

EFFECTS OF CURING ON THE FLAVOR AND TEXTURE OF BAKED SWEET POTATOES

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ABSTRACT

The objective of this investigation was to determine the quality advantages, if any, of curing whole sweet potatoes prior to marketing during the harvest season. Freshly harvested sweet potatoes were washed, graded, and boxed for shipment and then cured at 30°C and 90% RH for 0, 4 or 7 days prior to shipping. Preparations were timed so that all treatments could be shipped on the same pallet. During 2 yr a total of 8 shipments were made to northern cities (500–600 miles) by truck. Sample potatoes were evaluated by a trained flavor and texture profile panel and by analytical methods. Results indicated that curing for either 4 or 7 days developed a product that was superior in both flavor and texture. Viscosity of purees was lower for cured than for uncured sweet potatoes. Curing slightly reduced ascorbic acid content.

INTRODUCTION

THE SWEET POTATO (*Ipomoea batatas*) is an important crop in several southern states and California. Production in 1976 approached 14 million cwt of which North Carolina produced about one-third (USDA, 1977). A large percentage of the sweet potatoes are sold intact for baking or other use by the homemaker.

During the harvest season many sweet potatoes are shipped in a so called "green" condition without being cured. Curing as used here means subjecting the freshly harvested roots to an environment (30°C temperature and 90% RH) that quickly heals cuts, bruises and skinned areas (Kushman et al., 1977). Curing also increases the level of natural amylolytic enzymes which results in a sweeter flavor and more moist mouthfeel in roots baked under suitable conditions (Scott and Matthews, 1957; Sistrunk et al., 1954; Walter et al., 1975). The enzymes, α and β amylases (Balls et al., 1948; Ikemiya and Debold, 1966), can be used to enhance the sweetness of products such as dehydrated sweet potato flakes (Hoover, 1967; Walter et al., 1976).

Rheological properties of baked sweet potato flesh and heated purees are also affected by amylolytic enzyme activity (Ice, 1978; Nelson, 1973; Rao et al., 1975). Reduction in the molecular weight produces a more fluid consistency which is evidenced by lower apparent viscosity values for either the baked flesh or a puree. Rheological properties are related to mouthfeel as shown by Rao et al. (1975). Sweet potatoes that have a moist mouthfeel when baked (i.e., feel slick and absorb less moisture from the surface of the mouth) also have a lower viscosity when pureed.

Quality is improved and storage losses reduced if sweet potatoes are cured for about 1 wk before they are stored for later sale. Uncured roots are sold during the harvest

season because curing is expensive and competing shippers can sell uncured roots at lower prices than must be charged for profitable sale of cured roots. If marketed within 3 or 4 days, uncured roots also tend to have a brighter more appealing color. Kushman et al. (1977) suggested preparing freshly dug roots for market and curing them in their shipping containers prior to shipment. Curing as little as 4 days may be adequate.

Although it is common knowledge in the sweet potato industry that cured sweet potatoes are sweeter and more moist, documented quantitative sensory and instrumental data are limited. The objective of this investigation was to determine the quality advantages, if any, of commercially curing whole sweet potatoes for 4 or 7 days prior to marketing during the harvest season.

EXPERIMENTAL

Preparation and shipping

The experimental design included 4 bushels each of sweet potatoes that were uncured, cured 4 days or cured 7 days (total of 12 bushels), and moved through normal marketing channels as part of a large commercial shipment. Effects of curing treatments were evaluated by a sensory panel and by physical and chemical tests. The experiment was replicated 8 times: 5 times during the fall of 1976 and 3 times during the fall of 1977. One way analyses of variance were used to evaluate treatment effects and year effects.

Seven days prior to each shipment, newly harvested, graded and washed 'Jewel' sweet potatoes packed in 1 bushel corrugated paper shipping containers were placed in a commercial curing room in Nash county, North Carolina. Temperature and relative humidity in the room were nominally 30°C and 90%, respectively. These conditions are considered adequate for curing (N.C. Agric. Ext. Service, 1975). Temperature and humidity recorders were placed in the curing room to monitor conditions. Four days prior to shipping, a second group of sweet potatoes was placed in the curing room. On the shipping day the two cured groups were combined with 4 bushels of the normal "green" pack to form the experimental shipment.

Test shipments were to Cincinnati, Ohio, in 1976 and to Indianapolis, Indiana, in 1977. All shipments were in trucks with insulated bodies. A temperature recorder was placed in one shipping container each time to test for extreme temperatures. Shipping dates were Sept. 14, Oct. 1, Oct. 15, Oct. 29, and Nov. 14, in 1976, and Sept. 23, Oct. 4, and Oct. 21, in 1977.

