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Blanching Of Peanut Kernels As Affected By Repeated Rewetting-Drying Cycles[1]

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ABSTRACT

Shelled Spanish peanut kernels were subjected to repeated cycles of rewetting and drying at three levels of drying relative humidity (20%, 40% and 60%) and a single level of rewetting humidity (90%). Temperature was constant at 40 °C for all the experiments. Effects of relative humidity, number of rewetting-drying cycles, and the level of moisture content on the percentage of blanching were observed and analyzed. The number of rewetting-drying cycles, and the relative humidity of the drying air were found to be highly significant. Univariate models predicting blanching percentage as a function of the number of cycles of operation at fixed relative humidity levels, and bivariate model predicting blanching percentage as a function of drying relative humidity and number of cycles were fit to the experimental data. Skin moisture content and moisture history are suggested as important factors in peanut kernel blanching.

Key Words: blanching, humidity, moisture, rewetting-drying cycle, skin.

Introduction

Removal of peanut skin (testa) from peanut kernels, termed "blanching", is an important operation in the peanut industry. Mechanical methods of blanching are more widely used than chemical methods. Some of the factors which affect mechanical blanching have been defined. A comprehensive knowledge of factors such as kernel and skin moisture content, temperature, hygroscopic and thermal history, skin to kernel bond, skin tensile strength, dimensional changes, etc., and their relative influence is needed. The effects on the blanchability of repeated rewetting-drying cycles at a fixed temperature was desired to enhance the available information.

The specific objectives of the present study were to determine the effects of repeated rewetting-drying cycles, drying air relative humidity, and kernel moisture content on the blanchability of peanut kernels.

Shackelford (5) identified temperature and amount of moisture removed as factors affecting blanchability of peanuts. Woodward (9) found that tensile strength of peanut skin decreased with increased drying air temperature (increased drying rate). Beasley and Dickens (1) and Shackelford (5) indicated that the amount and rate of moisture removal affected blanchability more than did temperature. Woodruff (8) found that higher temperature adversely affected the flavor and shelf life of peanut kernels.

Paulsen (3) measured the dimensional changes in Spanish peanut kernel with respect to moisture loss. At constant temperature, high drying rates produced by low drying air relative humidities caused less volume shrinkage than slow drying at higher relative humidities. As suggested by Van Arsdel and others (6), a high drying rate creates a large moisture gradient which produces large internal stresses, cracks and holes, and prevents a hygroscopic material from shrinking fully. During slow drying, the moisture gradient is small, internal stresses are minimal, and the material shrinks to a more solid form. Walker and Barre (7), experimenting with soybean seed, found that cracks occur quite readily in seed coats when rapid drying (with air relative humidity reduced below 40%) is used.

The above findings raise questions regarding the relationship among drying rate, kernel dimension change, skin strength and blanching. How the intact skin behaves under relatively slow or fast drying rates is not known. If differential dimensional changes between the kernel and its skin were induced during drying or rewetting, a possible "skin loosening" effect or an increased tensile stress on the skin would occur depending on whether the skin expanded or contracted more (or less) than the kernel. Rapid drying would cause less kernel shrinkage, Paulsen (3) and Helton (2), and might similarly cause less skin contraction. The improved blanching found at high drying rates cannot be attributed directly to dimensional changes of the kernel. But the increased skin stress condition at high drying rates which may lead to skin rupture or differential dimensional response between kernel and skin could be the causes of enhanced blanchability. Additional studies were needed for better understanding of factors affecting blanchability of peanut kernels.

Materials and Methods

Spanish peanuts of Starr variety from the 1975 harvest were used for all experiments. Kernels from shelled peanuts having moisture content in the range of 4.6 to 4.9%, w.b., were stored at approximately 4 °C for experimental use as required.

An Aminco-Aire unit was used to condition air to the desired temperature and relative humidity levels. Peanut kernels were placed in thin layers on wire-mesh trays in an environmental chamber supplied with conditioned air. Kernels were first rewetted at 90% relative humidity and then dried at a selected relative humidity level for each cycle of operation. All rewetting and drying were done at a constant 40 °C temperature so that any thermal expansion difference between the peanut skin and kernel would be negligible.

