Studies on the Freezing of Green Plantains (*Musa paradisiaca*)

II. Sulfitation to Control Browning[1]

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ABSTRACT

The SO_2 content of green plantain slices sulfited in metabisulfite solutions increases with dipping time, but not in direct linear relationship. Increasing the concentration of the dipping solution resulted in a proportional increase in the SO_2 content. Lowering the pH of the sulfiting solution resulted in higher SO_2 uptake. Sulfurous acid solutions at pH 2.2 gave the higher SO_2 content at a given dipping time. When sulfiting plantain slices in $K_2S_2O_5$ solutions at pH 3.3, blanching increases the bisulfite absorption. Sulfiting in sulfurous acid solutions resulted in higher levels of SO_2 in hand peeled unblanched slices and lowest in steam peeled and blanched slices. The SO_2 content increased with the length of the blanching treatment for both water and steam blanching. Increasing the temperature during water blanching from 71.1° C (160° F) to 93.3° C 200° F) had no appreciable effect on the SO_2 content. When slices were sulfited in $K_2S_2O_5$ solutions, the loss of SO_2 during frying was greater in blanched fruit, either hand- or steam-peeled. When the slices were sulfited in sulfurous acid solutions, the greater loss of SO_2 during frying occurred in steam peeled fruit and neither the blanching method used nor the temperature had any effect on the SO_2 loss. Sulfiting to levels of 100–150 p/m SO_2 proved effective in controlling browning. The loss at this level during frying amounted to 50–60 percent, leaving a residue of SO_2 which could not be detected by tasters, and did not affect the flavor of the product.

INTRODUCTION

Peeled green plantains are highly susceptible to browning when exposed to the air. Browning not only takes place on the surface but is also very pronounced in the internal tissues around the placenta. When slices are prepared from green fruit and frozen, the surface discoloration due to browning adversely affects the appearance of the product.

Our investigations on the preparation of frozen plantain products showed

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that blanching reduced browning somewhat but the treatment was not sufficiently effective in controlling the browning reaction (16). Sulfitation of the slices for freezing thus has been studied as a means of improving product quality by controlling browning discoloration.

Although sulfiting of fruit and vegetables has been studied extensively for many products, no information was found in the literature pertaining to factors possibly effecting sulfitation of green plantains. This paper deals with the effect of type of sulfiting solution, SO_2 concentration, pH, length of time in treatment and the effects of different blanching methods on the take-up and subsequent retention of sulfur dioxide by the green plantain tissue during processing, storage and cooking.

MATERIALS AND METHODS

Plantains of the Maricongo cultivar were harvested at a pulp content of about 60 percent. The fingers were separated from the stem and either hand or steam peeled. In steam peeling, the fruit was treated with steam under pressure (80 lb/in²g) for 30 seconds followed by cooling with water sprays. After removal of the loose peel by hand, the fruit was sliced crosswise into sections about 2.5 cm (1 inch) thick. Hand-peeled fruit was sliced in the same way.

The slices were blanched either in water or steam depending on the nature of the experiment. When water blanching was used, the slices were blanched by dipping in hot water at the desired temperature for a specified length of time. Following the blanching treatment, the slices were cooled with water sprays to near room temperature (29.4°–32.2° C) (85°–90° F).

The procedure used in steam blanching was: The slices were blanched in a drapper conveyor type steam blancher. The steam pressure was adjusted to maintain a dense steam atmosphere inside the tunnel. The length of time in the blanching treatment was controlled by adjusting the speed of the conveyor and was varied as required by the experiment in progress. After blanching, the slices were cooled with water sprays as noted above.

The blanched slices were sulfited by dipping in the sulfiting solution for a specified length of time. In all the experiments, a proportion by weight of 3 parts sulfiting solution to 1 part of fruit was used.

The solution of sulfites were prepared by weight using demineralized water at 24° C. Sulfurous acid solutions were prepared by bubbling SO_2 gas through the water. The SO_2 content of each solution was adjusted to the desired level after the SO_2 content was determined by iodometric (13) titration. The pH of the sulfiting solutions was adjusted by the addition of either citric acid or NaOH.

After sulfiting, the slices were drained and packed in waxed lined cardboard boxes and overwrapped with vapor moisture proof material. The slices were frozen in a plate freezer at −42.7° C (−45° F) and stored at −23.3° C (−10° F).

For organoleptic tests, the frozen slices were fried without thawing in shortening at 176.6° C (350° F) for 8 minutes. The slices were pressed and immediately fried a second time at 190.5° C (375° F). The fried slices were submitted either under red or artificial light as required by the experiment to a panel of tasters for ranking (7). The SO_2 content of the sulfited slices was determined by the Monier-Williams method (12) by distillation from an acid solution into H_2O_2.

RESULTS AND DISCUSSION

EFFECT OF LENGTH OF DIP AND CONCENTRATION OF THE SULFITING SOLUTION ON THE SO_2 UPTAKE BY GREEN PLANTAIN SLICES PREPARED FROM HAND-PEELED UNBLANCHED FRUIT SULFITED IN $K_2S_2O_5$ SOLUTION

Figure 1 shows the effect of the length of time in the dip and of the concentration of the metabisulfite solution on the SO_2 content of slices prepared from unblanched hand-peeled fruit. The SO_2 content increases with dipping time, but not in direct linear relation. The incremental increases of the bisulfite uptake become smaller in magnitude after the first six minutes of treatment for the 0.5 $K_2S_2O_5$ solution, with the uptake curves showing a trend to level off as the dipping time increases.

