Lye Peeling of Taniers (*Xanthosoma* spp.)[1]

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ABSTRACT

Methods for lye peeling taniers (*Xanthosoma* spp.) were studied. Both medium- and large-size tubers could be peeled with high efficiency in 15% lye at 200° F (93° C), at a dipping time ranging from 6.5 to 10 min. Preheating the tubers in water for 30 min at 150, 160, and 170° F (66, 71, 97° C) increased peeling losses without effectively controlling the browning reaction. Tubers stored at room temperature (80° F; 26.7° C) remained in good processing condition 10 days. When stored for 25 days, suberization of wounds and decay caused high trimming losses. The main changes in chemical composition during storage were a decrease in moisture and starch content and a slight increase in acidity. An increase in shear-press force values was observed to take place concurrently with the decrease in moisture content.

INTRODUCTION

Lye is extensively used for peeling root crops. Methods for lye peeling sweetpotatoes were described by Woodroof et al. (9). Commercial methods for lye peeling potatoes were summarized by Talburt and Smith (7). Rivera and González (4) and Steele and Sammy (6) studied the lye peeling of yams (*Dioscorea* spp).

In the lye peeling of root crops, the tubers are scalded in a 10 to 20% lye solution at or near boiling temperature. The lye-treated tubers are then washed to remove the softened peel. The effectiveness of the lye-peeling process depends on several factors, such as characteristics of the raw material, lye strength and temperature, time retained in the lye bath, and the efficiency of the peeler-washer used to remove the peel.

This paper reports laboratory and pilot plant studies on the lye peeling of taniers conducted to develop a suitable method for efficient peeling of taniers in industrial quantities.

MATERIALS AND METHODS

Freshly harvested taniers of the Blanca cultivar obtained directly from farmers or from Experiment Station plantings were used. The tubers were stored in crates at room temperature and processed within 10 days after harvest, unless otherwise indicated.

The tubers were graded for size into groups ranging in diameter as follows: 1) Smaller than 2 in (5 cm); 2) 2 to 2.5 in (5 to 6.3 cm); 3) 2.5 to 3

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in (6.3 to 7.6 cm); and 4) not graded, but larger than 3 in (9.6 cm). Tuber length was not considered in grading. Each size group was processed separately.

Graded tubers were soaked in water at room temperature (80° F, 26.7° C) for 10 min. After soaking, they were washed in a rod-reel washer with sprays, at tap water pressure.

For the lye treatment, a rotary pilot-size lye peeler similar to the one described by Thurber and Bohne was used (8). The peeler discharged the treated roots directly into a rotary brushwasher (Magnubrusher, Model F).[3] The washed tubers were collected under water or weak citric acid solution in a trough forming part of the trimming table.

Losses during peeling were calculated from the difference in weight between raw and peeled tubers and are expressed as percent raw tuber weight. Trimming losses were calculated from the weight of the trimmings and reported either in percentage of raw tuber weight or as oz/lb (g/kg) of fresh tuber.

To determine peeling efficiency, the peeled and washed roots were classified according to the degree of trimming that would be required to remove any remaining peel, as follows: 1) No trimming; 2) light; 3) medium; and 4) heavy trimming. The degree of trimming required was judged from the appearance of the peeled root. When determining peeling efficiency from the degree of trimming required, only the presence of peel not removed by the peeling process was considered, disregarding, except as otherwise indicated, blemishes due to suberized tissue or rot. Peeling efficiency is expressed as percentage by count of the tubers classified into groups according to the degree of trimming required.

Moisture, pH, and total acidity were determined by A.O.A.C. official methods (1). Starch was determined by the method of Carter and Neubert (2) and sugars by the method of Moyer and Holgate (3).

For texture measurements, a Food Technology Corporation electrical recording texture instrument was used with a proving ring of 3000 lb with the instrument set to read 1500 lb at full scale; 100 g of tubers were placed in the standard shear cell and measurements recorded with a 1.5-min stroke. Force values were determined from the recorded curves at maximum peak.

RESULTS AND DISCUSSION

In developing procedures for lye peeling root crops, the performance of the washer used to remove the lye-softened peel must be taken into

[3] Trade names are used in this publication solely for the purpose of providing specific information. Mention of a trade name does not constitute a guarantee or warranty of equipment or materials by the Agricultural Experiment Station of the University of Puerto Rico or an endorsement over other equipment or materials not mentioned.

consideration as one of the more important factors determining the efficiency of the process.

