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Carbohydrate Changes in Sweet Potatoes During Curing and Storage

David H. Picha

Department of Horticulture, Louisiana Agricultural Experiment Station, Louisiana State University Agricultural Center, Baton Rouge, LA 70803

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Abstract. **The quantity and pattern of carbohydrate change during curing and storage differed among 6 sweet potato [*Ipomoea batatas* (L.) Lam] cultivars. 'Travis' contained the most total sugar and 'Whitestar' the least on a dry weight basis. Sucrose, the major sugar in raw sweet potatoes, sharply increased during curing (10 days at 32°C; 90% RH), and generally continued to increase in 4 orange-flesh cultivars during 46 weeks of 15.6° storage. Sucrose concentration decreased in 2 white-flesh cultivars after curing, followed by an increase after 14 weeks of storage. Glucose concentration was slightly higher than fructose in all cultivars except 'Centennial', which had similar monosaccharide concentrations. The pattern of monosaccharide change during curing and storage varied with cultivar, but generally increased during curing and the first 4 weeks of storage, followed by stabilization or a slight increase. Alcohol-insoluble solids (AIS) decreased with increasing lengths of storage in the 4 orange-flesh cultivars, which was attributed to continuous starch degradation. AIS increased during the first 4 or 14 weeks of storage in the 2 white-flesh cultivars, followed by a decrease during longer periods of storage.**

Using proper curing techniques (4–10 days at 30°–32°C; 90% RH) and optimal long-term storage conditions (15.6°; 90% RH), sweet potatoes can be held for up to a year without sprouting or serious decay (15). Many physiological changes occur during curing and storage that affect the internal composition of the root (6). The dry matter portion of sweet potatoes is mostly composed of carbohydrates. They exist primarily in the form of starch and sugars. Sucrose is the major sugar in unprocessed sweet potatoes and glucose and fructose are the main reducing sugars (11, 14).

Most previous studies reported an increase in reducing sugars (1, 2, 5, 20), nonreducing sugars (5, 7, 11, 20), and total sugar content (2, 9, 17, 18) in sweet potatoes during curing and several months of storage. However, nonreducing sugars decreased in some cultivars after curing (3), 1 month (7), 5 months (11), or 7 months (18) of storage, and reducing sugars did not increase after several months of storage in one cultivar (5). No increase in total sugar content was reported during curing (17) or after 2 months (17) or 7 months of storage (18) in some cultivars.

The cultivars of sweet potatoes currently grown are different from those used in the early carbohydrate metabolism studies. Expanded and improved storage facilities have allowed more

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roots to be stored for longer periods. A thorough understanding of the storage characteristics, including carbohydrate composition changes, needs to be established for the currently grown cultivars over the entire length of possible commercial storage (about 10 months).

The objective of this study was to determine the effect of curing and long-term 15.6°C storage on the carbohydrate metabolism in some of the leading orange-flesh cultivars currently grown in the United States, along with several high dry matter white-flesh cultivars.

Materials and Methods

Four orange-flesh sweet potato cultivars ('Centennial', 'Jewel', 'Jasper', and 'Travis') and two white-flesh cultivars ('Rojo Blanco' and 'Whitestar') were grown on a silt loam soil at the LSU Hill Farm in Baton Rouge, La. in 1982 and 1983 following cultural practices recommended for commercial production (10). All roots were harvested the same day in mid-October prior to any adverse cool or wet weather.

Analyses of AIS and sugar content in raw roots from each cultivar were made the day of harvest, after curing (10 days at 32°C; 90% RH, and after 4, 14, 22, 30, 38, and 46 weeks of storage at 15.6°; 90% RH. Six random U.S. No. 1 grade roots from each of 4 replications were taken at each analysis time.

