %w. b.	Splits %	Bald-face %	Total damage %	Shelling m. c. %w. b.
72	50	1.140	.300	1.440	9.57	4.874	.180	5.054	6.23	1.220	.166	1.386	9.87
72	78	.290	0.000	.290	9.67	-	-	-	-	.346	0.000	.346	9.80
81	38	.714	.126	.840	9.97	5.266	.460	5.726	5.60	2.686	.500	3.186	9.60
81	58	-	-	-	-	.946	.060	1.006	7.10	.706	.280	.986	9.50
81	78	.114	0.000	.114	9.90	.280	0.000	.280	9.87	.140	0.000	.140	9.77
86	50	.894	.326	1.220	9.83	4.794	.960	5.754	6.10	.940	.700	1.640	9.83
86	68	.474	0.000	.474	10.07	1.034	.034	1.068	7.40	.400	.060	.460	9.70
92	58	.401	.067	.468	9.63	3.286	.400	3.686	6.37	.566	.326	1.592	9.83
92	68	.774	0.000	.774	9.60	3.060	.060	3.120	6.53	1.220	0.000	1.220	9.43
96.5	38	.400	.354	.754	9.93	5.446	1.754	7.200	5.47	1.360	.980	2.340	9.57
96.5	50	.626	0.000	.626	10.07	4.680	1.800	6.480	5.90	1.546	.494	2.040	9.53
96.5	58	1.006	.254	1.260	9.67	4.194	.340	4.534	6.00	1.494	.354	1.848	9.53

[a]Each entry is the average of three replicated shelling tests.

milling quality at several different temperatures, as well as the effect of overdrying and reconstitution. With the exception of the samples dried to 9% moisture at 92 and 96.5^{o}F the data follows the same trends established in the 1960 data. The general level of shelling damage is lower than in the 1960 data for some samples, because they were shelled at higher moisture contents.

Data on the overdried samples reflect the effects of both overdrying and rate-of-drying on shelling damage. An increase in the drying potential of the curing air caused and increase in the drying rate and a decrease in the final moisture content (shelling moisture content) of the samples. The effects of overdrying can be determined by comparison of the overdried samples with those dried to 9% moisture content under the same curing conditions.

Reconstituting the overdried peanuts to about 9% moisture before shelling virtually restored the original milling quality. In only two cases did the shelling damage after reconstitution appear different from that before overdrying, and both of these were for peanuts cured at 38% relative humidity. It appears, therefore, that damage to milling quality through overdrying is not altogether irreparable.

It is interesting to compare the amount of shelling damage in the controlled-atmosphere tests with that of peanuts stackpole-cured in 1961. Field-cured peanuts are generally conceded to have desirable milling characteristics. Table 3 gives the shelling data for peanuts dug on six different dates in 1961 and stackpole-cured. These peanuts were grown on the same farm as those used in the 1961 controlled drying tests. The

Table 3. Shelling damage of field-cured peanuts, 1961

Date of Harvest	Splits %	Baldface %	Total Damage %	Shelling Moisture Content, % w.b.
Sept. 29	.91	0.00	.91	9.20
Oct. 6	.68	.037	.717	9.00
Oct. 12	1.06	.063	1.123	8.90
Oct. 20	.89	0.00	.890	9.03
Oct. 27	1.46	.027	1.487	8.97
Nov. 1	.68	.020	.700	9.60
Average	.947	.024	.971	9.11

average total shelling damage was about the same as for peanuts mechanically cured at 50% relative humidity and 90°F.

Kernel Size

Table 4 shows the average percentage of kernels from each 1961 curing treatment which fell into the size categories extra large kernels, ELK (rode a 21 1/2/64-inch screen); No. 1 kernels (fell through 21 1/2/64-inch screen and rode a 15/64-inch screen); and other kernels, OK (fell through a 15/64-inch screen). The data is grouped according to date of harvest to separate the effects of maturity on size. A plot of the data in Figures 8 and 9 show a definite trend toward more ELK and fewer No. 1 kernels as drying time to 9% moisture content increased for those samples not dried below 9% moisture. Those samples which were overdried and reconstituted did not demonstrate an appreciable effect of drying time on kernel size. The effects of drying time on kernel size could not be measured for the overdried samples, because the kernels in the different treatments were at different moisture contents, and moisture content

Table 4. The effect of curing conditions and final moisture content on the size of peanut kernels (1961)