Blanching of dried kernels was done using an abrasive rotary-roller blancher constructed at the OSU Agricultural Engineering Laboratory. Whole and split kernels containing no visible trace of skin after processing in the rotary-roller blancher were considered blanched. Processed kernels were separated by visual inspection to determine the percentage by weight of blanched peanuts.

Moisture content was measured with a Steinlite moisture tester calibrated against oven-dried moisture measurements. Sample

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sizes for experiments were approximately 1700 grams of whole kernels for each rewetting and drying test, and approximately 350 grams for each blanching. The following experimental parameters were used:

Air temperature: for both rewetting and drying, 40 °C

Air relative humidity: single level for rewetting, 90%; three levels for drying; 60%, 40%, and 20%

Kernel moisture contents: after rewetting, 13% (w.b.); after end of drying cycles, 6.4 to 7% (wb).

Number of rewetting-drying cycles: 1, 2, 3, and 4

A factorial experimental design was used. The three levels of drying-air relative humidity and the four rewetting-drying cycles resulted in 12 treatment combinations. Blanching was replicated three times for each treatment combination.

The same equipment setup as described above was used for experiments to determine the effect of moisture content on blanching. Kernels were rewetted and dried at a very slow rate. Relative humidity was increased by five percentage points per day until 90% relative humidity was reached. Then humidity was decreased at the same rate for slow drying. Samples were drawn at different moisture content levels during both rewetting and drying phases for blanching.

Results and Discussion

The results of drying at 40 °C using different levels of relative humidities (20%, 40%, 60%) are shown in Figure 1. Higher relative humidity and the resulting slow drying caused lower blanching percentage. Repeated wetting-drying cycles caused a progressive increase in blanching percentage as indicated from Figures 1 and 2.

The relationship between percentage blanched and the number of rewetting-drying cycles is apparently non-linear and assumed to be asymptotically approaching a maximum value of 100% for each relative humidity level. This suggested an exponential model. A logarithmic transformation of the data on percentage of unblanched kernels, instead of percentage of blanched kernels, made linear regression analysis possible. Regression analysis was performed on the percentage of unblanched kernels as a function of rewetting-drying cycles within each relative humidity level. Data were transformed to accommodate fitting a straight line to the following model.

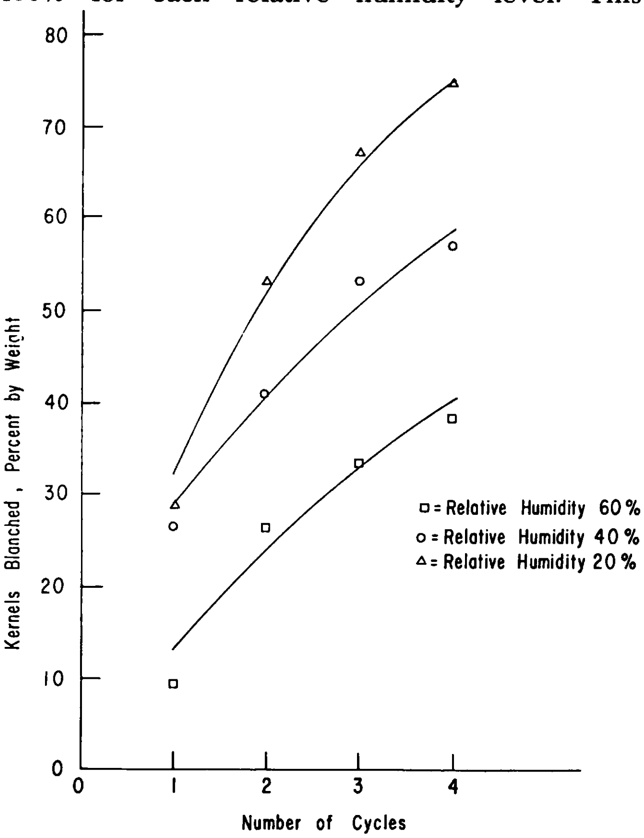

Fig. 1. Effect of Number of Rewetting-Drying Cycles on Peanut Kernels Blanched (Each Point is the Mean of Three Runs).