Increasing the concentration of the sulfiting solution twofold resulted in an almost twofold increase in the SO_2 content. Therefore, in sulfiting plantain slices it is preferable to use solutions of higher concentration to obtain a certain level of SO_2 than to increase the length of time in the treatment. In this respect, plantains respond similarly to potatoes, corn and apricots during sulfiting treatments (4,6,9,11,15,17).

EFFECT OF PH AND TYPE OF SULFITING SOLUTIONS ON THE SO_2 UPTAKE BY HAND-PEELED UNBLANCHED PLANTAIN SLICES

The effect of pH on the SO_2 uptake by hand-peeled unblanched plantain slices is shown by the data in tables 1 and 2. When the pH of a solution of SO_2 gas in water with a concentration of SO_2 ranging from 1624 to 1733 p/m was varied from 2.1 to 5.0, the SO_2 content of the slices treated for 5 minutes in the sulfiting solution ranged from 213 p/m at pH 2.1 to 25 p/m at pH of 5.0 (table 1). A similar effect of pH on SO_2 absorption, although of a slower magnitude, was observed when the pH of a $K_2S_2O_5$ solution was varied from 3.0 to 6.0 (table 2).

Figure 2 shows the effect of pH and type of sulfiting solution on the SO_2 uptake by the hand-peeled unblanched plantain slices. The SO_2 content during a 10 minute dip varied with pH from very low in the $NaHSO_3 \cdot NaSO_3$

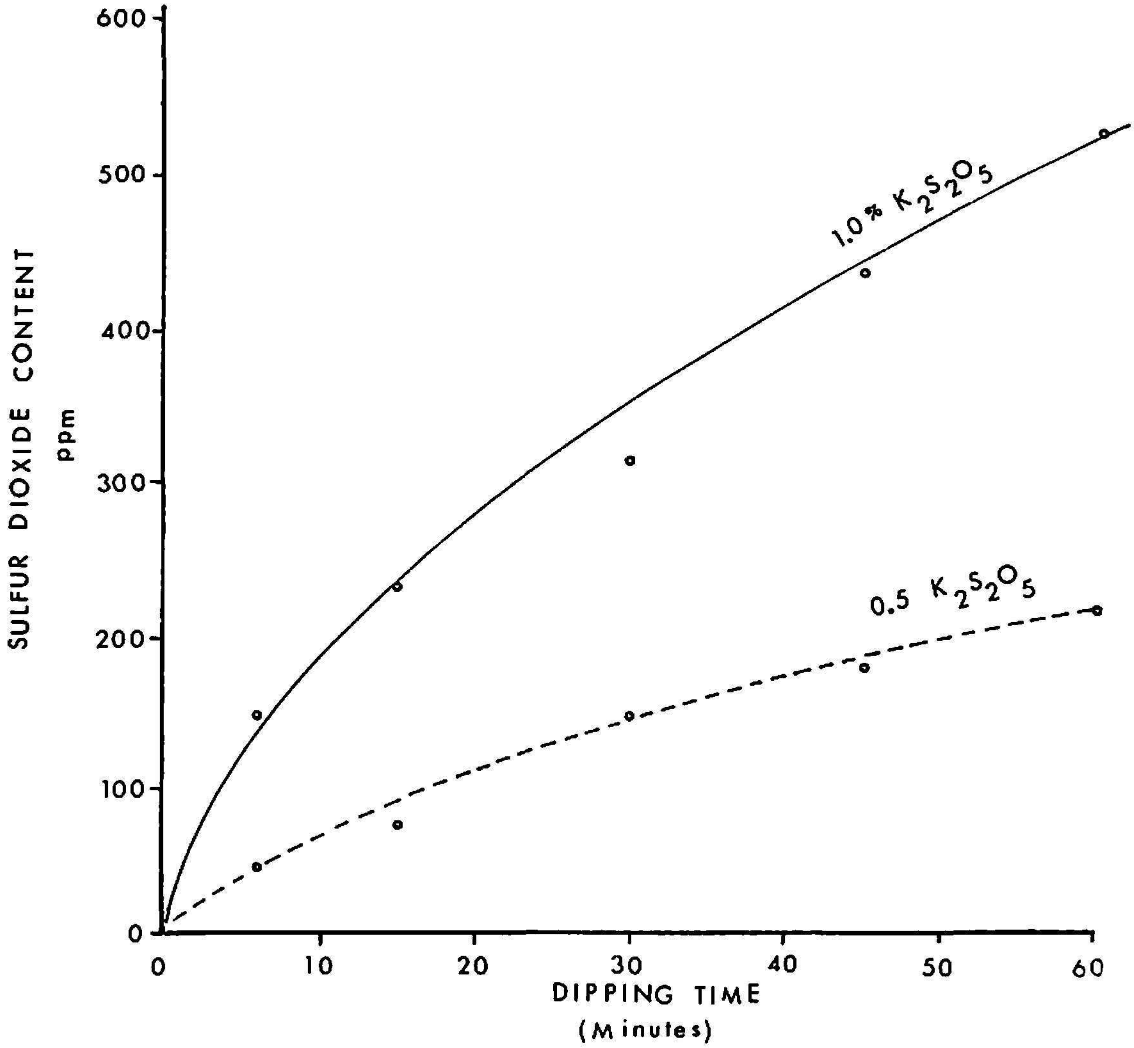

FIG. 1.—Effect of length of dipping time and concentration of the sulfiting solution on the SO_2 take up by green plantain slices.

