WALNUT SHELL/KERNEL DRYING CHARACTERISTICS

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ABSTRACT

Data were gathered on the relation between shell and kernel moisture contents of whole nuts during drying. This data is necessary in the development of drying equipment that may be used to speed up the rate of drying.

We found that shell moistures were always higher than kernel moistures at both the start and end of drying. For high moisture early season varieties, the shell moisture was less than the kernel's mid-way through the drying period.

Laboratory experiments were also conducted to determine if cracking the shell speeds up the rate of drying for whole nuts. The shells were cracked with a hammer, just enough so that at least one large crack appeared and the walnut remained intact. We found that the drying rate of both the shell and kernel was increased by this procedure; drying times for single layers of walnuts were reduced on the order of one third by this procedure.

OBJECTIVES

This year we conducted tests using a laboratory oven and a small scale drying unit to obtain data on drying rates for shells and kernels of both whole and cracked walnuts. Data on the drying characteristics of shells, kernels and whole nuts are important in the design of dryers, and also can help us understand measurements by in-bin moisture meters.

A series of tests were performed to compare the drying rates of whole cracked and uncracked walnuts. We are interested in trying to speed up the drying process for walnuts. One possible method (suggested by a board member at the 1988 Walnut research conference) is to crack the shells prior to drying. This could be done for those varieties that would be eventually be shelled anyway.

PROCEDURES

a.) Two tests were conducted to examine moisture variability for individual walnuts. One hundred and twenty nuts were placed in a laboratory oven at 110 °F. Twenty nut samples were withdrawn after 1, 2, 4, 8, 16 and 24 hours of drying. The nuts were shelled, and the moisture contents of the shells and kernels of each nut was determined using an oven drying method (24 hours at 190 °F in a laboratory convection oven). The nuts used in the tests were Ashley variety, and were randomly taken from the sorting conveyor of a huller.

b.) Eight tests were conducted using thin-layer drying test equipment in the department’s food engineering laboratory. Five of the eight tests were conducted to compare the drying rates of cracked and uncracked walnuts (Ashley and Serr varieties). The remaining three tests were done to gather basic drying rate data on Hartley variety whole nuts, shells and kernels.

The laboratory dryer contained three chambers, each containing a sample holder capable of holding about 4 pounds of dry nuts. All tests were made at a drying air temperature of 110 °F and a relative humidity of about 20%. Two lots of approximately 150 nuts each were
dryed in each test. The weight change of each lot was continuously monitored using electronic load cells. Moisture content versus time was calculated from the weight change data and the initial moisture content as determined by the oven method. A third lot of approximately 150 nuts was also dried in several of the experiments in order to monitor shell and kernel moisture changes during drying. Twenty nut samples were periodically removed from this chamber, shelled and the moisture content of the shell and kernels determined using the drying oven.

RESULTS

1.) Shell and kernel drying rates

Plots of shell and kernel average moistures for the first test are given in Figures 1 and 2. The standard deviations of the twenty nut samples at each time is also shown as a vertical line. The coefficient of variation (ratio of standard deviation to average moisture) ranged from 0.219 to 0.304 for the shells and from 0.174 to 0.373 for kernels. The data shows the danger of selecting just one or two nuts to determine shell and kernel moisture for a whole lot.

Shell moistures came down in an exponential fashion, the drying rate decreasing as the moisture content decreased. The kernel moistures were initially always lower than the shell and proceeded at a slower initial drying rate. A plot of the averages for the shell and kernel is given in Figure 3. Notice that the shell moisture dips below the kernel moisture after 6 hours and remains below the kernel moisture until 16 hours of drying. This type of behavior was only seen in high moisture samples, and was also noted by Marsh (1936) in a single test from the top of a drying bin. It has also been reported for filberts (hazelnuts) by Batsale and Puiggali (1985) and for peanuts by Colson and Young (1988). As the nuts became dryer later on in the season, the shell moistures were higher than kernel moistures during the entire drying period. This is shown in Figure 3 for the Serr variety walnuts and also in Figure 4 for the Hartley variety.

The initial lag in drying of the kernel appeared in almost all of the drying tests that we conducted. This is due to the fact that the kernel moisture must travel through the air space and into the shell. The effect of the nut structure on the drying rates of the shell and kernel can be seen by comparing the drying rates of shells and kernels alone to that of shells and kernels from whole walnuts. A plot of the moistures from such a test using Hartley variety walnuts is shown in Figure 4. The shells dry faster alone because there is more exposed surface area and because the water from the kernels in the whole nuts must pass through the shells too. The kernels alone dry faster because there is no barrier (shells) to impede water transfer to the drying air. (The wavy nature of the drying curves for the shell and kernels alone is caused by air flow induced vibrations on the sample trays.)

2.) Drying rates of cracked and uncracked nuts

Results of the five tests are shown in Figures 5 through 9. The cracked walnuts always dried at a faster rate than the whole ones. In most cases, the results were quite dramatic, for instance in the second test (89-2 in Figure 7), the cracked nuts reached 10% moisture in 11.5 hours while the whole nuts took 18.5 hours to reach this moisture.

Figure 7 shows the shell and kernel moistures for both cracked and uncracked walnuts as they dry. Both the shell and the kernel dry at a faster rate for the cracked nuts. The shells probably dry faster because there is more surface area exposed to the drying air when the nuts are cracked. The same is true for the kernels, more of the kernel is also exposed to the drying air when the nut is cracked, and thus they also dry at a faster rate. It is interesting to
compare the drying rates of the shells and kernels from cracked walnuts to those of shells and kernels dried alone as shown in Figure 4. As can be seen, the bare shell and kernels dried at a faster rate than those of the cracked nuts.

It should be noted that there is concern as to whether the cracked nuts can be stored without spoilage occurring. The injuries caused by cracking may promote deterioration of the nuts in storage. This aspect of the treatment needs to be examined.

ACKNOWLEDGMENTS

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REFERENCES


Figure 1. Shell moistures during thin-layer drying of Ashley variety.
Figure 2. Kernel moistures during thin-layer drying of Ashley variety.

Figure 3. Shell, kernel and whole nut moistures during thin-layer drying of early and late season walnuts.
Figure 4. Shell and kernel drying curves during thin-layer drying of Hartley variety.

Figure 5. Drying curves for whole and cracked Ashleys, test 89-1.
Figure 6. Drying curves for whole and cracked Ashleys, test 89-2.

Figure 7. Drying curves for whole and cracked Ashleys, test 89-3.
Figure 8. Drying curves for whole and cracked Ashleys, test 89-4.

Figure 9. Drying curves for whole and cracked Serr variety.
Figure 10. Drying curves for shell and kernels in Ashley variety test 89-4.