centration reaches approximately 0.5 μg. In lower concentrations the color is a rather faint bluish gray. Since the formation of 5-hydroxymethylfurfural is one of the earliest indications of storage changes in several different types of food materials, this method should find a wide applicability in quality control and food research laboratories.

Although taste panel studies have indicated that HMF is not responsible for the flavor considered characteristic of stored orange powders, its detection may be the first indication of storage changes.

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MOISTURE DETERMINATION

Rapid Estimation of Dried Fruit Moisture by Refractive Index

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Moisture of dried prunes, raisins, figs, and apricots was estimated by the use of a refractometer. The refractive index of ground, unfiltered, dried fruit correlates with moisture as determined by vacuum oven. Statistical evaluation indicates that the precision of the refractometric method is excellent.

THE STABILITY, texture, and appearance of dried fruits depends to a large extent upon their moisture content. Frequent moisture measurements are made during production to ensure fruit of optimum quality. The literature is replete with discussions and reports of moisture analyses, but workers in the field still seek more accurate or practical methods.

A thorough discussion of water determination in foods is given by Joslyn (*1*). Stitt (*4*) discussed moisture equilibrium of dehydrated foods and evaluated several methods of moisture determination. A rapid chemical method based on oxidation with dichromate has been reported by Tomimatsu and Launer for determining moisture in fruits and vegetables (*5*).

The vacuum oven method is the standard or reference method for moisture determination in dried fruits. However, for commercial application where rapid, simple methods are required, the vacuum oven process is too slow and involved. This study was undertaken to determine if there is sufficient correlation between the refractive index of dried fruits and their moisture content (as determined with the vacuum oven) to employ the refractive index to estimate moisture content.

Material and Methods

Dried prunes, raisins, figs, and apricots in the natural or low-moisture state (about 10 to 19% moisture) were obtained from commercial sources. These fruits were then hydrated to various moisture levels by immersion in boiling water, immersion in boiling water followed by cold water (*2*), and by cold water addition alone. Retail packages of several brands of each dried fruit (which contain about 16 to 30% moisture) were also tested.

A random sample of each lot of dried fruit was ground and mixed well (prunes were pitted). A 50-gram portion of the ground fruit was taken for the determination of refractive index and vacuum oven moisture. The refractive index was determined on three separate portions of the 50-gram sample by placing about 50 mg. of the ground fruit directly on the prism of a Bausch and Lomb Abbe-3L refractometer. The refractometer was maintained at 25° C., and the average of the three readings was recorded. The vacuum oven moisture was determined from two 5-gram samples of the original 50-gram portion according to the procedure of Nury (*3*). The averages of readings for each test were used in the statistical calculations.

Table I. Statistical Relationship of Refractive Index (X) and Vacuum Oven Moisture (Y) of Some Dried Fruits

Fruit	Observations	Correlation Coefficient (r)	Regression Equation
Raisins	11	−0.9998	$Y = 591.630 - 385.625X$
Prunes	11	−0.9993	$Y = 612.324 - 399.619X$
Figs	7	−0.9922	$Y = 621.793 - 406.636X$
Apricots	7	−0.9992	$Y = 628.615 - 410.414X$

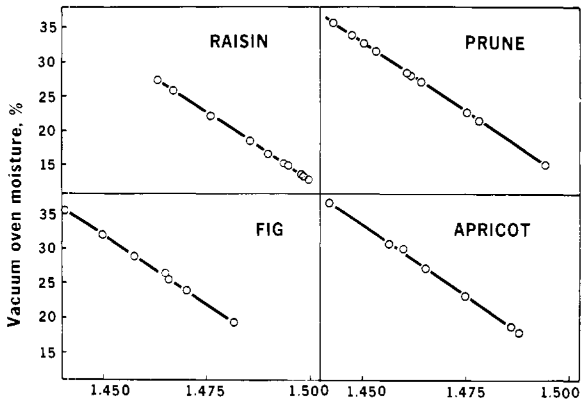

Figure 1. Relationship of refractive index to moisture in raisins, prunes, figs, and apricots

Results and Discussion

In the moisture range of 11 to 36%, refractive index was related to the moisture content of the dried fruits (Figure 1). (The graphs do not start at zero for the X and Y axes.) The refractive index correlated well—significant below the 0.001 level—with the vacuum oven moisture, as indicated by the correlation coefficient (Table I).

The refractive index readings can be translated to moisture content values by solving a linear regression equation or by reading the values on a calibration curve based on the equation. Since a slightly hazy line is observed in the refractometer when the ground fruit is placed directly on the prism, a certain amount of subjectivity is inherent in the procedure. Therefore, each operator probably should prepare his own calibration line for each fruit.

The refractometric moisture method has the advantage of being simple and rapid. A nontechnical person can easily make a determination in seconds, after the fruit is ground. In contrast, vacuum oven moisture determinations require a technically trained person, and the results cannot be obtained for 6 to 30 hours.

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MOISTURE BY GLC

Gas-Liquid Chromatography and Vacuum Oven Determination of Moisture in Fruits and Fruit Products

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The gas chromatographic estimation of water in fruits and dried fruit products is evaluated. A column of polyethylene glycol on polytetrafluoroethylene resolved water, 2-butanol (internal standard), and methanol. Peak area ratios are used to calculate moisture content. Results compare well with those of the vacuum oven method.

Gas chromatography has been reported to be a reliable method for determining the moisture of a number of materials. Workers at the National Bureau of Standards (*7*) have adapted gas-liquid chromatography to determine moisture in grains. Schwecke and Nelson (*9*) report its use in determining moisture of cereal products, raisins, and other materials. Kuwada (*4*) measured the water content of samples of hydrazine by GLC with satisfactory precision and accuracy. Hawkin *et al.* (*3*) reported successful separation of water from azeotropes by chromatography on a column of di(2-ethyl hexyl) phthalate on Celite 545 and his method affords quantitative measurements of the components. Bennett (*1*) pointed out that the usefulness of GLC for moisture analysis depends largely on preventing the water peak from tailing off. Columns of Teflon powders impregnated with various stationary phases reduce water tailing. The present investigation shows that water content of fruits and dehydrated fruit products can be determined by gas-liquid chromatography and compares results to those from the vacuum oven method.

Experimental

Materials Analyzed. Banana puree was prepared by blending peeled Chinese (Cavendish) bananas. Papayas were peeled, the seeds removed, and the remaining portion blended to a puree. Guavas were chopped in a Fitzmill, passed through a 0.033 pulper screen, then a 0.020 finisher screen to yield a smooth puree. Air-dried bananas were prepared from banana slices that had been dipped in SO_2 solution, then dried in a forced draft oven at 140° F. Drum-dried banana powder was prepared by drying banana puree on a double-drum dryer operated at 50 p.s.i. steam pressure