# Absorption of Sulfur Dioxide by Habanero (*D. rotundata*) Yam[1]

*Edelmiro J. Rodríguez-Sosa and Orlando Parsi Ros*[2]

ABSTRACT

Habanero (*D. rotundata*) yam chunks were dipped in 4,000 p/m sulfur dioxide solutions at different pH levels and at different dipping times. As dipping time increased, $SO_2$ absorption increased whereas when pH of the solution increased, $SO_2$ absorption decreased. Total acidity of yam chunks varied from 0.095 to 0.143%. Total acidity tended to increase with the increase in dipping time.

## INTRODUCTION

Yam (*Dioscorea rotundata*) is one of the most extensively cultivated root crops in Puerto Rico (3). For processing, fruits and vegetables are generally peeled with hot lye solutions. In the case of Habanero yam, this treatment activates the enzyme system, rendering the tuber unfit for processing if proper measures are not taken to inhibit that system.

Sulfite solutions are generally used to inhibit enzyme activity in processing fruits and vegetables. Sulfur dioxide is used as an antioxidant and as an inhibitor of enzyme catalyzed oxidative discoloration, and of non-enzymic browning during preparation, storage, or distribution of many food products (6).

Stafford and Bolin (16) found an increasing absorption rate of bisulfite in apricots that were dipped in progressively lower pH solutions. Sánchez-Nieva et al. (12) found that the $SO_2$ content of green plantain slices sulfited in metabisulfite solutions increases as dipping time increases but not in a direct linear relationship. They also found that as pH of sulfiting solutions decreased, $SO_2$ absorption increased, and that sulfiting to levels of 100 to 150 p/m $SO_2$ controlled browning. Sánchez-Nieva and Mercado (15) found that in hot-water and steam-peeled green bananas sulfited in an aqueous $K_2S_2O_5$ solution at room temperatures, sulfite absorption increased with an increase of $K_2S_2O_5$ concentration and with the dipping time, but decreased if the pH of the sulfiting solution was lowered by the addition of citric acid. They also found that decreasing the pH of the sulfiting solution increased the acidity and decreased the pH of the fruit, but that these changes had no effect on flavor. To prepare banana flour, Rodríguez-Sosa et al. (8) soaked steam-peeled green bananas for 4 min in

[1] Manuscript submitted to Editorial Board March 31, 1980.

[2] Associate Food Technologist and Research Assistant, respectively, Food Technology Laboratory, Agricultural Experiment Station, Mayagüez Campus, University of Puerto Rico, Río Piedras, P.R.

a 1000 p/m $K_2S_2O_5$ solution previously acidified to pH 3.3 with citric acid. Blanching ripe bananas prior to drum drying improved the product, and the addition of $SO_2$ improved its color (11).

Taniers (*Xanthosoma sagittifolium*) also developed browning discolorations after lye peeling. These reactions could be controlled by a 2-min dip in a 1% citric acid solution followed by sulfitation to levels of 200 p/m (13). Working with potatoes, Amla and Francis (1), Ross and Treadway (10), and Francis and Amla (5) found that sulfite absorption increased as pH of the $SO_2$ solution decreased, but working with taniers Sánchez-Nieva (14) found that as pH of the sulfiting solutions decreased, $SO_2$ absorption decreased.

In view of the differences found in $SO_2$ absorption reported in the

TABLE 1.—*Sulfur dioxide absorption and total acidity of Habanero yam chunks dipped at different time intervals in 4,000 p/m potassium metabisulfite solutions*