TABLE 1.—*SO_2 absorption by plantains slices sulfited in SO_2 gas solutions at different pH, immersion time 5 minutes*

pH	SO_2 in solution	SO_2 content in sulfited fruit
	P/m	*P/m*
2.1	1632.8	213.2
3.0	1716.0	38.9
4.0	1733.3	23.3
5.0	1624.4	24.5

TABLE 2.—*SO_2 absorption by plantain slices sulfited in $K_2S_2O_5$ solutions at different pH, immersion time 5 minutes*

pH	SO_2 in solution	SO_2 in sulfited fruit
	P/m	*P/m*
3.0	2153	29.7
4.0	2093	21.7
5.0	2077	15.5
6.0	1750	16.8

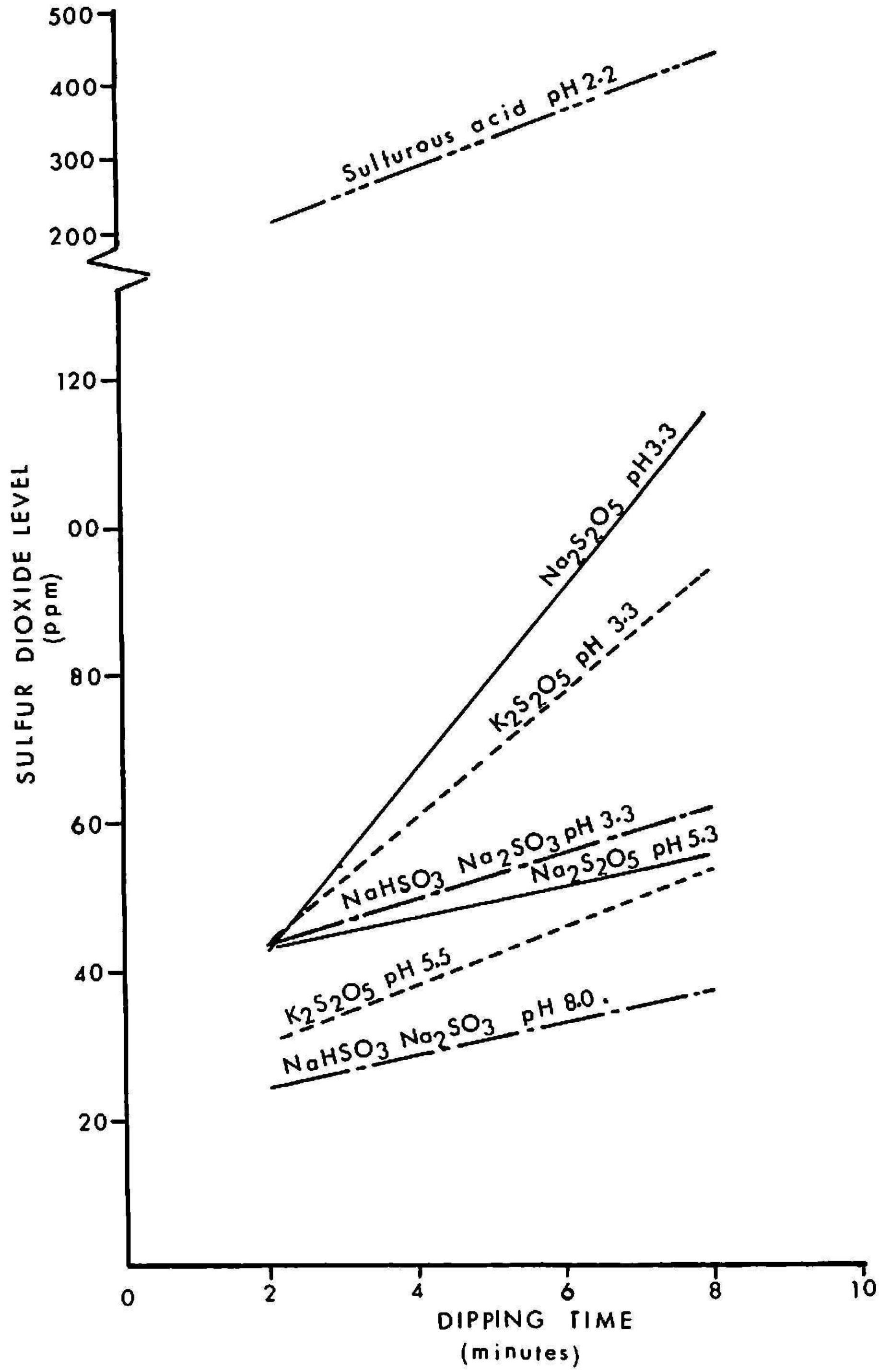

FIG. 2.—Effect of pH and type of sulfiting solution on the SO_2 content of plantain slices prepared from hand-peeled unblanched fruit.

solutions at a pH of 8.0 to very high absorption in the SO_2 gas solution (sulfurous acid solution) at a pH of 2.2. It was also noted that the level of SO_2 after treating in the sulfite solutions was appreciably higher when the pH of the sulfiting solution was lowered to 3.3. The data also shows that the rate of SO_2 absorption by the tissue increased with pH. When the pH of all the sulfiting solutions was adjusted to the same level (pH 5.0), the uptake in all five solutions tested (table 3) was found to lie within similar ranges. The low level of SO_2 reached is due to the fact that at this pH, HSO_3 is almost nonexistent. These results show that irrespective of the sulfiting solution used, whether it be solutions of sulfites or of sulfur dioxide, at a given SO_2 concentration, the SO_2 uptake by plantain tissue is directly related to pH of the solution. This is in accord with the results with pre-peeled potatoes obtained by Amla and Francis (1), Ross and Treadway (15), Francis and Amla (4), with corn by Hayes et al. (6), with apples by Walker et al. (18), and with apricots by Stafford and Bolin (17).