Date of Harvest	Temp. ^{o}F	R. H. %	Drying Time to 9% m. c. Hours	Dried to 9% m. c. ELK %	Dried to 9% m. c. No. 1 %	Dried to 9% m. c. OK %	Overdried ELK %	Overdried No. 1 %	Overdried OK %	Reconstituted to 9% m. c. ELK %	Reconstituted to 9% m. c. No. 1 %	Reconstituted to 9% m. c. OK %
Oct. 13	96.5	50	34.75	46.80	50.27	2.93	46.32	47.17	6.51	53.76	43.21	3.03
(test 1)	92	58	40.50	49.65	48.11	2.24	40.87	52.37	6.76	50.33	46.59	3.08
	86	68	67.75	52.31	44.64	3.05	42.71	51.42	5.87	53.80	43.40	2.80
	81	78	97.25	54.12	43.09	2.80	49.65	45.75	4.60	49.72	46.85	3.44
Oct. 18	110	50	28.00	54.49	43.07	2.44	45.41	49.89	4.70	56.17	41.38	2.46
(test 2)	96.5	38	34.50	57.23	40.20	2.57	47.59	47.24	4.91	56.21	41.10	2.68
	86	50	70.50	56.01	41.25	2.74	50.64	45.35	4.01	56.39	41.94	1.67
	81	58	96.00	-	-	-	53.26	43.73	3.01	58.33	39.24	2.43
	72	78	142.50	64.13	34.16	1.71	-	-	-	58.11	39.66	2.22
Oct. 25	120	50	20.50	55.62	43.25	1.12	41.58	55.05	3.37	60.10	38.16	1.74
(test 3)	96.5	58	42.00	56.98	41.36	1.66	52.84	45.26	1.91	58.93	39.60	1.47
	81	38	51.00	62.38	36.40	1.21	55.76	42.13	2.12	64.93	33.73	1.34
	92	68	65.50	62.12	36.74	1.14	53.30	44.96	1.74	60.97	37.28	1.75
	72	50	73.00	64.40	34.33	1.27	57.96	39.92	2.12	63.07	35.75	1.18

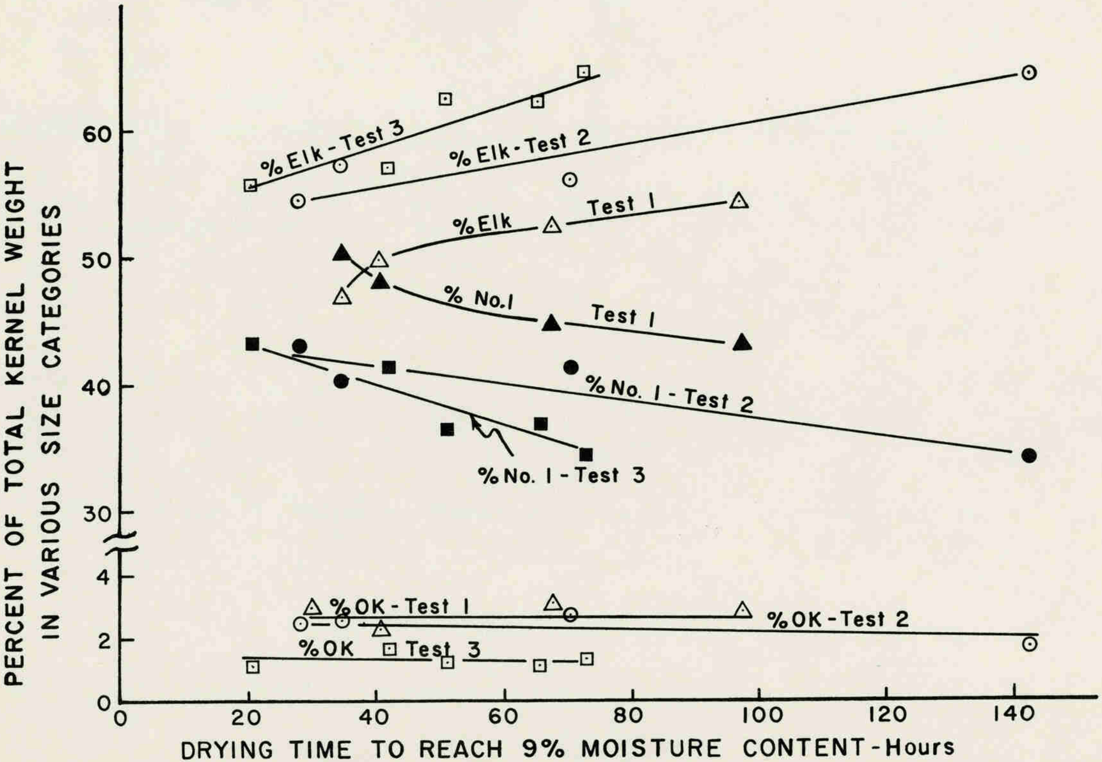

Figure 8. The effect of drying rate on the size of peanut kernels, when drying was terminated at 9 percent moisture content, 1961.

