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HIGH RADIOPASTEURIZATION OF FOODS

Period November 21, 1956, to January 20, 1957

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Project 2596

QUARTERMASTER FOOD AND CONTAINER INSTITUTE
FOR THE ARMED FORCES, CHICAGO
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CONTRACT RESEARCH PROGRESS REPORT

QUARTERMASTER FOOD AND CONTAINER INSTITUTE
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SUMMARY

This is the second progress report of research performed at the Fission Products Laboratory of The University of Michigan in the field of high radio-pasteurization of foods and of investigations made with the cooperation of the Kelvinator Institute for Better Living of the Kelvinator Division of American Motors Corporation.

Included in this report is further preliminary work with precooked food and baked products, a previous study of irradiated apples, and work in progress with fruit and vegetables.

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FRESH FRUIT AND VEGETABLES

APPLES

In the fall of 1955, Dr. Frederick Ludwig of Port Huron, Michigan, suggested an experiment utilizing gamma radiation as a means of preserving apples. He supplied the apples used in this work, culls that would not have been expected to keep for extended periods, even under the most favorable conditions. The varieties used were: Delicious, Golden Delicious, and Northern Spies. The radiation doses employed were 50,000, 100,000, and 200,000 rep. The apples used for the major experiment had been held in cold storage from September to December 7. After irradiation at the Fission Products Laboratory they were returned to cold storage in Port Huron. Apples were individually packaged in polyethylene and sealed. One year from the harvest date, about half of the apples that had been irradiated at 50,000 and 100,000 rep were still crisp and juicy--in excellent condition. A slightly lower percentage of those apples irradiated at 200,000 rep were also in excellent condition. The spoilage of the remainder of the apples is reported to have been caused by rot and mold. All control apples had spoiled by the end of May.

In a supplementary experiment wherein the apples were irradiated immediately after harvest prior to cold storage, the irradiated apples kept only slightly longer than the controls; however, only a few samples were employed in this experiment.

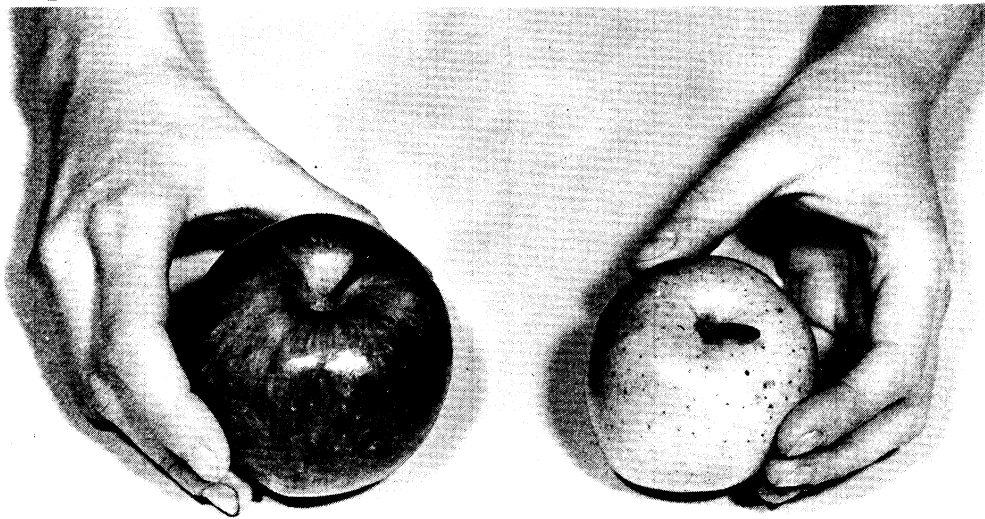


Fig. 1. Northern Spy (left) and Golden Delicious apples harvested in the fall of 1955, irradiated at 100,000 rep December 7, 1955, and photographed in January, 1957.

At the end of October, 1956, Northern Spy and Red Delicious apples were purchased from Applecrest Farm at Northville, Michigan. These apples were of No. 1 quality, hand picked, hand graded, and brought down to storage temperature at the farm. They were then transferred to the University Food Service and held at 35°F for about three months. Prior to irradiation these apples were packaged in perforated polyethylene squares and sealed with cellophane tape. All apples other than the control group received 100,000 rep. The temperature in the cave at the time of irradiation was 38°F. All apples were then returned to 35°F storage at the University Food Service and are regularly examined. There were no noticeable differences immediately after irradiation between the irradiated samples and the nonirradiated.