It should be noted also that the most effective sulfiting solution of those tested was the sulfurous acid solution at a pH of 2.2 followed by the metabisulfites at a pH of 3.3. According to Vas and Ingram (19) pH determines

TABLE 3.—*SO_2 content of hand peeled fresh plantains after dipping for various lengths of time in sulfiting solutions with pH adjusted to 5.0*

Sulfiting solution	SO_2 in solution	SO_2 content in fruit after dipping for the time indicated in minutes				
		2	4	6	8	10
	P/m			*P/m*		
$Na_2SO_3 + NaHSO_3$	2566	32.7	37.4	38.9	—	—
Na_2SO_3	2529	49.1	36.2	25.8	45.1	56.5
$Na_2S_2O_5$	2554	14.2	42.6	51.7	25.8	36.2
$K_2S_2O_5$	2504	16.8	23.3	45.2	55.6	38.8
SO_2 gas	2638	22.0	47.8	37.5	45.2	36.2

the distribution of H_2SO_3, HSO_3 and SO_3 in solution, increasing the concentration of H_2SO_3 as the pH is lowered. As SO_2 absorption is greater in H_2SO_3 solutions, lowering the pH increases the SO_2 absorption by the tissue.

EFFECT OF PEELING AND BLANCHING METHODS ON THE SO_2 CONTENT

Figure 3 shows the effect of the various peeling and blanching methods on the uptake of SO_2 by plantain slices sulfited in $K_2S_2O_5$ solutions with a 0.3% titratable SO_2 content. Curves 1 and 2 show that blanching of hand-peeled plantains resulted in a marked increase in the SO_2 content. During the first 5 minutes of treatment, the SO_2 content in the hand peeled unblanched slices reached a level of 48 p/m SO_2, while during the same period the SO_2 uptake by the blanched slices reached a level of 334 p/m.

Curve 3 shows the effect of blanching on the SO_2 level in steam peeled fruit. The effect of blanching on the SO_2 content in the slices prepared from the steam peeled fruit was not so striking as with the hand-peeled, but it should be noted that blanching also resulted in slightly higher SO_2 levels. Steam-peeled blanched and unblanched samples showed a higher uptake

