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RADIATION PASTEURIZATION OF FRESH MEATS AND POULTRY

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RADIATION PASTEURIZATION OF

FRESH MEATS AND POULTRY

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Contract AT(11-1)-1689

DIVISION OF APPLIED TECHNOLOGY
UNITED STATES ATOMIC ENERGY COMMISSION

Annual Report

February 15, 1970 through June 14, 1971

ABSTRACT

The objective of work during the present contract period was a continuation of the three previous years' work, namely, to develop the process of radiation pasteurization of fresh meats and poultry to permit centralized cutting of these products.

No off-flavor was detected with irradiated, phosphate-treated beef. Dipping was the only satisfactory method for adding phosphates.

Oxidation of fat resulted from action of atmospheric oxygen and not irradiation. The addition of ascorbic acid helped control fat oxidation.

PREFACE

This annual report was prepared in accordance with the terms of Contract No. AT(11-1)-1689, Modification Nos. 2-2 and 2-3 between the United States Atomic Energy Commission and Michigan State University.

The material included in this fourth report under said contract is based upon experimental work that is continuing. The conclusions stated in this report are therefore tentative and the interpretation based upon current results may change as investigations continue and new data, observations, information and materials become available.

When the product of a specific manufactuere is stated as having been used in the work described herein, this is not meant to imply an endorsement of said manufacturer, nor is it meant to imply that similar products made by other manufacturers are not equally suitable for the same use.

SUMMARY

The objective of work during the present contract period was a continuation of the three previous years' work, namely to develop the process of radiation pasteurization of fresh meats and poultry to permit centralized cutting of these products.

Work was instituted to obtain a picture of the microbial outgrowth patterns of beef handled according to the proposed procedure. This work is in progress.

A study of the effect of sodium metaphosphate glass (SMPG, 64% P_2O_5) or added water along with irradiation on the flavor of beef revealed that no detectable change occurred.

Of the two methods, dipping and pumping, dipping proved to be the only satisfactory method of adding phosphate. The rise in thiobarbituric acid values (TBA, an index of fat oxidation) in beef was correlated with exposure to atmospheric oxygen and was not the consequence of irradiation. Ascorbic acid was found to aid controlling the fat oxidation.

Holding beef in a vacuum under refrigeration for three days prior to irradiation did not scavenge oxygen entrapped in the primary package.

INTRODUCTION

This fourth report covers certain work completed subsequent to that given in previous reports. Considerable background information and literature review were included in the earlier reports, to which reference may be made by the reader.

Earlier work (1)(2)(3) had developed a procedure treating and handling red meats and poultry which may be described as follows:

1) Treat with condensed phosphates
2) Wrap in fresh-meat film
3) Group a number of cuts and package in vacuum
4) Irradiate
5) Transport to retail stores, open bulk package and display cuts

With handling at 40°F or lower, this procedure should provide a salable product life of about three weeks. With such a life the centralized cutting and packaging of red meats and poultry should be technically feasible.

This year's work was at a reduced level due to the availability of smaller funds. The work involved: a) a study of microbial outgrowth patterns of beef; b) efforts to determine the best way to add phosphate to meats; c) investigation of a flavor change revealed by earlier work and which was thought to be associated with the combined action of phosphate (or incidentally added water) and radiation; d) to determine the cause of a slight degree of fat oxidation previously observed; and e) to determine if ascorbic acid (an antioxidant) might prevent this fat oxidation.

EXPERIMENTAL RESULTS

A. MICROBIOLOGY

Work was instituted to obtain a picture of the microbial outgrowth patterns of beef handled according to the proposed procedure. This work is in progress. It involves examination of beef for: a) numbers of organisms present (both mesophyllic and psychrophyllic); b) coliform; c) Clostridium perfringens; d) Staphylococcus (coagulase positive); and e) Salmonellae.

Knowledge of the outgrowth pattern under the conditions of handling is important since it characterizes the sensory spoilage which ultimately occurs and also in order to assess any health hazard which might develop.

This work is in progress and results will be reported at a later date.

B. STUDIES ON THE EFFECT OF PHOSPHATES ON THE FLAVOR OF IRRADIATED BEEF

Earlier work has suggested that a slight off-flavor may occur with phosphate-treated irradiated beef. Since flavor is a critical factor in the acceptance of meat, it was considered desirable to conduct a specific study to determine whether in fact an off-flavor does develop.

