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B624: A Comparison of Several Peeling Methods as Applied to Maine Potatoes for Processing

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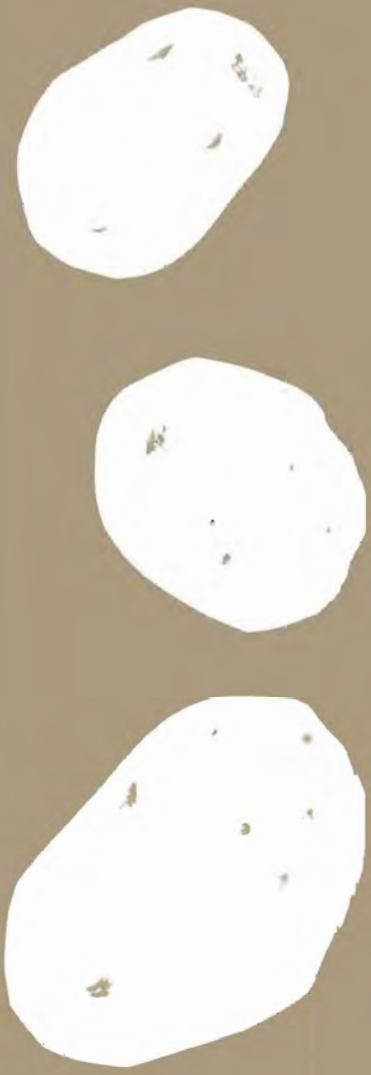

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CONTENTS

A COMPARISON OF SEVERAL PEELING METHODS AS APPLIED TO MAINE POTATOES FOR PROCESSING

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Introduction

Peeling and trimming losses of white potatoes for utilization by the processed potato industry vary widely due to many factors. Among the factors which influence such losses are the peeling method employed, variety and configuration of the tuber, size of the tuber, climatic conditions during the growing season, cultural practices, length of time in storage, and finally the storage and handling conditions to which the raw potatoes are subjected.

Published observations on peeling and trimming losses in white potatoes do not always agree, perhaps partly because all of these influences have not been considered. As a result, it is impossible for a processing plant operator to draw workable conclusions from these published data and to make a decision regarding the most efficient and economical method for peeling and trimming.

Wright and Whitman, 1949(1),[3] reported the peeling losses on several varieties of potatoes from different locations in the United States, using abrasive peeling techniques, to be 17.5 to 22.5 percent for Katahdins, and 22.0 to 25.0 percent for Russet Burbanks. An anonymous report, 1943(2), mentioned the use of boiling brine at 228°F. for softening the skin and adjacent cells followed by a water spray at 125 pounds per square inch on various root vegetables, but no peeling loss data were included. Olson and Treadway, 1949(3), described numerous methods for peeling, but reported no data on peeling-trimming losses. Harrington, *et al.*, 1956(4), discussed low temperature lye peeling i.e. below 160°F., and indicated losses when comparing this method with abrasive peeling. Losses of 25 percent for White Rose variety with lye peeling and 9 percent with abrasive peeling were reported. Lye peeled Russet Burbanks showed a 14 percent loss while abrasive peeling resulted in a 25 percent loss with this variety. Garrott, 1955(5), stated that operations on a plant production basis produced greater variations when comparing various peeling methods. Generally lye peeling removed skins with less loss than abrasive peeling. Peeling losses varied from 5

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[3] Numbers in parentheses refer to items in the bibliography, page 19.

to 28 percent with lye and 14 to 18 percent using abrasive peeling techniques. Potato varieties were not specified. It was noted in passing that cost of peeling small potatoes was greater than for large potatoes. Greig and Manchester, 1958(6), reporting on lye plus steam versus abrasive peeling indicated losses of 24.9 percent for abrasive methods, 22.4 percent for lye, and 18.6 percent for steam. Adams, *et al.*, 1960(7), discussed lye and steam pressure peeling using Idaho potatoes. When using 5 percent lye followed by steam at 75 p.s.i. a loss of 14.6 percent was observed. Mazzola, 1946(8) (9), appraised peeling methods used on a commercial basis, and comparing potatoes composed of 40 percent U.S. No. 1 stock, stated that factory production runs showed poorest yields with the brine peeling methods, good results with abrasive peeling and better with the steam peeling batch process. High temperature lye peeling was judged best. Werner, 1950(10), discussing the economy of peeling as affected by size of tubers, mentioned that peeling losses were less with large than with small sizes. Observations were reported on the basis of pounds of usable material rather than peeling losses. A National Restaurant Association Report, 1953(11), reported cost of peeling large potatoes was lower than for small potatoes. In addition it was stated that potatoes sized into various lots prior to peeling resulted in lower peeling costs when compared with peeling jumble pack or field run.

Materials

The varieties for this study were Katahdin, Kennebec, and Russet Burbank grown in Maine. Samples from two growing seasons (1959-60) were included. Potatoes were grown, harvested, graded (when required) and stored by the Plants and Soils Department under commercial storage conditions. Potatoes were peeled shortly after digging, after four months' storage, and after seven months' storage.

In order to obtain more uniform results, two lots of potatoes of each variety were used. The first consisted solely of field run tubers of each variety for each year, ungraded. The second lot consisted of tubers for each variety grown under similar conditions which had later been size graded and recombined on a percentage size basis, to coincide, as nearly as possible, with the average size distribution for each variety as reported by Murphy, *et al.*, 1957-1958(12) (13).

