Effect of Peeling Method on the Absorption of Aqueous Bisulfite by Green Bananas[1]

F. Sánchez Nieva and M. Mercado[2]

ABSTRACT

Peeling of green bananas is facilitated by heating the fruit in steam or hot water. When fruit peeled with hot water and steam was sulfited in an aqueous $K_2S_2O_5$ solution at room temperature, sulfite uptake increased with the concentration of the sulfiting solution and the length of the dip, but decreased when the pH of the sulfiting solution was lowered by the addition of citric acid. Lowering the pH of the sulfiting solution lowered the pH and increased the acidity of the fruit, but these changes had no effect on flavor. When steam-peeled fruit blanched in hot water at 200° F (93° C) was sulfited, sulfite uptake increased with length of the treatment; when fruit was blanched in steam, sulfite uptake decreased as time of blanching increased.

INTRODUCTION

One of the most difficult operations in the processing of green bananas is peeling. The peel is strongly attached to the pulp and is very difficult to remove by hand. Sánchez Nieva et al. (16) peeled green plantains by steaming the fruit at 80 lb/in^2 steam pressure for 30 s. The treatment loosened the peel which could then be the easily removed by hand. This same method was used for peeling green bananas for dehydration by Rodríguez Sosa et al. (15). Green bananas may also be peeled by heating in water at or near boiling temperature until the peel is loose enough to be removed by hand.

When bananas are peeled, if the enzyme polyphenol oxidase is still active, rapid browning of the exposed tissue takes place (19). Sulfitation is extensively used to control enzymatic browning in fruits and vegetables (9, 12, 4). Although sulfites are considered safe additives (4), it is desirable to use the lowest effective dosage in controlling browning. Sulfite uptake is influenced by factors such as nature of the raw material sulfited, type of sulfite used, pH and concentration of the sulfiting solution, dipping time, blanching treatments and other processing variables (1, 2, 6, 7, 8, 10, 14, 18). This paper reports the results of studies to determine the effect of peeling method on the absorption of aqueous bisulfite by green bananas.

MATERIALS AND METHODS

The green bananas used in this study were purchased from a banana-ripening plant the same day received. Stage of development ranged

[1] Manuscript submitted to Editorial Board September 15, 1977.

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

from light three quarters to full. Post harvest handling and storage before delivery to the ripening plant was not known. All bananas were of the Montecristo cultivar grown in Puerto Rico.

The green fruit was stored at 45° F (7.2° C) until processed. Two methods of removing the peel were used: 1) Hot-water peeling in which the hands were cut from the main stem and submerged in water at 200°

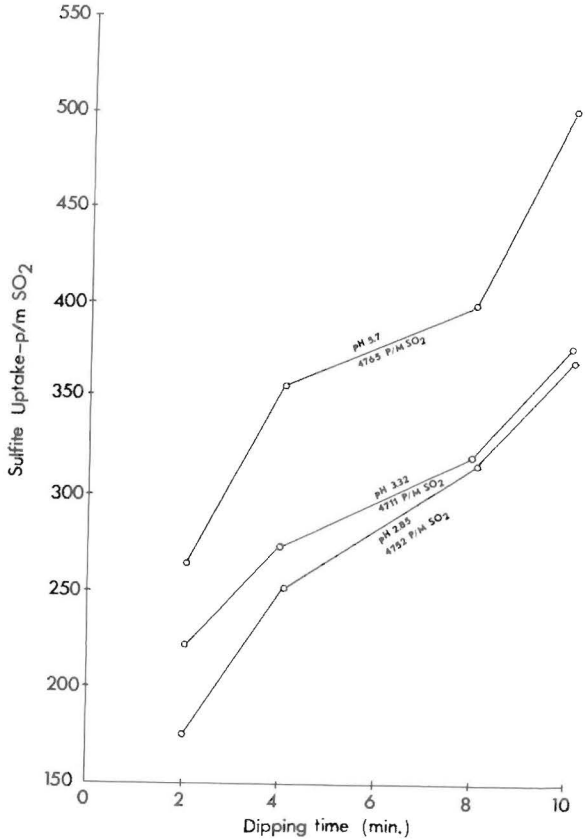

FIG. 1. – Effect of pH and dipping time on sulfite uptake by hot-water-peeled green bananas. Sulfiting solution – 1% w/w $K_2S_2O_5$.

F (93° C) for 30 min, and then cooled under water at room temperature until the temperature dropped enough for safe handling. The peel was removed by hand and the peeled fruit was kept under water at room temperature until further processed; and 2) steam-peeling in which the fruit was treated in a retort at 80 lb/in^2 steam pressure for 30 s. After discharge from the retort, the treated fruit was handled as indicated for the hot-water-peeled fruit.