In the early part of these studies, a rotary drum-washer consisting of a perforated steel drum provided with a spiral and water sprays throughout its length was used to wash the lye-treated tubers. Irrespective of the lye treatment used, this equipment did not remove the peel completely. Probably due to the irregular shape of taniers, the rather gentle rubbing of the tubers together and their contact with the rough surface of the drum did not provide enough friction to remove all of the peel.

When the rotary brush washer was used, the peel could be completely removed if it had been properly softened by the lye treatment. All subsequent studies were therefore conducted using this type of washer.

The brush-washer used had two adjustments which affect peeling efficiency: The speed at which the roll with the brushes rotates controlling the scrubbing action; and the speed of the auger, which determines the retention time of the tubers in the washer. Under the conditions of these experiments, in which the machine operated below normal throughout, a roll setting of five and an auger setting of three proved to give the best results[4].

EFFECT OF LYE CONCENTRATION, TEMPERATURE, AND LENGTH OF TREATMENT ON PEELING EFFICIENCY

As a preliminary step in these investigations, 10-lb (4.5-kg) lots were peeled in a 10-gal (40-l) batch peeler with 20 and 10% boiling lye—boiling points 226° F (107° C) and 216° F (102° C)—varying the retention time in the lye bath from 2 to 10 min. The results of these tests showed that when the tubers were treated in boiling 20% lye solution, extensive discoloration and gelation of the tissue in contact with the lye took place, making it very difficult to remove the peel in the washer. In the 10% solution, discoloration and gelation were less pronounced, but peel removal was not satisfactory. These results suggested that taniers must be lye-peeled at a temperature lower than the boiling point of the lye solution. Therefore, subsequent experiments were directed to determine the conditions for peeling the taniers with lye heated below the boiling point.

Table 1 shows the results obtained when taniers were peeled in lye solutions of 10, 15, and 20% by weight at 210° F (99° C). In the three lye solutions, the loss in weight of the tubers during peeling and washing increased with the length of the treatment. Short dipping times in 10 and 15% lye solutions resulted in poor peel removal. Long lye treatments resulted in high peeling efficiency, but in higher peeling losses.

[4] The figures indicated correspond to the adjustment guide numbers indicated in the corresponding scales in the machine.

When 20% lye solution was used, peeling efficiency was low, due mainly to gelation of the tissue, which resulted in poor peel removal which required extensive trimming.

When the treatments with the lowest weight loss and higher peeling efficiency are selected from the data in table 1, the following tabulation is obtained:

Lye concentration – % by weight	10	15	20
Dipping time – min.	7.7	7.9	6.6
Loss in weight during peeling – %	29.8	30.8	30.4
Peeling efficiency – %	80.0	95.0	65.0

It is evident that under conditions of the experiments, 15% lye was more efficient for peeling taniers than the 10 and 20% lye concentrations.

TABLE 1.—*Effect of lye concentration and time of immersion on the loss in weight of the tubers during peeling and on the efficiency of the peeling process. Temperature of lye solution at 210° F (99° C)*

Time of immersion	Lye concentration	Loss in weight of lye-treated tubers	Peeling efficiency[1]
Min	%	%	%
3.5	10	20.0	60.0
6.4		29.7	70.0
7.7		29.8	80.0
9.3		45.0	60.0
11.5		37.2	70.0
12.0		40.0	87.5
3.6	15	20.4	60.0
6.2		25.6	80.0
7.9		30.9	95.0
9.6		32.5	85.0
11.5		37.5	90.0
3.9	20	22.1	65.0
6.6		30.4	65.0
7.5		31.9	65.0
9.3		32.8	60.0

[1] Peeling efficiency is the total percentage of tubers requiring no trimming or only light trimming to remove any remaining peel.

Table 2 includes the results when taniers were peeled in 15% lye at 190, 200 and 210° F (88, 93, 99° C). The data show that at the three temperatures tested the peeling efficiency was 100%. Peeling losses, however, increased with temperature. As the temperature of the lye bath was lowered, surface discoloration was less and the peeled taniers looked whiter.

Further analyses show that at 190° F (88° C), if the dipping time is

reduced by 1.5 min, peeling efficiency drops to 75%. At 200° F (93° C) changing the dipping time 1.5 min caused a peeling efficiency ranging from 95 to 100%. This suggests that for peeling taniers satisfactorily under commercial conditions under which dipping times may vary, the temperature of the lye should not be lower than 200° F (93° C). Replicated pilot runs confirmed that peeling taniers with 15% lye solution at 200° F (93° C) caused low peeling and trimming losses. The following tabulation shows that overall recovery of product ready for packing ranged from 70 to 79.36%.