Table 1 shows the percent distribution by size and variety for the two years, 1957-1958:

Table No. 1
Percent Average Size Distribution 1957 - 1958

Size in inches	Katahdin	Kennebec	Size in ounces	Russet Burbank
2½-2⅞"	52.3	46.5	Less than 4 oz.	20
2⅞-3¼"	27.8	30.8	4 to 10 oz.	54.1
3¼-4"	19.9	22.7	Over 10 oz.	25.9

Equipment

Equipment consisted of a batch peeler for abrasive peeling, figure 1. A static lye bath was used for lye peeling, figure 2. Steam peeling was accomplished by using a stainless steel drum of 20-pounds capacity capable of being rotated while the potatoes were under pressure, figure 3. Lye plus steam peeling was accomplished using the lye bath and steam peeler. A rod-reel washer, figure 4, was used after lye, lye plus steam, and steam peeling. Figure 5 shows a typical hand trimming operation.

FIGURE 1 Abrasive peeling

Procedure

After harvesting and grading all lots and varieties, initial samples were peeled as soon as possible. The remaining potatoes were stored at 50°F. until time for the second peeling run for each year. Following this period, the remaining potatoes which had been held at 50°F. were sorted, desprouted, and transferred to 38°F. storage where they were held until the final peeling for each season. Withdrawal intervals from storage were October, February, and April.

Peeling and trimming loss determinations were made on 100 pound lots of each variety of potato for each method and withdrawal period from storage. These included field run as well as average reconstituted lots.

Four methods of peeling were employed: abrasive, high pressure steam, lye, and lye plus steam.

For abrasive peeling, a batch peeler of 20-pound capacity was used. Peeling contact time was from 40 to 60 seconds. Lye peeling was ac-

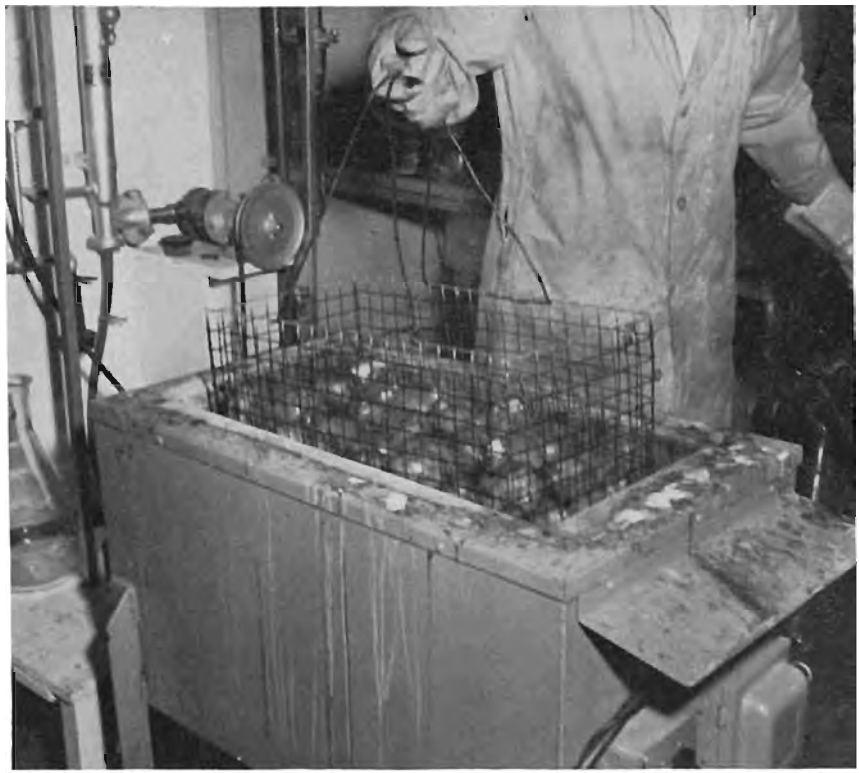

FIGURE 2 Lye peeling bath

complished in a static lye bath of 20 percent NaOH strength at a temperature of 180° to 190°F. using 20 pounds of potatoes per peeling cycle. Residual caustic was neutralized by a 2 percent hydrochloric acid rinse followed by a high pressure water wash in a rod-reel washer. Steam peeling was accomplished in a stainless steel pressure vessel holding 20 pounds of raw material per loading. Steam was admitted until 90 p.s.i. was obtained and the drum rotated from 1½ to 3 minutes depending on the length of time the potatoes had been in storage. Greater exposure time was used on samples from the longest storage periods. At the end of this period, steam was vented via a quick release valve, and the potatoes were removed. Potatoes were then washed in a rod-reel washer using a high pressure water spray. Lye plus steam peeling using a 20-pound loading per cycle was carried out by dipping tubers in 20 percent lye solution and holding them for one minute at 120°F. to 130°F. Fol-

