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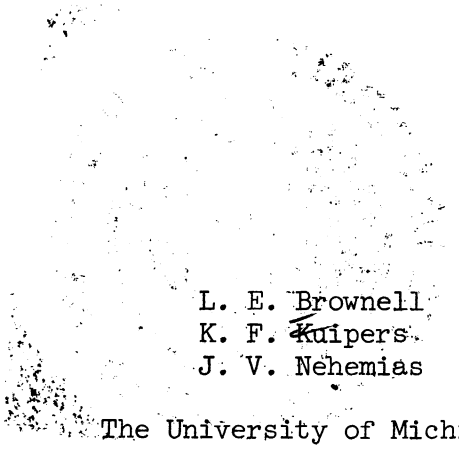
Progress Report No. 1

HIGH RADIOPASTEURIZATION OF FOODS

Period September 21 to November 20, 1956



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Project 2596

QUARTERMASTER FOOD AND CONTAINER INSTITUTE
FOR THE ARMED FORCES, CHICAGO
CONTRACT NO. DA 19-129-QM-756

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CONTRACT RESEARCH PROGRESS REPORT

QUARTERMASTER FOOD AND CONTAINER INSTITUTE
FOR THE ARMED FORCES, CHICAGO

Research and Development Division
Office of the Quartermaster General

Fission Products Laboratory
The University of Michigan
Engineering Research Institute
Ann Arbor, Michigan

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Report No. 1 (Progress)
Period: 21 September 56 to 20 November 56
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Title of Contract: High Radiopasteurization of Foods

SUMMARY

This first progress report of the work done at the Fission Products Laboratory of The University of Michigan in the field of high radiopasteurization of foods reports work done at this institution as well as investigations made with the cooperation of the Kelvinator Institute for Better Living of the Kelvinator Division of the American Motors Corporation.

Studies conducted during this reporting period include initial inquiries into precooked food, baked products, sandwiches, and fresh vegetables, as well as an intermediate experiment with broccoli.

PROCEDURE FOR JUDGING THE ACCEPTABILITY OF IRRADIATED FOODS

Foods are prepared at The University of Michigan or at the Kelvinator Institute for Better Living; they are packaged, sealed, and irradiated at the Fission Products Laboratory. Following irradiation, a sample of each food is informally tested. When the product under consideration is judged to be a good product, the pretreatment and radiation dose are selected, and the product is prepared in quantity and stored at refrigeration temperature. It is checked regularly for spoilage and general physical condition. After a reasonable storage period, if the product is still considered acceptable, it will be sent to the Kelvinator Institute for Better Living and evaluated by a consumer-type taste panel set up by that organization. If the product is acceptable to that group, a supply will be sent to the QMC for evaluation by the QMC taste panel.

FRESH FRUITS AND VEGETABLES

A preliminary investigation was undertaken, using various fresh vegetables in season, to determine the physical effects of irradiation. To the time of this report, cauliflower, Brussels sprouts, peas, and broccoli have received some study because of their local availability at the time of this reporting period.

BROCCOLI

Because a preliminary study of irradiated broccoli gave promising results, an intermediate experiment was performed to narrow the range of investigation by selecting the dosage and blanching time to be used for a future quantity storage experiment. The broccoli used in this experiment was locally grown and of excellent quality. It was processed within 16 hours of the time it was cut. Each group of broccoli, although processed on different days, was cut from the same field and held under the same conditions before and after treatment. Only one variety of broccoli was considered, "Italian Green Sprouting." The two variables controlled in this study were blanching time and radiation dosage. Boiling, unsalted water was used for blanching. Group A was not blanched, Group B was blanched for 30 seconds, Group C for one minute, and Group D for two minutes. The dosages in all groups were 0, 0.5, 0.75, and 1 megarep. In each group 15 samples were packaged at each dosage range, making a total of 60 samples in each group.