Since phosphates are always added as a water solution, there is also the possibility that the added water, through the indirect action of the radiation, might cause an off-flavor development.

The experiments reported in this section include different methods of adding phosphate, namely pumping and dipping, or combinations of these two. The phosphate used was a commercial product, a sodium metaphosphate glass (SMPG) identified as a polyphosphate containing 64% P_2O_5. It was recommended by the manufacturer mainly because of its solubility, which is greater than that of sodium tripolyphosphate.

Since the off-flavor development of concern involved only phosphate and irradiation, the beef was tested for flavor shortly after irradiation, that is, without storage.

Experiment 1:

Objective

Through panel testing, to evaluate the flavor of beef treated by dipping in solutions of SMPG, with and without irradiation and without storage.

Materials and Method

Beef samples, prepared from the round of USDA Choice grade beef obtained from the Michigan State University Food Stores and of unknown history were cut into pieces approximately 3/4 inch thick and of 6 oz. weight. These were treated with the indicated solutions of SMPG by dipping for one minute. They were irradiated with a dose of 100 krad. The samples were panel-evaluated, either on the same day as preparation, or on the following. If stored until the next day, they were kept under refrigeration. Cooking was done by oven-broiling to a medium-well condition.

Results and Discussion

The panel data are given in Table 1. Based on the averages of the results of Table 1, which it will be noted involved 24 sets of samples and several concentrations of SMPG, no real difference in flavor was detected. In terms of flavor, the phosphated meats were indistinguishable from the control.

Experiment 2:

Objective

Through panel testing, to evaluate the flavor of beef treated by pumping with solutions of SMPG and with pure water, with and without irradiation and without storage.

Materials and Method

Relatively large pieces (about 4 lb each) of USDA Choice grade beef of unknown history obtained from the Michigan State University Food Stores and treated by pumping with SMPG solutions or with pure water. Pumping was accomplished with the same device used previously (4)(5). They were then irradiated with a dose of 100 krad. The samples were panel evaluated either on the same day of preparation or on the following. If stored until the next day, they were kept under refrigeration. For panel testing, the large cuts were reduced to approximately 3/4 inch thick slices. Cooking was done by oven-broiling to a medium-well condition.

Results and Discussion

Panel results are given in Table 2. Based on the results of Table 2, there is no indication of an off-flavor due to presence of either added water or SMPG phosphate. The only significant flavor difference was a slightly lower score observed with the beef given radiation alone; this is unexplained in view of previous results.

Table 1 -- Effect on Flavor of Dipping Beef in Sodium Metaphosphate Flass (SMPG, 64% P_2O_5) Solutions of Several Concentrations

Sample Set No.	Flavor Scores* Treatment**			
	S	A	T	O
1	7.5	7.5	7.0	7.1
2	4.1	5.3	3.8	6.6
3	7.0	6.3	6.0	7.1
4	7.2	8.1	8.0	8.3
5	6.0	5.3	5.5	5.8
6	6.8	6.8	7.0	6.5
7	7.5	5.8	6.5	7.2
8	7.5	7.5	7.0	6.0
9	8.0	7.1	6.0	6.5
10	6.0	6.3	7.1	6.3
11	6.6	4.8	6.1	7.1
12	6.0	6.8	5.1	5.5
13	6.5	6.6	6.5	5.5
14	5.6	6.4	6.8	5.6
15	6.6	7.0	5.3	6.6
16	7.6	8.5	6.1	6.1
17	7.0	6.8	6.8	6.6
18	6.5	5.6	7.0	6.6
19	7.6	6.3	7.5	7.5
20	5.1	5.8	6.0	4.8
21	6.6	8.1	7.2	8.2
22	7.1	6.8	7.5	6.5
23	6.1	7.1	6.2	6.2
24	5.8	5.8	5.6	6.2
Average	6.5	6.6	6.3	6.5

* 9-Point Hedonic Scale: 9, Excellent; 1, Poor. Each figure is the average panel score for the sample.