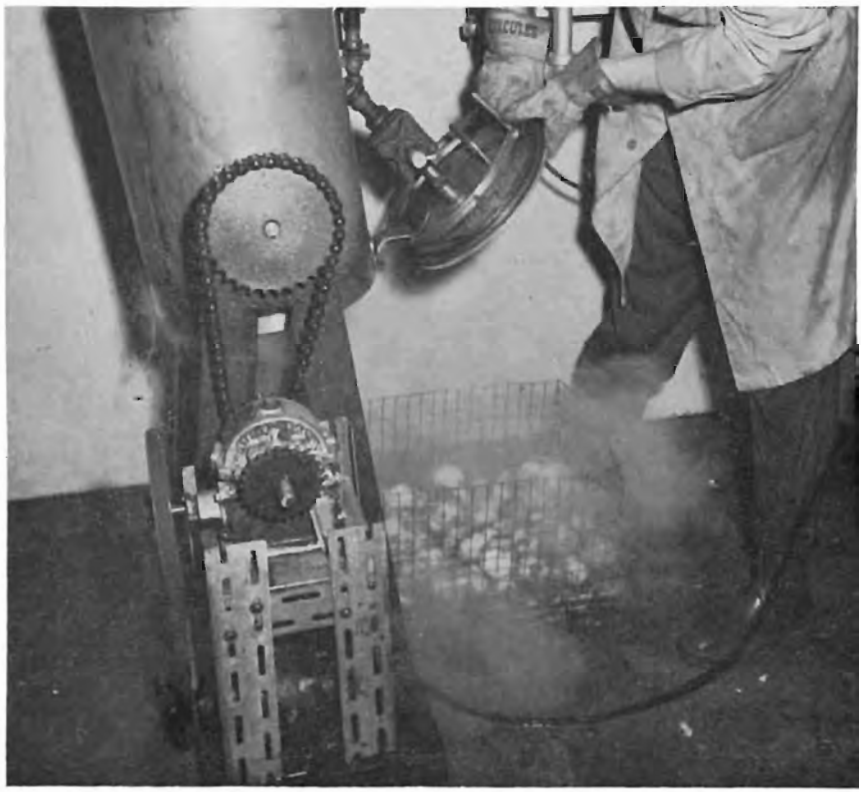

FIGURE 3 Discharge from steam peeler

lowing this operation the potatoes were exposed to steam peeling at 90 p.s.i. for 1½ minutes, followed by a high pressure water spray wash to remove loose skins prior to trimming.

After peeling, each lot was weighed prior to trimming and weighed again after a hand trimming operation to obtain losses.

Figures 6a through 8d show tubers of each variety prior to peeling (top row of each picture), after peeling (second row), and trimming (bottom row). Russet Burbank potatoes shown are from the first season's samples which were more misshapen than those from the second season.

