CARIBBEAN FOOD CROPS SOCIETY

40

Fortieth

Annual Meeting 2004

Proceedings of the Caribbean Food Crops Society. 40:41-45. 2004

ALCOHOL INSOLUBLE SOLIDS AND RELATIVE SWEETNESS FOR SWEETPOTATO VARIETIES RECOMMENDED FOR PUERTO RICO

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ABSTRACT: In sweetpotato, alcohol insoluble solids is an indirect measurement for starch. Recent efforts toward improvement of the tropical-type adapted to the Caribbean Basin relate to the assessment of starch and sugar concentration. The objective was to assess the starch content of two types of varieties recommended for use in Puerto Rico and to compare results to that of the standard variety. The results confirm the higher sweetness of the tropical-type variety as compared to that of the substaple-type. The increase in sweetness was accompanied by a decrease in alcohol insoluble solids. Percentage of alcohol insoluble solids for the substaple variety was significantly higher than that of the tropical-type indicating more starch concentration in the former. Dominicana, the standard variety used in Puerto Rico was statistically similar in alcohol insoluble solids to the substaple-type. It is reasonable to suggest that the Puerto Rican market has accepted a variety with a relatively high starch content.

INTRODUCTION

Research documenting carbohydrate changes in sweetpotato (*Ipomoea batatas*) roots dates back to the 1910s (Hasselbring and Hawkins, 1915). In 1920, there was a report on Diastase (now Beta-amylase), the enzyme involved in the conversion of starch into sugars (Gore, 1920). Carbohydrates constitute about 80 to 90% of the dry matter in sweetpotato root and are mainly composed of starch and sugars (Martin, 1986; Kays et al., 1989; Picha, 1985). Starch may vary from 50 to 73%, whereas sugars varied 5.8 to 14.9% (Babu, 1994). Increase in total sugars after heating comes from the thermal and enzymatic hydrolysis of starch (Kays et al., 1989; Babu, 1994).

Tropical-type varieties, of preference in the Antilles of the Caribbean Basin, have greater dry weight than the dessert-type varieties, commonly grown throughout the Southern US (La Bonte et al., 2000). As the dry matter in sweetpotato storage roots is directly correlated to starch content, tropical-type varieties tend to be starchier than the dessert-types. In sweetpotato, the alcohol insoluble solids (insoluble fraction after the ethanolic extraction of sugars) is an indirect measurement for starch (Wu et al., 1991; Walter Jr., 1992; Walter Jr. et al., 1997).

Recent efforts toward improvement of the tropical-type adapted to the Caribbean Basin relate to the assessment of starch and sugar concentration. Base line information on the relative starchiness of sweetpotato varieties used in Puerto Rico was obtained by Hernandez-Carrion (2001); parts of the results are presented herein. The specific objective of this study was to assess the starch content of two types of varieties recommended for use in Puerto Rico and to compare results to that of the standard variety. This work was conducted as part of a more ample effort for the establishment of quantitative criteria for the selection of new tropical-type varieties.

MATERIALS AND METHODS

Storage roots were obtained from a field planted at the Juana Diaz Experiment Station farm of the University of Puerto Rico. Data obtained for varieties 'Miguela' and 'Viola' were used. 'Miguela' is a tropical-type variety selected during the 1960-70s (Badillo-Feliciano, 1976), whereas 'Viola' is a substaple-type variety (Martin, 1987). Results on alcohol insoluble solids for 'Dominicana' were included to be compared to those of the two former varieties. Dominicana is cream-fleshed and the standard variety used in Puerto Rico.

Plantings were in May and December 1999. After planting, standard management practices were followed (University of Puerto Rico - Estacion Experimental Agricola, 1997). Data presented was for storage roots harvested 162 days after planting. Roots weighing from 150 to 450 g were selected at random, and after curing were processed either raw, boiled or microwaved. Roots were processed as: i) boiling water for 30 minutes, ii) microwaved at maximum energy in a 2450 MHz microwave oven for 12 to 15 minutes or iii) neither boiled nor microwaved (plain raw). Once treatments were applied, flesh was removed from the center of the root, dried at 55°C and ground to pass a # 20 mesh for preparing a flour. The flour was placed in glass jars and frozen at -20°C until the extraction of sugars, the concentration of which was determined.