** S = SMPG Concentration, 5% (W/W); 100 krad

A = SMPG Concentration, 10% (W/W); 100 krad

T = SMPG Concentration, 20% (W/W); 100 krad

O = SMPG Concentration, 0% (Control)

Table 2 -- Effect on Flavor of Pumping Beef with SMPG Solutions of Several Concentrations

Sample Set No.	Flavor Scores* Treatment**					
	A	O	I	U	M	E
1	5.3	5.6	6.5	6.3	7.0	5.3
2	6.0	5.8	4.6	6.0	6.3	4.3
3	6.1	6.0	6.0	6.5	6.6	5.3
4	5.3	6.1	7.2	5.0	5.5	3.6
5	6.8	5.6	4.8	5.3	5.8	6.0
6	6.1	6.1	6.0	6.1	5.3	5.6
7	6.5	6.5	7.5	6.3	6.1	6.5
8	5.6	4.6	5.5	7.1	6.5	6.6
9	8.0	7.2	6.6	6.6	7.0	8.0
10	5.3	6.6	4.8	4.0	7.0	5.5
11	6.1	6.1	6.3	5.8	6.5	6.1
12	5.0	3.5	3.5	4.5	4.6	3.6
13	5.5	5.3	6.0	6.6	6.0	5.0
14	6.0	5.3	6.6	6.1	5.3	5.6
15	3.8	3.6	5.6	5.1	4.3	4.5
16	5.0	3.3	6.1	4.3	5.8	5.1
17	5.3	5.3	6.3	4.3	6.1	4.9
18	6.5	5.1	6.1	7.0	7.5	7.0
19	5.8	5.0	4.3	7.0	5.8	3.1
20	5.1	6.6	6.0	6.1	5.0	4.3
21	6.0	6.5	6.0	6.5	6.3	6.4
22	4.0	4.0	3.5	3.6	2.8	2.1
23	5.1	6.6	7.1	6.6	7.0	6.3
24	6.5	7.0	7.0	7.5	5.8	6.1
Average	5.6	5.5	5.8	5.8	5.9	5.0

* 9-Point Hedonic Scale: 9, Excellent; 1, Poor. Each figure is the average panel score for the sample

** A = No Treatment

O = SMPG Concentration, 5% (W/W); 100 krad

I = SMPG Concentration, 20% (W/W); 100 krad

U = 3% added water; 100 krad

M = 10% added water; 100 krad

E = 100 krad only

Experiment 3:

Objective

To evaluate the effect of added phosphates and water plus irradiation on the flavor of beef.

Materials and Method

U. S. Choice grade beef eye-of-round, of unknown history, was secured from Michigan State University Food Stores. Using the pumping device previously described (4)(5), either a 20% (W/W) SMPG solution or pure water was pumped into fairly large pieces (about 1.5 lb) to secure either relatively low or high weight gains. These were bulk vacuum packaged and irradiated with a dose of 100 krad. Within two hours after irradiation, the cuts were converted to 3/4 inch slices, oven-broiled to a medium-well condition and evaluated for flavor by a taste panel.

Results and Discussion

Results are shown in Table 3. No large differences of flavor were observed. There is indication, however, of a slight flavor difference (about 0.5 flavor score unit) when SMPG is present. Addition of pure water was without effect.

In summary, the findings of Experiments 1, 2 and 3 indicate that neither SMPG phosphate solution nor pure water cause any appreciable off-flavor in irradiated beef.

Table 3 -- Effect on Flavor of Pumping Beef with 20% SMPG Solutions or Pure Water

Sample Set No.	Flavor Scores* Treatment**					
	A	E	I	U	M	N
1	6.0	6.0	5.5	6.8	6.7	6.7
2	7.0	7.8	7.2	5.8	5.2	5.3
3	7.0	6.3	6.3	6.5	6.3	4.5
4	8.0	7.6	7.8	8.0	6.2	7.0
5	6.2	7.0	6.2	6.2	4.8	3.8
6	5.8	5.5	6.2	3.5	5.7	5.2
7	5.7	6.0	6.3	6.0	3.2	7.7
8	5.8	5.0	6.4	5.3	6.5	4.2
9	6.5	7.2	6.3	7.2	7.0	7.2
10	7.3	7.7	7.3	6.5	5.8	5.2
11	5.3	5.7	5.2	5.5	5.8	4.5
12	6.8	6.0	6.7	6.8	3.8	4.8
13	4.2	6.0	5.3	4.0	6.3	3.7
14	6.0	5.5	6.2	6.2	5.2	6.2
15	6.0	7.3	7.2	7.4	5.8	6.3
16	5.9	6.2	6.6	5.8	4.7	8.4
17	5.0	5.3	4.3	5.5	5.7	4.5
18	5.5	5.5	5.7	5.2	4.7	6.3
19	5.5	7.0	6.8	6.2	5.2	5.7
20	6.2	6.7	6.2	6.0	6.3	3.7
21	7.7	7.0	7.0	7.0	5.0	6.8
22	7.8	7.0	6.5	6.2	6.5	6.8
Average	6.2	6.4	6.3	6.1	5.6	5.7

