

Lye Peeling of Fresh Yam, *Dioscorea alata*¹

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INTRODUCTION

Yam (*Dioscorea* spp.) is one of the important starchy root crops grown in the mountainous area of Puerto Rico. Efforts presently are being made to develop industrial yam products such as dehydrated flakes, flour, and instant mixes. Information regarding the mechanical peeling of yams is necessary for guiding the future development of such products.

Hand peeling of fruits and vegetables is an intensive labor-consuming operation affecting both quality of finished products and quantity of waste. It was thought possible that a mechanized operation such as lye peeling, being used successfully with many other fruits and vegetables, might be adopted satisfactorily for peeling yam tubers.

Peeling fruits and vegetables by means of hot lye solutions combine the effectiveness of both chemical attack and thermal shock in loosening and softening the surface skin (7). The lye acts more vigorously when hot so it is used at or near the boiling point for greater effectiveness. This treatment facilitates the further processing of the materials. Although lye peeling is suitable for all sizes and shapes of most fruits, vegetables and root crops, the appropriate relation of lye concentration, temperature of the solution, and immersion time must be established for each product as stated by Woodroof (9).

Mazzola (5) developed a rapid method for peeling potatoes by dipping them for 10 seconds in a 53-percent lye solution at 300° F. Greig and Manchester (3) recommended an 8-minute immersion in a 15-percent lye solution at 155° F., while Dunlop (1) reported satisfactory results with a 2-minute dip in a boiling 14-percent lye solution.

Similar studies have been conducted with other products. Woodroof and Atkinson (8) peeled sweet potatoes by immersing the tubers for 2 minutes in a boiling 14-percent lye solution. As reported by Stateler (6), carrots can be peeled satisfactorily by a 70-second dip in a 18-percent lye solution at 218° F. or a 2-minute immersion in a boiling 3-percent lye solution (2).

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Although abundant information appears to be available with regard to the lye-peeling method for fruits and vegetables, none exists for lye peeling tubers of *Dioscorea* spp. Studies thus were conducted to determine the appropriate relationships between the proper concentration of lye and the exposure time in boiling solutions required for peeling yams satisfactorily.

MATERIALS AND METHODS

Freshly harvested tubers of *Dioscorea alata* (variety Florido) of all sizes and shapes were used in these studies. The tubers were processed within 10 days after harvest.

Lye solutions were prepared at 10-, 15-, and 20-percent concentrations by weight using NaOH flakes of 76-percent purity. Boiling temperatures for the solutions were 216-, 221-, and 226° F., respectively. Concentrations were readjusted periodically by titration with standardized hydrochloric acid (3N), using phenolphthalein as an indicator. Adjustments were made by adding water or lye flakes as necessary.

A 17-gallon steel vessel was used for the lye peeling. The tubers were immersed in the solution in a steel basket fitted with a cover.

Prior to peeling, the tubers were washed free of dirt and divided into 15-pound batches. They were then immersed in the boiling lye solution for a predetermined period of time, withdrawn from the solution, and rinsed immediately with water for 1 minute, and washed further in a rotary washer. The tubers finally were scrubbed by hand under sprays of water until the reaction on the peeled surface was negative to a phenolphthalein indicator.

The yam tubers were evaluated visually to determine the efficiency of peeling and then submitted to chemical analyses and sensory evaluation. Hardness, as measured with the Food Technology Corporation Shear Press, and total acidity were determined on the outer part of tubers peeled with a potato peeler. The total weight loss recorded was the difference in weight between the unpeeled and the lye-peeled batch. This record indicated the peel removed and any other wasted material which might separate from the tubers during lye treatment.

For the Shear Press determinations, pressure was set at 1,500 pounds and velocity at 1.5 mm./second. For total acidity determinations, the samples were ground with water at a 1:1 proportion. Twenty-gram samples were titrated with a sodium hydroxide solution and the results expressed in terms of percent of citric acid. The results were compared against those obtained from a hand-peeled control.

