INTERRELATIONSHIP BETWEEN CHILL TIME, HOLDING TEMPERATURE AND PACKAGING PROCEDURE ON SHELF-LIFE OF FRYERS

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INTERRELATIONSHIP BETWEEN CHILL TIME, HOLDING TEMPERATURE AND PACKAGING PROCEDURE ON SHELF-LIFE OF FRYERS

By

Edward Horace Farmer

AN ABSTRACT

Submitted to the College of Agriculture of Michigan State University of Agriculture and Applied Science in partial fulfillment of the requirements for the degree of

MASTER OF SCIENCE

Department of Poultry Science

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Approved L. E. Dawson

ABSTRACT

This study was undertaken to evaluate the interrelationships between chill time, packaging treatment and holding temperature on shelf-life of fryers. Six experiments were conducted using a sufficient number of fryers in each experiment to evaluate birds every two days for 30 calendar days. Birds were evaluated for odor score by a panel of four or five persons, and were classified as acceptable or not acceptable.

Bacterial counts were determined on fryers in one experiment. In four experiments fluorescent scores were determined by observing the birds under a "black light" in a darkened room. A combination of these three procedures was made to evaluate the effectiveness of the treatments.

Five different packaging materials (Cryovac bags, Cryovac sheets, Mylar, Cellophane and Pliofilm) were used in one or more experiments. These materials were used as either tight fitting packages over the fryers, or as overwraps over tray packaged fryers.

Birds were held in ice, or under refrigerated temperatures of $34^{\circ}F$, $36^{\circ}F$, and $48^{\circ}F$. Chill times (ice water) varied from two hours to 48 hours.

The temperature of melting ice ($33^{\circ}F$) or the refrigeration temperature of $34^{\circ}F$ inhibited the growth of odor and slime producing bacteria. Fryers held at $34^{\circ}F$ remained acceptable about one week longer than fryers held at $36^{\circ}F$ and two weeks longer than those held at $48^{\circ}F$. A holding temperature of $48^{\circ}F$ caused a rapid

deterioration of the product and an early rejection by the panel.

Fryers stored in a packaging material that excludes air by partial vacuum and that will minimize subsequent contamination of the fryers showed less growth of spoilage bacteria. On the basis of results obtained, the shelf-life of fryers was favorably influenced by Cryovac, Mylar, Cellophane and Pliofilm in this order respectively. Cryovac and Mylar, when properly applied as tight fitting wraps over the birds, or as tight fitting tray pack overwraps, were effective in increasing shelf-life of fryers. On the basis of odor scores, bacterial counts and fluorescing bacteria, Cryovac wrapped fryers had the longest shelf-life.

Birds chilled for only two hours remained acceptable for one week longer than birds similarly packaged and chilled for 24 hours. Chilling for 48 hours reduced the acceptable shelf-life to six days when the holding temperature was raised to 48°F. Fryers chilled two hours and vacuum packaged in Cryovac bags had the longest shelf-life for these experiments.

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INTRODUCTION

Dressed poultry, in recent years, has been transported through market channels packed in crushed ice and packaged in wire-bound cases. Many tons of ice have been transported throughout the United States to help maintain poultry meat quality. Transporting ice-packaged poultry is costly and the investment in additional ice-making machinery at processing centers and the heavy equipment used to handle crates is high. Although the use of ice helps to maintain an ideal environment for dressed poultry, problems associated with drip from melting ice and the excessive weight of product, container and ice are intensified.

A more efficient method for transporting dressed poultry from processing areas to the retail markets would be to transport pre-cooled dry-packed poultry in refrigerated trucks. This method would allow the packaging operation to be performed in efficient processing plants and would eliminate the ice packaging operations. The development of a packaging method and operation which would yield maximum shelf-life and maintain satisfactory product quality and appearance could increase the speed and efficiency of distributing dressed poultry in market channels.

LITERATURE REVIEW

Studies involving packaging materials and methods for poultry meat products have usually been concerned with a product treatment as well as a packaging treatment.