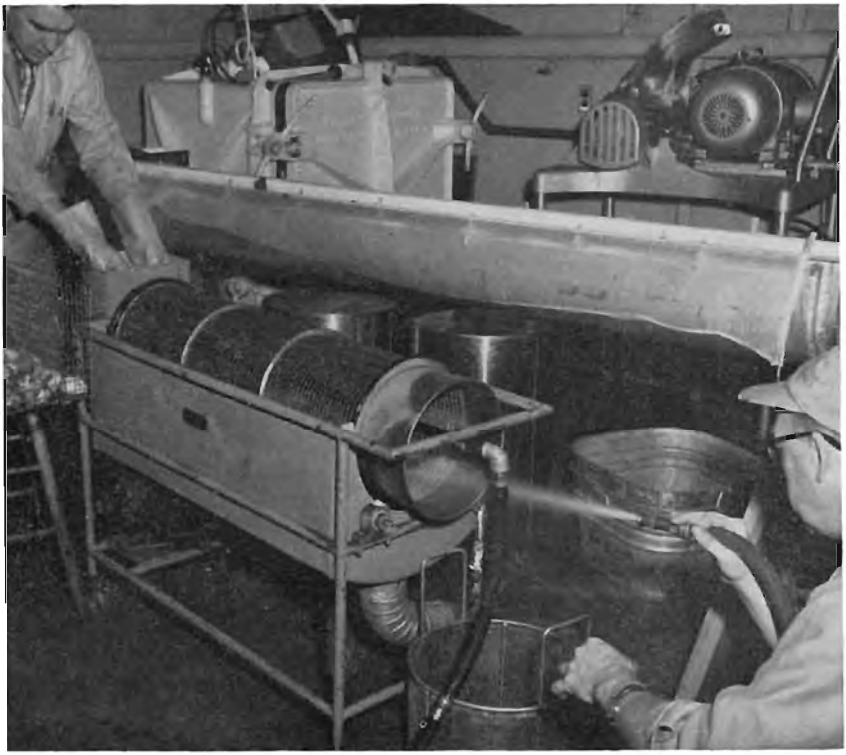

FIGURE 4 Washing after lye peeling

FIGURE 5 Hand trimming after peeling operations

FIGURE 6a Kennebec, abrasive peeled and trimmed

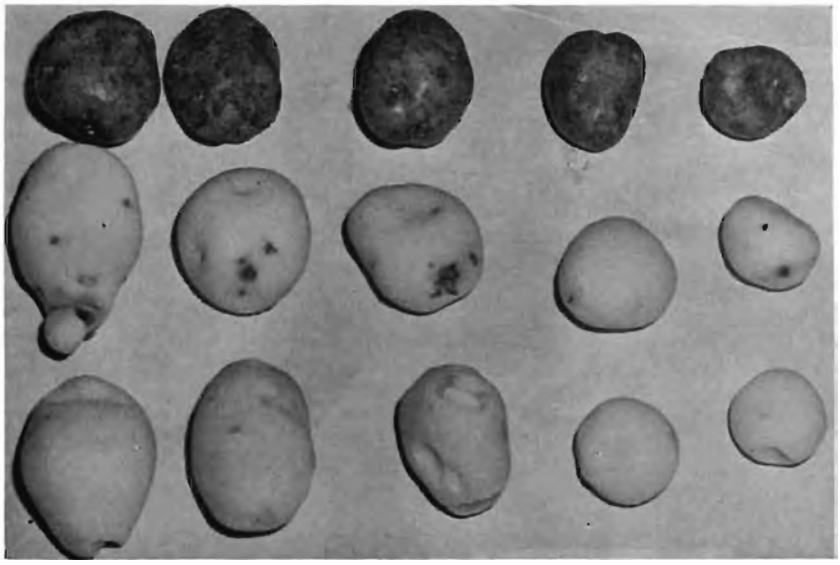

FIGURE 6b Kennebec, steam peeled and trimmed

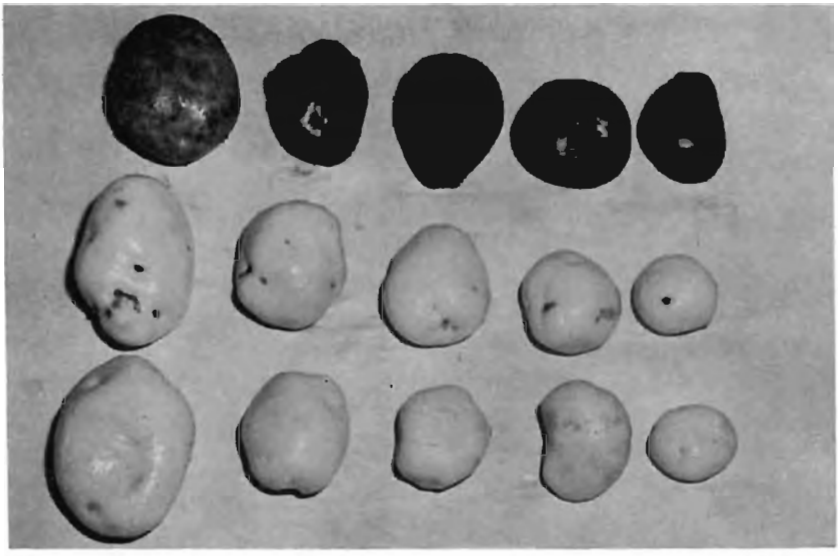

FIGURE 6c Kennebec, lye peeled and trimmed

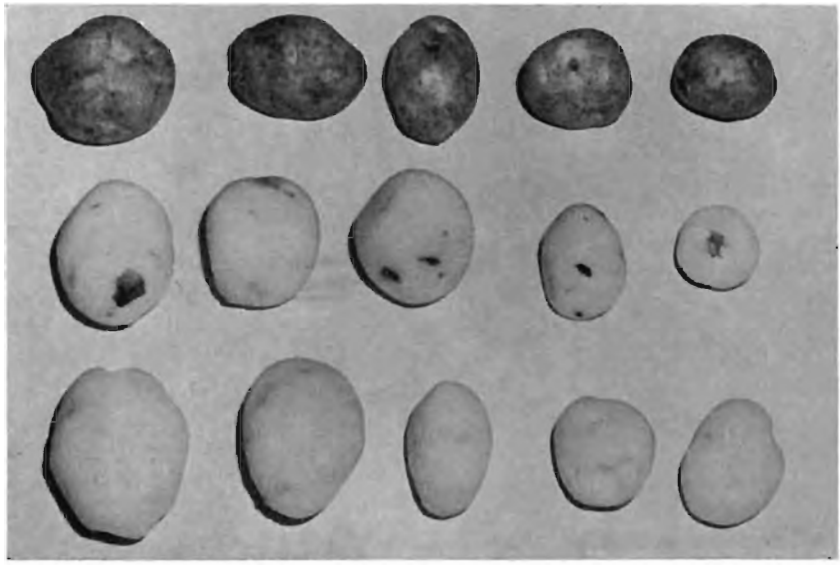

FIGURE 6d Kennbec, lye plus steam peeled and trimmed

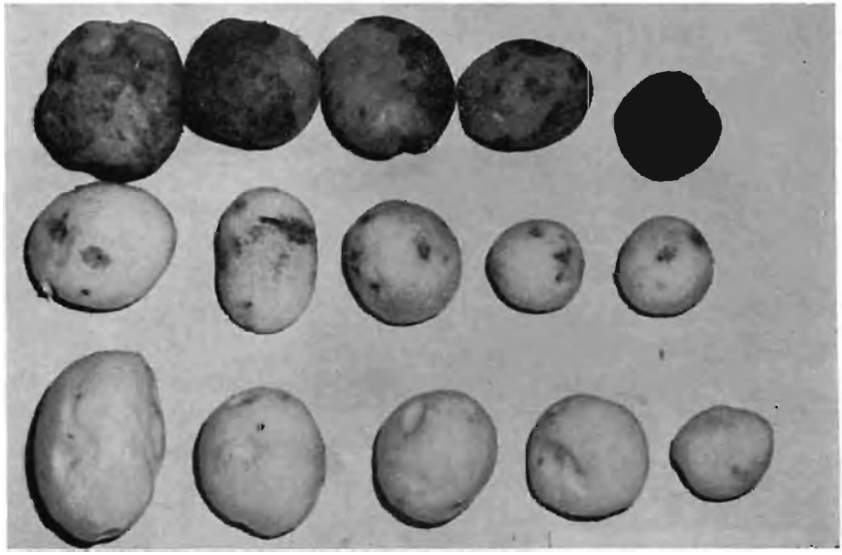

FIGURE 7a Katahdin, abrasive peeled and trimmed

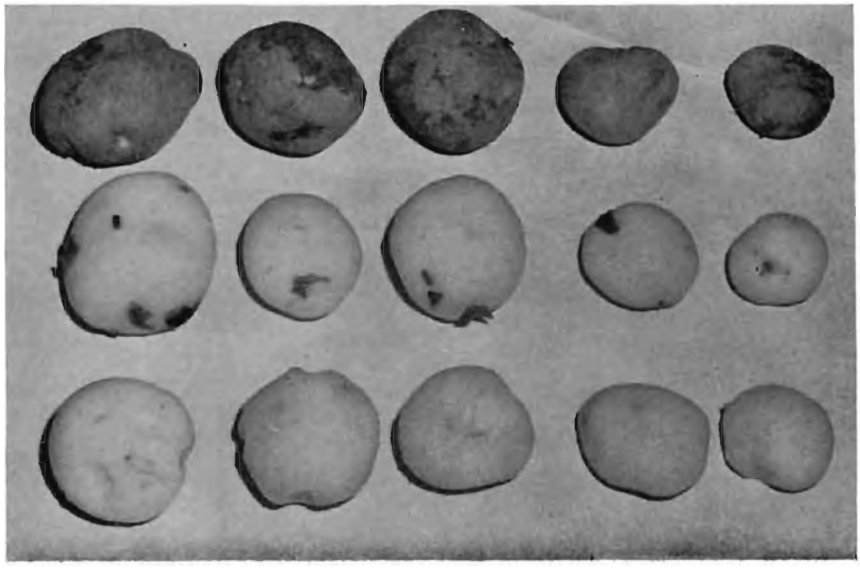