A second study was undertaken using Golden Delicious apples. These apples were purchased in October, packaged in tissue paper, and irradiated as soon as they were received with 25,000, 50,000, and 100,000 rep. They were then stored at 35°F at the University Food Service with the control apples. At the end of this reporting period, no differences could be noted between the irradiated groups and the control apples.

These three varieties were chosen because they had been used in the first apple experiment, and because of the susceptibility of these apple varieties to different physiological disorders.

SUSCEPTIBILITY OF APPLE VARIETIES TO PHYSICAL DISORDERS¹

Variety	Water Core	Scald	Soft Scald	Bitter Pit	Miscellaneous
R. Delicious	Severe	Slight	None	Slight	Mealy breakdown
G. Delicious	Slight	Slight	Severe	None	Shriveling
Northern Spy	Slight	Slight	None	Severe	Spy spot, breakdown

The size of the parenchyma cells, which comprise the major portion of the edible part of the mature fruit varies considerably; the cells of the Delicious are medium, of the Northern Spy, large. Therefore, the effect of radiation might depend upon varietal differences.

The price of apples increases as the season advances, allowing Michigan growers who hold apples in storage to increase their net returns significantly. Prices compiled by the Bureau of Agricultural Economics, U. S. Department of Agriculture, and based on the average mid-month price of Michigan apples (1937-52, excluding the war years of 1943-46) showed a net gain per crate of 33 cents above the price received for these apples in October.²

The normal cold storage season for these varieties, all "good keepers," is as follows:

COLD STORAGE SEASON³

Variety	Normal Days	Maximum Days
R. Delicious	90-120	180
G. Delicious	90-120	180
Northern Spy	120-150	180

If the results of the first apple experiment are verified by these experiments, the economic potential of radiation preservation of apples could be tremendous.

BROCCOLI

INTERMEDIATE BROCCOLI EXPERIMENT
(Continued from Progress Report No. 1)

Group	Blanching Time (sec)	Radiation Dosage (megarep)	Percent of Acceptable Samples After Five Weeks' Storage						Primary Reason for Unacceptable Rating
			5	6	7	8	9	10	
D	120	0.75	100	68	50	25	0	0	Mold
D	120	1.0	100	80	50	40	25	0	Mold

PEAS

Fresh peas, which had been flown in from California, were purchased on the Detroit market and used for a storage experiment. The peas were shelled, blanched in boiling water for 90 seconds and immediately chilled in cold water for about three minutes, drained, and packaged in polymylar envelopes. All samples other than the control were irradiated at one megarep. Between the shelling and blanching operations the product was held at refrigeration temperature. The temperature in the cave during irradiation was 36 - 38°F. After irradiation the samples were stored at 40°F. After some "aging" the peas will be evaluated by the taste panel of the Kelvinator Institute for Better Living. The samples are checked regularly to determine what physical changes are taking place. The pea storage experiment is based on the preliminary pea experiment reported in the previous Progress Report.

PRE-COOKED FOODS .

Considerable work has been done during this reporting period in the development of experimental recipes. Much of this development has been done at the Kelvinator Institute for Better Living. Because the quantities used are for a small experimental batch, the methods of preparation used are "home methods."

All the following recipes have been informally tasted subsequent to irradiation and judged to be good to excellent products. Each product will be prepared in quantity and stored at 40°F and rated by the Kelvinator test panel.

Although the following recipe contains a high percentage of cheese, a flavor change has not been noted in the cheese, the beef, or the total product when compared after irradiation to the control.

Tomato Beef Swirls

2-1/2 C small bread cubes	2 tsp salt
2 C grated Cheddar cheese	1/4 tsp pepper
1 C chopped green pepper	1 can condensed tomato soup
1/2 C grated onions	1 egg, beaten
1 tsp Worcestershire sauce	2 lb ground beef

Combine bread cubes, cheese, green pepper, onions, Worcestershire sauce, salt and pepper, and 1/2 C tomato soup. Mix lightly, but thoroughly. Blend in 1/2 C tomato soup and egg with beef. Pat meat mixture out evenly into a rectangle 1/4 inch thick. Spread stuffing evenly over meat. Roll up as for a jelly roll and cut into 1-1/2 inch slices. Arrange in a shallow baking dish. Pour remaining tomato soup over meat slices. Bake at 325°F, 40-45 min. Cool before packaging.