Spencer et al. (1956), reported the effect on shelf-life of a combination of four packaging treatments and four antibiotic treatments. Half birds from each antibiotic treatment (5 to 10 ppm aureomycin for 10 and 20 minutes) were packaged in cellophane, polyethylene, evacuated heat shrinking polyethylene and evacuated heat shrinking polyvinylidene. Birds were held at 32°F until spoilage resulted. The shelf-life of untreated control birds packaged in both evacuated heat shrinkable films was increased approximately two days over those packaged in cellophane or polyethylene. As antibiotic concentration or dipping time was increased, the shelf-life was lengthened for both evacuated heat shrinking films. Dipping for twenty minutes in a 10 ppm solution gave a five-day shelf-life increase for the group packaged in shrinking polyvinylidene. It appeared that the less permeable polyvinylidene film offers an unfavorable atmosphere for the growth of yeasts and molds. Kish (1953), reported no differences in shelf-life of birds overwrapped with LSAT cellophane, 100 polyethylene film, 100 saran 517 or 120 pliofilm HM. All groups of birds in this test were held at 34-38°F in a self-service open-top refrigerator and were unsaleable after 72 hours of storage. As measured by the presence of off-odors, slime and changes in carcass color, 48 hours appeared to be the

maximum shelf-life. No significant differences were found between films with respect to weight loss through 48 hours of storage. An aureomycin or crystalline chlortetracycline dip prior to packaging with Cryovac or LSAD 300 cellophane resulted in no difference in meat flavor scores due to packaging treatment (Carlin, Hall and Walker, 1957). Birds in this study were stored at 34°F for 11 days. The birds vacuum packed in a Cryovac overwrap frequently had lower bacterial counts and higher flavor scores than did those packaged with an overwrap of LSAD cellophane. For these commercially processed birds, regardless of package or antibiotic treatment, there was a gradual deterioration in the quality of poultry meat. It was suggested that factors other than bacterial numbers determine the flavor score of poultry meat.

Wells, Spencer and Stadelman (1958), evaluated the shelf-life of packaged fryers after they were chilled in ice water, water containing 30 ppm chlortetracycline and water containing 30 ppm oxytetracycline. Samples of birds from each treatment were placed on cardboard trays and overwrapped with cellophane, vinylidene chloride copolymer and vinylidene chloride copolymer (evacuated). Ice chilled fryers overwrapped with vinylidene chloride copolymer (air evacuated) had an increased shelf-life of four days. The antiobiotic treated birds wrapped in vinylidene chloride copolymer had an increased shelf-life of two days. Partially removing the air from packages of fryers wrapped in impermeable films reportedly inhibited bacterial growth by reducing oxygen tension.

Cotterill (1956), evaluated the development of Pseudomonas

fluorescens on fryers by means of an ultra violet lamp. Carcasses overwrapped with polyethylene, Pliofilm or LSAT cellophane showed fluorescence after three days of holding. Packaging fresh fryers in polyvinylidene chloride bags prevented fluorescence for 14 days. Dipping cut-up poultry in an aureomycin solution and subsequent packaging in polyethylene, Pliofilm, or cellophane (LSAT) showed fluorescence after eight days of storage. Aureomycin fluoresces in the yellow region of the visible spectrum. Essary et al. (1958), reported that as the chill time of fryers was increased the shelf-life was decreased. Fryers chilled in ice for two or four hours had a longer shelf-life than those chilled for 12, 16, 18, or 24 hours. A short chill time without an aureomycin dip gave longer shelf-life than did a 24 hour chill time with the antibiotic. The longest shelf-life was obtained by a short chill time, antibiotic treatment and storage at low temperature.

PROCEDURE

Six experiments were conducted to evaluate the influence of chilling treatment, packaging procedure and holding environment on shelf-life of fryers. The fryers used in each experiment were similar in age and weight and were slaughtered and processed in the same manner. All birds were obtained from the Research Farm of the Poultry Science Department, Michigan State University.

Processing Procedure

Six birds were hung on a killing wheel, bled by the so-called "Kosher" method (outside cut) and allowed to bleed for two minutes. They were then placed in a roto-matic scalder containing water maintained at a temperature of $128^{\circ}F \pm 2^{\circ}F$ and semi-scalded for one minute. After scalding, they were manually picked on a dual-drum rubber-fingered picker, hung on shackles and pinned, eviscerated and washed. Fryers were then placed in chill tanks containing water and chipped ice.

After chilling for periods from two to 48 hours, each fryer was individually packaged and placed in the appropriate refrigerator.

Odor Evaluation

Fryer halves were removed from treatment environment and placed on cellophane paper on a stainless steel table in a clean room. After one hour at room temperature, the fryers were evaluated by a panel of four persons who evaluated the birds using a six-point hedonic score card as illustrated in Table 1.

TABLE 1. An example of the raw odor evaluation score card used.

