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EFFECTS OF IONIZING RADIATION ON WHITE POTATOES[1]

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Among factors other than sprout inhibition which must be considered in the practical application of ionizing radiation as a process for increasing the shelf life of white potatoes are the effects of the treatment on (1) weight losses during storage, (2) the normal resistance of the tubers to decay, (3) peeling and trimming losses, and (4) cooking quality and acceptance. This report deals with an evaluation of some of these factors as observed in two varieties.

EXPERIMENTAL

A limited quantity of Michigan-grown Sebago and Russet Rural potatoes was obtained from the Fission Products Laboratory, University of Michigan, Ann Arbor, Michigan. These were part of a large procurement used by the Fission Products Laboratory for detailed studies which will be reported at a later date.

The potatoes were harvested in October 1955, delivered to the radiation site on November first and held at 5°C. until irradiated at 0, 5, 10, 15, 20, 25, 50, 100 and 200 kilorep using a cobalt^{60} source. On arrival at Quartermaster Food and Container Institute on January 3, 1956, there was no evidence of sprouting or decay in any of the lots; however, all lots showed signs of softening and had a slightly shriveled appearance. Triplicate samples of each treatment weighing approximately 2.0 kilograms, were packed on January 3, and stored at 13°C. and 22°C. (R.H. 85 to 90 per cent) After one and two-month storage periods, the various samples were examined for sprouting and storage losses. Certain treatments were evaluated for peel and trim losses and for differences in preference.

RESULTS

Effects of Irradiation on Sprouting

The extent of sprouting was determined by counting the number of sprouts over ¼ inch long in each sample and by weighing them after removal. Sprouting occurred normally in the untreated controls and was completely inhibited in all lots treated with 15 or more kilorep. The lots treated with 5 kilorep and stored at 13° C. had not sprouted after one month storage, but had developed many small (less than ¼ inch long) abnormal sprouts after two month's storage. Those stored at 22° C. had developed about 20 per cent as many sprouts as the untreated control after one month storage, and about 34 per cent as many sprouts after two month's storage. In the lots treated with 10 kilorep, only a rare sprout occurred in those stored at 22° C. and none was noted in the lots stored at 13° C. The weight loss through sprouting was negligible in all samples.

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Effects of Irradiation on Weight Loss and Decay

Each sample, when withdrawn from storage, was again weighed. The gross loss in weight represented the combined losses caused by transpiration and respiration of the tubers, the growth and respiration of the contaminating microorganisms, and the growth and development of sprouts in the lots where sprouting occurred. All visible decay and sprouts were trimmed from each sample and each was weighed. The remainder was weighed and is expressed as the usable portion before peeling.

The findings (Figures 1 and 2) suggest that weight loss and decay in the samples treated with irradiation doses above that required to inhibit sprouting are greater than the weight loss and decay in the untreated controls. Doses at or near the minimum sprout inhibiting dose appear to cause a decrease in these losses.

Effects of Irradiation on Peeling and Trim Losses and Preference Ratings

After removing sprouts and visible decay, weighed portions of certain samples were studied to determine the effects of irradiation on peel and trim losses. For these studies, all peeling and trimming was done by hand using a potato peeler and paring knife. These results, shown in table 1, indicate that such losses were lowest in the lots treated in the minimum sprout inhibition range.

TABLE 1.—*Effects of irradiation on peeling and trimming losses in white potatoes during storage.*

Dose (kr)	Initial			After One Month			After Two Months		
	Peel	Trim	Total	Peel	Trim	Total	Peel	Trim	Total
	Sebago Variety Stored at 13° C.								
0	10	3	13	29	3	32	16	4	20
10	18	2	20	18	8	26	17	7	24
20	19	5	24	16	19	35	20	15	35
100	11	3	14	17	9	26	12	5	17
	Russet Rural Variety Stored at 13° C.								
0	18	3	21	16	5	21	17	6	23
5	20	2	22	17	3	20	19	3	22
10	18	0	18	19	3	22	24	5	29
20	33	5	38	18	8	26	20	14	34
100	13	5	18	17	25	42	25	11	36
200	16	18	34	17	19	36	30	16	46
	Sebago Variety Stored at 22° C.								
0	22	3	25	20	3	23	17	15	32
10	13	3	16	17	13	30	16	6	22
20	25	7	32	18	17	35	12	10	22
100	14	3	17	19	19	38	19	11	30
	Russet Rural Variety Stored at 22° C.								
0	32	3	35	22	3	25	26	6	32
5	13	2	15	15	3	18	11	11	22
10	18	3	21	22	4	26	17	9	26
20	14	5	19	20	20	40	18	20	38
100	22	10	32	18	22	40	7	51	58
200	15	20	35	All Decay		100	All Decay		100

Numbers represent per cent based on usable portion before peeling.