* 9-Point Hedonic Scale: 9, Like Extremely; 1, Dislike Extremely; 5, Neither Like nor Dislike

** A = No Treatment

E = 100 krad

I = 2% (W/W) water; 100 krad

U = 13.5% (W/W) water; 100 krad

M = 1% (W/W) of 20% (W/W) SMPG Soln.; 100 krad

N = 11% (W/W) of 20% (W/W) SMPG Soln.; 100 krad

C. INVESTIGATION OF PUMPING AND DIPPING METHODS FOR ADDING PHOSPHATES TO BEEF

The method of introducing phosphate into meat has important practical considerations. For thin pieces, dipping or spraying seems satisfactory. For larger pieces, dipping may not be effective. The use of injection or pumping is an alternative method. A combination of dipping and pumping also is a possibility. While the primary reason for using phosphates is to control drip, their action in maintaining color is also important. Color was studied in Experiment 4 and color and drip in Experiment 5.

Experiment 4:

Objective

To determine the effect on color of beef of adding sodium tripolyphosphate (TPP) by dipping or by pumping or by pumping and dipping.

Materials and Method

A USDA Commercial grade beef round, of unknown history, was obtained from Michigan State University Food Stores. One half of the round was converted into 3/4 inch slices. One half of these slices was dipped in 10% (W/W) TPP solution. The remaining slices were not treated with phosphate.. The other half of the round was cut into rather large pieces (approximately 4 lbs) and pumped by means of the device previously described (4)(5) with 10% TPP to about a 3% weight gain based on the weight of the cut. After pumping, these large cuts were converted into 3/4 inch slices. Of these slices, one half was dipped in 10% TPP.

All samples were bulk vacuum-packaged and irradiated with a dose of 100 krad. They were stored for 18 days at 38°F, following which each cut was individually packaged in oxygen-permeable film and stored for an additional three days. The color was judged visually.

Results and Discussion

Results are given in Table 4. Based on the results given in Table 4, dipping alone is the best procedure for adding phosphate. The poor results with the combination treatment of pumping and dipping are without explanation. Pumping alone apparently fails to provide sufficient phosphate at the surface of the meat.

Table 4 -- Color Evaluation of Beef Treated with Sodium Tripolyphosphate (TPP) by Different Methods

Treatment	Color Score*	
	18 days (Vac.)** at 38°F	18 days Vac. plus 3 days air at 38°F
No TPP	3.4	2.6
TPP - Dip only	2.2	1.0
TPP - Pump & dip	3.2	3.8
TPP - Pump only	2.6	3.6

* Scoring Scale: 1, Excellent; 2, Very Good; 3, Good; 4, Fair; 5, Poor. Each figure is the average score for a number of steaks.

** Color evaluated two hours after packaging in oxygen permeable film.

Experiment 5:

Objective

To evaluate the effect of pumping and dipping beef with 17% SMPG solution on color and drip after storage at 38°F.

Materials and Method

A USDA Commercial grade bottom round of beef, of unknown history, was obtained from Michigan State University Food Stores. One-half of this round was cut into 3/4 inch slices. These were bulk vacuum-packaged and irradiated with a dose of 100 krad.

The other half of the round was cut into two pieces, each having a bottom round portion (about 6 lbs.) and an eye of the round portion (about 3.5 lbs.). One bottom round portion and one eye of round were weighed and pumped with 17% SMPG solution and the weight gains noted. These pieces were then sliced into 3/4 inch steaks. Each steak was dipped briefly in 17% SMPG solution. The treated steaks were bulk vacuum-packaged and irradiated with a dose of 100 krad. The untreated bottom round and eye of round were similarly packaged and irradiated. All samples were stored for 18 days at 38°F.

At the end of the storage period, the amount of free liquid in each bulk package was determined. Color was also evaluated.

The individual steaks were wrapped in oxygen-permeable film and stored an additional three days at 38°F. Again the color was noted.

Results and Discussion

Results are given in Table 5. The results given in Table 5 indicate that SMPG can reduce the drip formed in bottom round. It is to be noted, however, that the untreated eye of round had about the same amount of drip as the treated. Colors for all cuts at 18 days were fairly good, but did not hold up in the three-day exposure to air. In this respect, the performance of the SMPG does not equal that of TPP.