The broccoli was washed and cut into uniform lengths of 3-1/2 inches. Those stems or flowers that appeared overly mature or were considered undesirable for other reasons were discarded. The cut broccoli

was placed in a wire blanching basket and immersed in rapidly boiling, unsalted water for the predetermined blanching time. After blanching, the basket of broccoli was immediately quenched in very cold water for approximately the same time used for blanching. When the temperature of the broccoli had been reduced to that of the water, it was removed and drained. Three spears of broccoli were packaged in each polymylar envelope, heat-sealed, and marked with the date of irradiation, the dosage, and group letter. After irradiation, the samples were stored at refrigeration temperature. Each sample was checked periodically to determine if any change in color, odor, flavor, texture, or general acceptability could be observed. The observations were made before and after cooking. The samples in each group, with blanching time constant but with dosage varying, were checked against each other and the control and rated accordingly. The possibility of using polyethylene bags as packaging material for broccoli was investigated, but it was found that the storage period of the product stored in polymylar was notably longer. Some results of the intermediate broccoli experiment follow (also see Table I).

Group A (No Blanching).—The control samples were judged unacceptable at seven days' storage time. The broccoli receiving 750,000 rep was stored for the longest period in this group (13 days) but was considered unacceptable at the 16th day. No mold could be detected on any sample.

Group B (30-Second Blanch).—The samples receiving 500,000 rep were considered good at 20 days but unacceptable at 23 days. On this day the nonirradiated sample was considered a fair product. After 35 days' storage, the controls were spoiled (exact date of spoilage was between 23 and 35 days) and three samples of the remaining eight samples receiving 750,000 rep were spoiled; no mold was evidenced. The flavor of the unspoiled samples was considered good.

Group C (One-Minute Blanch).—The nonirradiated samples were judged unacceptable at 13 days. On this day, the samples that received 500,000 rep were judged characteristic of broccoli; those receiving 750,000 rep were flat but had no "off flavor." The samples that received one million rep had a strong taste with a definite "off flavor." By the 19th day, all the 0.5×10^6 and 0.75×10^6 samples had spoiled; several showed mold growth. Two of the 14 samples at 1 megarep showed breakdown but no mold growth. The unspoiled samples had a strong "off flavor."

Group D (Two-Minute Blanch).—Nonirradiated samples were unacceptable at 13 days. On this day, 13 of 15 samples that had received 500,000 rep showed mold. At the end of this reporting period, the broccoli is 27 days old. The samples that received 750,000 rep are bright green in color, slightly flat to taste but show no "off flavor," no mold, and no deterioration. The samples that received one million rep are more olive in color, the texture is more limp, and the flavor is more flat than the 0.75×10^6 samples. An "off flavor" is quite evident but no spoilage is in evidence. The samples that received 750,000 rep are considered to

TABLE I

INTERMEDIATE BROCCOLI EXPERIMENT

Group	Blanching Time (sec)	Radiation Dosage (megarep)	No. of Samples	Percent of Acceptable Samples After Five Weeks' Storage					Primary Reason for Unacceptable Rating
				1	2	3	4	5	
A	0	0	15	100	0	0	0	0	Flavor
A	0	0.50	15	100	0	0	0	0	Flavor
A	0	0.75	15	100	100	0	0	0	Flavor
A	0	1.0	15	100	0	0	0	0	Flavor
B	30	0	15	100	100	100	-	0	Disintegration
B	30	0.5	15	100	100	100	0	0	Disintegration
B	30	0.75	15	100	100	100	62.5	0	Disintegration
B	30	1.0	15	100	100	0	0	0	Disintegration, flavor
C	60	0	15	100	0	0	0	0	Disintegration
C	60	0.50	15	100	100	0	0	0	Disintegration, mold
C	60	0.75	15	100	100	0	0	0	Disintegration, mold
C	60	1.0	15	100	100	0	0	0	Flavor 0.86%, mold 14%
D	120	0	15	100	0	0	0		Disintegration
D	120	0.5	15	100	13.3	0	0		Mold
D	120	0.75	15	100	100	100	100		
D	120	1.0	15	100	100	100	100		

be a good product. The ultimate storage life of the products will be reported in subsequent reports.

