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THE UNIVERSITY OF MICHIGAN  
ANN ARBOR

Progress Report No. 1

DETERMINATION OF RADIATION STERILIZATION  
DOSE FOR CANNED MEAN

L. L. Kempe  
J. T. Graikoski

Project 2681

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CONTRACT RESEARCH PROJECT REPORT

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Hq, QM Research and Development Command,  
QM Research and Development Center, Natick, Mass.

The University of Michigan  
Engineering Research Institute  
Ann Arbor, Michigan

Official Investigator: Lloyd L. Kempe  
Collaborator: J. T. Graikoski

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Title of Contract: **Determination of Radiation Sterilization  
Dose for Canned Meat**

SUMMARY

Combined irradiation-heat sterilization dosages have been determined for canned green peas inoculated with 300 PA-3679 spores per can. A marked reduction of the  $F_0$  value required for sterilizing canned green peas followed even very light dosages of gamma radiation. For example, following 0.6 megarad, an  $F_0$  of less than 1 was sufficient, but without irradiation, an  $F_0$  between 4.1 and 4.9 was necessary under these conditions. Since these results appear encouraging, additional studies are being carried out using C. botulinum 213B inocula.

Preparations are being made to determine the true radiation-sterilization dose for canned meats and the combined irradiation-heat processing treatments needed for canned pork luncheon meat.

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PHASE I:  
EFFECT OF PREIRRADIATION OF CANNED GREEN  
PEAS ON THE  $F_0$  SUBSEQUENTLY REQUIRED  
FOR STERILIZATION

Combined irradiation-heat processing may be conceivably applied to other foods than meat. The logically expected benefits would follow from possible lessened texture damage, etc., that could result from the reduced heating involved. With this in mind, canned peas were selected for study.

#### MATERIALS AND METHODS

Frozen green peas were obtained in 2-1/2-lb boxes from the stock supply of The University of Michigan Food Service. These peas carried the label of the Frost Queen Packing Co. of Tacoma, Washington. The packages indicated that the peas contained a "slight amount" of added salt.

In preparation for a run, 15 lb of the frozen peas were placed in a stock pot and then were covered with a brine containing 1.8% sodium chloride and 2.2% sucrose. This brine has previously been described for peas by Reed *et al.*<sup>1</sup> The stock pot was then placed in a boiling water bath for about 1-1/2 hr during which time the frozen peas melted and were brought to a temperature of 205°F.

No. 1 Picnic tin cans were filled with these peas; care was taken to cover the peas with brine. Covers were then placed loosely on the cans and these were set in an autoclave which was kept filled with flowing steam. After the cans had been exhausted for a few minutes in the flowing steam, individual cans were removed from the autoclave, inoculated with one ml of a spore suspension, sealed in a commercial-type closing machine, dumped into cold, running water for 20 minutes, and then refrigerated until they were either irradiated, heat-processed, or incubated as required.

Irradiation was carried out in the center well of the large Cobalt-60 source at The University of Michigan. Since these cans were irradiated during the summer, they were covered with dry ice to keep them cold during irradiation.

Irradiation, dosimetry, heat processing, and incubation were carried out in the same way as previously described for canned meat.<sup>2</sup> However, the data are reported in megarad rather than megarep as directed.<sup>3</sup>

RESULTS

Data from runs CP-1 through CP-6 are shown in the table below. An inoculum of 300 PA-3679 spores per can was used. These data are summarized in the figure.

F<sub>0</sub> Values Required to Sterilize Canned Green Peas Packed in No. 1 Picnic Tin Cans, Inoculated with 300 PA-3679 Spores Per Can, and Irradiated with Gamma Rays from Cobalt-60 Before Heat Processing at 230°F and Incubated at 85°F.