RAW ODOR:

Name: _____ Date: _____

	Code:			
1. Normal chicken odor				
2. Very slight abnormal odor				
3. Slight abnormal odor				
4. Abnormal odor				
5. Strong disagreeable odor				
6. Very offensive odor				
	Standard Foreign Void Accept Reject	Standard Foreign Void Accept Reject	Standard Foreign Void Accept Reject	Standard Foreign Void Accept Reject

Fluorescence Evaluation

In experiments 2, 3, 5 and 6, each fryer half was examined carefully in a dark room before an ultraviolet lamp. This procedure was used to check the development of colonies of fluorescent-type bacteria . . mainly Pseudomonas fluorescence. A score of 0 indicated no fluorescence, 1--not over three or four visible fluorescent spots not over two or three mm in diameter, 2--several visible fluorescent colonies not over five mm in diameter, 3--a few larger fluorescent areas visible . . many small, and 4--many large fluorescent areas visible (10 mm or over)

Bacterial Evaluation

In Experiment 1, the fryers, after odor evaluations, were evaluated for bacterial incidence and growth. Each half-bird was placed aseptically in a sterile one-gallon glass jar and 400 ml of sterile saline was then added. This volume was chosen in order to have adequate washing action; it approximates the average weight of the half birds. The jar was then vigorously shaken by means of a reciprocal shaker for two minutes at 200 oscillations per minute. Serial dilutions of the diluent were made for plating purposes. One ml of the diluent was routinely used as an inoculum in the tube test procedure.

Tryptone glucose extract agar (TGE) was employed as a plating medium for determinig total bacterial count from both rinse and swab diluents. The medium was held at 45-48^{o}C before pouring to avoid destroying the thermal sensitive psychrophiles. Plates were

made in triplicate for each serial dilution and incubated at 20°C and 4.5°C. When the plates were incubated at 20°C for 72 hours, growth of both gram-positive and negative mesophilic and psychrophilic bacteria occurred. When the plates were incubated for 4.5°C for seven days only psychrophiles developed. This procedure was done in accordance with Standard Methods for the Examination of Dairy Products (10th Ed.).

Experiment 1

Thirty (30) White Rock fryers weighing 2 1/2 to 3 1/2 pounds each were processed, halved and chilled in slush ice for two hours. The birds were divided into four groups of 15 halves each. Birds for Treatment A were placed in crushed ice in stainless steel pans and placed in a 34°F walk-in type cooler in which the air was moved by a blower. Those for Treatment B were tray-packed and overwrapped with Cryovac film,[1] sealed, and dipped in hot water (200°F) to shrink the film. In Treatment C, birds were tray-packed and overwrapped with MSD[2] and cellophane, and in Treatment D were overwrapped with Cryovac bags and vacuum packed with 15 inches of vacuum. Birds of Treatments B, C and D were placed in an open display type meat cooler at 34°F. The temperature inside the package was observed to be 36°F. On three days per week (Monday,

[1]Vinylidene chloride produced by the Cryovac Company.

[2]MSD cellophane refers to moisture proof, heat sealing cellophane produced by the Dupont Corporation.

Wednesday, and Friday) including the 21st day of holding, one package from each treatment was removed and evaluated for odor. Bacterial counts were taken from each fryer-half the same day. Total counts were determined on each half.

Odor scores obtained in Experiment 1 are reported in Table 2. A score of higher than three usually indicated rejection by the panel members. Fryers in Treatments A and B were rejected by the odor panel after 19 and 14 days of storage, respectively; those in Treatment C were found unacceptable after 12 days of storage, and those in Treatment D were acceptable throughout the experiment. Figure 1 illustrates the changes in odor scores which occurred more rapidly after seven days of storage. The odor scores of the tray packaged fryers declined more rapidly than did odor scores of the birds packed in ice or in Cryovac bags.

Total bacterial counts per half fryer are presented in Table 3. On the fifth day of holding, the total counts were comparable for all lots (Figure 2). After nine days of holding, fryers in Treatment C showed higher counts than did fryers in Treatments A, B or D. Fryers in Treatments A, B, and C had counts of approximately 10^9 bacteria per square inch of skin surface after 21 days, while those in Treatment D showed counts of 10^7 after 21 days of holding.

Psychrophilic bacterial numbers were obtained by incubating plates at 4.5°C for seven days. Figure 3 shows that the initial psychrophilic count (determined on the second day of holding) was considerably lower than the total count as determined by use of

TABLE 2. Odor scores of fryers held at 36°F.