FIGURE I

EFFECTS OF IRRADIATION ON LOSSES IN SEBAGO WHITE POTATOES AFTER ONE MONTH STORAGE AT 22° C

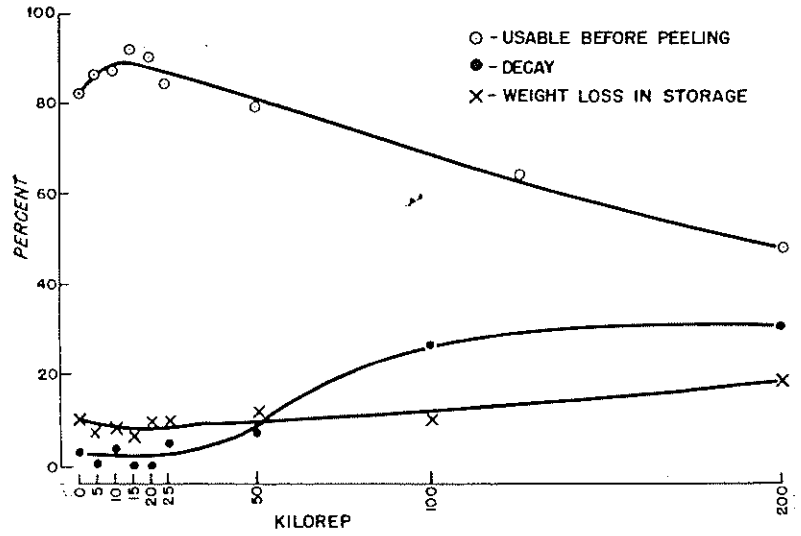
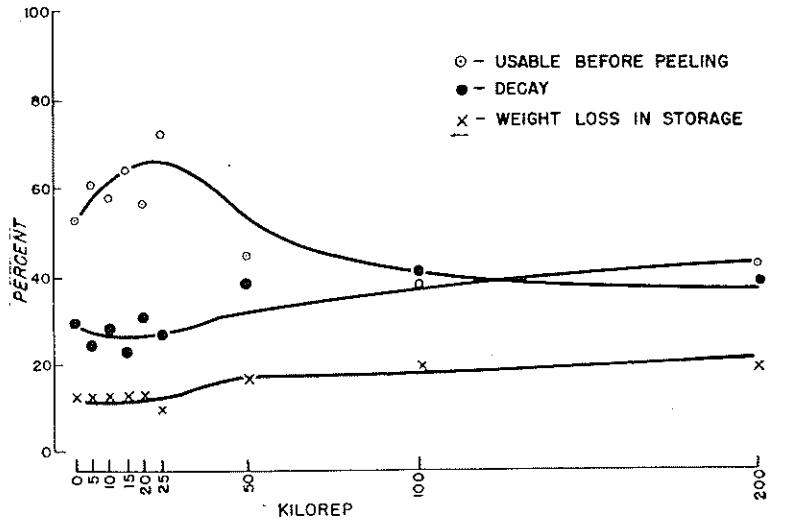


FIGURE II

EFFECTS OF IRRADIATION ON LOSSES IN SEBAGO WHITE POTATOES AFTER TWO MONTHS STORAGE AT 22° C



Diced samples, after cooking in boiling salted water, were drained and buttered. They were then rated for preference using the hedonic rating scale. These results, shown in table 2, clearly indicate that irradiation has no effect on preference.

TABLE 2.—*Effects of irradiation on flavor preference in white potatoes following gamma irradiation.*

Hedonic Mean for Main Effects

Temperature *vs.* Time

Temperature	Time: Initial	One Month	Two Months	Average
13°C	6.7	6.7	6.7	6.7
22°C	6.7	6.5	6.5	6.6
Average	6.7	6.6	6.6	6.6

Time *vs.* Irradiation Dose

Time	Dose x 10^3 rep. 0	10	20	100	Average
Initial	6.9	6.8	6.8	6.4	6.7
One Month	6.8	6.8	6.4	6.6	6.7
Two Months	6.8	6.7	6.6	6.3	6.6
Average	6.8	6.8	6.6	6.5	6.7

Temperature *vs.* Variety

Temperature	Sebago	Russet Rural	Average
13°C	6.6	6.8	6.7
22°C	6.5	6.6	6.6
Average	6.6	6.7	6.6

DISCUSSION AND CONCLUSIONS

This study confirms previous observations that 15 kilorep will completely inhibit sprouting and that, for practical purposes, 10 kilorep, or less, is ample. The study also confirms previous observations that doses up to 100 kilorep have little or no effect on preference.

It is interesting to note that weight loss, decay, and peel and trim loss appear to be lowest in the lots receiving irradiation in the minimum sprout inhibition range. Irradiation above this level appears to render the tubers more susceptible to decay and this change in susceptibility to decay increases with increasing dosage. In *in vitro* studies conducted by Waggoner (2), 30 and 80 kilorep affected wound periderm formation and did not increase the resistance of the tubers to decay. However, Sawyer, Dallyn, and Cotter (1) report that tubers treated with 12 kilorep would not sprout and would develop wound periderm if held under optimum conditions. It does seem essential that dosages be kept at the minimum sprout inhibition level in order to keep losses to a minimum. Experiments now in progress are concerned with minimum practical dosage, the effects of this dosage on weight loss and decay, and the effect of pre- and post-irradiation environments on wound healings.

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