Unpeeled roots were halved longitudinally and uniformly grated over the entire surface to a depth of about 3 mm. The grated tissue from each of the 6 roots per replication was combined and 10.0 g was homogenized in 80% ethanol for 1 min at high speed using a Virtis 45 homogenizer. The resulting slurry immediately was boiled for 15 min, cooled, and filtered through Whatman #4 paper. The residue and original container were washed with additional 80% ethanol and the filtrate was made to a final volume of 100 ml. Alcohol-insoluble solids content was determined by the weight of the insoluble residue retained on the filter paper after 24 hr of drying at 35°C under vacuum. Sugar content of the filtrate was determined by high performance liquid chromatography (HPLC) as previously described (14), and the results were expressed on a dry weight basis to avoid differences in water loss and content among cultivars during curing and storage. Dry weight of the raw roots was determined by drying duplicate 10.0-g samples of grated tissue from 4 replications at 70° for 48 hr in a forced-air oven.

Results and Discussion

Results for 1982 and 1983 were similar; therefore, only the 1983 data are presented. A wide range in percentage of dry matter existed among cultivars, with values at harvest being: 'Whitestar', 31.6%; 'Rojo Blanco', 29.2%; 'Centennial', 26.3%; 'Jewel', 23.4%; 'Jasper', 22.7%; and 'Travis', 17.7%. After 46 weeks of storage these values decreased by about 3%. Other workers also reported less percentage of dry weight in stored roots compared to freshly harvested roots in a number of cultivars (7, 9, 11).

Monosaccharides. Fructose (Fig. 1) and glucose (Fig. 2) were the only monosaccharides detected in the 6 cultivars analyzed, and both increased in concentration during curing in all cultivars. The monosaccharide increase during curing was consistent with the previous results of other cultivars (1, 2, 5, 20). Further increases in fructose and glucose occurred during storage in all cultivars except 'Jasper', with most of the increase generally occurring in the first 4 or 14 weeks. In 'Travis', fructose concentration continued to increase for 38 weeks and glucose for

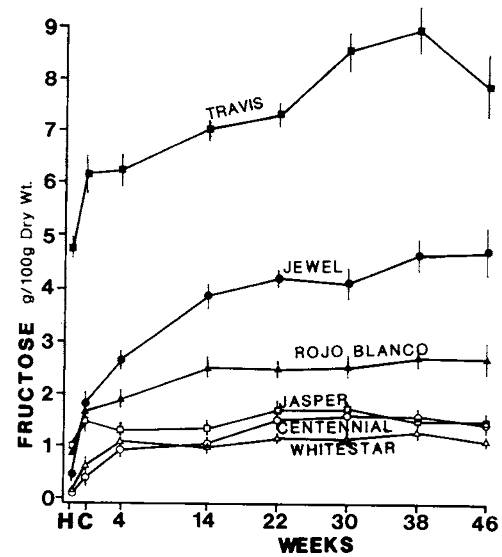

Fig. 1. Fructose concentration in 6 sweet potato cultivars at harvest (H), after curing (C), and during 46 weeks of storage at 15.6°C. Bars represent SE of the mean and, when absent, fall under the symbol.

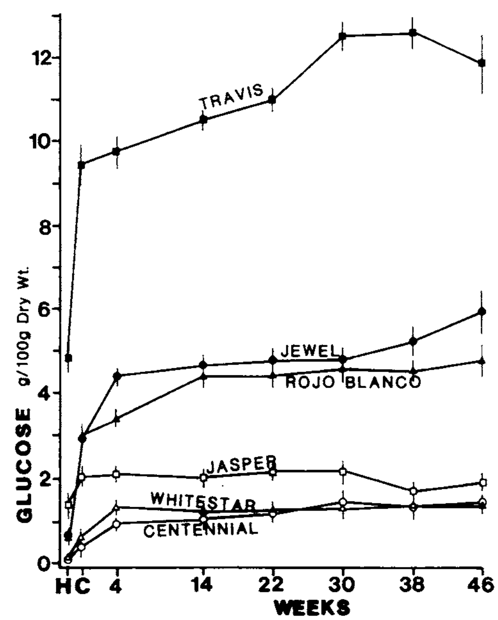

Fig. 2. Glucose concentration in 6 sweet potato cultivars at harvest (H), after curing (C), and during 46 weeks of storage at 15.6°C. Bars represent SE of the mean and, when absent, fall under the symbol.