Days of storage	Treatments[1] A	B	C	D
	Average odor score			
2	1.25	1.66	1.00	2.00
5	1.75	1.75	1.25	1.25
7	1.00	1.00	1.25	1.75
9	1.75	2.75	2.75	2.00
12	1.00	2.25	3.25	2.25
14	2.00	3.50	4.00	2.75
16	2.00	3.50	4.25	2.75
19	2.50	4.50	4.50	2.50
21	3.75	4.75	3.00	3.00

[1]Treatments

A Ice pack in 34°F cooler

B Cryovac film over tray pack (heat shrunk)

C MSD cellophane over tray pack

D Cryovac bag (vacuum packed)

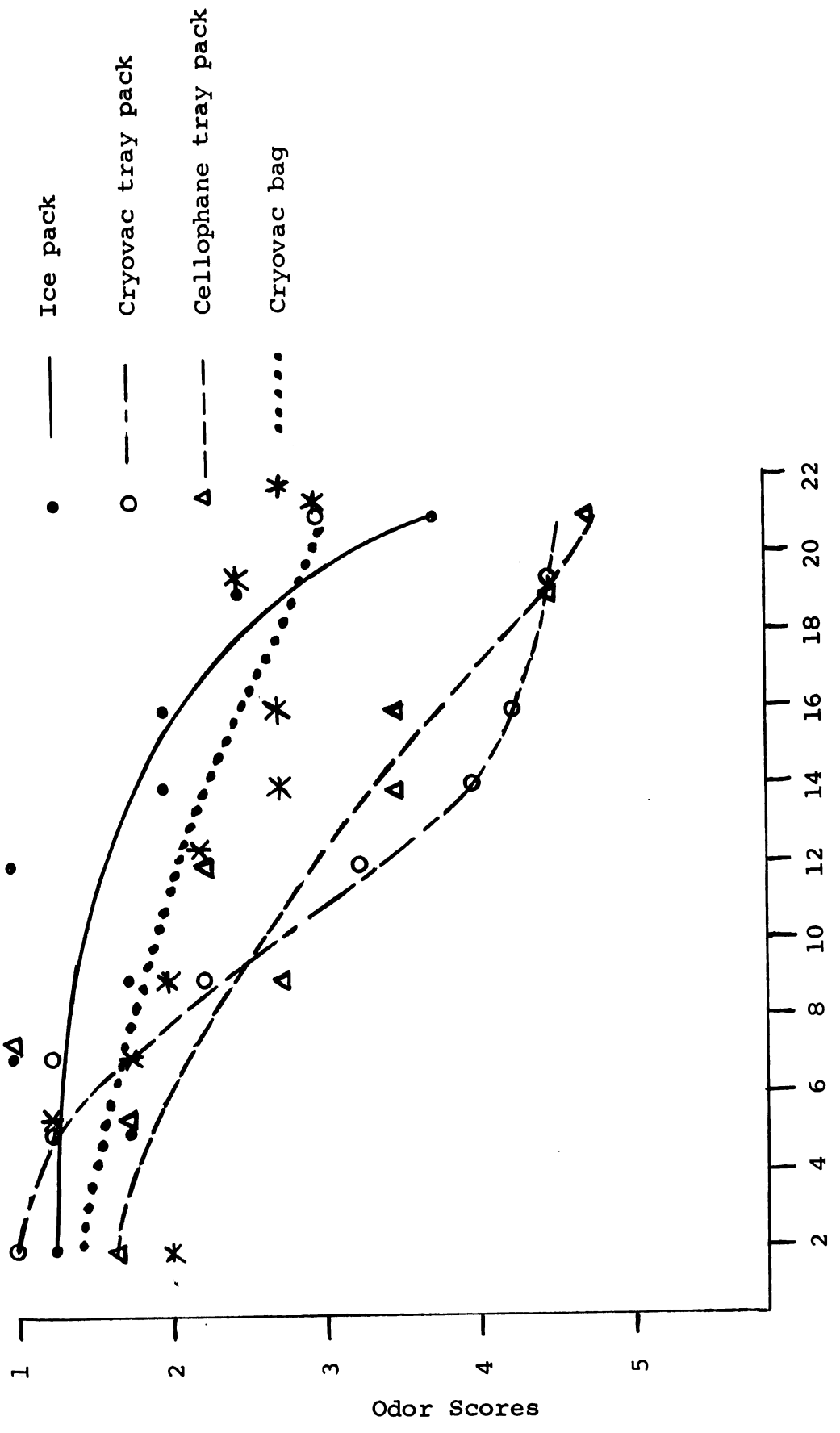

FIGURE 1. Average odor scores for fryers held at 36°F.

TABLE 3. A comparison of total bacterial counts of fryers held at 36°F.