| Dipping time | pH of $K_2S_2O_5$ dipping solutions | | | | | | |
|---|---|---|---|---|---|---|---|
| | 3.00 | 3.50 | 4.00 | 4.50 | 5.00 | 5.50 | 6.00 |
| *min* | *$SO_2$ absorption (p/m)* | | | | | | |
| 2 | 51.25 | 43.24 | 40.84 | 41.64 | 34.43 | 32.00 | 10.41 |
| 4 | 93.68 | 65.66 | 46.44 | 41.64 | 35.23 | 41.60 | 10.41 |
| 6 | 97.69 | 72.86 | 51.25 | 51.25 | 40.84 | 43.20 | 14.41 |
| 8 | 100.09 | 74.46 | 51.22 | 57.65 | 73.66 | 41.60 | 14.41 |
| 10 | 139.33 | 92.08 | 60.85 | 64.86 | 76.07 | 64.00 | 15.22 |
| | *Total acidity (%)* | | | | | | |
| 2 | 0.110 | 0.095 | 0.110 | 0.097 | 0.103 | 0.128 | 0.105 |
| 4 | 0.110 | 0.103 | 0.110 | 0.101 | 0.095 | 0.128 | 0.105 |
| 6 | 0.125 | 0.110 | 0.117 | 0.103 | 0.095 | 0.123 | 0.105 |
| 8 | 0.143 | 0.106 | 0.115 | 0.103 | 0.110 | 0.129 | 0.105 |
| 10 | 0.143 | 0.106 | 0.128 | 0.110 | 0.103 | 0.114 | 0.105 |

literature when different commodities and pH levels were used, this study was undertaken to determine the characteristics of $SO_2$ absorption in Habanero yams.

## MATERIALS AND METHODS

Habanero yams were obtained in the local market. They were brought to the laboratory and stored at ambient conditions until used. About 10 lb were used per test. Yams were peeled in a 20% boiling lye solution for 4 min, brushed in a rotary washer provided with water jets and nylon brushes for removal of any peel left and excess lye solution, and trimmed and cut into chunks of about 1/2 × 1/2 × 2 in. To avoid browning reactions the peeled yams were kept under water until sulfitation. After

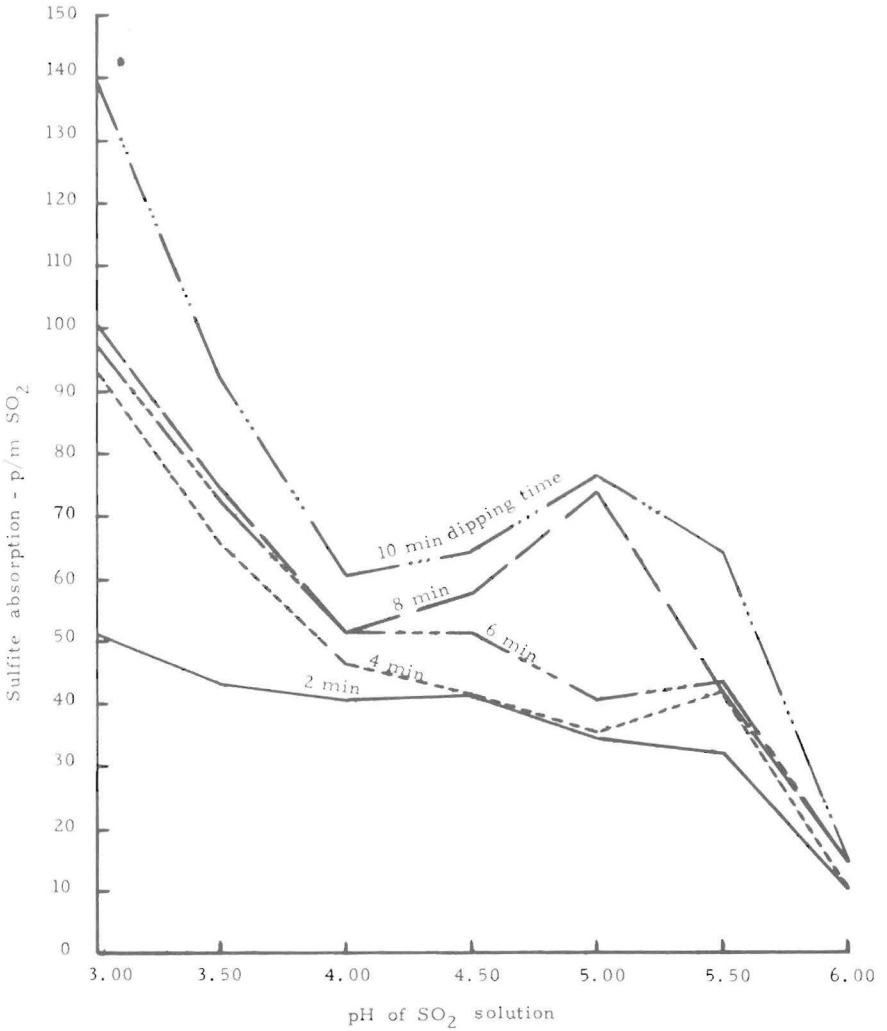


FIG. 1.—Relation of $SO_2$ absorption with pH of solutions at different dipping times.

being cut, yams were dipped for 2, 4, 6, 8, and 10 min in 4,000 p/m $K_2S_2O_5$ solution previously acidified with citric acid to pH 3.00, 3.50, 4.00, 4.50, 5.00, and 6.00. Samples of each dipping time and pH level were taken for $SO_2$ and total acidity analyses.