Run No. CP-1	— Can Size	-No. 1 Picnic (211 x 400)
	Product	-Green Peas
	Inoculum	-300 PA-3679 spores per can
	Irradiation	-None
	Processing Temperature	-230°F
	Incubation Temperature	-85°F

F <sub>0</sub>	Can No.	Days to Gas Formation
Inoculated Controls	1	3
	2	3
Noninoculated Controls	3	4
	4	4
Can 1, 3.25	5	-
Can 2, 3.25	6	-
Can 3, 3.25	7	-
	8	7
Can 1, 4.11	9	-
Can 2, 4.11	10	6
Can 3, 4.11	11	-
	12	-
Can 1, 4.91	13	-
Can 2, 4.91	14	-
	15	-
	16	-

Run No. CP-1 (Concluded)

$F_0$	Can No.	Days to Gas Formation
Can 1, 5.97	17	-
Can 2, 5.97	18	-
	19	-
	20	-
Can 1, 6.95	21	-
Can 2, 6.95	22	-
	23	-
	24	-
Can 1, 8.50	25	-
Can 2, 8.50	26	-
	27	-
	28	-
*Can 1, 2.20	29	5
Can 2, 2.20	30	4
	31	5
	32	4
Can 1, 2.95	33	-
Can 2, 2.95	34	5
Can 3, 2.95	35	-
	36	5

Conclusion: Under these conditions canned green peas were sterilized by an  $F_0$  between 4.1 and 4.9.

\* Cans 29 through 36 were packed and processed as part of run CP-6.

Run CP-2 -- Can Size -No. 1 Picnic (211 x 400)  
 Product -Green Peas  
 Inoculum -300 PA-3679 spores per can  
 Irradiation -As Indicated  
 Processing Temperature -Not Heat-Processed  
 Incubation Temperature -85°F

Megarad	Can No.	Days to Gas Formation
Inoculated Controls	1	5
	2	6
Noninoculated Controls	3	7
	4	-
1.302	5	4
	6	3
	7	3
	8	4
1.770	9	-
	10	8
	11	-
	12	-
2.05	13	-
	14	-
	15	-
	16	-
2.42	17	-
	18	-
	19	-
	20	-

Conclusion: Under these conditions, canned green peas were sterilized by between 1.77 and 2.05 megarad of Cobalt-60 gamma radiation.

Run CP-3 -- Can Size -No. 1 Picnic (211 x 400)  
 Product -Green Peas  
 Inoculum -300 PA-3679 spores per can  
 Irradiation -0.465 Megarad  
 Processing Temperature -230°F  
 Incubation Temperature -85°F

F <sub>0</sub>	Can No.	Days to Gas Formation
Inoculated Controls	1	2
	2	2
Noninoculated Controls	3	2
	4	9
Can 1, 6.00	5	-
Can 2, 6.00	6	-
Can 3, 6.00	7	-
	8	-
Can 1, 4.60	9	-
Can 2, 4.60	10	-
Can 3, 4.60	11	-
	12	-
Can 1, 3.40	13	-
Can 2, 3.40	14	-
	15	-
	16	-
	17	-
Can 1, 2.25	18	-
Can 2, 2.25	19	-
Can 3, 2.25	20	-
	21	-
Can 1, 1.39	25	8
Can 2, 1.39	26	-
Can 3, 1.39	27	-
	28	-
Can 1, 0.74	*29	-
Can 2, 0.74	*30	20
Can 3, 0.74	*31	-
	*32	-

Conclusion: Following 0.465 megarad of gamma radiation, from Cobalt-60, canned green peas were sterilized by an F<sub>0</sub> between 1.39 and 2.25.

\* Processing temperature reached 234°F.

Run CP-4 -- Can Size -No. 1 Picnic (211x 400)  
 Product -Green Peas  
 Inoculum -300 PA-3679 spores per can  
 Irradiation -0.930 megarad  
 Processing Temperature -230°F  
 Incubation Temperature -85°F

$F_0$	Can No.	Days to Gas Formation
Noninoculated Controls	1	3
	2	3
	3	3
	4	4
Inoculated Controls	5	2
	6	2
	7	2
Can 1, 0.69 Can 2, 0.69 Can 3, 0.69	8	-
	9	-
	10	-
	11	-
Can 1, 1.44 Can 2, 1.44 Can 3, 1.44	12	-
	13	-
	14	-
	15	-
Can 1, 0.25 Can 2, 0.25 Can 3, 0.25	16	4
	17	-
	18	-
	19	-
Can 1, 0.49 Can 2, 0.49 Can 3, 0.49	20	-
	21	-
	22	-
	23	-
Can 1, 0.14 Can 2, 0.14 Can 3, 0.14	24	4
	25	-
	26	-
	27	-