FIGURE 7b Katahdin, steam peeled and trimmed

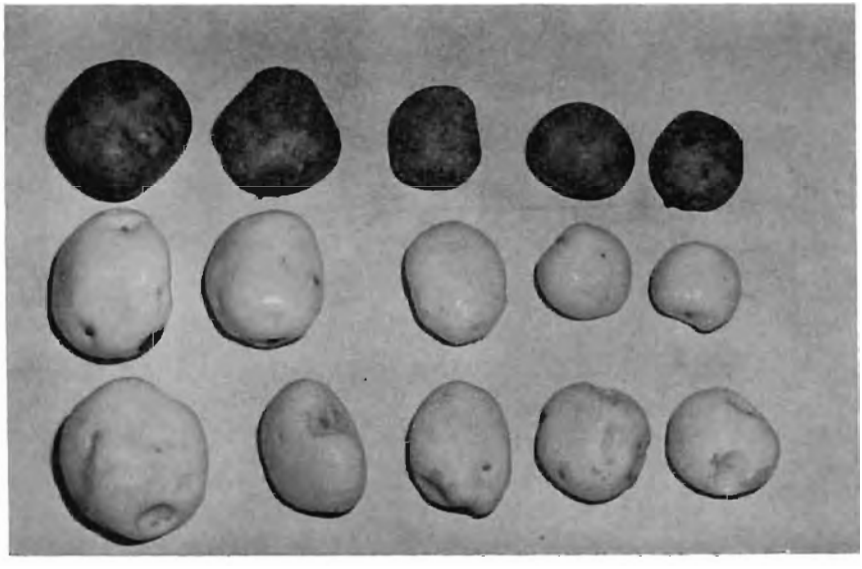

FIGURE 7c Katahdin, lye peeled and trimmed

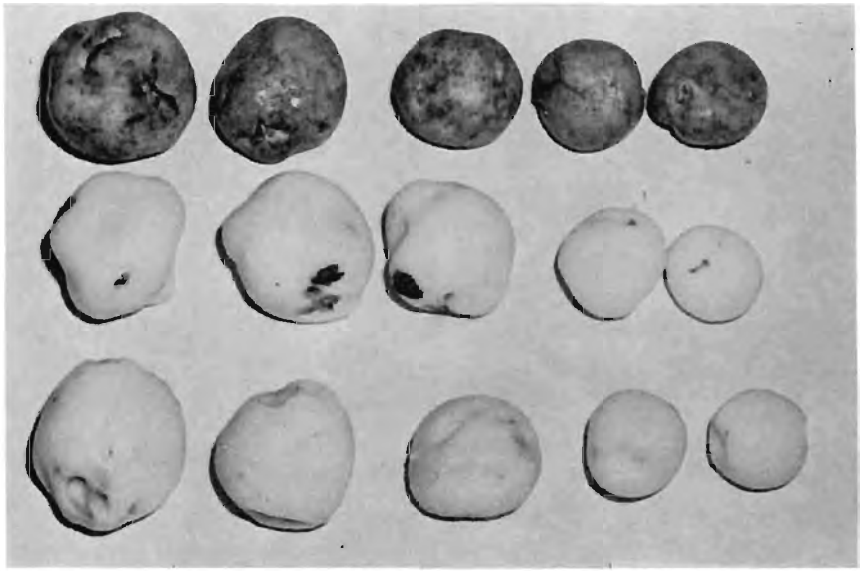

FIGURE 7d Katahdin, lye plus steam peeled and trimmed

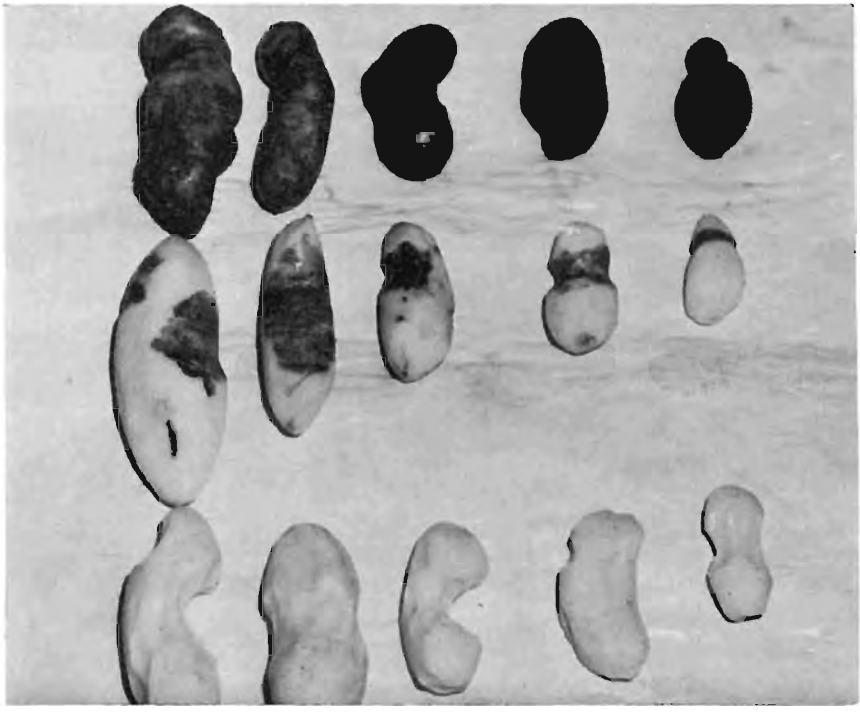

FIGURE 8a Russet Burbank, abrasive peeled and trimmed

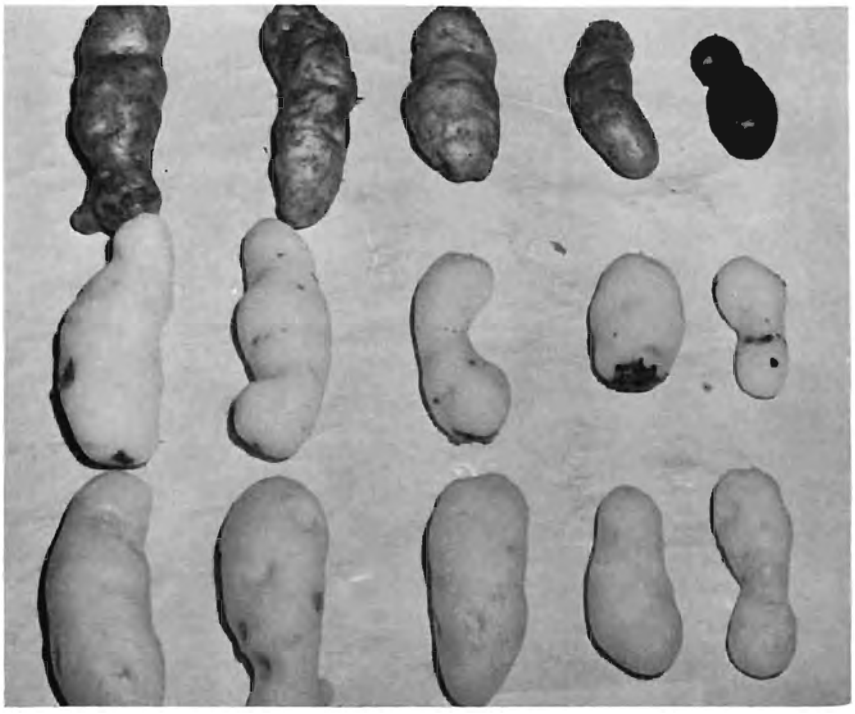

FIGURE 8b Russet Burbank, steam peeled and trimmed

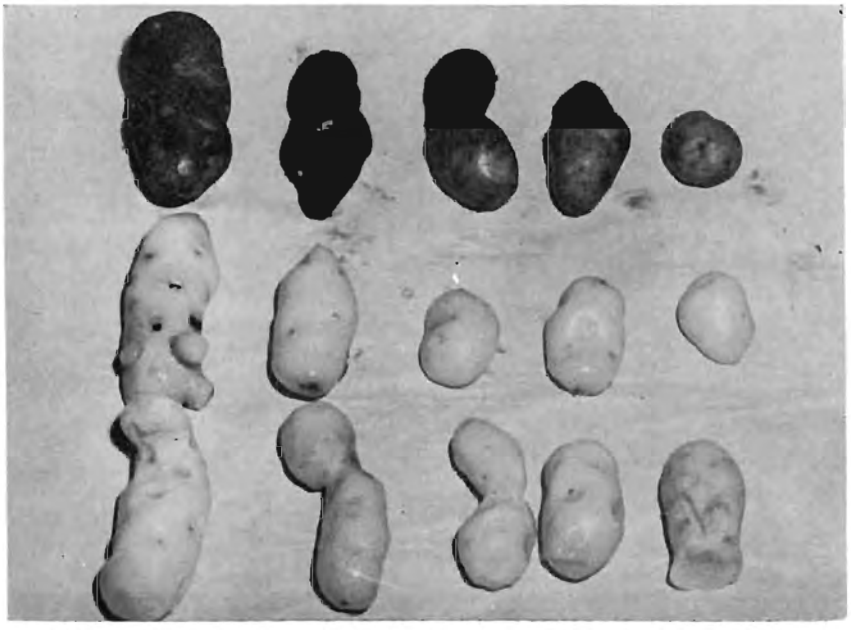

FIGURE 8c Russet Burbank, lye peeled and trimmed

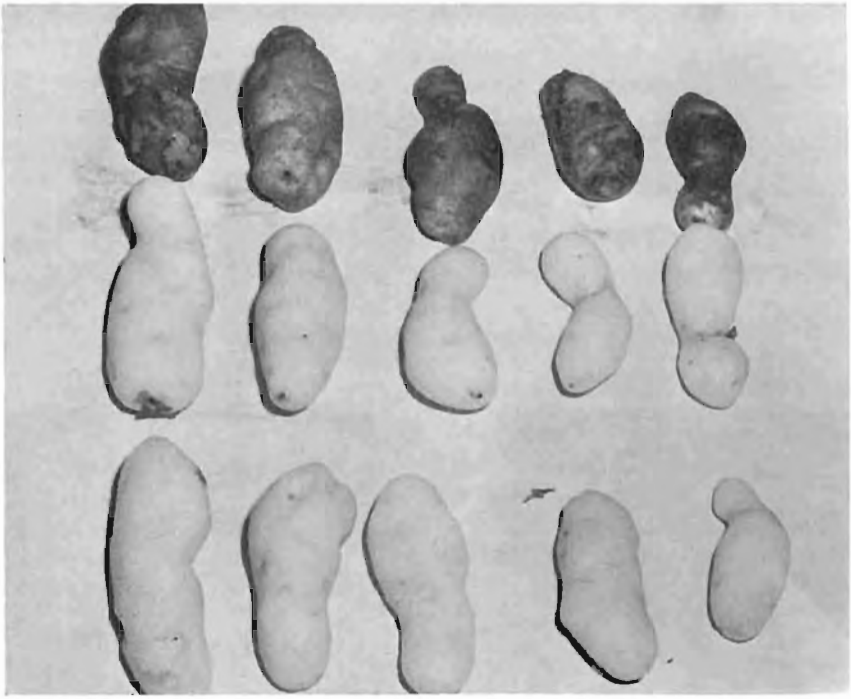

FIGURE 8d Russet Burbank, lye plus steam peeled and trimmed