The test sweet potatoes were collected from a chain store warehouse in 1976 and from retail stores in 1977. Any comments of wholesalers, retailers, or customers about the sweet potatoes were noted but comments were not solicited. Samples, 8 US #1 sweet potatoes averaging about 350g each, were taken randomly from each treatment to simulate purchase from a retail store. Samples were placed in an insulated container with the temperature recorder and transported by air as personal luggage to the Food Science Dept., N.C. State Univ., Raleigh, N.C., then held at about 16°C for a few hours. Then, 6 or 7 days after they had left Nash County, North Carolina, the sweet potatoes were baked.

Quality evaluation

The sweet potatoes were wrapped in aluminum foil and baked in a convection oven at 190°C for 80 min. They were then cut open and the flesh was spooned out leaving about 2 mm near the skin and avoiding the fibrous materials at the ends. The flesh of all potatoes of each sample was combined and pressed through a colander (2 mm hole size); 250g was reserved for rheological and chemical tests, the rest was placed in plastic bags for evaluation by the sensory panel.

Sensory evaluation was by a trained profile panel of 6 to 8

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Table 1—Effect of curing and year on sensory and analytical evaluations of baked jewel sweet potatoes

Panel note or analytical test	Means for days of curing and year of shipment						Level of sig. between days cured (%)	Level of sig. between years (%)	Correl. coeff. between panel & apparent viscosity
	0 days		4 days		7 days				
	76	77	76	77	76	77			
Flavor notes^a									
Sweet aromatic	2.6	2.7	4.2	4.3	5.2	4.3	1	NS ^b	-0.73
Sweet basic	2.6	2.7	3.8	4.7	4.4	5.0	1	5	-0.39
Starchy	5.2	3.7	4.0	2.7	3.4	3.3	1	1	0.36
Caramel	1.8	1.0	2.4	2.3	3.2	2.3	1	5	-0.63
Sweet after taste	2.2	1.7	2.8	3.3	3.6	3.0	1	NS	-0.54
Texture notes^a									
First bite denseness	10.6	11.0	9.2	10.3	8.4	10.3	1	1	0.76
First bite moistness	6.8	4.7	8.0	5.7	9.4	5.7	1	1	-0.82
Mastication gumminess	10.0	10.7	8.2	10.0	7.2	10.3	1	1	0.90
Mastication moist. absorpt.	9.6	10.0	8.8	9.3	7.6	9.7	5	5	0.80
Ease of swallow	8.4	8.0	9.4	9.0	10.2	8.3	1	1	-0.83
Chalkiness	4.8	5.3	3.4	4.7	2.2	4.3	1	1	0.63
Analytical									
Apparent viscosity (Pa.s)	6.6	7.6	4.1	5.7	3.1	5.8	1	1	-
Ascorbic acid (mg/100g) puree	29.3	25.4	27.9	23.9	25.4	20.5	7	5	-

^a Based on a 0 to 14 intensity scale: 1 — not detectable; 14 — extremely intense.

^b Not significant at the 5% level.

members. They had been trained in both flavor (Cairncross and Sjostrom, 1950) and texture (Brandt et al., 1963; Szczesniak, 1963) profile methods by G.V. Civille (See Civille and Liska, 1975) and had several years experience on a variety of foods. A specific lot of canned, syrup-packed whole sweet potatoes was used as the standard against which all treatments were compared on all test dates. The pertinent flavor and texture notes used in the comparison are described as follows:

Flavor. *Sweet aromatic*—sweet perceived through the olfactory epithelium in the nasal air passage; *Sweet basic*—sweet perceived on the taste buds of the tongue; *Starchy*—resembling the typical flavor of white potato, an awareness of potato starch; *Caramel*—processed or cooked sugar flavor; and *Sweet after-taste*—aromatic sweet as perceived through the olfactory epithelium up to 1 min after swallowing.

Texture. *Denseness*—degree to which sample is solid or thick; *Moistness*—degree to which sample is wet, perceived as wet to the palate; *Gumminess*—amount of energy required to disintegrate sample to a state for swallowing; *Moisture absorption*—amount of saliva needed to hydrate sample; *Ease of swallow*—effort required to swallow sample; and *Chalkiness*—degree to which very fine sand-like particles are felt on the mouth surfaces, usually followed by a dry mouthfeel.

For rheological comparisons purees were made with 4 parts of cooked flesh to 3 parts water and stirred with a glass rod. Each puree sample was allowed to stabilize for about 1 hr and tested at room temperature. Puree apparent viscosities were measured with a Haake Rotovisco Model RV-1 viscometer (Haake, Inc., Saddle Brook, N.J.) equipped with a SVP-II rotor operating at 97.2 rpm. The method and equipment were previously used by Rao et al., 1975.