An additional experiment was performed using *Dioscorea alata* tubers stored for more than 10 days after harvest. The tubers were peeled with a

TABLE 1.—*Relation between immersion time and lye concentration on the efficiency of the lye peeling operation*

| Lye concentration | Time of immersion | Visual evaluation ¹ | Loss in weight of lye-peeled tubers ² |
|--------------------------|-------------------|--------------------------------|--|
| <i>Percent by weight</i> | <i>Minutes</i> | | <i>Percent</i> |
| 10 | 2 | Questionable | 5.6 |
| | 3 | Questionable | 11.11 |
| | 4 | Questionable | 12.78 |
| | 5 | Good | 14.44 |
| | 6 | Very good | 17.50 |
| 15 | 2 | Questionable | 7.22 |
| | 3 | Questionable | 11.11 |
| | 4 | Good | 13.33 |
| | 5 | Very good | 16.11 |
| 20 | 1 | Questionable | 6.67 |
| | 2 | Questionable | 8.89 |
| | 3 | Good | 12.21 |
| | 4 | Very good | 13.33 |

¹ Questionable: Tubers retained large patches of peel or many small patches. Good: Tubers with one or two small patches of peel which can be removed easily by trimming. Very good: Tubers completely peeled.

² Average of three runs.

TABLE 2.—*Hardness and titrable acidity of lye-peeled yam*

| Lye concentration | Time of immersion | Shear area | Press, maximum inflection | Titrable acidity (expressed as percent citric acid) |
|--------------------------|-------------------|----------------------|---------------------------|---|
| <i>Percent by weight</i> | <i>Minutes</i> | <i>Square inches</i> | <i>Units</i> | <i>Percent</i> |
| 10 | 5 | 2.62 | 645 | 0.091 |
| | 5 | 2.90 | 645 | .087 |
| | 5 | 3.14 | 645 | .072 |
| Hand peeled (control) | | 2.88 | 585 | .095 |
| 15 | 4 | 2.77 | 645 | .143 |
| | 4 | 2.67 | 600 | .134 |
| | 4 | 2.52 | 570 | .126 |
| Hand-peeled (control) | | 2.69 | 555 | .131 |
| 20 | 3 | 3.30 | 630 | .082 |
| | 3 | 2.82 | 600 | .112 |
| | 3 | 2.95 | 570 | .108 |
| Hand-peeled (control) | | 3.10 | 585 | .115 |

10-percent lye solution for 5 minutes applying the same general procedure described above for fresh peeled tubers, and a visual evaluation of the product made.

RESULTS AND DISCUSSION

RELATION BETWEEN IMMERSION TIME AND LYE-SOLUTION CONCENTRATION, AND A GOOD PEELING OPERATION

Yam tubers were immersed in the boiling lye solutions from 2 to 6-, 2 to 5-, and 1 to 4 minutes for the 10-, 15-, and 20-percent concentrations, respectively. The data obtained from these experiments is presented in table 1. Each value represents the average of three runs. The results show that good peeling is obtained by any one of the three following combinations: 5 minutes in a 10-percent boiling lye solution, 4 minutes in a 15-percent boiling lye solution, and 3 minutes in a 20-percent boiling lye solution.

EFFECT OF LYE PEELING ON THE TITRABLE ACIDITY AND HARDNESS OF THE TUBERS

Table 2 shows the results of the experiments performed to determine the effects of the lye treatment on the hardness or acidity of the lye peeled yams as compared with a hand-peeled control. It shows that lye peeling has no appreciable effect on the tritable acidity or hardness of the product. The acidity and hardness values of the hand-peeled tubers as compared with the corresponding values of those batches peeled by immersion in lye show similar results.

EFFECT OF LYE PEELING ON THE PALATABILITY OF YAMS

The tubers were lye-peeled using the 10-percent 5-minute and the 20-percent 3-minute treatments. The tubers were then submitted to a sensory evaluation against hand-peeled controls, using a +2, -2 scale as suggested by Kramer (4), where +2 is considered very acceptable and -2 as not acceptable. The results obtained from the sensory evaluation tests show no significant difference between hand- and lye-peeled yams.

FIG. 1.—Effect of exposure to air on lye-peeled tubers of *Dioscorea alata*. A, Unpeeled; B, lye-peeled; C, 30 minutes after being peeled.