The peeled fruit was sliced by hand into pieces from 1 to 1.5 in (25–38 mm) thick, sulfited at room temperature (82° F, 27.8° C) in $K_2S_2O_5$ solution of the strength required by the experiment in progress. If pH adjustment was needed, the pH of the sulfiting solution was adjusted to the desired value with citric acid.

Acidity and pH were determined by official A.O.A.C. methods (11). SO_2 content of the sulfiting solution was determined by the method

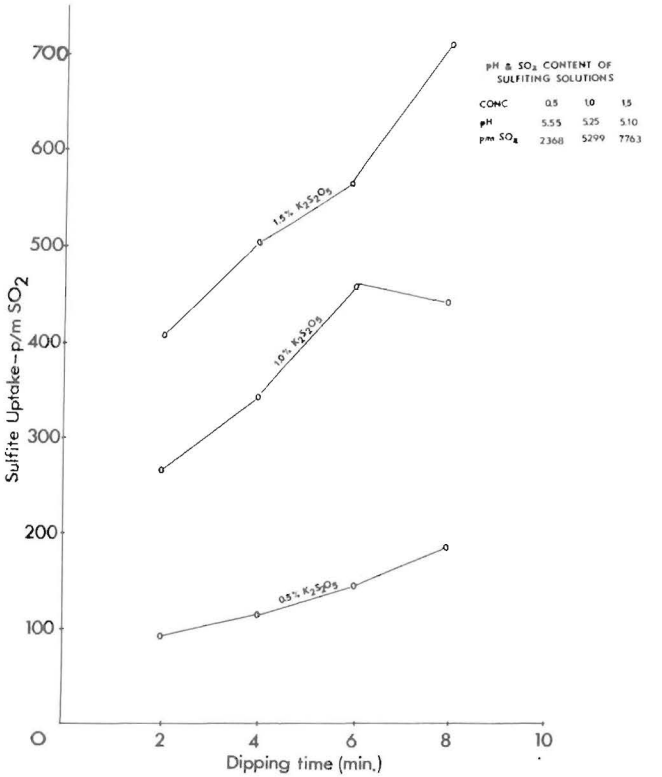

FIG. 2.—Effect of concentration of sulfiting solution on sulfite uptake by hot-water-peeled green bananas.

described in the Food Chemical Codex (5). SO_2 content in raw and frozen sulfited slices was determined by the method of Ross and Treadway (23). Sulfite content is expressed as p/m SO_2.

For the determination of polyphenol oxidase activity, a slice about 1/8 in thick was cut crosswise from a banana. The slice was placed in an open petri dish and bathed with a 1% cathecol solution. Positive enzyme activity was indicated by the development of a brown color in the tissue within 5 min of exposure to air (12).

RESULTS AND DISCUSSION

HOT-WATER PEELING

Figure 1 shows the effect of pH on the sulfite uptake by hot-water-peeled green bananas sulfited at room temperature (82° F, 27.8° C) dipped from 2 to 8 min in 1% $K_2S_2O_5$ solution. Sulfite uptake for each dipping time decreased when the pH of the sulfiting solution was lowered from 5.7 to 2.85 by the addition of citric acid. Similar results were obtained when the green bananas were sulfited in 0.5% $K_2S_2O_5$ solution. Sánchez Nieva et al. (16) found that when sulfiting green plantains, sulfite uptake decreased as the pH of the sulfiting solution increased. Although quite similar in chemical composition and other

TABLE 1.—*Effect of pH of sulfiting solution and dipping time on the pH and acidity of the sulfited green bananas*

Dipping time	pH of sulfiting solution	Sulfited bananas	
		pH	Acidity
Min			%
	5.7		
0		5.30	0.180
2		5.22	.209
4		5.25	.199
6		5.22	.215
8		5.22	.204
	2.85		
0		5.21	.216
2		4.99	.237
4		4.90	.259
6		4.91	.277
8		4.89	.273

characteristics, green bananas and plantains, it was found, behave very differently on sulfiting.

In prepeeled potatoes Amla and Francis (1), Ross and Treadway (14), and Francis and Amla (6) reported an increase in sulfite uptake as the pH of the sulfiting solution was lowered. However, Sánchez Nieva (17) found that when taniers, which are similar in composition to potatoes, are sulfited, lowering the pH of the sulfiting solution resulted in a lower sulfite uptake. Evidently, the nature of the material has an effect on the sulfite uptake that determines the effect of pH in lowering or increasing sulfite absorption by the tissue.

Figure 2 shows the effect of concentration and dipping time on sulfite uptake by hot-water-peeled bananas. Sulfite uptake increased with the concentration of sulfite in solution. Sulfite uptake proceeded at a faster rate as the concentration of sulfite was increased. The effect of concen-

tration of sulfite and dipping time followed the same pattern as that observed by Brekke and Allen (3) in ripe bananas and by Sánchez Nieva et al. (16) in green plantains.