Average weight of tubers processed – lb	0.22	0.23
g	98.4	104.3
Loss in weight of tubers during peeling and washing – %	19.2	28.6
Loss in weight of tubers due to trimming – %	1.34	1.44
Overall recovery – %	70.06	79.36

EFFECT OF TUBER SIZE ON PEELING EFFICIENCY

When processing taniers commercially, processors face the problem of lack of uniformity of size and shape. Although it is possible to classify

TABLE 2. —*Effect of immersion time and temperature on peeling losses and on the efficiency of the peeling process when using 15% lye*

Time of immersion	Temperature	Loss in weight of lye-treated tubers	Peeling efficiency
Min	*°F (°C)*	*%*	*%*
6.5	190 (88)	29.9	75.0
8.0		33.8	100.0
6.5	200 (93)	34.6	100.0
8.0		37.1	95.0
6.5	210 (99)	35.5	80.0
7.5		37.7	100.0
9.3		41.1	70.0

the roots by size to obtain uniformity in the processed product, the problem of peeling large size tubers remains.

To determine whether the size of the tuber affects peeling efficiency, tubers ranging in length from 6 to 8 in (15–20 cm) and with a diameter exceeding 2.5 inches (6.5 cm) were peeled in 15% lye solution at 200° F (93° C) varying the retention time from 8 to 14 min.

Table 3 shows that when peeling large size tubers, it is necessary to increase the length of the lye treatment to 10 min to remove the peel satisfactorily. Under these conditions, peeling losses averaged 26.6% with a trimming loss of only 0.9 oz/lb (80 g/kg). About 30% of the tubers required trimming. The need for trimming was due to the presence of suberized tissue and decayed areas and not to poor peel removal. At

lower dipping times peeling was not complete, the tubers requiring more extensive trimming.

EFFECT OF PREHEATING THE TUBERS BEFORE LYE PEELING ON PEELING LOSSES AND PEELING EFFICIENCY

When lye-peeled, most tubers suffer extensive browning when exposed to air, due to the action of phenolases. In lye peeling sweetpotatoes, it was found that preheating the roots to 130° F (54° C) for 30 min before peeling reduced the browning due to enzyme action (5). Although preheating may reduce trimming losses, higher losses during peeling result.

Since the authors were also studying methods for the control of browning in lye-peeled tubers as part of the investigations to develop procedures for the freezing preservation of taniers, the effect of preheating on the peeling process was investigated.

TABLE 3.—*Effect of immersion time on the efficiency of the peeling process when peeling large-size tubers in 15% lye solution at 200°F (93° C)*

Immersion time—min	8	10	14.5
No. of tubers processed	20	40	20
Average weight of tubers—lb	.5	.6	.7
Loss in weight during peeling and washing—%	25.0	26.1	31.0
Loss in weight of tubers due to trimmings—oz/lb	.08	.13	.18
Overall recovery—%	74.5	73.17	67.87
Peeling efficiency—%	100.0	97.5	95.0

When taniers are lye-peeled at 200° F (93° C) without preheating, the average loss in weight is around 30% with a peeling efficiency ranging from 95 to 100%. Table 4 gives the results obtained when the tubers were preheated before peeling. Preheating from 150 to 170° F (66, 71, 77° C) resulted in higher peeling losses which ranged from 38.0 to 42.8%. None of the treatments tested controlled the discoloration of the lye-peeled tubers when exposed to air. Preheating for 30 min at the 3 temperatures tested resulted in gelation of some roots, which made peeling more difficult, reducing peeling efficiency. The reduction in peeling efficiency was more pronounced when the tubers were heated for 30 min at 170° F (77° C). It can therefore be concluded that preheating taniers before lye-peeling has no beneficial effect either on the peeling process or in controlling discoloration.

EFFECT OF STORAGE OF THE TUBERS AT ROOM TEMPERATURE (80° F, 26.7° C) ON PEELING EFFICIENCY AND YIELDS

Another problem which processors face when processing taniers is the variation in the age of the tuber at the time of processing. Due to

conditions in the market, they may obtain tubers either freshly-dug or stored at ambient conditions for a variable length of time. During storage, wounds suberize and rot; decay may take place, especially around badly wounded or bruised areas. Since suberized tissue and portions affected by decay are not removed during lye peeling, the extent to which damage takes place in storage directly affects yield and peeling efficiency.