HAND PEELING OF FRESH TUBERS

Experiments performed to determine the average weight loss of hand-peeled yam tubers furnished the following data:

| Number of tubers | | Weight of tubers | | Peel lost | |
|------------------|----|------------------|------|----------------|-------|
| | | <i>Pounds</i> | | <i>Percent</i> | |
| | 15 | | 15.0 | | 18.33 |
| | 12 | | 15.0 | | 23.33 |
| | 10 | | 15.0 | | 25.00 |
| | — | | — | | — |
| Total | 37 | Total | 45.0 | Average | 22.22 |

The above data shows that the average loss for hand-peeled tubers was 22.22 percent, which is higher than the losses shown in table 1. Lye peeling thus results in lower weight losses, saves time and labor, and furnishes products of good quality.

EFFECT OF EXPOSURE OF PEELED TUBERS TO AIR

It was discovered during the course of these experiments that both hand- and lye-peeled tubers must be kept underwater. Otherwise, brown spots develop which may impair the appearance of the tubers. These spots possibly are due to oxidation or enzymatic action. This effect is shown in photographs of tubers taken 30 minutes after being peeled (figs. 1, A, B, and C).

TABLE 3.—*Effect of storage on the lye peeling of yam*¹

| Storage period | | Peel lost | Visual evaluation ² |
|----------------|--|----------------|--------------------------------|
| <i>Days</i> | | <i>Percent</i> | |
| 2 | | 14.0 | Good |
| 14 | | 13.5 | Good |
| 21 | | 13.33 | Good |
| 28 | | 10.0 | Questionable |
| 35 | | 11.13 | Questionable |
| 45 | | 11.67 | Questionable |

¹ 10 percent by weight of lye solution for 5 minutes.

² See table 1, footnote 1, for rating legend.

EFFECT OF STORAGE ON THE EFFICIENCY OF THE PEELING OPERATION

The efficiency of the lye-solution peeling method changed when applied to yams stored for 4 weeks. As shown in table 3, the 10-percent 5-minute treatment may be used only on tubers stored up to 3 weeks. The peeling action is not as efficient thereafter.

SUMMARY

Studies were conducted to determine the most suitable conditions for the lye-peeling of fresh yam, *Dioscorea alata*, of the Florido variety. Good

peeling resulted from each of these boiling lye solution combinations: 5 minutes in 10-percent, 4 minutes in 15-percent, or 3 minutes in 20-percent. The average weight loss resulting from these three combinations was approximately the same, but less in each instance than when the tubers were hand-peeled.

Changes in titrable acidity and hardness values of the tubers were approximately equal to those which resulted from hand-peeled yam. The sensory evaluation of the samples showed no significant difference between hand- and lye-peeled tubers.

The lye-peeling method was not wholly satisfactory when the yams had been in storage for more than 3 weeks.

RESUMEN

Se llevaron a cabo estudios para determinar cuáles eran las combinaciones más prácticas de varias concentraciones de una solución de lejía (soda cáustica) y el tiempo de inmersión requerido en cada caso para pelar tubérculos de ñame fresco, *Dioscorea alata*, de la variedad Florido.

Los resultados obtenidos indican que para el ñame fresco así tratado debe aplicarse una de las siguientes combinaciones: Inmersión por 5 minutos en una solución en ebullición al 10 por ciento; inmersión por 4 minutos en una solución en ebullición al 15 por ciento; o inmersión por 3 minutos en una solución en ebullición al 20 por ciento. Los varios tratamientos causaron una merma por el desprendimiento de la cáscara, de 14.44, 13.33 y 12.21 por ciento, respectivamente. En todos los tratamientos la merma fue mucho menor que el 22.22 por ciento que tuvo lugar cuando los tubérculos se pelaron a mano.

No se registraron cambios desfavorables en los valores de la acidez ni la dureza del tubérculo que puedan atribuirse al efecto del pelado con lejía. En las pruebas organolépticas que se llevaron a cabo no se revelaron diferencias significativas entre los tubérculos de ñame pelados a mano y los que se pelaron con lejía.

El método de pelar el ñame con lejía perdió parte de su eficacia cuando los tubérculos habían estado almacenados por más de 3 semanas.

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