Table 1 shows the effect of the pH of the sulfiting solution and dipping time on the pH and acidity of the sulfited bananas; pH decreased with dipping time with the corresponding increase in acidity. Sulfiting in solutions of low pH resulted in sulfited bananas with lower pH and higher acidity. The change in acidity resulting from sulfiting in solutions of low pH had no effect on flavor.

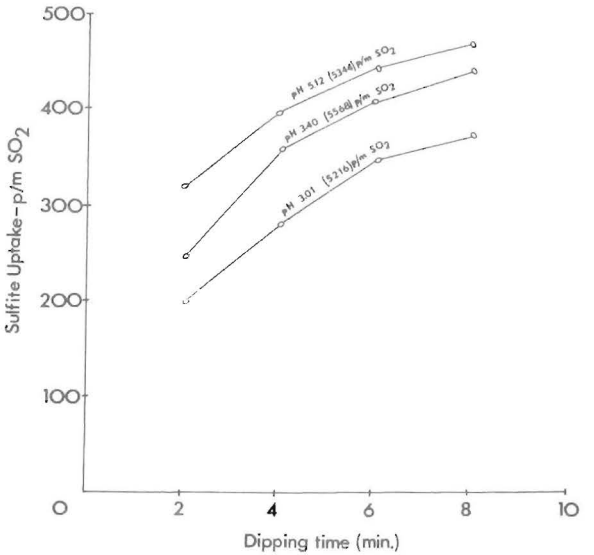

FIG. 3.—Effect of pH and dipping time on sulfite uptake by steam-peeled green plantains.

STEAM PEELING

Figure 3 shows the effect of pH and dipping time on the sulfite uptake by steam-peeled bananas. As the pH was lowered, sulfite uptake decreased following the same pattern observed in hot-water-peeled bananas (fig. 1). Increasing sulfite concentration increased the rate of absorption and the concentration of bisulfite.

Table 2 shows the effect of hot-water and steam blanching on the sulfite uptake by steam-peeled bananas. When the steam-peeled fruit was blanched in water at 200° F (93° C) and sulfited in $K_2S_2O_5$ solution of 4,000 p/m SO_2 at pH 5.1 sulfite, uptake increased with the length of the blanching treatment. When the fruit was blanched in steam, sulfite uptake decreased with the length of the treatment. Sánchez Nieva et

TABLE 2.—*Effect of water and steam blanching on the SO_2 uptake by steam-peeled green bananas. Sulfitation in $K_2S_2O_5$ solution, 2,723 p/m, pH 5.0, dipping time 3 min*

Blanching time	Blanching treatment	SO_2 content
Min		*P/m SO_2*
	Water at 200° F	
0		117
2		121
4		121
6		123
8		236
10		219
	Steam	
0		128
2		128
4		88
6		84
8		63
10		81

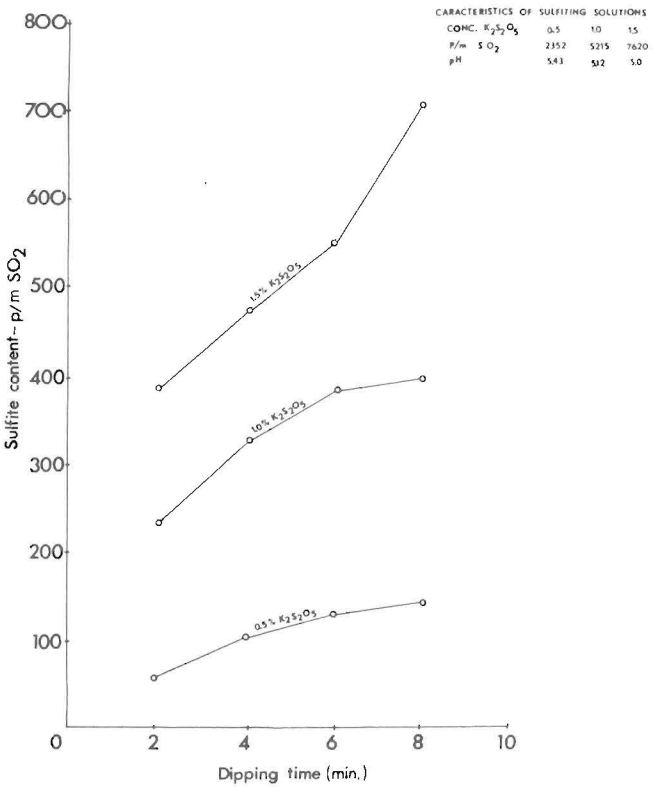

FIG. 4.—Effect of concentration of sulfiting solution and dipping time on sulfite uptake by steam-peeled green plantains.

al. (16) found that sulfite uptake in plantains blanched in water at 190° F (87.8° C) increased during the first few minutes of blanching and then decreased with the length of the blanching treatment. When plantains were steam blanched, sulfite uptake increased with the length of the treatment. Again it is observed that although green bananas and green plantains are similar in composition, their behavior on sulfiting is different.