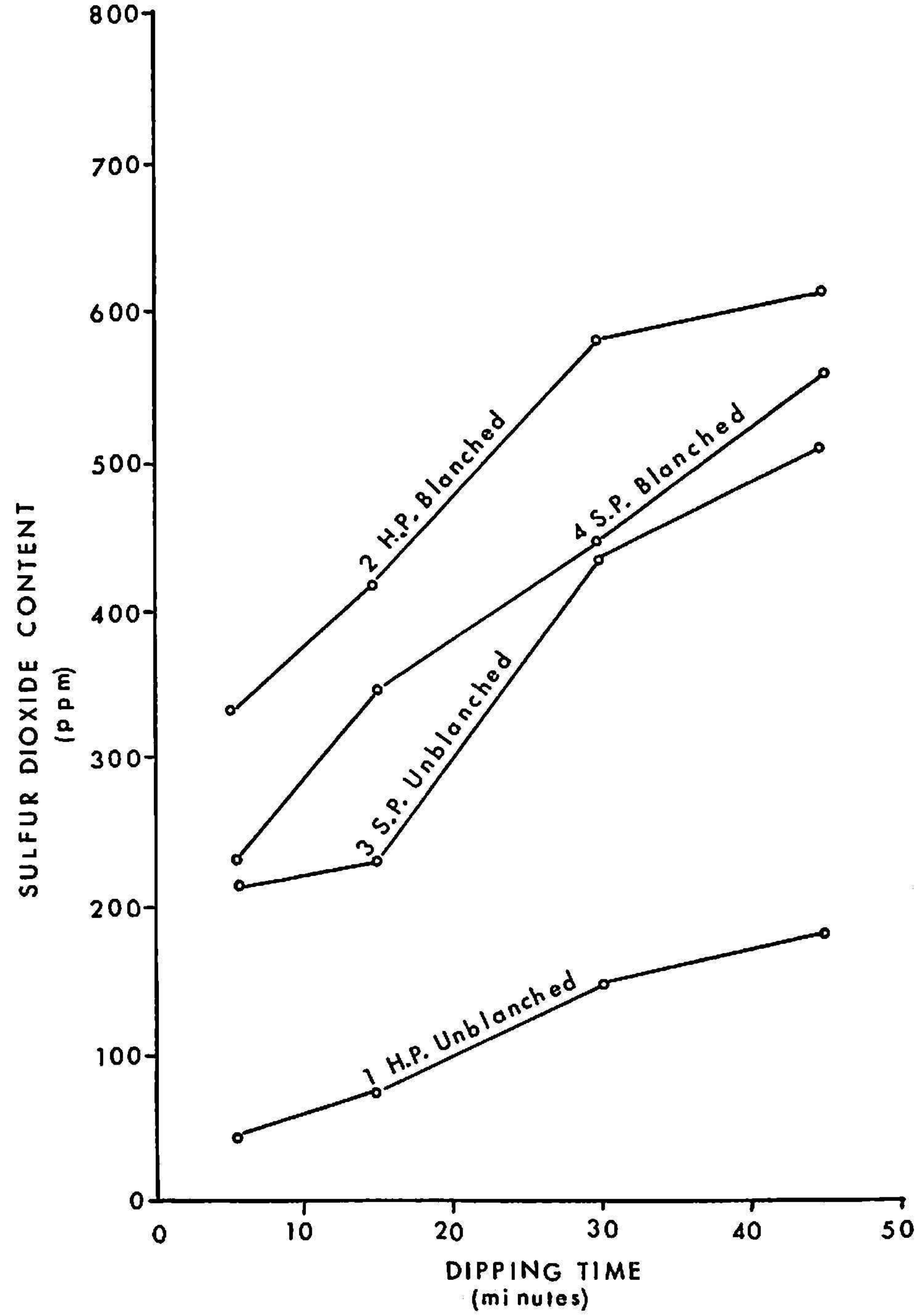

FIG. 3.—SO_2 absorption by hand- (H.P.) and steam-peeled (S.P.), blanched and unblanched slices sulfited in $K_2S_2O_5$ solution (.3 percent free SO_2, pH 3.5).

of SO_2 than hand-peeled unblanched samples, indicating that a preheating treatment before sulfiting in $K_2S_2O_5$ solution at pH 3.5 results in an increase in the bisulfite uptake. Further tests in sulfiting steam-peeled blanched and unblanched slices in $K_2S_2O_5$ solutions confirmed that blanching increases the SO_2 content (fig. 4) although the difference in the SO_2 levels of the sulfited slices with and without blanching is not as great as those with hand-peeled fruit.

Slices prepared from hand- and steam-peeled fruit with and without blanching and sulfited in SO_2 gas solutions resulted in a different pattern of SO_2 uptake. Figure 5 shows, that the highest SO_2 absorption took place in the hand-peeled unblanched slices, and the lowest uptake occurred in the steam-peeled blanched fruit. It should be observed that curves 2 and 3 for the hand-peeled blanched slices and for the steam-peeled unblanched slices

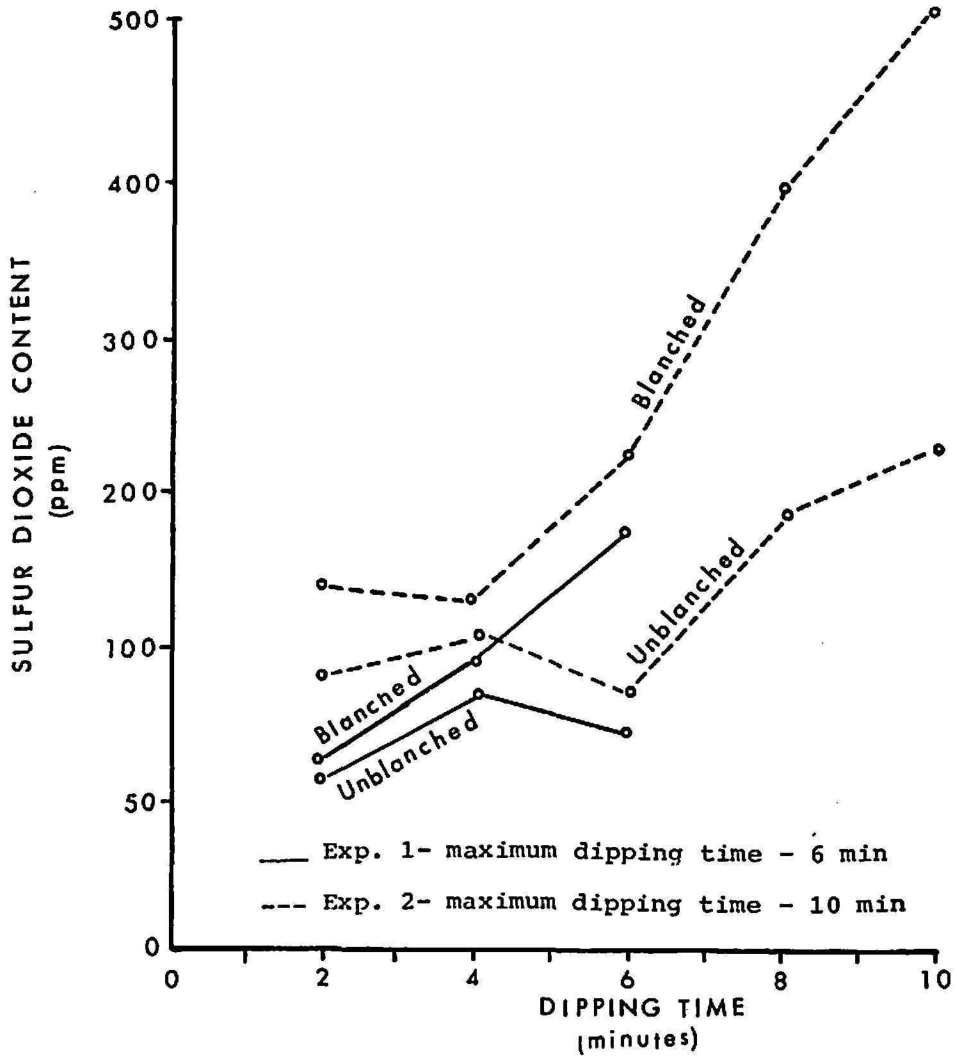

FIG. 4.—Effect of blanching on the SO_2 absorption by steam peeled fruit sulfited in $K_2S_2O_5$ solutions (.3 percent free SO_2, pH 3.3).

are very close to each other and lie in between curves 1 and 4 corresponding to the hand-peeled blanched and the steam-peeled unblanched slices, respectively. Repeated tests verified data resulting from these experiments.