Table 5 includes the data obtained when processing tubers stored at room temperature for a period ranging from 4 to 25 days. The tubers remained in fairly good condition for a period of 10 days. During this period peeling losses ranged from 25.5 to 28.7%; the tubers requiring trimming ranged from 0 to 12.5%. Total recovery after peeling and

TABLE 4.—*Effect of preheating the tubers on the loss in weight during lye peeling and on peeling efficiency*

Preheating bath temperature		Length of treatment	Loss in weight of lye-peeled tubers	Peeling efficiency
°F	°C	*Min*	%	%
150	66	30	39.7	98.0
160	71	15	39.1	100.0
		30	38.3	80.0
170	77	15	38.0	95.0
		30	42.9	75.0

TABLE 5.—*Processing data for tubers stored at room temperature for a period ranging from 4 to 25 days lye-peeled in 15% lye at 200° F (93° C)*

Storage period	Average weight of tubers		Loss in weight of tubers during peeling	Roots requiring trimming	Total recovery
Days	*Lb*	*Kg*	%	%	%
4	0.24	0.11	28.7	—	69.2
7	.31	.14	25.5	12.5	72.4
10	.31	.14	25.8	7.0	72.1
18	.21	.10	27.5	65.0	66.7
25	.19	.09	21.9	77.2	63.5

trimming ranged from 69.2 to 72.4% with an average for the period of 70.9%. By the 18th day in storage the number of tubers requiring trimming incresed to 65%, and although peeling losses were similar to the previous lots processed, total recovery dropped to 66.7% on account of heavier losses while trimming.

After being stored 25 days, the tubers were in rather poor condition due to the presence of extensive areas with suberized tissue and rot. Peeling losses were smaller than those of the previously processed lots because neither the suberized tissue nor the decayed areas were removed by the lye treatment. The number of tubers requiring trimming increased to 77.2% with a trimming loss of 14.6%; overall recovery decreased to 63.5%.

Table 6 gives the analytical data from the analyses of the tubers at four intervals during storage. The main changes observed in the chemical composition are loss of moisture of about 6%, increase in acidity, and a marked decrease in starch content. No change in total or reducing sugars took place even though the starch content dropped from 28.2 to 16.1%. A change in texture took place; shear-press value increased from 967 lb to 1072 lb, which suggests that the tubers became tougher during storage. The change in texture seems to be somewhat related to the loss of moisture. Further studies are needed to determine whether the loss of starch is due to the respiration of the tissue. Although the results of the organoleptic tests conducted at different storage periods are not conclusive, they seem to indicate that no marked change in flavor took place.

TABLE 6.—*Changes in chemical composition and texture in tubers of the Blanca cultivar stored in crates at room temperature*

Storage period	Moisture	Acidity as citric acid	pH	Starch	Total sugars	Reducing sugars	Texture—shear-press maximum force
Days	%	%		%	%	%	*Lb*
3	69.30	0.08	6.53	28.18	0.08	0.01	967
9	65.00	.11	6.55	28.50	.05	.02	910
14	67.40	.11	6.49	28.60	.06	.02	900
24	63.10	.11	6.51	16.07	.06	.02	1072

RESUMEN

Se hizo un estudio para averiguar las condiciones óptimas para pelar yautías con soda cáustica. Yautías medianas y grandes en diámetro pudieron pelarse con una eficiencia de 95 a 100% cuando se sumergieron durante 6.5 a 10 min. en una solución de soda cáustica de 15% por peso a 200° F. (93° C) y se lavaron en una lavadora de cepillos de fibra.

Cuando las yautías se sumergieron en agua a 150, 160 y 170° F. (66, 71, 77° C.) por 30 min. antes de tratarlas con soda, las peladuras aumentaron significativamente, disminuyendo el rendimiento.

El almacenamiento de las yautías a temperatura ambiente (80° F. 26.7° C.) por 10 días no afectó ni la eficiencia de la pela ni los rendimientos. Sin embargo, cuando se almacenaron por 25 días las pérdidas por la pela aumentaron considerablemente debido a la suberización de las heridas y a la pudrición del tejido lacerado, disminuyendo los rendimientos.

La humedad y el almidón disminuyeron durante un almacenamiento de 25 días; la acidez aumentó ligeramente. Aun cuando el almidón bajó alrededor de 43%, no hubo cambios apreciables en azúcares totales o reductores. Al cabo de 25 días de almacenamiento la dureza aumentó al disminuir la humedad.

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