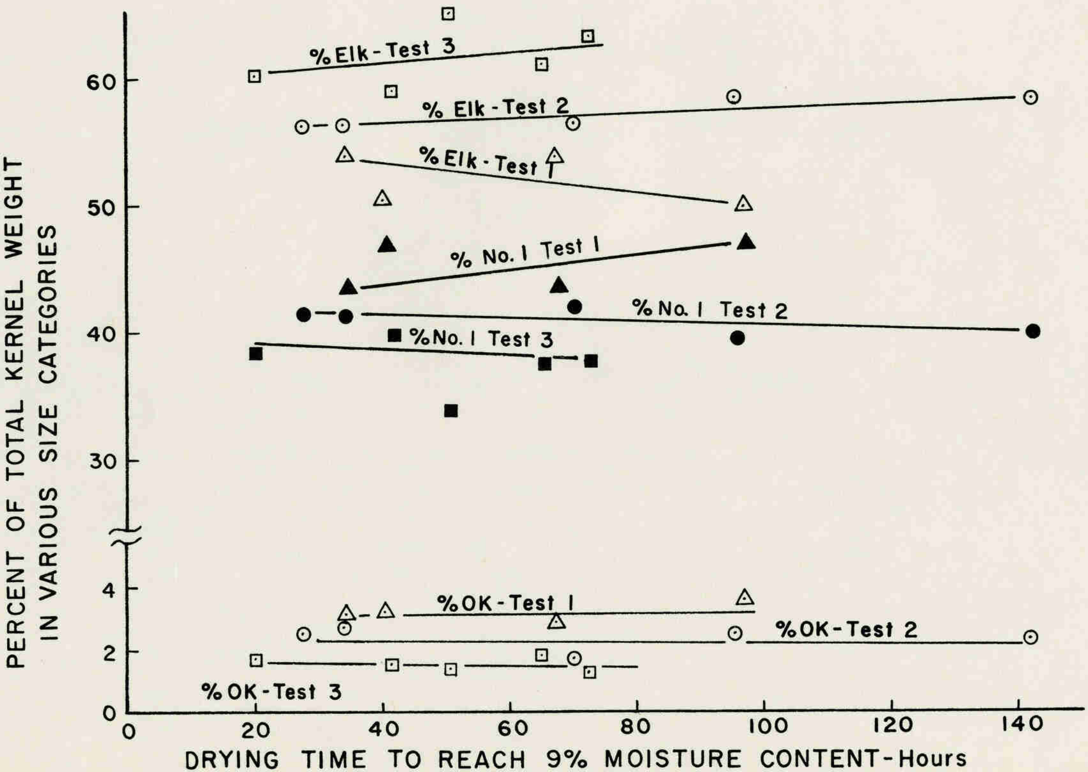

Figure 9. The effect of drying rate on the size of peanut kernels which were overdried and reconstituted to 9 percent moisture content, 1961.

affects kernel size independent of rate of drying. The effects of moisture content on kernel size can be determined from Table 4 by comparing the overdried samples with those samples cured to 9% moisture in the same curing environment.

Density.

Density measurements were made on approximately 100 grams of ELK from the peanuts which were dried to 9% moisture content in 1961. The average density as a function of drying time is plotted in Figure 10. In general, the density was greater for slower-dried peanuts, but the trend was not well-defined. This plot does not distinguish dates of harvest, but no improvement in correlation was noticeable when such a separation was made.