If most of the fat is trimmed from the pork before it is baked, no flavor that is inconsistent with Barbecued Pork can be detected after irradiation.

Barbecued Pork Chops

8 pork chops, 3/4 inch thick	1/3 C bottled meat sauce
1/2 C minced onions	1 tsp dry mustard
3 tbs hydrogenated fat	3 dashes Tabasco
1-1/2 C chili sauce	1 tbs Worcestershire sauce
	1 tsp salt

Brown pork chops on both sides in fat trimmed from chops. Cook onions in fat until tender. Add remaining ingredients to cooked onions and mix well. Pour barbecue sauce over pork chops. Cover: simmer 1 hour or until tender. Remove cover and cool.

The removal of all fat from the meat is also important in the successful preparation of Pennywise City Chicken for it seems that it is the fat that carries the "irradiation flavor."

Pennywise City Chicken

1/4 C all-purpose flour	<u>Gravy</u>
1 tsp salt	1/4 C melted fat
1/4 tsp pepper	1 bay leaf, crushed celery tops
1/4 tsp thyme	1/2 C sliced onions
1/4 tsp sage	2 C water
8 city chickens (veal and pork cubes threaded on wooden skewers)	2 tbs all-purpose flour
	1/3 C water
	1 tsp salt

Mix together 1/4 C flour, salt, pepper, thyme, and sage. Dredge meat in flour mixture. Brown meat in fat. Add bay leaf, celery tops, onions, and water. Cover and cook over low heat about 30 min. Remove meat. Blend flour with 1/3 C water. Pour flour paste gradually into water, stirring constantly. Cook until smooth and thickened. Cool. Package city chickens and gravy separately.

For those who like curry, the following recipe for Chicken Curry is an excellent one that has no flavor of irradiation after receiving one million rep.

Chicken Curry

1 medium sized stewing chicken, cooked and diced	1/4 C chicken fat
1 C tomato juice	1/3 C flour
2 C chicken stock	1/2 tsp Worcestershire sauce
1/2 C chopped onion	Salt and pepper
1/2 C chopped celery	1-1/2 tbs curry powder
	4 C cooked rice

Brown onion and celery in hot fat. Add the flour and blend. Add the stock and cook until thick. Add the tomato juice, Worcestershire sauce, seasonings, chicken, and rice. Package.

Shrimp Creole

Fresh frozen shrimp were cooked for four minutes in boiling, salted water and added to the recipe of Spanish Rice reported in Progress Report No. 1. This was packaged and irradiated at one million rep. The resulting dish masks or prohibits the slight irradiation flavor found in shrimp irradiated alone.

The foregoing recipes have been repeated with variations and tasted informally. The quantity experiments have been postponed until the next reporting period, by which time a new kitchen will have been installed at the Fission Products Laboratory, with support from the Kelvinator Division of the American Motors Corporation and other industrial projects. This kitchen is particularly designed to accommodate both small batch and quantity irradiated food experiments and give greater validity to all experiments by permitting more exacting quality and quantity controls.

BAKED PRODUCTS

PASTRY SHELLS

Pastry shells were made, keeping flour, salt, and water standard but varying the shortening. Half of the pastry shells were baked and packaged before irradiation. The other half were packaged and irradiated. This set of samples was held at 40°F for a week, removed from the package, and baked.

FLAVOR ACCEPTABILITY

Shortening	Product Baked Prior to Irradiation	Product Baked After Irradiation
Hydrogenated Fat "A"	Poor	Excellent
Hydrogenated Fat "B"	Poor	Excellent
Vegetable Oil	Fair-good	Poor
Lard	Poor	-

This was a preliminary study and much more work is planned with pastry shells.

REFERENCES

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3. Gaston, H. P., and Levin, J. H., "On the Farm Refrigerated Fruit Storage," Special Bulletin 389 (Jan., 1954), Michigan State University Agricultural Experiment Station, East Lansing, p. 7.