Sugars extraction was made by using boiling the flour in 80% ethanol for 5 minutes. Sugars; glucose, fructose, sucrose, and maltose, were determined by using a chromatograph system equipped with an autosampler and a refractive index detector. Procedures for sugar determinations followed those described by Picha (1985) as modified by Hernandez-Carrion (Hernandez-Carrion, 2001; Hernandez-Carrion et al., 2003). Concentration of sugars was used to calculate sucrose equivalents as a measurement of sweetness (Koehler and Kays, 1991). Once sugars were extracted, the insoluble solid fraction (the alcohol insoluble solids) were placed in a tarred weighing dish, dried in a convection oven at 55° C for 24 h then weighed for the alcohol insoluble solids determination. Alcohol insoluble solids were expressed as a percentage of the flour used for sugar extraction.

RESULTS AND DISCUSSION

Sucrose equivalents:

As expected, across the flesh-processing treatments, sucrose equivalents for the tropical-type 'Miguela' were higher than those for the substaple-type 'Viola' in both the May and the December plantings (Table 1). These results confirm the higher sweetness of the tropical-type as compared to that of the substaple-type. Except for 'Miguela' in the May planting, sucrose equivalents increased after boiling and microwaving (Table 1). Increase in whole sweetness after boiling and microwaving has been associated primarily with the increase in the concentration of maltose. This general pattern has previously been reported by Picha (1985), Koehler and Kays (1991) and Hernandez-Carrion et al., (2003) among other researchers. In this study the increase in sweetness after boiling and microwaving was accompanied by a decrease in alcohol insoluble solids ($r = -0.26$) (Table 1). The decrease in alcohol insoluble solids after heating in a proportion similar to the increase in total sugars has previously been reported by Szyperski et al., (1986), Wu et al., (1991) and Walter Jr. et al., (1997) among others.

Alcohol insoluble solids:

Starch is the main component of the dry matter in sweetpotato storage roots. As previously stated, in sweetpotato the alcohol insoluble solids is an accepted indirect measurement of starch (Wu et al., 1991; Walter Jr., 1992, Walter Jr. et al., 1997). Percentage of alcohol insoluble solids for the substaple variety 'Viola' was significantly higher than that of the tropical-type 'Miguela' indicating more starch concentration in the former (Table 1). 'Dominicana', the standard variety used in Puerto Rico, however, was statistically similar in alcohol insoluble solids to the substaple-type 'Viola' (Table 2). Because 'Dominicana' has been the dominant variety for more than a decade in Puerto Rico; and because it is similar in starch content to a substaple-type, it appears reasonable to suggest that the Puerto Rican market has accepted a variety with a relatively high starch content. However, it must be taken into account that classification of sweetpotato varieties into types is strictly arbitrary and that there is variation in characteristics of varieties within a particular type. Notwithstanding, if there is a change in market from a relatively low starch content such as that in 'Miguela' to an increased starch content such as that in 'Dominicana', our breeding program must take into account such changes.

ACKNOWLEDGEMENTS

This study was supported in part by the USDA-CSREES's, Special Grant Tropical/Subtropical Agricultural Research (T-STAR) administered by the Caribbean Advisory Group. Project Grants were 97-34135-4717, 02-34135-12662, and a special TSTAR travel grant to attend to the 40th Caribbean Food Crop Society Annual Meeting.

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Table 1. Sucrose equivalents and alcohol insoluble solids (AIS) for sweetpotato varieties planted in two seasons [1].

			Flesh Processing Treatments					
			Raw		Boiled		Microwaved	
Season of Planting	Variety	Variety Type	Sucrose Equivalents	AIS	Sucrose Equivalents	AIS	Sucrose Equivalents	AIS
				%		%		%
May	Viola	Substaple	2.5	90	4.2	78	5.4	77
	Miguela	Tropical	10.0	84	5.8	76	6.0	74
November	Viola	Substaple	2.8	93	4.0	75	5.1	77
	Miguela	Tropical	5.5	89	4.9	73	6.2	73

[1] Results in this table are a summary of those which were excerpted from Hernandez-Carrion (2001). Results for other varieties were omitted for the effects of these proceedings.

Table 2. Alcohol insoluble solids for three sweetpotato varieties planted at two seasons [1].

Month of Planting	Variety	Flesh Processing Treatments		
		Raw	Boiled	Microwaved
		%		
May	Viola	90a[2]	78a	77a
	Dominicana	91a	76b	75ab
	Miguela	84b	76b	74b
November	Viola	93a	75a	77a
	Dominicana	92a	76a	76a
	Miguela	89b	73b	73b

[1] Results in this table are a summary of those which were excerpted from Hernandez-Carrion (2001). Results for other varieties were omitted for the effects of these proceedings.
[2] Means followed by the same letter are not significantly different.