Sweet potato purees from the various treatments were compared chemically on the basis of total alcohol soluble carbohydrates (Dubois et al., 1956), total reducing sugars (Hodge, 1964), carotenes (Walter et al., 1978), ascorbic acid (AOAC, 1970) and percent dry matter.

RESULTS & DISCUSSION

General observation

Recorded temperatures in the shipping containers did not fall below 13°C (55°F) nor were there long periods above 30°C (85°F). Detrimental effects due to shipping temperature were, therefore, considered unlikely except for early season moderately high temperatures promoting sprouting.

In the early season shipments of 7-day cured potatoes, sprouting was quite noticeable in 1976 but was less noticeable in 1977. The sprouting disappeared as the season progressed. Moderate sprouting normally is characteristic of healthy roots with high organoleptic quality, but was considered undesirable by the warehouse produce manager in 1976 and some customers in 1977. Those that commented, with one exception, expressed a preference for sweet moist sweet potatoes over dry starchy ones. Most of the store managers said the shelf life was longer for the cured sweet potatoes than the uncured.

A few decaying potatoes were found both years, with more in 1976 than 1977. In both years, decay first appeared early in the season in the 7-day cured sweet potatoes. As the season progressed little or no decay was found in the cured roots, but began to appear in the uncured. Decay, however, was not a big problem.

Measured quality differences

The panel detected flavor differences among curing treatments (Table 1). Three of the notes also differed significantly between years. Overall, the uncured roots were less sweet and more starchy than the roots cured 4 or 7 days. This was sensed both as an aromatic sweetness and direct contact sweetness. Caramel flavor was also more evident in cured than in uncured roots. Roots cured 7 days generally were slightly sweeter than those cured only 4 days in 1976, but not in 1977. Apparently under the conditions of this study, the 4-day cure was nearly as effective as the 7-day cure.

The panel also detected texture differences. Higher first bite moistness, and lower moisture absorption during mastication were indications that the cured roots had a more moist mouthfeel. Probably, lower mastication gumminess and greater ease of swallow are also factors in the trait known as moistness in the sweet potato industry. A somewhat unexpected character note of significance was chalkiness. Both years the uncured roots were more chalky than cured. Chalkiness apparently differed between the 4-day and 7-day cures in 1976 but not in 1977 (Table 1). For specific years there was a strong correlation between starchy flavor and chalkiness.

Our data for apparent viscosity confirmed those of Rao

et al. (1975). Uncured roots produced more viscous purees than cured and mean viscosity was slightly lower for the 7-day than for the 4-day cure. Apparent viscosity was closely correlated with panel texture notes involving moist mouthfeel. Correlation coefficients were 0.8 or greater (Table 1).

Sweet potatoes tended to be less moist and more viscous, as measured instrumentally, in 1977 than in 1976 (Table 1). Curing reduced viscosity in both years but absolute values were higher in 1977 than in 1976. In 1977 we checked the viscosity of puree of sweet potatoes from the same farm that had been cured and stored for approximately a month. Viscosity was down to 3 pa.s, which approximated the value for the 1976 7-day cure, but was higher than the 1.5 pa.s value found by Rao et al. (1975) for 1973 'Jewel' sweet potatoes tested after a few weeks storage. It would have been desirable to have measured the alpha- and beta-amylase activities to determine if levels correlated with texture but this was not done. It is interesting that the flavor notes did not differ as significantly between years as the texture notes did. Possibly some unknown factor affected texture in 1977. It may or may not be coincidental that sprouting was less noticeable in 1977.

The various chemical analyses showed that only ascorbic acid level was affected by curing treatments and this difference was small compared to the differences between years and among shipments (Table 1). In 1976, the roots cured 7 days had significantly less ascorbic acid than the uncured roots (5% level). Over both years the difference was only significant at the 7% level (Table 1).

In the tests we used, sensory and physical measurements apparently were more sensitive to curing than the chemical analyses. It may mean that reductions in starch molecular weights insufficient to form dextrins and sugars are dominant.

CONCLUSIONS

NEWLY HARVESTED sweet potatoes that were cured before marketing produced a sweeter cooked product with a more moist and less chalky mouthfeel than uncured. A 4-day cure was nearly as good as a 7-day cure insofar as flavor and mouthfeel were concerned. Purees made from cured sweet potatoes were less viscous than purees made from uncured roots.

A possible problem in marketing cured roots during the so-called "green" season is sporadic sprouting.

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