Results and Discussion

Tables 2 and 4 show the averages for two growing seasons of peeling, trimming and total losses for the three potato varieties studied, and the four peeling methods used. These tables also cover the three peeling

Table No. 2
Percent Peeling-Trimming Loss Averages for Two Growing Seasons
Field Run

Peeling	Peeling	Katahdins			Kennebecs			Russet Burbanks		
Intervals	Methods	Peel	Trim	Total	Peel	Trim	Total	Peel	Trim	Total
October		14.39	4.25	18.64	23.97	2.97	26.94	16.60	8.40	25.00
January	Abrasive	17.10	4.28	21.38	20.15	3.75	23.90	20.72	6.90	27.62
April		17.01	4.17	21.18	18.36	3.45	21.81	19.04	5.85	24.89
October		10.78	3.00	13.78	10.90	1.72	12.62	16.03	1.35	17.38
January	Steam	16.25	1.94	18.19	14.55	2.41	16.96	17.63	2.85	20.48
April		15.48	2.36	17.84	13.37	2.03	15.40	18.68	2.15	20.83
October		13.35	2.47	15.82	13.25	2.13	15.38	12.28	4.07	16.35
January	Lye	14.85	2.82	17.67	13.57	1.94	15.51	18.72	3.85	22.57
April		16.88	2.14	19.02	16.51	2.17	18.68	19.60	3.26	22.86
October	Lye	12.13	1.85	13.98	10.22	2.13	12.35	16.07	3.00	19.07
January	and	15.96	2.38	18.07	11.57	1.82	13.39	15.00	3.38	18.38
April	Steam	16.60	3.27	19.87	14.70	2.54	17.24	17.10	2.10	19.20