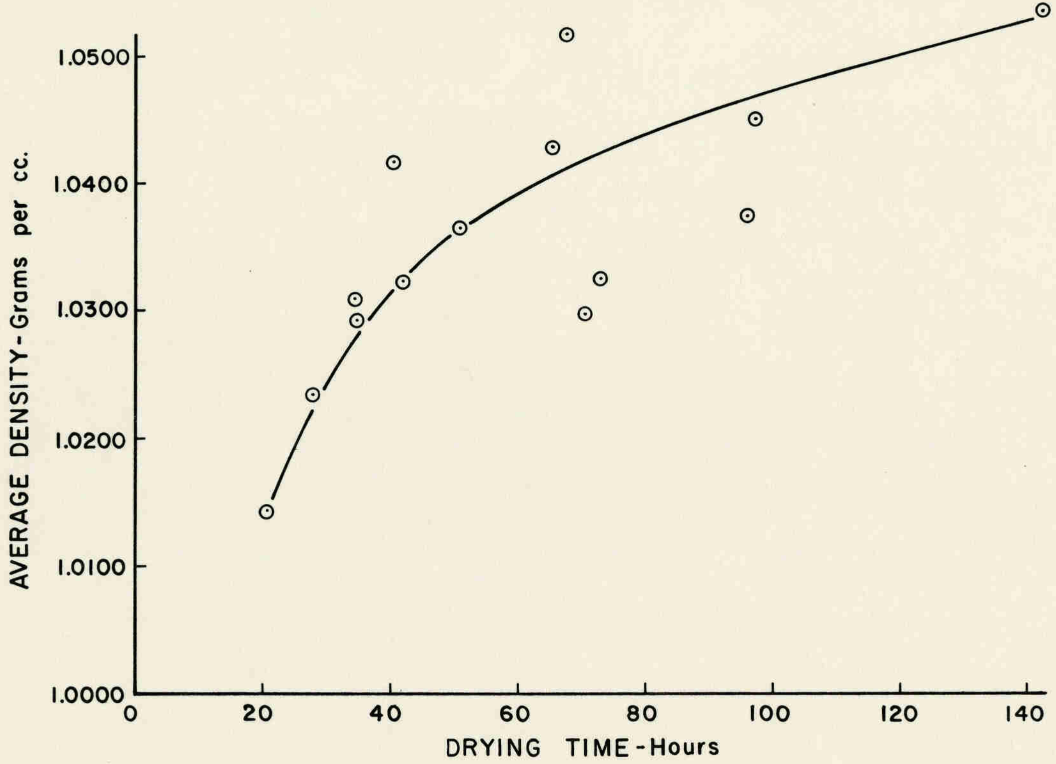

Figure 10. The effect of drying rate on the average apparent density of peanut kernels, 1961.

SUMMARY AND CONCLUSIONS

Freshly-dug Virginia bunch peanuts were cured in 1960 and 1961 with a wide variety of closely-controlled temperature and relative humidity combinations. The amount of shelling damage was measured for each curing treatment, and the effects of drying rate were examined. Some of the samples were deliberately overdried and reconstituted to normal moisture content in order to investigate the extent and permanence of milling quality impairment through overdrying.

An increase in the drying rate of peanuts during the curing operation will cause an increase in split and skinned kernels during mechanical shelling. The actual rate of water removal appears to be the overriding factor in this relationship, rather than any physiological changes brought about by elevated temperatures *per se*.

The moisture content of peanuts had a profound effect on the amount of splitting and skinning which resulted from the shelling operation. Reducing the shelling moisture content from 9% to 6% increased the total shelling damage 500 to 700 percent in some cases. This excessive shelling damage was avoided to a large degree when the moisture content was restored to 9% prior to shelling.

The data suggests that kernel size as determined by screening was affected by rate of drying, with faster drying rates yielding a slightly lower percentage of extra large kernels (ELK) and a correspondingly higher percentage of No. 1 kernels. Moisture loss was definitely accompanied by shrinkage of the kernels, which resulted in fewer extra large kernels and more No. 1 and shriveled kernels (OK). This change proceeded in the opposite direction when moisture content was increased.

The apparent density of the kernels tended to be less for the faster drying rates. This fact, coupled with the decrease in kernel size with increased drying rate, seems to indicate either an actual loss of dry matter from the peanut kernel or a change in kernel configuration due to rapid drying. Further investigation of this effect appears desirable.

One observation is clearly justified by the results of these tests. Every physical quality factor considered was either definitely or tentatively enhanced by a moderate to slow rate of drying, with drying terminated at not less than 9 to 10% moisture content. Kernel size is a factor in determining the farmer's price for peanuts, and continues to be important throughout processing and use of the product. Milling quality is important to the sheller, and is also of considerable interest to subsequent processors. Density has not been singled out as a primary quality factor, but higher density peanuts would appear to be preferable to those with lower density. The advantage of increased curing capacity brought about by a more rapid drying rate must therefore be weighed against the reduction in peanut quality which would ensue.

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