The broccoli blanched for two minutes and given 0.75×10^6 and 1×10^6 rep doses has been stored for a much longer period than any other group. The product receiving 0.75×10^6 is superior in color, flavor, and texture to that receiving a million rep. When the blanching period was extended beyond two minutes and combined with an irradiation dosage of either 750,000 or a million rep, the end product had an overcooked appearance and could not be heated for serving without breaking the product.

Results of this intermediate study indicate that the optimum duration of time for blanching broccoli which is to be irradiated is two minutes, and the optimum dosage is 750,000 rep (see Fig. 1 below).

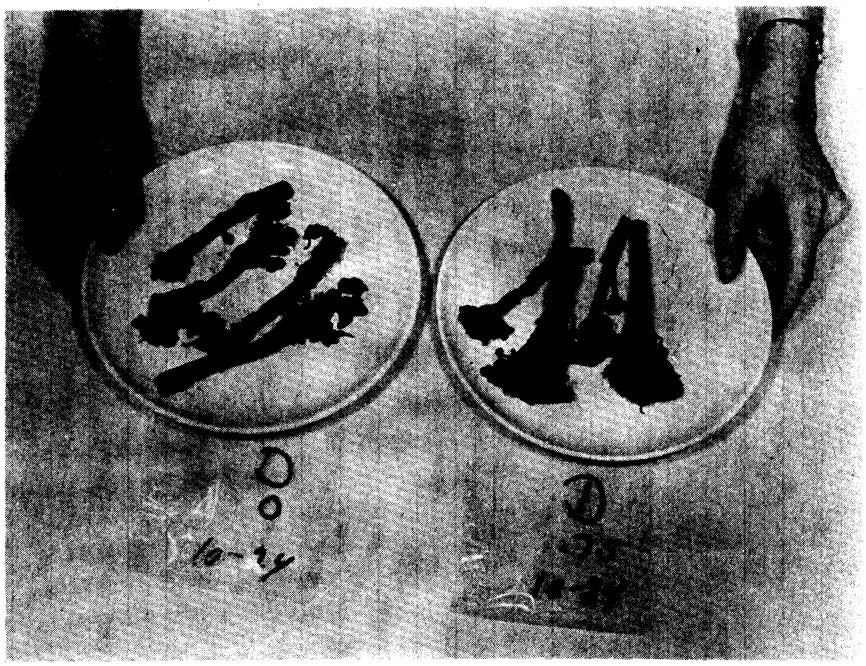

Fig. 1. Broccoli blanched two minutes, observed after 17 days of storage at refrigeration temperature. Left Plate: Not irradiated; disintegration and bleaching are evident. Right Plate: Broccoli that received 750,000 rep, still in excellent condition.

CAULIFLOWER

Cauliflower heads were washed and cut into uniform-size flowerettes. These were blanched in boiling water, chilled in cold water, drained, and packaged in polymylar envelopes. The samples received 0.75×10^6 and 1×10^6 rep and were held at refrigeration temperatures after irradiation. The color of the samples was good and the flavor of both

the 0.75- and 1-megarep samples was considered within the range of acceptability, although the samples were rather flat in taste when compared with the control. If the product were well-seasoned and served with a suitable sauce, the end product might be desirable. Cauliflower will receive further study.

PEAS

Fresh peas were irradiated at 0.75×10^6 and 1×10^6 rep. One group of peas was blanched in boiling water for 1-1/2 minutes and a second group was blanched for 2-1/2 minutes. After blanching, the peas were chilled in cold water, drained, and packaged in polymylar envelopes. After irradiation, the samples were stored under refrigeration. The color of the irradiated samples could not be distinguished from the control. The peas were not graded and a difference in flavor was noticeable between the large peas, which were rather tough and starchy, and the small, tender peas. The flavor of the small peas seemed sweeter and more desirable than that of the control, while the larger peas developed a very slight "off flavor."

Because the results of this experiment seem promising, a quantity experiment is being planned using several bushels of fresh peas. These will be stored under refrigeration at approximately 40°F and checked periodically for spoilage. These peas will also be evaluated periodically for color, flavor, and general acceptability at The University of Michigan and by the taste panel of the Kelvinator Institute for Better Living. The evaluation of the taste panel will be reported.