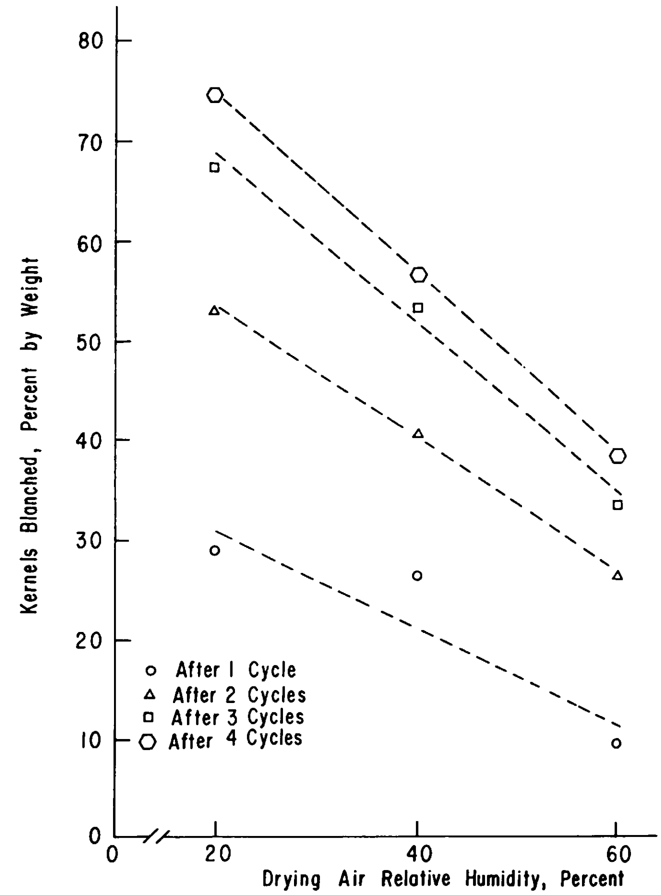

Fig. 2. Effect of Drying Air Humidity on Peanut Kernels Blanched (Each Point is the Mean of Three Runs).

model: % unblanched = A * Exp (b * Cycles)

transform: log (% unblanched) = Log A + (b * Cycles)

where % unblanched = 100 − % blanched

The parameters 'Log A' and 'b' were determined from simple linear regression analysis utilizing SAS (Statistical Analysis System) program (4). The log-transformed linear model was found adequate as the ratio of sum of squares from lack of fit to the sum of squares from experimental error was not signigicant at 1% level at each relative humidity level. The null hypothesis of no dependence on number of cycles was also rejected at significance level of 0.1% or less in each case. The following untransformed prediction equations, expressed in terms of percent of blanched kernels were found to best fit the data.

(a) at 60% RH; percent blanched = 100 − 98.75 Exp (−0.1252 * Cycle)

(b) at 40% RH; percent blanched = 100 − 85.92 Exp (−0.1837 * Cycle)

(c) at 20% RH; percent blanched = 100 − 96.49 Exp (−0.3454 * Cycle)

An analysis of variance was performed on the combined data. Number of cycles and humidity levels were highly significant while the cross product was significant only at the 10% level of confidence.

Linear regression analysis was also done to test the dependence of blanching on the relative humidity of drying air within each number of cycle of treatment. The null hypothesis of no dependence could be rejected in each case at the 5% significance level. The regression equations were as follows:

(a) after 1 cycle; percent blanched = 40.21 − 0.473 * RH

(b) after 2 cycles; percent blanched = 67.06 − 0.674 * RH

(c) after 3 cycles; percent blanched = 85.46 − 0.846 * RH

(d) after 4 cycles; percent blanched = 92.84 − 0.910 * RH

The correlation coefficients (R-square values) were 0.65 for 1 cycle, 0.78 for 2 cycles, 0.94 for 3 cycles, and 0.97 for 4 cycles.

A bivariate linear model was also tried. The resulting prediction equation, percent blanched = 42.15 + 11.70 * Cycles − 0.726 * RH, had an R-square value of 0.88 for tests at 40 °C. But this model should not be used for a wide range since it fails to take into account the physical limitation of the value of percentage blanched (i.e., 100% or less).