Sulfur dioxide analyses were performed according to the method developed by Ross and Treadway (9). Total acidity was measured according to AOAC (2). The obtained data was submitted to the analysis of variance and Duncan's multiple range test (4, 7).

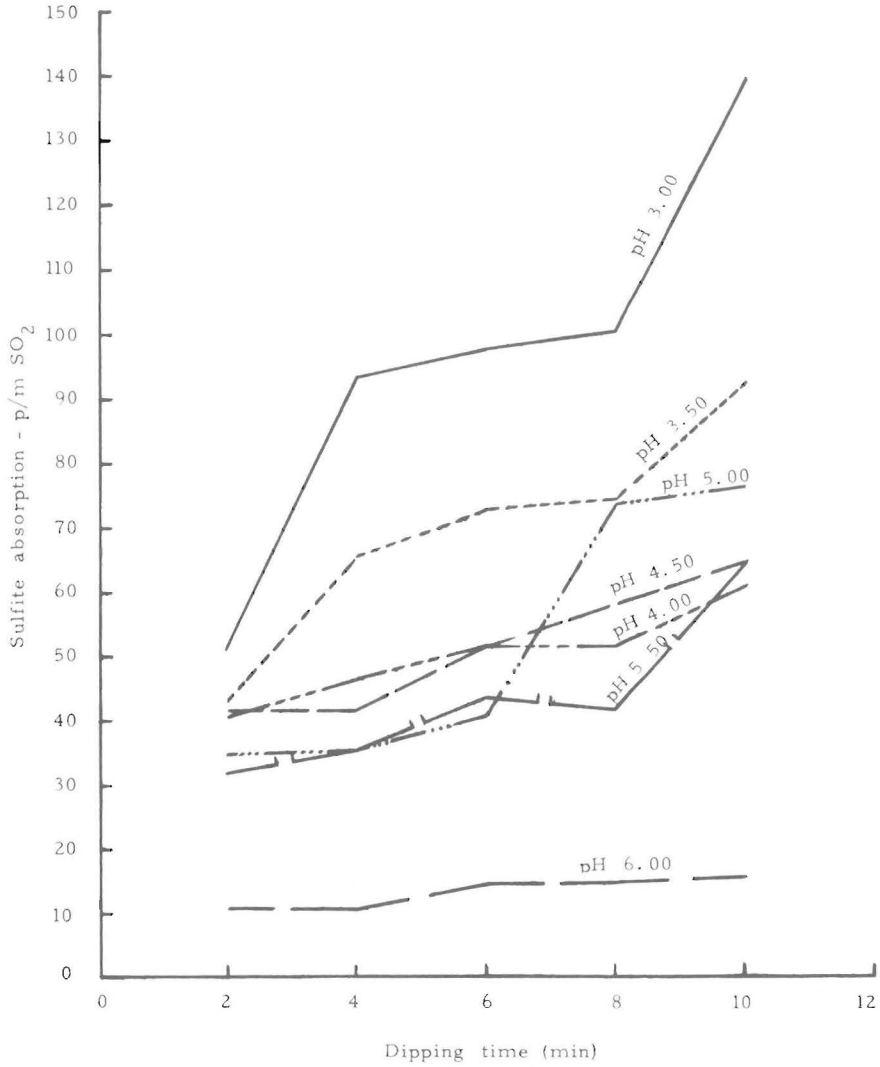


FIG. 2.—Relation of $SO_2$ absorption with dipping times in solutions of different pHs.

## RESULTS AND DISCUSSION

Table 1 shows the results of $SO_2$ and total acidity analyses. As pH of the dipping solution was increased, $SO_2$ content of yam chunks decreased (fig. 1); as dipping time increased, $SO_2$ absorption by yam chunks increased (fig. 2). Thus, the higher $SO_2$ absorption was found in samples at pH 3.00 and 10 min dipping time; the lower was found at pH 6.00 and 2 min dipping time.

