SURFACE BROWNING OF FLORIDA POTATOES[1]

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ABSTRACT

The physiological disorder of surface browning periodically develops on Florida potatoes during transportation and marketing. Browning probably results from oxidation of natural substances in the potato such as tyrosin or orthohydroxyphenols which are liberated upon injury.

Weather conditions and handling techniques during harvesting predispose tubers to surface browning. Incidence of surface browning is coincident with diurnal changes where temperature is high and relative humidity low. Increased danger of browning occurs when the relative humidity falls below 50%. With low humidity conditions, skinned potatoes started to brown within 15 minutes from exposure and proceeded at a rapid rate as the exposure period was extended. A combination of skinning and bruising accentuated browning.

Avoidance of skinning or cessation of harvest during periods when the humidity is in the danger range would essentially eliminate surface browning.

INTRODUCTION

Production and harvesting of Florida potatoes has become a highly mechanized operation. These potatoes are quite perishable as compared with the National crop. Efficiencies which go along with the mechanized operation frequently cause damage to many of the tubers. Unless extra precautions are taken these tubers are predisposed to rot or to being thrown out of grade.

Harvest temperatures are most generally within the range to promote normal suberin formation; however, relative humidity especially during the middle of the day is suboptimal. When these conditions exist, portions of mechanically damaged tubers undergo oxidation resulting in objectional browning. The affected spots darken with time and become much more noticeable after a few days than at the end of the exposure period.

Market conditions generally determine the extent of complaints registered by buyers. A strong market favors merchandising of damaged potatoes without complaint while the same potatoes would be discounted or rejected under conditions of a weak market. The occurrence of objectionable surface browning is very sporadic due to changing markets and irregularities in weather conditions which predispose damaged tubers to this physiological disorder.

Weather conditions which are conductive to high rates of evaporation are the primary cause of surface browning. In laboratory tests, subjection of skinned tubers to a dry air blast (relative humidity of 25-30%, air speed of 250-300 feet per minute) for as little as 30 minutes was sufficient to cause pronounced browning, after the potatoes had been stored for several days (5). Exposure of like tubers in moist air for as long as 24 hours resulted in no browning upon subsequent holding. Potatoes in "still" dry air browned less than those exposed to the air blast.

Surface browning was prevented from developing on freshly skinned tubers by holding them for 12 hours under moist conditions at a temperature of about 80° F. (5). Shorter periods of exposure under the moist conditions resulted in increasing incidence of browning. When skinner potatoes were held under similar moist conditions at a much lower temperature (42-50° F.) prior to similated shipping, browning occurred within a relatively short time.

It would appear therefore, that surface browning is associated with suberization. This protective barrier was evident on the cut surface of potatoes after 1 day when the tubers were held at 70 to 95° F. and high humidity conditions (1). It is postulated that the 12 hour exposure period, under moist conditions and elevated temperature, was sufficient to initiate suberization thus blocking the browning reaction. A period of three days was required for suberization to appear on cut surfaces of potatoes held at about 45° F. (1). Thus, the skinned tubers held at the reduced temperature, which subsequently browned, did not develop sufficient suberin to prevent the blocking reaction.

Under field conditions, browning has been frequently observed when skinned tubers have been exposed to drying winds (2, 3, 4, 6), either while lying in the field, in bags, or in open

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trucks while being hauled to the packinghouse. Potatoes dug in the middle of the day or early in the afternoon and left exposed on the ground are much more likely to be damaged by browning than those dug early in he forenoon or late in the afternoon (6). Diurnal changes in both temperature and relative humidity are conducive to higher rates of evaporation and thus drying conditions, during this mid-day period. No definite relationship existed between temperature of the air nor light intensity and the severity of browning.

Varietal variation in susceptibility to browning has been noted (5) but few conclusions can be derived because of the paucity of data. Probably the incidence of drowning is well correlated with the susceptibility of the various cultivars to skinning, which may also be a function of maturity.

The purposes of this current study were to (1) ascertain the susceptibility of 2 important Florida varieties of potatoes to surface browning under varying conditions of relative humidity, (2) determine the time required to initiate browning, and (3) evaluate Florida weather conditions as to the extent they are conducive to the development of browning.

Experimental Procedure

Sebago and Red Pontiac potatoes were carefully dug from commercial fields at Bunnell, placed in protective polyethylene bags and transported immediately to the Vegetable Crops laboratory at Gainesville. Tubers were washed, dried, and then skinned by abrasion with and without bruising prior to being placed in large glass desiccators. Relative humidity within desicators was maintained at a range of from 25 to 100%. Agitation of air within the desiccators was accomplished by an externally driven impeller. Tubers were exposed to the various relative humidity regimes for 2 hours at a temperature of 70° F. and subsequently held 10 days at 70-80% relative humidity.