Conclusion: Following 0.930 megarad of gamma radiation from Cobalt-60, canned green peas were sterilized by an  $F_0$  between 0.25 and 0.49



Run CP-5 -- Can Size -No. 1 Picnic (211 x 400)  
 Product -Green Peas  
 Inoculum -300 PA-3679 spores per can  
 Irradiation -0.697 megarad  
 Processing Temperature -230°F  
 Incubation Temperature -85°F

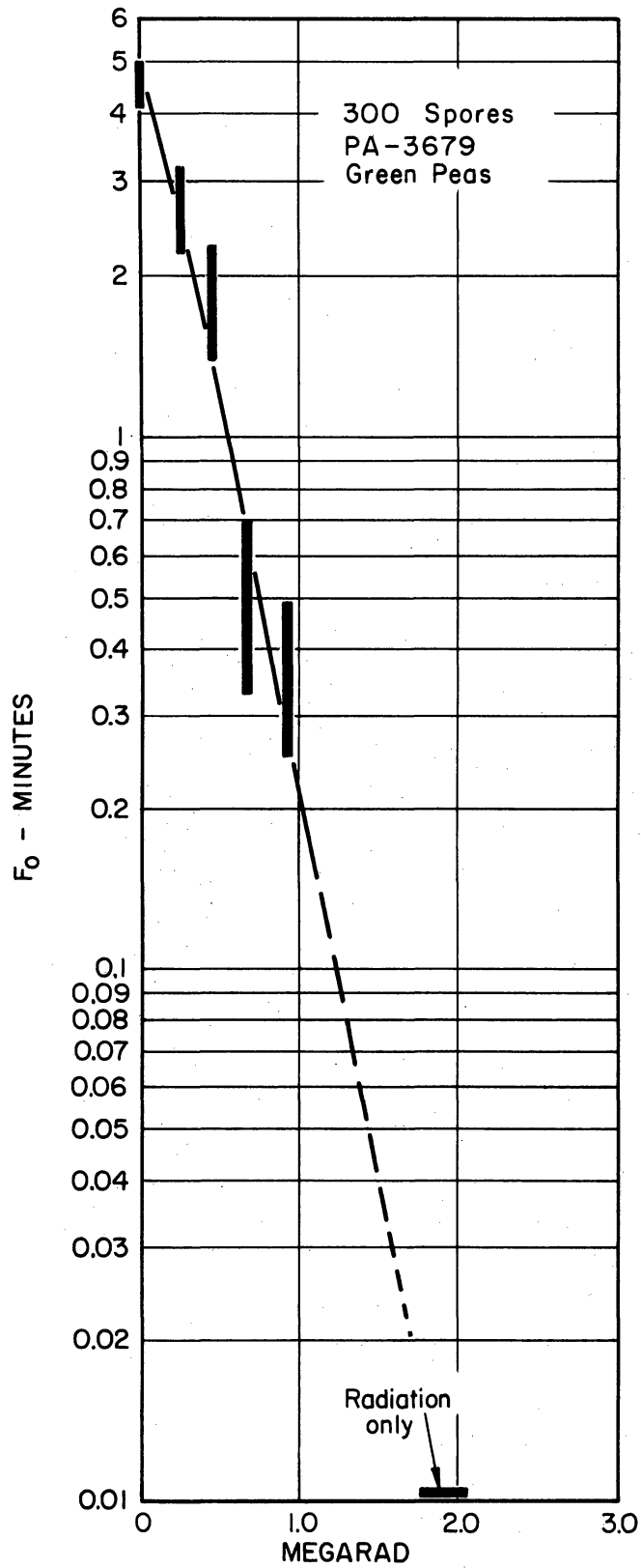
F <sub>0</sub>	Can No.	Days to Gas Formation
Noninoculated Controls	1	-
	2	6
	3	6
	4	4
Inoculated Controls	5	3
	6	3
	7	3
Can 1, 1.10	8	-
Can 2, 1.10	9	-
Can 3, 1.10	10	-
	11	-
Can 1, 0.69	12	-
Can 2, 0.69	13	-
Can 3, 0.69	14	-
	15	-
Can 1, 0.33	16	4
Can 2, 0.33	17	6
Can 3, 0.33	18	-
	19	6
Can 1, 0.18	20	-
Can 2, 0.18	21	6
	22	6
	23	-

Conclusion: Following 0.697 megarad of gamma radiation from Cobalt-60, canned green peas were sterilized by an F<sub>0</sub> between 0.33 and 0.69.