In summary, the most effective way of adding phosphate appears to be by dipping. There are, however, some anomalies in the results of the experiments reported in this section, which suggest further investigation.

Table 5 -- Color and Drip of Beef Pumped and Dipped with 17% SMPG Solution and Stored at 38°F

	Weight gain due to SMPG (%)		Drip after 18 days at 38°F		Color*			
					18 days vac. at 38°F**		18 days vac. plus 3 days air at 38°F	
Treatment	Bottom	Eye	Bottom	Eye	Bottom	Eye	Bottom	Eye
No SMPG	-	-	4.6	1.7	2.1	1.5	5.0	5.0
SMPG	4.2	2.6	1.7	1.5	1.6	1.4	5.0	5.0

* Scoring Scale: 1, Excellent; 2, Very Good; 3, Good; 4, Fair; 5, Poor. Each figure is the average score of 10 samples.

** Color evaluated two hours after packaging in oxygen permeable film.

D. STUDIES ON THE OXIDATION OF THE FAT OF BEEF

Previous work has indicated that the fat of beef undergoes a small degree of oxidation. This has been a matter of concern because because of the possibility of an associated flavor change. Of special concern was the possibility that the oxidation was the consequence of the radiation.

Two experiments were conducted, one aimed at determining any possible association of fat oxidation with radiation and the other to prevent oxidation through the addition of an antioxidant.

Experiment 6:

Objective

To determine the role of radiation and atmospheric oxygen in the increase in thiobarbituric acid (TBA) values (6) of beef in storage at 38°F.

Materials and Method

USDA Choice grade bottom round, of unknown history, was secured from Michigan State University Food Stores and converted into four steaks approximately 3/4 inch thick. Each steak was cut into two equal portions. One-half of each steak was wrapped in oxygen-permeable film and stored for three days at 38°F. It was sampled for TBA-value at 0 and 3 days. The other half of each steak was individually vacuum-packaged, irradiated with a dose of 100 krad and stored at 38°F for 18 days. At the end of this period, the vacuum package of steak-half was opened, a sample for TBA analysis taken, and the steak rewrapped in oxygen-permeable film and stored an additional three days at 38°F. At the end of this period, the steak was again sampled for TBA analysis.

Results and Discussion

Results are shown in Table 6. Based on the results given in Table 6, oxidation leading to higher TBA values is mainly associated with the presence of atmospheric oxygen. The non-irradiated samples held three days in air indicate that radiation plays little or no role in the process.

Experiment 7:

Objective

To determine the effect of added ascorbic acid on the TBA value of beef fat and on the flavor of beef stored at 38°F.

Materials and Method

A USDA Choice grade top and bottom round, of unknown history, was obtained from the Michigan State University Food Stores. It was

Table 6 -- Change in TBA Values of Beef as a Result of Storage Conditions

	TBA Value*			
Sample	0 Days	3 Days (Air)	18 Days (Vac.)	21 Days (18 Days Vac., 3 Days Air)
1A	0.23	1.3		
1B			0.84	1.8
2A	0.16	1.6		
2B			1.1	1.5
3A	0.23	2.3		
3B			0.66	2.0
4A	0.16	2.3		
4B			0.66	0.89

* mg malonaldehydes per 1000 g of meat

converted to steaks approximately 3/4 inch thick. Randomly selected steaks were divided into five groups. One group was dipped in 0.5% water solution of ascorbic acid, a second in a solution containing 0.5% ascorbic acid and 10% TPP, a third in a solution containing only 10% TPP, and the fourth group was untreated. The samples of each of these four groups were bulk vacuum-packaged and irradiated with a dose of 100 krad. The fifth group received no treatment, including no irradiation.

All samples of the first four groups were stored for 18 days at 38°F. The steaks were then packaged in oxygen-permeable film and stored an additional three days at 38°F.

Panel evaluations of flavor were carried out at 0, 18 and 21 days of storage. At the same time, samples were taken for TBA-value determinations.

Results and Discussion

Results are shown in Tables 7 and 8. Based on the data of Table 7, there is evidence that the addition of ascorbic acid yields a slightly higher flavor score after storage in the presence of air. This is supported by somewhat lower TBA values shown in Table 8.

