Improvement in the Reproducibility of the Enzymatic Analysis of Sucrose in Stored Golden Delicious Apples

The precision of the enzymatic analysis of sucrose in stored Golden Delicious apples is improved by removing the natural glucose.

The coefficients of variability for sucrose content (Golden Delicious apples, harvest 1971) after 195 and 216 days of storage were respectively ±18.0 and ±16.3% (Gorin, 1973). These high coefficients were explained by the high relative content of natural glucose to sucrose. Original glucose was not destroyed because the ratio of glucose to sucrose was lower than 5:1 (Boehringer Mannheim GmbH, 1971).

When estimating sucrose enzymatically as previously described (Gorin, 1973) but with stored apples of harvest 1972, natural glucose was removed with glucose oxidase and catalase (Boehringer Mannheim GmbH, 1971) from the moment that the coefficient of variability became higher than ±10%. This point was chosen because glucose was no longer analyzed and therefore the ratio of glucose to sucrose was unknown.

Table I. Estimation of Sucrose in Golden Delicious Apples,[a] Harvest 1972, after Removing Natural Glucose

	$\bar{x}$	$s \pm$	CV, %
	62 Days of Storage[b]		
Sample I	1.21	0.02	1.3
Sample II	1.45	0.03	2.2
Sample III	1.29	0.03	2.7
	90 Days of Storage[b]		
Sample I	1.06	0.03	2.8
Sample II	1.12	0.01	1.1
Sample III	1.41	0.01	0.8

[a] Apples were purchased from the same fruit grower (Puiflijk, Netherlands) as those of 1971. Values are expressed as grams/100 g fresh weight. They are not corrected for initial fresh weight, *i.e.*, in respect to zero time storage. $\bar{x}$ = average of three estimations; $s = (\Sigma d^2/n - 1)^{1/2}$; CV (%) = $s100/\bar{x}$. [b] Storage at 4° in a controlled atmosphere (1973) (Gorin, 1973).

Table I records the data of sucrose enzymatically estimated after removing natural glucose. Without this step the coefficient of variability was higher than ±10% as was confirmed with apples stored for 62 days.

From Table I we may conclude that the precision (Fischer and Peters, 1968; Crockford and Nowell, 1956) of the enzymatic analysis of sucrose is improved by removing natural glucose.

In addition we would recommend applying this procedure to Golden Delicious apples before the ratio of glucose to sucrose becomes 5:1.

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Determination of Sucrose, Glucose, and Fructose by Liquid Chromatography

A simple and rapid method for the determination of sucrose, glucose, and fructose in plant foods by elution with water from a cation exchange resin and detection with a differential refractometer is described. The separation of the three sugars in deionized juices or food extracts can be completed in as little as 10 min and microgram quantities of the individual sugars can be measured. Examples of application to food products are shown. The method can also be utilized for determination of a limited number of other sugars.

Plant foods are primary sources of free sugars in the diet. Sucrose, glucose, and fructose predominate in plants, other sugars seldom occurring in more than trace quantities. Thus, the food scientist and nutritionist, as well as the plant biochemist, often wish to determine these three sugars in plant tissues. Recent evidence that the ingestion of particular sugars encourages development of dental caries and possibly cardiovascular disease provides additional impetus for measuring the dietary intake of individual sugars.

There is a scarcity of data on the concentration of individual sugars in plant foods. The most extensive compilation available is that of Hardinge *et al.* (1965). These authors present the data as a "temporary expedient," recognizing the lack of uniformity in sampling and analytical techniques. Nor is there any information on the effect of variety, origin, maturity, or storage, except to state that the samples were fresh foods in a stage of maturity as commonly eaten. Additional data on sugars in fruits and vegetables have become available recently. Dako *et al.* (1970) used enzymatic methods to determine sucrose, glucose, and fructose in 14 different fruits, and to show the