EFFECT OF THE LENGTH OF TIME IN THE BLANCHING TREATMENT AND TEMPERATURE ON THE SO_2 UPTAKE

The data in table 4 shows the effect of the length of time in the steam blanching treatment on the SO_2 content in slices prepared from steam-peeled fruit sulfited in $K_2S_2O_5$ solutions. Increasing the length of the blanching treatment from 2 to 6 minutes resulted in higher bisulfite uptake. The data also confirms previously reported results (fig. 3) that blanching results in higher SO_2 content when steam-peeled fruit is sulfited in $K_2S_2O_5$ solutions.

The data in table 5 shows that when water blanching is used during the

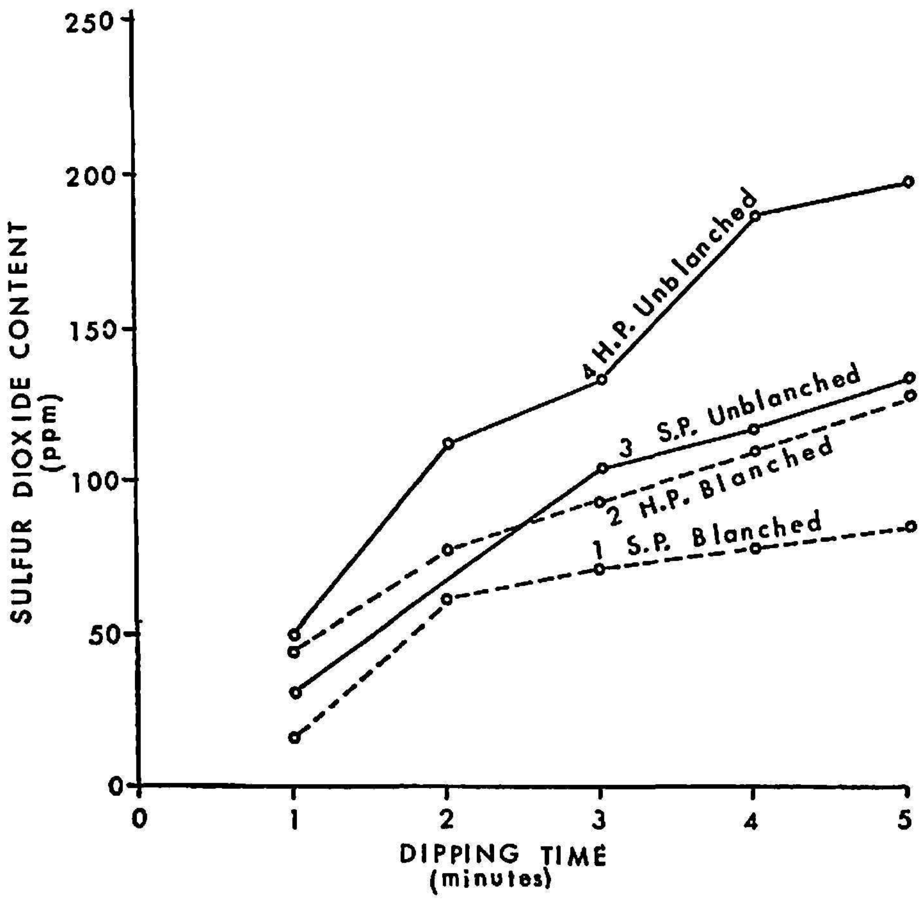

FIG. 5.—SO_2 absorption by hand- (H.P.) and steam- (S.P.) peeled fruit sulfited in SO_2 gas solution (.3 percent SO_2, pH 2.2).

TABLE 4.—*Effect of the length of steam blanching treatment on the SO_2 content of slices prepared from steam-peeled fruit when sulfited in $K_2S_2O_5$ solutions (0.3% free SO_2 at pH 3.3)*

Length of blanching treatment	SO_2 Content after immersion in the sulfiting solution for the time in minutes indicated		
	2	4	6
Minutes	*P/m*	*P/m*	*P/m*
0	57.0	86.0	116.0
2	61.0	89.0	123.0
4	65.0	118.9	169.0
6	98.6	128.4	166.0

first four minutes of treatment, the level of SO_2 uptake increased with the length of the blanching treatment. When the blanching treatment was extended to 6 minutes, a reduction in the SO_2 content was observed.

The effect of temperature in water blanching of steam-peeled slices on the SO_2 content is shown in table 6. Varying the blanching temperature from 71.1° C (160° F) to 93.3° C (200° F) had no appreciable effect on the SO_2 content for a blanching time of 3 minutes.