The effect of kernel moisture content on blanching was found significant. A null hypothesis of no effect of moisture on blanchability was rejected at the 1% significance level using a linear model. The data from this test in which very slow rewetting and drying (as described earlier) was used, are plotted in Figure 3 to show the sequence of blanching information collected. Figure 3 provides some indication that blanchability may be higher during the drying phase (when the skin is drier) even though the overall moisture content of the whole kernel may be the same.

Results obtained in these experiments may be compared with the findings of Helton and Brusewitz (2) which show that kernel moisture contraction is increased when drying air relative humidity is increased and slower drying is used.

The above findings clearly show that blanchability increases at drying conditions which produce comparatively less dimensional change. Thus, the kernel dimension change alone cannot be a major factor affecting blanching. Apparently, stress in the skin or stress between the skin and kernel causes increased blanching after rapid drying. Cyclic rewetting and drying increases blanching and the kernel moisture content also affects blanching. Figure 3 suggests that skin moisture content may affect blanching; drier skin apparently enhances blanchability. Rapid drying rates, low moisture content, and cyclic rewetting and drying operations conceivably create repeated stress conditions which

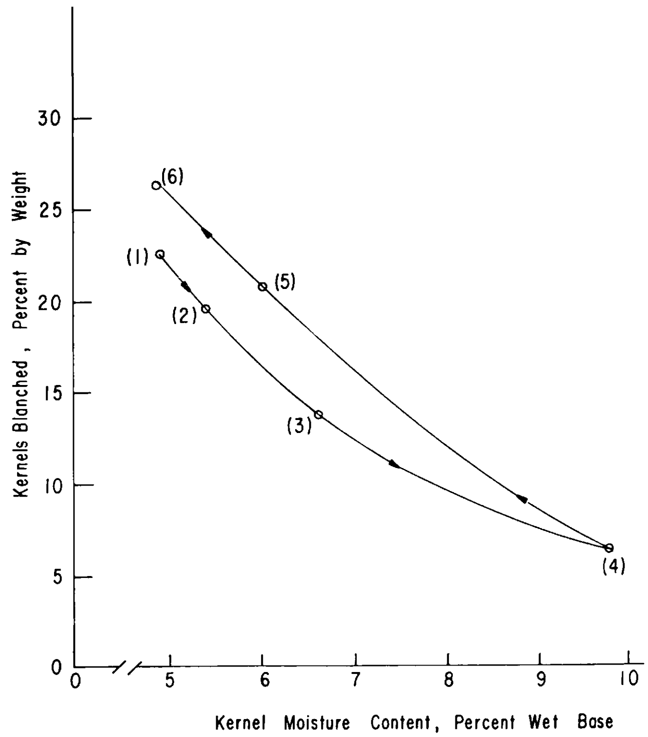

Fig. 3. Effect of Kernel Moisture Content on Peanut Kernels Blanched.

may reduce skin tensile strength and overcome the bond between the skin and the kernel causing improved blanching. Woodward's (9) indication of reduction in skin tensile strength at higher temperature (and higher drying rates) lend support to this explanation.

The results indicate that skin moisture content and moisture history (i.e., cycles of humidification and dehumidification) is an important factor for peanut blanching. Since kernel conditions are far easier to monitor than skin conditions, it is essential to know the relative equilibrium moisture content of kernel and skin under both static and dynamic conditions. Estimation of skin condition and history from information of kernel condition and history may help obtain better blanching.

A practical implication of the above results is that peanut blanching can be improved at temperatures below that in current use if a series of rewetting and drying cycles are used at suitable drying humidity level. A lower temperature process may be preferable because, according to Woodruff (8), the low temperature blanching maintains flavor and shelf life better than a high temperature process.

Conclusions

The following conclusions may be drawn from the work described above.

(a) Lower drying air relative humidity and higher drying rate increase blanchability at constant drying temperature.

(b) Lower kernel moisture content improves blanching while other factors are kept constant.

(c) Repeated rewetting and drying cycles improve blanchability of Spanish peanut kernels under constant drying air temperature and relative humidity.
(d) Skin moisture content and moisture history are suggested as important factors affecting blanchability.

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