Table 7 -- Effect of Ascorbic Acid Addition and Irradiation on the Flavor of Beef After Storage at 38°F for 0, 18 and 21 Days

	Flavor Scores* Treatment**				
	0-0	0-I	P-I	P-AA-I	AA-I
0 Days					
	5.7	6.8	6.2	6.2	5.8
	5.8	6.7	7.7	6.8	6.0
	6.8	6.8	6.7	6.3	7.7
	6.5	4.3	8.2	4.2	6.7
	6.7	5.8	6.8	6.8	6.3
	5.3	5.5	5.0	5.7	5.8
	5.2	3.8	5.8	4.3	6.7
	6.2	6.7	6.8	6.3	6.7
	7.0	4.2	5.3	5.7	6.3
	7.0	6.0	6.8	6.3	6.8
	7.5	6.8	7.2	6.5	6.2
	5.3	5.5	6.3	6.0	5.5
	5.7	7.0	6.0	5.3	5.8
	5.2	4.5	5.2	5.0	4.8
	6.2	6.8	7.7	7.0	6.5
	7.0	7.2	8.0	7.2	6.8
	4.5	5.2	4.8	4.0	5.8
	4.8	6.7	4.2	6.5	5.8
	6.3	4.3	5.5	6.2	6.0
	5.3	5.0	4.2	4.8	5.0
	3.8	4.2	5.7	6.5	5.5
	6.2	6.7	6.2	6.2	7.0
	4.3	5.7	4.8	4.5	5.7
	6.7	6.2	6.8	7.4	7.2
	5.3	5.8	5.8	5.3	6.7
Average	5.8	5.8	6.2	5.6	6.2

Table 7 continued on next page...

Table 7 -- continued

	Flavor Score* by Treatment**				
	0-0	0-I	P-I	P-AA-I	AA-I
18 days (Vac)	-	6.0	7.2	6.5	6.0
		6.7	6.7	5.3	6.3
		6.8	6.7	6.7	6.3
		6.3	6.2	7.0	5.5
		6.5	6.5	6.5	7.0
		4.8	7.7	4.8	8.0
		6.0	6.8	7.2	5.3
		7.5	6.5	7.0	7.0
		6.4	7.7	7.2	6.9
		5.0	5.3	6.5	6.9
		5.8	6.3	7.0	5.7
		4.5	5.2	6.5	4.0
		6.0	7.2	7.2	5.7
		5.3	7.7	6.0	6.5
		6.7	6.2	5.7	5.7
		5.7	5.8	5.2	5.7
		4.6	4.7	5.8	5.0
		6.7	7.0	7.5	6.2
		7.0	6.4	6.8	6.8
		6.5	7.0	8.0	5.3
Average	-	6.0	6.5	6.5	6.1
18 days (Vac) plus 3 days (Air)	-	4.5	5.3	7.3	6.0
		4.2	2.7	6.2	7.3
		4.7	5.7	5.7	4.8
		6.2	5.2	5.3	3.8
		7.3	6.8	6.5	7.0
		6.2	7.2	7.0	6.5
		6.0	5.3	5.3	6.2
		4.8	5.5	5.8	6.8
		4.3	4.7	4.5	4.3
		4.8	4.8	5.3	5.3
		5.3	6.2	6.2	6.2
		5.8	6.7	7.7	6.2
		4.2	5.3	6.0	6.2
		5.8	6.3	7.0	6.0
		5.3	6.3	6.2	6.3
		4.6	4.3	6.0	5.3
		6.2	6.3	6.2	6.5
		4.2	4.7	6.0	5.3
		4.5	5.5	6.2	5.8
		5.7	5.2	5.3	5.2
Average	-	5.2	5.5	5.9	5.9

Table 7 continued on next page...

Table 7 -- continued

* 9-Point Hedonic Scale: 9, Like Extremely; 1, Dislike Extremely; 5, Neither Like nor Dislike

** Treatment

0-0 = None

0-I = 100 krad only

P-I = 10% TPP dip, 100 krad

P-AA-I = 10 TPP and 0.5% ascorbic acid dip, 100 krad

AA-I = 0.5% ascorbic acid dip, 100 krad

Table 8 -- Effect of Ascorbic Acid Addition on the TBA Value of Beef After Storage at 38°F for 0, 18 and 21 Days

Treatment*	TBA Value**		
	0 Days	18 Days	21 Days
0-0	0.20	-	-
0-I	0.23	0.45	2.0
P-I	0.12	0.27	2.3
P-AA-I	0.12	0.12	0.23
AA-I	0.08	0.14	1.4