TABLE 5.—*Effect of the length of water blanching at 87.76° (190°F) on the SO_2 content of slices sulfited in $K_2S_2O_5$ solutions (0.3% SO_2, pH 3.3)*

Length of water blanching treatment	SO_2 uptake when dipped in the $K_2S_2O_5$ solution for time in minutes indicated		
	2	4	6
Minutes	*P/m*	*P/m*	*P/m*
2	79.6	126.1	149.9
4	109.7	136.6	164.6
6	108.0	89.8	133.4

TABLE 6.—*Effect of water blanching temperature[1] on the SO_2 content of slices sulfited in $K_2S_2O_5$ solutions (0.3% $K_2S_2O_5$ pH 3.3)*

Temperature	SO_2 uptake after immersion in the sulfiting solution for the time in minutes indicated			
	2	4	6	8
°C	*P/m*	*P/m*	*P/m*	*P/m*
71.1 (160°F)	69.9	89.6	101.8	161.3
76.6 (170°F)	39.5	79.0	98.7	136.8
82.2 (180°F)	53.2	80.5	103.5	118.5
87.7 (190°F)	65.3	86.6	101.8	131.8
93.3 (200°F)	71.4	88.1	98.7	118.5

[1] Length of water blanching period = 3 min.

The data from the blanching studies show that the effect of blanching on the SO_2 content of the plantain slices depends on type of sulfiting solution used, type of blanching (water or steam) and length of time in the blanching treatment. Unless the blanching and sulfiting variables are specified, generalities should not be made on the effect of blanching on SO_2 uptake. Variations in experimental procedures may account for the conflicting reports in the literature on the effect of blanching on SO_2 uptake (2,9,10, 19).

RETENTION OF SO_2 DURING FRYING

For serving, the frozen slices were fried in shortening at 176.6° C (350° F) for 7 minutes, then flattened and fried a second time at 190° C (375° F) for 5 minutes. Table 7 shows the effect of the peeling and blanching method on the loss of SO_2 during frying by slices sulfited in $K_2S_2O_5$ and sulfur dioxide solutions. In the slices sulfited in $K_2S_2O_5$ solution, the loss of SO_2 during frying was greater in the blanched fruit irrespective of the peeling method. The hand-peeled unblanched fruit showed the higher retention of SO_2 during frying.

The loss of SO_2 during frying slices sulfited in the sulfur dioxide solutions was higher in the steam-peeled fruit than in the hand-peeled. The blanching treatment had little, if any, effect on the loss of SO_2, irrespective of the peeling method.

TABLE 7.—*Loss of sulfur dioxide during frying of plantain slices sulfited in $K_2S_2O_5$ solutions and in SO_2 gas solutions*

Peeling and blanching treatment	Sulfitation in $K_2S_2O_5$ solution		Sulfitation in SO_2 gas solution	
	Initial level of SO_2	Loss	Initial level of SO_2	Loss
	P/m	*Percent*	*P/m*	*Percent*
Hand-peeled				
Blanched	132.6	65.6	104.0	85.0
Unblanched	107.9	24.1	113.1	86.2
Steam-peeled				
Blanched	273.9	69.9	76.7	91.5
Unblanched	143.0	42.7	107.7	93.0

When the data for the $K_2S_2O_5$ and sulfur dioxide treatments are compared, it is observed that the loss of SO_2 during frying was higher in the fruit sulfited in sulfurous acid solutions.

Table 8 shows the effect of different blanching treatments on the retention of SO_2 during frying. The blanching treatments did not differ appreciably in their effects on the loss of SO_2 during frying. It should be noted that the higher retention of SO_2 during frying took place in the unblanched samples as previously shown by the data in table 7.

The retention of SO_2 during frying was found to depend also on the initial level of SO_2 in the tissue. Table 9 shows the loss during frying in slices sulfited to different levels of SO_2 in $K_2S_2O_5$ solutions. At higher concentrations of SO_2 than shown in the table, the loss during frying was even less. At 534–557 p/m levels of SO_2, the loss on frying ranged from 26.1 to 37.4 percent.

THE EFFECT OF SULFITING ON THE QUALITY AND SHELF LIFE OF FROZEN GREEN PLANTAINS

The data obtained from a large number of experiments indicate that sulfitation effectively controlled the browning of plantain slices prepared from hand- or steam-peeled fruit, blanched or unblanched, at levels as low as 50 p/m. When sulfited samples were compared by ranking with unsulfited controls, tasters preferred the sulfited samples, mainly because of their improved color and appearance (table 10). This proved true with fresh frozen samples as well as with samples kept at −23.3° C (−10° F) for a year. Sulfiting to levels from 100 to 200 p/m also improved flavor and shelf life. Sulfited samples stored for periods as long as one year at −23.3° C (−10° F) were always preferred to controls, not only because of their better color and appearance but also because of their better flavor. Tasters could detect no sulfur flavor or off-flavors when the SO_2 content of the fried slices ranged from 50 to 200 p/m. At higher levels there were some indications of a decrease in the intensity of the natural plantain flavor.

TABLE 8.—*Effect of type of blanching and temperature on the loss of SO_2 by plantain slices sulfited in $K_2S_2O_5$ solution*

Blanching treatment	Initial level of SO_2	Level of SO_2 in fried slices	Loss of SO_2 during frying
	P/m	*P/m*	*Percent*
No blanching	86.1	57.8	32.8
Blanching in water for 3 minutes at—			
71.1° C (160° F)	89.6	47.9	46.5
76.6° C (170° F)	79.8	26.4	66.9
82.2° C (180° F)	80.5	43.7	45.7
87.7° C (190° F)	86.6	46.3	46.3
93.3° C (200° F)	88.1	32.8	62.7
Steam blanching 2 minutes	89.0	50.1	44.8

TABLE 9.—*Loss of SO_2 during frying in slices sulfited to different levels in $K_2S_2O_5$ solutions*

Initial SO_2 content	Loss of SO_2 during frying	
	Range	Mean
P/m	*Percent*	*Percent*
50	49.2–67.3	58.6
51–100	53.0–71.0	62.3
101–150	52.2–72.9	62.5
151–200	37.9–53.7	48.1
201–250	37.9–55.6	48.1

Due to the many process variables which affect the SO_2 uptake by the green plantain slices, recommended levels of SO_2 for commercial processing would be in the range of 100 to 150 p/m. As at this level of SO_2, the loss during frying would be about 50 to 60 percent of the initial content, thus the residue of SO_2 in the fried product will always be below the level at which it can be detected by the average consumer.