Run CP-6 -- Can Size -No. 1 Picnic (211 x 400)  
 Product -Green Peas  
 Inoculum -300 PA-3679 spores per can  
 Irradiation -0.279 megarad  
 Processing Temperature -230°F  
 Incubation Temperature -85°F

F <sub>0</sub>	Can No.	Days to Gas Formation
Noninoculated Controls	1	3
	2	-
	3	23
	4	6
Inoculated Controls	5	3
	6	3
	7	6
	8	7
Can 1, 3.16 Can 2, 3.16	9	-
	10	-
	11	-
	12	-
Can 1, 0.77 Can 2, 0.77 Can 3, 0.77	13	4
	14	4
	15	4
	16	4
Can 1, 1.47 Can 2, 1.47	17	5
	18	4
	19	4
	20	5
Can 1, 2.19 Can 2, 2.19 Can 3, 2.19	21	-
	22	5
	23	-
	24	-

Conclusion: Following 0.279 megarad of gamma radiation from Cobalt-60, canned peas were sterilized by an F<sub>0</sub> between 2.2 and 3.2.



F<sub>0</sub> required to sterilize green peas packed in No. 1 Picnic tin cans, inoculated with 300 PA-3679 spores per can, and irradiated with gamma rays from Cobalt-60 before heat processing at 230°F and incubation at 85°F.

A marked reduction in the  $F_0$  value required for sterilizing canned green peas followed even light dosages of gamma radiation. Thus, following 0.6 megarad, the  $F_0$  value required was reduced to less than 1. Furthermore, no radiation "induction" dosage was noted in canned peas as had been previously found in canned meat.<sup>2</sup>

The heat resistance of the spores of PA-3679 was less in this canned pea medium than we have previously reported for canned meat.<sup>2</sup> However, the radiation resistance was apparently unaffected since approximately 1.9 megarad was required in both instances for a 300 PA-3679-spores-per-can inoculum.

## DISCUSSION

The fact that no "induction" radiation dosage was necessary before the effect on reduction of the  $F_0$  value subsequently required for sterilization of canned peas began, has both practical and theoretical significance. From a possible utilization standpoint, the fact that less than 0.6 megarad is sufficient to reduce the  $F_0$  required to less than 1 is significant since Morgan<sup>4</sup> has reported that peas withstand much higher dosages than 0.6 megarad without noticeable radiation damage. Furthermore, it is generally recognized that reduced heat processing produces better canned products.<sup>5</sup>

## PHASE II DETERMINATION OF RADIATION STERILIZATION DOSE FOR CANNED MEAT

Preparations are being made to conduct this work. Since, in our source, the radiation times must necessarily be extended to about 2 days for these experiments, it is considered best to carry them out next winter when the cave in which our Cobalt-60 is housed will be at a temperature of about 10°F. Specifically, we are doing the following at present:

- 1) Accumulating Clostridium botulinum 213B spores.
- 2) Designing, fabricating, and studying dosimetry patterns in a carrier for mushroom-type cans containing meat.

- 3) Arranging with the American Can Co. to provide a seaming chuck for the vacuum-type-can closing machine which they have loaned The University of Michigan for these purposes.

PHASE III  
DETERMINATION OF THE COMBINED IRRADIATION-  
HEAT PROCESSING TREATMENTS REQUIRED  
TO STERILIZE CURED MEAT PRODUCTS

Arrangements have been made through Dr. W. M. Urbain of Swift and Co. to furnish us "Savortite" Pure Pork Luncheon Meats for these studies. When the meat arrives, which should be relatively soon, we plan to carry out these studies immediately.

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