Table No. 3

Percent Peeling-Trimming Loss Averages of Potatoes
From Three Storage Intervals for Two Years
Field Run

Peeling	Katahdins			Kennebecs			Russet Burbanks		
Methods	Peel	Trim	Total	Peel	Trim	Total	Peel	Trim	Total
Abrasive	16.17	4.23	20.40	20.83	3.39	24.22	18.79	7.05	25.84
Steam	14.17	2.43	16.60	12.94	2.05	14.99	17.45	2.12	19.57
Lye	15.03	2.48	17.50	14.44	2.08	16.52	16.86	3.73	20.59
Lye and Steam	14.80	2.50	17.31	12.16	2.16	14.32	16.05	2.83	18.88

Table No. 4

Percent Peeling-Trimming Loss Averages for Two Growing Seasons
Graded and Composited

Peeling	Peeling	Katahdins			Kennebecs			Russet Burbanks		
Intervals	Methods	Peel	Trim	Total	Peel	Trim	Total	Peel	Trim	Total
October		13.25	3.60	16.85	15.62	3.32	18.94	17.72	5.50	23.22
January	Abrasive	14.10	3.54	17.64	21.66	3.00	24.66	22.66	6.22	28.88
April		14.47	3.69	18.16	20.75	3.75	24.50	23.66	6.06	29.72
October		23.31	1.47	24.78	11.10	1.25	12.35	14.85	1.85	16.70
January	Steam	13.44	2.03	15.47	13.47	3.04	16.51	15.13	3.25	18.38
April		12.90	1.47	14.37	15.09	1.89	16.98	17.35	1.91	19.26
October		10.78	2.29	13.06	11.48	2.07	13.55	14.82	2.44	17.26
January	Lye	11.85	1.85	13.70	14.50	1.91	16.41	20.44	1.50	21.94
April		11.97	3.07	15.04	14.31	3.20	17.51	16.66	4.63	21.29
October	Lye	11.53	1.50	13.03	11.72	1.75	13.47	13.97	1.97	15.94
January	and	12.25	2.41	14.66	11.75	2.60	14.35	14.62	3.53	18.15
April	Steam	13.50	1.82	15.32	15.94	2.07	18.01	14.83	2.88	17.71

Table No. 5

Percent Peeling-Trimming Loss Averages of Potatoes
From Three Storage Intervals for Two Years
Graded and Composited

Peeling	Katahdins			Kennebecs			Russet Burbanks		
Methods	Peel	Trim	Total	Peel	Trim	Total	Peel	Trim	Total
Abrasive	13.94	3.61	17.55	19.34	3.36	22.70	21.35	5.93	27.27
Steam	16.55	1.66	18.21	13.22	2.06	15.28	15.78	2.34	18.12
Lye	11.53	2.40	13.92	13.40	2.39	15.82	17.31	2.86	20.16
Lye and Steam	12.43	1.91	14.34	13.14	2.14	15.28	14.47	2.79	17.27

intervals, i.e. for samples withdrawn at three storage intervals. Table 2 is comprised of data for field run samples while table 4 contains data from graded composited samples.

Tables 3 and 5 show peel, trim, and total losses when data for the three storage withdrawals are combined and averaged, for each peeling method. Table 3 contains data from field run samples and table 5 offers data from graded, composited samples.

Data were statistically analysed as a split plot design, with varieties and intervals as main plot factors, and methods as a sub-plot factor. The structure of the analysis of variance was as follows:

Source	Degrees of Freedom
Main Plot Analysis.	
Varieties	2
Intervals	2
Varieties x Intervals	4
Error (a)	27
Sub-Plot Analysis.	
Methods	3
Methods x Varieties	6
Methods x Intervals	6
Methods x Varieties x Intervals	12

Inasmuch as there was no sub-plot replication, there was no error term for the sub-plot analysis. The three factor interaction had consequently to be used as a measure of error, under the assumption that there was, in fact, no significance attached to the three-factor interaction. Because there was no evidence of significant variety by interval interaction, it seemed most unlikely that a three-factor interaction involving variety and interval could exist.

Summary and Conclusions

Under the conditions of this study, for both series, peel, trim and total losses were significantly greater for the abrasive method used than for the other three methods, at the 1 percent level. See tables 2 and 4. There was no evidence that losses by methods, other than abrasive, were appreciably different except trim losses in the graded, composited samples. Evidence in that instance showed steam peeling induced significantly lower losses than either the lye or lye plus steam methods.

In general, storage intervals did not significantly affect the peel-trim or total losses in either series of samples. However an exception

was the evidence that peel losses in field run samples were somewhat lower in October than January or April, at the 5 percent level.

Peel and total losses from Russet Burbank tubers were substantially higher at the 1 percent level than those from Katahdin and Kennebec varieties. This was true for field run and graded-composited series of samples. Trim losses also tended in the same direction but were slightly short of significance for the field run series. Large variability in the data from graded series may have masked significance in that series.

In neither set of data was there any evidence of interaction between variety and storage time.

Based on the results of this study, it would seem that the relation between peeling methods and peeling losses, other than the abrasive method, were of minor significance in choosing a peeling technique.

Selection of a peeling method, other than abrasive, may depend more on savings reflected in trimming, following peeling, in terms of trim losses and labor costs involved in the hand trimming operation, or capital investment in peeling equipment.

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