30 weeks. Reducing sugars in most other cultivars increased after several months of storage (2, 5, 20). Walter and Hoover (20) also reported monosaccharides to increase more rapidly and to higher levels in 'Jewel' than 'Centennial' during curing and storage.

Glucose concentration was slightly greater than fructose, except in 'Centennial'. 'Travis' contained the most glucose and fructose among cultivars, followed by 'Jewel', while 'Centennial' and 'Whitestar' contained the least.

Sucrose. Sucrose was the major sugar at harvest in all 6 cultivars. Nonreducing sugars were higher in concentration than reducing sugars in a number of other cultivars (1, 2, 5, 7, 11).

Sucrose increased during curing in all 6 cultivars, and generally continued to increase during storage in the 4 orange-flesh cultivars (Fig. 3). The substrate for sucrose formation probably was starch, since AIS [mostly starch (2)] decreased during curing and storage (Fig. 4). The enzymes involved in starch–sugar metabolism were not characterized in this study, but starch probably was degraded by phosphorylase, because no maltose was detected. Amylases, however, are the primary enzymes responsible for starch degradation during baking (19). The source of glucose and fructose during storage in the 4 orange-flesh cultivars was probably from starch degradation and not sucrose, since no decline in sucrose concentration occurred. Starch content (20) and AIS (4, 7, 17) decreased while nonreducing sugars increased (5, 7, 11, 20) during curing and storage in other orange-flesh cultivars.

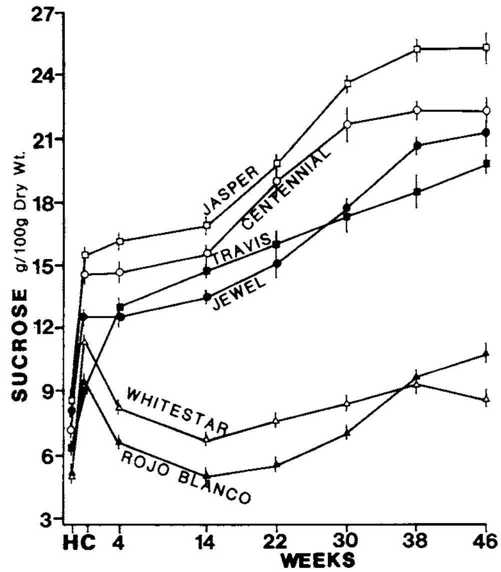

Fig. 3. Sucrose concentration in 6 sweet potato cultivars at harvest (H), after curing (C), and during 46 weeks of storage at 15.6°C. Bars represent SE of the mean.

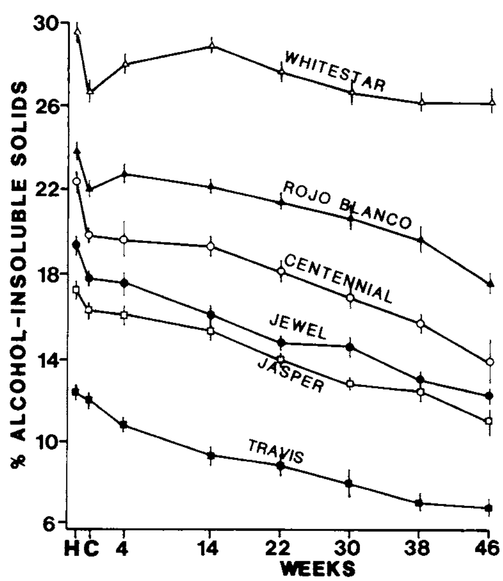

Fig. 4. Alcohol-insoluble solids (AIS) content of 6 sweet potato cultivars at harvest (H), after curing (C), and during 46 weeks of storage at 15.6°C. Bars represent SE of the mean.