Highly significant differences were found among samples at pH 3.00 and 3.50; but at the same time there were also highly significant differences between these samples and all other samples. At the same time they differed in a highly significant way from each other. No significant differences were found among samples at pH 4.00, 4.50, and 5.00, but they were highly different from samples at pH 5.50 and 6.00. Finally, there was a high significant difference between samples at pH 5.50 and 6.00. Regarding dipping time, all samples were highly different from each other.

Total acidity of samples varied from 0.095 to 0.143% and increased with the increase in dipping time.

No browning was observed in samples after dipping in the $SO_2$ solutions at the different pH levels and dipping times. On the other hand, the levels of $SO_2$ absorption were relatively low, so no flavor changes are expected in the yams after processing.


## RESUMEN

El tratamiento con bisulfito es uno de los más extensamente usados para evitar las reacciones de oscurecimiento en frutas y hortalizas. En este estudio se investigó la retención del bisulfito por el ñame Habanero cuando fue sumergido en soluciones de 4,000 ppm a diferentes niveles de pH y la duración de la inmersión. Se determinó que a mayor tiempo de contacto mayor es la absorpción de bisulfito por el ñame y que mientras más bajo es el pH mayor es la absorpción de dicho agente químico. La acidez en las muestras tratadas con bisulfito varió entre 0.095 y 0.143% y tendió a aumentar con la prolongación de la inmersión. Se encontró además que todas las soluciones y los periodos de inmersión inhibieron las reacciones enzimáticas de descoloración.


## LITERATURE CITED


1. Amla, B. L. and Francis, F. J., 1961. Effect of pH of dipping solutions on the quality of prepeeled potatoes, Am. Potato J. 38: 121–30.
2. Association of Official Agricultural Chemists, 1979. Official Methods of Analyses, 12th ed, Washington, D.C.
3. Facts and Figures of Puerto Rico Agriculture, 1977. Department of Agriculture, Santurce, P.R.
4. Duncan, D. B., 1955. Multiple range and multiple F test, Biometricts 2: 1–42.
5. Francis, F. J. and Amla, B. L., 1961. Effect of residual $SO_2$ on the quality of prepeeled potatoes, Am. Potato J., 38: 89–94.
6. Joslyn, M. A. and Braverman, J. B. S., 1964. The chemistry and technology of the pretreatment and preservation of fruits and vegetable products with sulfur dioxide and sulfites, Adv. Food Res. 5: 97–160.
7. Robinson, P., 1959. Test of significance, Bull. Stat. Res. Ser., Canada Dep. Agric.
8. Rodríguez-Sosa, E. J., González, M. A., B. de Caloni, I. and Parsi-Ros, O., 1977. The preparation of green banana flour, J. Agri. Univ. P.R., 61 (4): 470–8.

9. Ross, L. R. and Treadway, R. H., 1960. A rapid method for the determination of sulfur dioxide in sulfite prepeeled potatoes, Am. Potato J. 37: 102–4.
10. ——, and ——, 1961. Factors affecting the $SO_2$ uptake in sulfited prepeeled potatoes, Am. Potato J., 38: 9–13.
11. Samish, Z. and Coussin, B. R., 1965. The production of dehydrated flakes as a means of utilizing surplus bananas, Israel J. Agric. Res., 15 (1): 49.
12. Sánchez-Nieva, F., Bueso, C. E. and Hernández, I., 1975. Studies on the freezing of green plantains (*Musa paradisiaca*) II. Sulfitation to control browning. J. Agri. Univ. P.R., 59 (2): 92–106.
13. ——, 1977. A comparison of the processing characteristics of three tanier cultivars. J. Agri. Univ. P.R., 61 (3): 337–44.
14. ——, 1977. Control of browning in lye peeled taniers, J. Agri. Univ. P.R., 61 (4): 489–500.
15. —— and Mercado, M., 1978. Effect of peeling method on the absorption of aqueous bisulfite by green bananas, J. Agri. Univ. P.R., 62 (2): 191–8.
16. Stafford, A. E. and Bolin, H. R., 1972. Absorption of aqueous bisulfite by apricots, J. Food Sci., 37 (6): 941–3.