BRUSSELS SPROUTS

Brussels sprouts were washed, trimmed, blanched in boiling water, chilled in cold water, drained, packaged in polymylar envelopes, and irradiated at 0.75×10^6 and 1×10^6 rep. After irradiation the samples were held with the control samples at refrigeration temperature. They were tasted immediately after irradiation and after a two-week storage period. The product at both dosages had a strong acrid taste and was considered unacceptable. The flavor did not improve with the two weeks of storage.

PEACHES

Whole peaches and sliced peaches in syrup were irradiated, but the supply of fruit was meager and the quality of the fruit inferior because investigation was begun at the end of the growing season. The results were judged inconclusive.

SANDWICHES

Complete sandwiches and their components are being individually packaged and irradiated at 0.75×10^6 and 1×10^6 rep. A sandwich provides a most complex problem, for a very slight "irradiation flavor" in each component might be readily acceptable when tasted by itself while the cumulative flavor of the several items composing the sandwich might be quite unpalatable.

Now under investigation are the following condiments:

Mustard
Ketchup
Chili Sauce
Barbeque Sauce
Mayonnaise
Salad Dressing
Pickle Relish

Of these, a salad dressing, a prepared mustard, and a pickle relish have been selected in which a flavor change is not discernible at one megarep.

Several whole wheat, rye, and pumpernickle breads have been irradiated at 750,000 and one million rep. In breads of full flavor, no "irradiation flavor" could be detected; however, a drying effect after irradiation was evident in all samples. Since the acceptability of a sandwich depends upon bread looking and tasting fresh as well as having an appetizing filling, a limited attempt is being made to develop a formula for a bread that appears fresh after irradiation.

Simple fillings for sandwiches have received preliminary investigation. Of these, sliced, boiled ham and hard salami were considered acceptable at one million rep immediately after irradiation when informally tasted. Considerable study is planned with more complex sandwich fillings.

BAKED GOODS

Because the national eating pattern is to assume a dessert at the end of a meal, some time will be spent investigating a variety of baked goods, including pastries, cookies, cakes, and specialty items.

Up to the end of this reporting period, soft molasses cookies and spice cake have received preliminary study. A recipe for soft molasses cookies (a moist cake-like cookie) was developed at the Kelvinator Institute

for Better Living. These cookies have been found to be free from flavor change up to one megarep when tasted immediately after irradiation.

These cookies will be prepared in quantity, packaged in polymylar bags, stored at 40°F, and evaluated periodically by the taste panel.

The recipe for soft molasses cookies follows:

1 c Butter	3 c sifted all-purpose flour
1 c sugar	2 t soda
1 egg	1 t salt
1/2 c molasses	1 t ginger
3/4 c sour cream	1 t cinnamon

Cream butter and gradually blend in sugar until light and fluffy. Beat in egg and molasses. Add sour cream and stir in alternately with flour which has been sifted together with soda, salt, ginger, and cinnamon. Drop by teaspoon on ungreased cookie sheet. Bake 10-12 minutes at 375°. Spread with thin coating of confectioners sugar and sour cream (about 1 c confectioners sugar to 1/2 c sour cream).

PRECOOKED FOODS

A simple creole sauce has been developed in which no flavor change can be detected at one million rep. This sauce, combined with short grained rice which was cooked separately, makes an excellent Spanish rice. The mixture was packaged in polymylar envelopes and irradiated at 0.75×10^6 and 1×10^6 rep. It was tasted immediately after irradiation and again after a storage period of two weeks under refrigeration. The product at both doses was judged very good when informally tasted, being free of radiation flavor change, and will be prepared in quantity for storage and subsequent evaluation by the taste panel.

The recipe for creole sauce follows.

1/4 c finely chopped onion
2 c canned tomatoes
1 t salt
1/8 t pepper
1/2 t A-1 sauce
few drops tabasco sauce

Blend all ingredients together and simmer for 15 minutes.