A second lot of tubers was skinned and exposed in an atmosphere of 25% relative humidity for periods varying from 10 to 120 minutes. As before, tubers were held for an additional 10 days before being scored for surface browning.

Severity of browning was determined numerically on a hedonic scale of 0-5 with 0 representing no browning and 5 as severe browning.

To establish the frequency of weather conditions which can initiate surface browning of Florida potatoes, daytime temperature and relative humidity readings during the month of May, 1957-1966, were tabulated from U.S. Dept. of Commerce Climatological Data sheets, Jacksonville area. These data are applicable to the conditions prevailing at Hastings during the latter part of the harvest period when expected danger of browning would be most prevalent.

Results and Discussion

Skinned potatoes exposed to decreasing percent atmospheric relative humility resulted in a progressive increase in the severity of surface browning as shown in Figure 1. The physiological disorder did not become readily apparent until the relative humidity was reduced to approximately 55%. Under the conditions of this study the tubers did not become objectionally brown until they had been exposed for 2 hours at a relative humidity of about 40%. A slight amount of browning occurred before this exposure but under most market conditions would be acceptable. Although the condition of no skinning nor browning is desired in the trade, neither is commensurate with economic production and handling practices.

Red Pontiac tubers were slightly more susceptible to browning than were those of Sebago variety. Growers have received more complaints

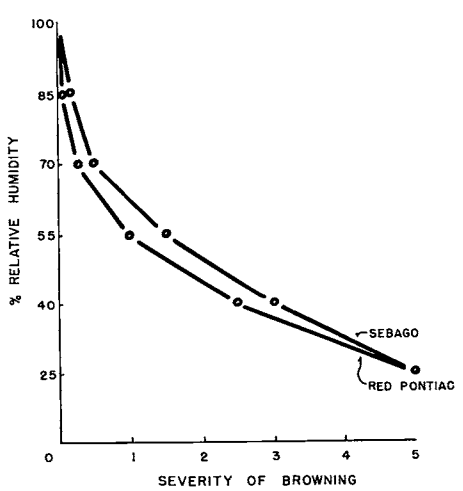

Fig. 1.—Effect of relative humidity on the development of surface browning. Skinned tubers were exposed for 2 hours and then held in storage for 10 days.

about red potatoes browning than white varieties, so it has been assumed the former were much more susceptible to browning than white varieties.

If it is assumed that browning is a result of oxidation of naturally occurring substances in the tuber which are liberated upon rupture of surface cells, then gross differences between varieties would not be expected, as cultivars tend to be rather homogeneous in internal composition. More likely, susceptibility to browning is probably associated with an increased incidence of mechanical damage. Red potatoes could be more easily damaged or the maturity at which they are dug might account for the increased injury.

At low relative humidity conditions (25%) when the rate of evaporation would be very high, browning was initiated after as little as 15 minutes exposure (Figure 2). Increasing time of exposure at this low relative humidity condition progressively increased the severity of browning. Skinned tubers exposed for 60 minutes at 25% relative humidity developed surface browning comparable to those exposed for 120 minutes at 55% humidity.

The severity of browning increased on all potatoes that were bruised and skinned. It would appear that bruising caused a greater liberation of substances that were oxidized. Bruising also caused desiccation of the surrounding tissue.

During the daylight hours, temperatures followed an expected pattern, as shown in Figure 3, reaching a maximum at 1 P.M. Although the 10 year mean temperature at 1 P.M. was 83° F., there was a considerable range, 62-97° F., from day to day at this particular hour. Temperature is secondary to relative humidity in the cause of surface browning but generally higher temperature is associated with a reduced relative humidity thus compounding predisposition of tubers to oxidation.

Evapo-transpiration potential was maximal at 1 P.M. as shown in Figure 4. The mean low, 52%, at this period of the day might suggest that browning conditions are minimal. However, actually a relative humidity of less than 50% was recorded during 134 days out of the 310 days under study. Thus, during about half of the days of May, conditions were experienced which were conductive to development of high rates of browning. In view of these data the danger period occurred between 10 A.M. and 4 P.M. Although some low relative humidity condions prevailed at 7 P.M., danger of browning at this period of the day would be minimal because of reducing temperature and rapidly increasing humidity conditions.

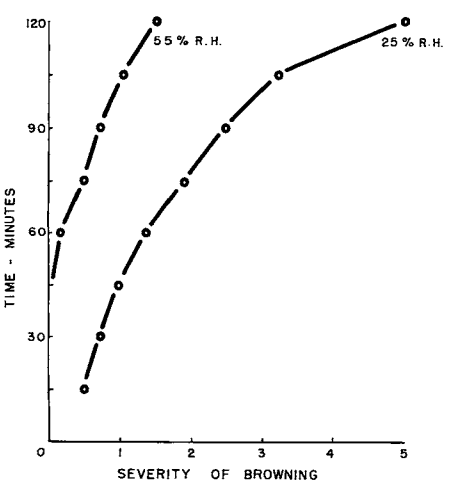

Fig. 2.—Effect of exposure duration and relative humidity on development of surface browning on skinned Sebago potatoes.