* Treatment

0-0 = None

0-I = 100 krad only

P-I = 10% TPP only, 100 krad

P-AA-I = 10% TPP and 015% ascorbic acid dip, 100 krad

AA-I = 015% ascorbic acid dip, 100 krad

** mg malonaldehyde per 100 gm of meat

E. AN ATTEMPT TO SCAVENGE OXYGEN TRAPPED IN THE PRIMARY MEAT PACKAGE BY USING THE NATURAL "BIOLOGICAL OXYGEN DEMAND" OF THE MEAT

In the basic plan for centralized cutting, the retail cuts would be individually wrapped in an oxygen-permeable film, probably in conjunction with a plastic tray. These then would be put in a bulk vacuum package.

Previous work has indicated that the above procedure leads to the entrapment of some air (oxygen) in the individual packages, which to a degree negates the purpose of the bulk vacuum package. Although elimination of this entrapped oxygen will be attempted by development of a suitable packaging technique, one possible other approach to securing an anaerobic condition is to make use of the normal "biological oxygen demand' of meat to use of or scavenge the entrapped oxygen. Part of this biological oxygen demand is made up of the microbial population of the meat. Hence, some value might be anticipated in holding the meat in a vacuum for a period prior to irradiation, during which time the bacteria initially present might contribute to the reduction of the oxygen present.

Experiment 7:

Objective

To determine the effect on TBA value of a three-day storage in vacuum prior to irradiation.

Materials and Method

USDA Choice grade bottom round, of unknown history, was obtained from Michigan State University Stores, and converted to ten steaks approximately 3/4 inch thick. These were individually placed in plastic retail meat trays and overwrapped with oxygen-permeable film.

Five wrapped steaks were bulk vacuum-packaged in each of two packages. One bulk package was irradiated immediately with a dose of 100 krad. The other was held for three days at 38°F and then irradiated with a dose of 100 krad.

All steaks were stored at 38°F for 18 days from the time of initial packaging. At this time, the bulk package was opened and the individually packaged steaks held for an additional three days at 38°F. Samples for TBA analysis were taken at 0, 18 and 21 days.

Results and Discussion

Results are shown in Table 9. These samples were not treated with phosphate and consequently had a poor color. Based on the results given in Table 9, the holding in vacuum prior to irradiation did not remove the entrapped oxygen. TBA values were high in both sets of samples, even at the end of the 18 day vacuum storage and this clearly indicates the presence of oxygen in the individual package.

Table 9 -- TBA Values of Beef Stored at 38°F, Irradiated Immediately After Vacuum Packaging or After a Three-Day Holding Period at 38°F

TBA Value*				
0 Days	18 Days		21 Days	
	II**	IH***	II**	IH***
0.31	4.3	5.2	3.6	5.7
0.16	3.5	7.3	2.5	4.1
0.27	4.5	6.8	3.7	5.3
0.23	4.7	7.4	4.7	7.4
0.27	3.6	4.7	2.9	3.7

* mg malonaldehyde per 100 g meat

** II = Immediate irradiation

*** IH = Irradiation after a 3-day hold

CONCLUSIONS

Earlier work has indicated that beef handled according to the proposed procedure and three weeks of age from final cutting could be distinguished flavor-wise from fresh beef. This difference was small and the panel work entailed in its determination did not indicate that it was objectionable. It appeared to be associated with the combination of phosphate addition and irradiation.

The experiments performed in the present reporting period in which phosphates or water were added followed by irradiation did not demonstrate a detectable flavor difference immediately after irradiation. This suggests that the previously observed difference may be associated with some other factor such as the microbial flora, which is different from that of non-irradiated meat, or possibly the action of atmospheric oxygen in fat and other meat components.

It is desirable to evaluate the flavor of the treated and stored beef by use of a suitable representative of the consuming public. This cannot be done until a pilot-scale level of operation is available which will permit large scale consumer testing.

The action of oxygen of the air in oxidizing beef fat apparently is normally experienced in the present handling practices. The data obtained clearly show that such oxidation is not the result of irradiation. Hence, there is no reason for concern for the observed TBA values. However, should there be, the use of ascorbic acid as an antioxidant appears to offer a means of prevention.

The experiment to scavenge the entrapped oxygen in the primary package by holding the meat under vacuum for three days prior to irradiation clearly showed that this procedure is not effective. It points to the need, therefore, to develop a packaging technique which prevents the entrapment of air.

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