A different pattern of carbohydrate metabolism existed in the 2 white-flesh cultivars during the early storage period immediately following curing. Sucrose concentration decreased (Fig. 3) and AIS increased (Fig. 4). The C source for the AIS synthesis appeared to be sucrose, since the monosaccharides did not decline. This conclusion is consistent with the belief that the C source for starch synthesized in reserve tissue is sucrose (16). Kinetic studies of sucrose synthase isolated from sweet potato roots strongly indicated that this enzyme was involved in the cleavage of sucrose to yield UDP-glucose and fructose (12). UDP-glucose may be transformed to ADP-glucose and used as a glucosyl donor in the synthesis of starch via starch synthase (13). Invertase has been reported to be active in sweet potato roots (8), and some sucrose hydrolysis into glucose and fructose via invertase reactions may also have occurred. Sugar changes in 'Whitestar' and 'Rojo Blanco' during the first 14 weeks of storage indicated a portion of the sucrose was used in the net formation of glucose and fructose while another portion was used for AIS (starch) biosynthesis. A shift to net AIS degradation and sucrose synthesis occurred after 14 weeks of storage. Nonreducing sugars were found to decrease after curing (3) and 1 month of storage (7) in different cultivars, including one high dry matter, cream-flesh type ('Triumph').

Sucrose concentration was greater in the 4 orange-flesh cultivars than in the 2 white-flesh cultivars during storage. 'Jasper' and 'Centennial', respectively, contained the most sucrose among cultivars.

Total sugar. Carbohydrate metabolism during curing in all cultivars favored a net synthesis of total sugar (Fig. 5), since both reducing sugar and sucrose content increased. Total sugar concentration continued to increase during storage in the 4 orange-flesh cultivars—until 30 weeks in 'Centennial', 'Jasper', and 'Travis', and through 46 weeks in 'Jewel'. Total sugar concentration decreased in the white-flesh cultivars during the first 4 weeks ('Rojo Blanco') and 14 weeks ('Whitestar') of storage, followed by a slight increase during longer periods of storage. The 4 orange-flesh cultivars contained more total sugar than the 2 white-flesh cultivars. 'Travis' had the highest total sugar concentration and 'Centennial' the lowest among orange-flesh types. 'Whitestar' contained the lowest concentration of

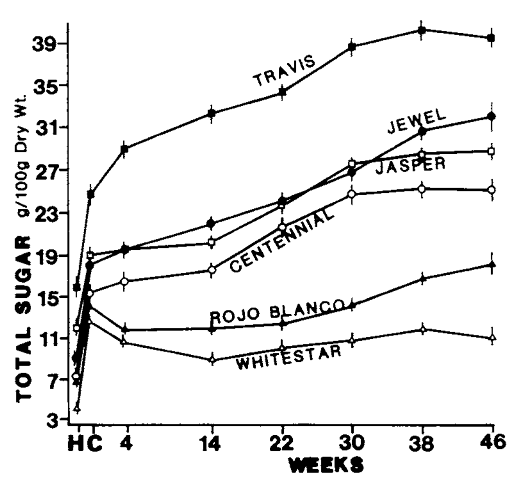

Fig. 5. Total sugar concentration in 6 sweet potato cultivars at harvest (H), after curing (C), and during 46 weeks of storage at 15.6°C. Bars represent SE of the mean.

total sugar among all cultivars during storage. The cultivar with the most AIS ('Whitestar') contained the least total sugar content, and the cultivar with the least AIS ('Travis') contained the most total sugar. Amount of total sugar concentration would be different if the data were expressed on a fresh weight basis or if the analyses were performed on baked roots (14), because of large dry matter differences among cultivars and maltose formation during baking.

Sweet potato carbohydrate composition is thus dependent on cultivar and storage duration. The greatest increase in sugar concentration generally occurred during the curing period. Additional studies are needed to characterize the enzymes and pathways involved in carbohydrate transformation in sweet potatoes during curing and storage.

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