RESUMEN

En este estudio se determinó el efecto del método usado para mondar el guineo (banano) verde sobre la absorción de sulfito en soluciones acuosas de metabisulfito de potasio.

Cuando la fruta pelada en agua a 200° F. (93° C.) por 30 minutos se sulfitó en soluciones de $K_2S_2O_5$ a temperatura ambiente (82° F., 27.8° C.), la absorción de sulfitos aumentó al aumentar la concentración de la solución sulfitante y el tiempo de inmersión. Cuando el pH de la solución sulfitante se redujo mediante acidulación con ácido cítrico, la absorción del sulfito disminuyó. El pH de la fruta tratada bajó y su acidez aumentó al bajar el pH de la solución sulfitante. Estos cambios, sin embargo no afectaron el sabor de la fruta.

Cuando la fruta tratada con vapor se sulfitó, se comportó de modo similar a lo observado en fruta tratada con agua caliente. Cuando la fruta tratada con vapor se escaldó en agua caliente a 200° F. (93° C.), la absorción de sulfitos aumentó en proporción a la duración de la escaldadura. Cuando la fruta se escaldó al vapor, disminuyó la absorción de sulfitos a medida que aumentó la duración de la escaldadura.

LITERATURE CITED

1. Amla, B. L., and Francis, F. J., 1961. Effect of pH of dipping solution on the quality of prepeeled potatoes, Am. Potato J. 38: 121-30.
2. Bhatia, B. S., Amin, H. D., and Girdahari, L., 1962. Studies on the dehydration of some tropical fruits. Part I. Absorption and retention of SO_2 during sulfuring and sulfiting, J. Food Sci. (India) 11: 63-8.
3. Brekke, J. F., and Allen, L., 1966. Banana Dehydration, Tech. Prog. Rep. 153, Hawaii Agric. Exp. Stn., 15 pp.
4. Expert Panel of Food Safety and Nutrition of I.F.T., 1975. Suflites as food additives, Food Technol. 29(10): 117-20.
5. Food Chemical Codex, Nat. Acad. Sci. Nat. Res. Coun., Pub. 1143: 184, Washington, D.C., 1963.
6. 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.
7. Furlong, C. R., 1961. Preservation of prepeeled potatoes. II. Uptake of bisulfite by peeled and chipped potatoes treated with sodium bisulfite, J. Sci. Food Agric. 12: 49-53.
8. Hayes, R. E., Nelson, A. I., and Steimberg, M. P., 1956. Consideration in sulfiting sweet corn with an aqueous salt solution prior to dehydration, Food Technol. 10: 18-21.
9. Joslyn, M. A., and Braverman, J. B. S., 1954. The chemistry and technology of pretreatment and preservation of fruit and vegetable products with SO_2 and sulfites, Adv. Food Res. 5: 127-9.
10. McBean, D., Johnson, A. A., and Pitt, J. I., 1964. The absorption of SO_2 by fruit tissue. J. Food Sci. 29: 257-65.
11. Official Methods of Analysis of the Association of Official Agricultural Chemists, 12 ed, Washington, D. C. 1975.

12. Ponting, J. D., 1960. Control of enzymatic browning in fruits, in Food Enzymes, H. W. Schults, Ed, pp. 105–24, Avi Publishing Co., Westport, Conn.
13. Ross, L. R., and Treadway, R. H., 1960. A rapid method for the determination of sulfur dioxide in sulfited prepeeled potatoes, Am. Potato J. 37: 102–7.
14. ——and——, 1961. Factors affecting the SO_2 uptake in sulfited prepeeled potatoes, Am. Potato J. 38: 9–13.
15. Rodríguez Sosa, E. J., González, M. A., Caloni, I., and Parsi Ros, O., 1977. The preparation of green banana flour, J. Agric. Univ. P. R. 61(4): 470–9.
16. Sánchez Nieva, F., Bueso, C., and Hernández, I., 1975. Studies on the freezing of green plantains, II. Sulfitation to control browning, J. Agric. Univ. P.R. 59(2): 92–106.
17. Sánchez Nieva, F., 1977. Control of browning in lye-peeled taniers, J. Agric. Univ. P.R. 61(4): 489–500.
18. Stafford, A. E., and Bolin, H. R., 1972. Absorption of aqueous bisulfite by apricots, J. Food Sci. 37: 941–3.
19. Weaver, C., and Charley, H., 1974. Enzymatic browning of ripening bananas, J. Food Sci. 39: 1200–2.