TABLE 10.—*Results of ranking tests in which sulfited samples were compared with unsulfited controls for flavor, color and appearance*

Range of SO_2 level in sample		Results
Fresh frozen	Fried	
P/m	*P/m*	
0–80	10.0–46.6	Control rejected for inferior appearance. Fried sample with SO_2 content of 11 p/m selected as best (1% P).
	0–34.5	Control rejected for inferior flavor (5% P). Sulfited samples selected as best because of better appearance and flavor.
	0–42.2	No difference in flavor among samples. Sample with the highest SO_2 content selected as the best in appearance (5% P).
0–294	27–99	No difference in the intensity of plantain flavor among sulfited samples. Sample with highest SO_2 content rejected for inferior flavor at 1% P.
	0–196	Control sample, a borderline reject for flavor. Sulfited samples preferred for appearance at 1% P.
	0–19	No difference in flavor among samples. Samples with the highest SO_2 content selected as best in appearance at 1% P.

RESUMEN

Cuando el tejido del plátano verde se expone al aire, se desarrollan unas manchas obscuras que afectan la calidad de las rodajas congeladas. Se ha llevado a cabo un estudio para controlar el obscurecimiento del tejido por un tratamiento con bióxido de azufre. Se estudiaron los distintos factores que afectan el contenido de SO_2 en las rodajas cuando éstas se tratan en soluciones de metabisulfito, sulfito y ácido sulfuroso.

Al tratar las rodajas de plátano verde en soluciones de metabisulfito de potasa, se observó que el nivel de SO_2 en el tejido aumentó más rápidamente durante los primeros minutos de tratamiento disminuyéndose el nivel de absorción al aumentar el tiempo en que se mantuvieron las rodajas sumergidas en la solución. Al aumentar la concentración de la solución de metabisulfito, se lograron niveles más altos de SO_2 en el tejido.

Se observó que el pH de la solución usada para sulfitar las rodajas tiene un efecto pronunciado sobre el contenido final de SO_2. Cuando la sulfitación se llevó a cabo en soluciones de $K_2S_2O_5$, $Na_2S_2O_5$, de $NaHSO_3$-Na_2SO_3 (1:1) y en soluciones de ácido sulfuroso, el contenido de SO_2 en las rodajas aumentó al bajar el pH. El contenido

menor de SO_2 se obtuvo al sulfitar en soluciones de $NaHSO_3$ con Na_2SO_3 (1:1) a pH de 8.0 y el mayor en soluciones de ácido sulfuroso a pH de 2.2. Una solución de ácido sulfuroso fue más eficaz para lograr altos niveles de SO_2 en las rodajas que soluciones de metabisulfito de potasio o de sodio aun a pH ácidos.

El método usado para pelar la fruta así como escaldar las rodajas afectó el patrón de absorción del SO_2 cuando la sulfitación se llevó a cabo en soluciones de $K_2S_2O_5$ y de ácido sulfuroso. En la fruta pelada a mano, escaldar al vapor resultó en un aumento marcado en el contenido de SO_2 en las rodajas. Cuando la fruta se peló con vapor, el aumento en el contenido de SO_2 al escaldar fue mucho menor. Cuando la sulfitación se llevó a cabo en una solución de ácido sulfuroso, se observó un patrón de absorción de SO_2 completamente distinto. El mayor nivel de SO_2 se obtuvo en la fruta pelada a mano y sin escaldar, y el nivel más bajo en la fruta pelada al vapor y escaldada.

El contenido de SO_2 en rodajas sulfitadas en soluciones de metabisulfito de potasa aumentó progresivamente con la duración del tratamiento de escaldar, ya fuese este en agua caliente o al vapor. Cuando las rodajas se escaldaron en agua caliente, la temperatura usada no tuvo efecto apreciable sobre el contenido final de SO_2.

Para consumo, las rodajas congeladas se fríen en dos etapas, la primera a 178.6°C por 7 minutos y la segunda a 190.5°C por 5 minutos. Las rodajas que se escaldaron y se sulfitaron en soluciones de $K_2S_2O_5$ perdieron al freír un porcentaje mayor de SO_2 que aquéllas que no fueron escaldadas. Cuando la sulfitación se llevó a cabo en soluciones de ácido sulfuroso, las rodajas preparadas de fruta pelada al vapor sufrieron una pérdida mayor de SO_2 que las de fruta pelada a mano, teniendo en este caso el tratamiento de escaldar muy poco o ningún efecto sobre la pérdida de SO_2. En términos generales, el tratamiento de escaldar tuvo muy poco efecto sobre la pérdida de SO_2 al freír.

La información obtenida de estos estudios indica que la sulfitación a niveles de 100 a 150 ppm de SO_2 resultó efectiva, evitando el obscurecimiento del tejido. A estos niveles de sulfitación, la pérdida de SO_2 al freír asciende a un 50–60 por ciento, quedando una cantidad residual de SO_2 relativamente baja que no afecta adversamente el sabor del producto y que no pudo ser detectada por los catadores.

LITERATURE CITED

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