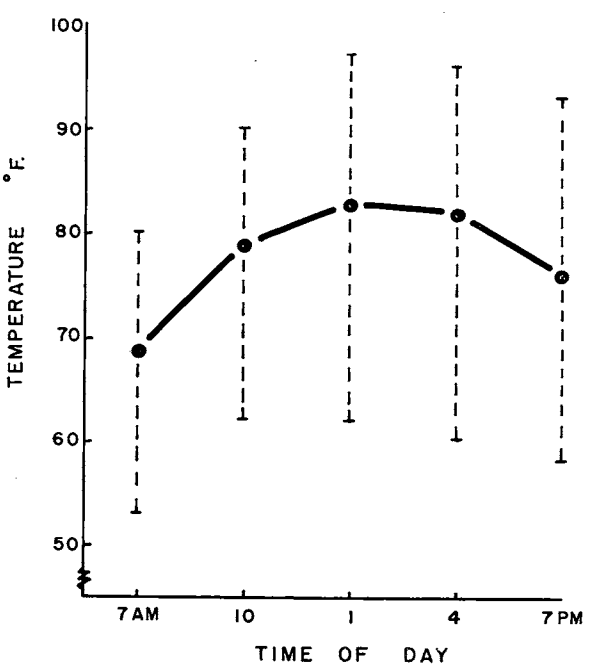

Fig. 3.—Mean temperature and range during daylight hours at Jacksonville, Florida. May 1957-1966.

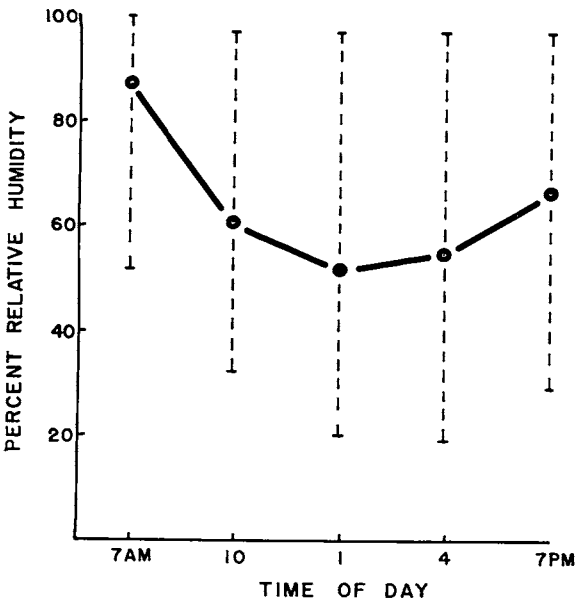

Fig. 4.—Mean percent relative humidity and range during daylight hours at Jacksonville, Florida. May 1957-1966.

It is therefore concluded that freshly dug Florida potatoes, both red and white varieties, are subject to surface browning if epidermal tissue is injured and they are exposed to brief periods when the evaporation rate is high. On a very dry, hot day potatoes may be injured by exposure for as little as 15 minutes. In general it takes at least 2 hours to initiate browning. Dry conditions are most prevalent between 10 A.M. and 4 P.M. during which time growers, particularly those not harvesting in bulk, should provide immediate protection to skinned tubers. During extremely dry conditions growers might curtail harvesting until more favorable conditions exist.

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FACTORS AFFECTING THE PHYSICAL AND NUTRIENT COMPOSITION OF DRIED CITRUS PULP

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Dried citrus pulp has been shown by both research (1, 3, 5, 7, and 9) and practical feeding to be a valuable feedstuff for ruminants. Specific processing procedures vary from one production source to another and may vary within the same source throughout the season. The basic procedure consists of grinding or chopping and then dehydrating the fruit residue. The fruit residue is either dehydrated as such, or it is pressed and molasses is produced from the press liquor. A portion of the molasses is sometimes added back to the pulp in the drying process. The finer particles of the dried pulp are often removed and either sold as citrus meal or pelleted and added back to the pulp. These and other differences in processing, in source and variety of fruit, and in type of canning operation from which the fruit residue is obtained, may result in variations in the nutrient content of dried citrus pulp.

The objectives of this study were to determine: (1) physical characteristics of dried citrus pulp, (2) nutrient content and the contribution of the various physical fractions to the total nutrient composition of pulp, and (3) variability in the nutrient composition of citrus pulp marketed within the state.

EXPERIMENTAL PROCEDURE

Twenty-four, 100-pound samples of dried citrus pulp representing thirteen production

Florida Agricultural Experiment Stations Journal Series Number 2546.
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