Days of Storage	Treatments[1]			
	A	B	C	D
	Log of Bacterial Counts			
2	3.20	2.85	3.12	2.92
5	2.69	3.07	3.62	3.56
7	3.75	2.95	2.01	3.13
9	3.97	5.05	7.18	3.27
12	4.77	5.40	7.87	4.76
14	5.94	7.98	8.97	5.39
16	6.96	8.51	8.38	7.09
19	8.25	9.05	8.71	6.57
21	8.93	9.09	8.90	7.24

[1]Treatments

A Ice pack in 34°F cooler

B Cryovac film over tray pack (heat shrunk)

C MSD cellophane over tray pack

D Cryovac bag (vacuum packed)

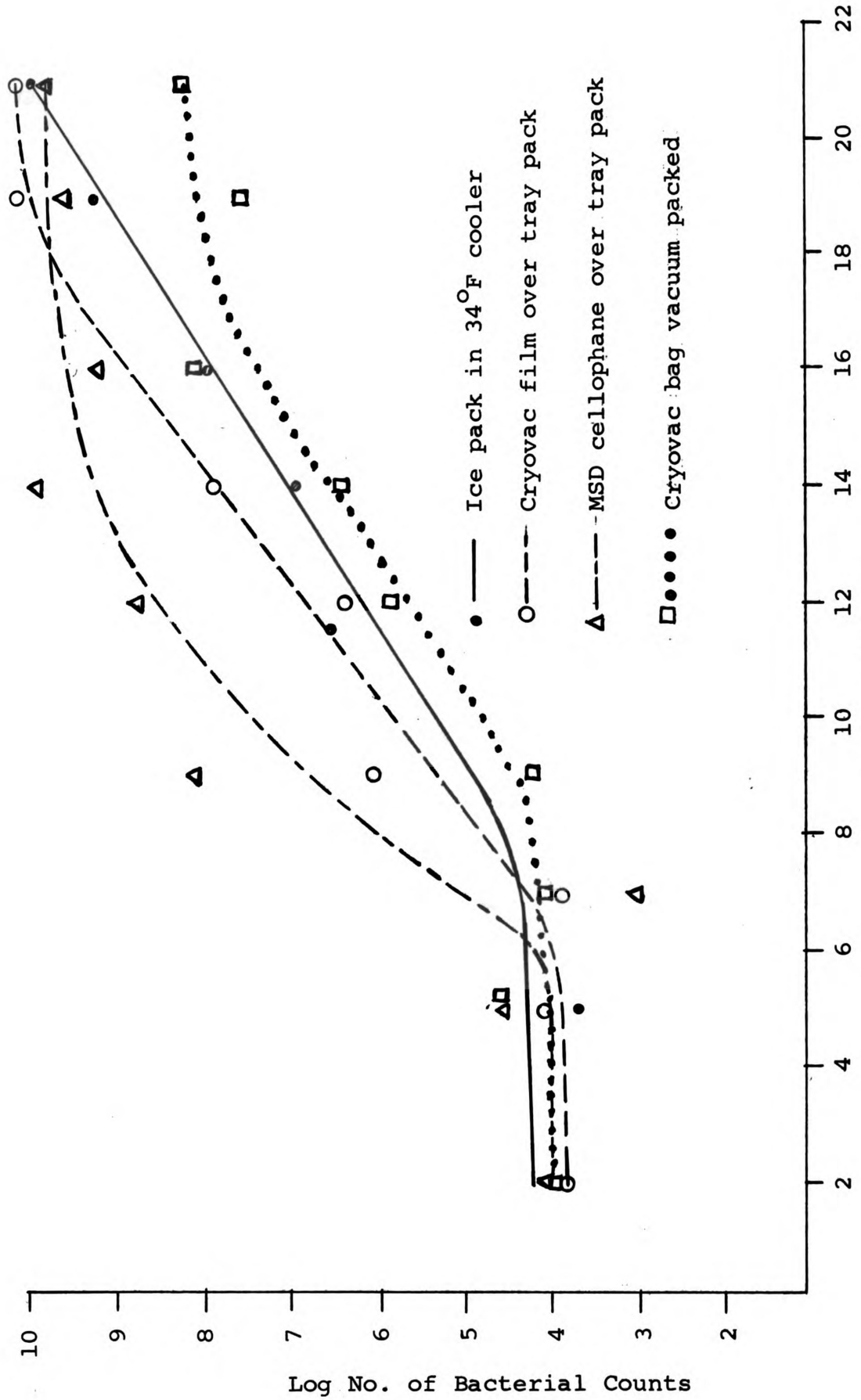

FIGURE 2. Total becterial counts per square inch of skin surface area on fryers held at 36°F.

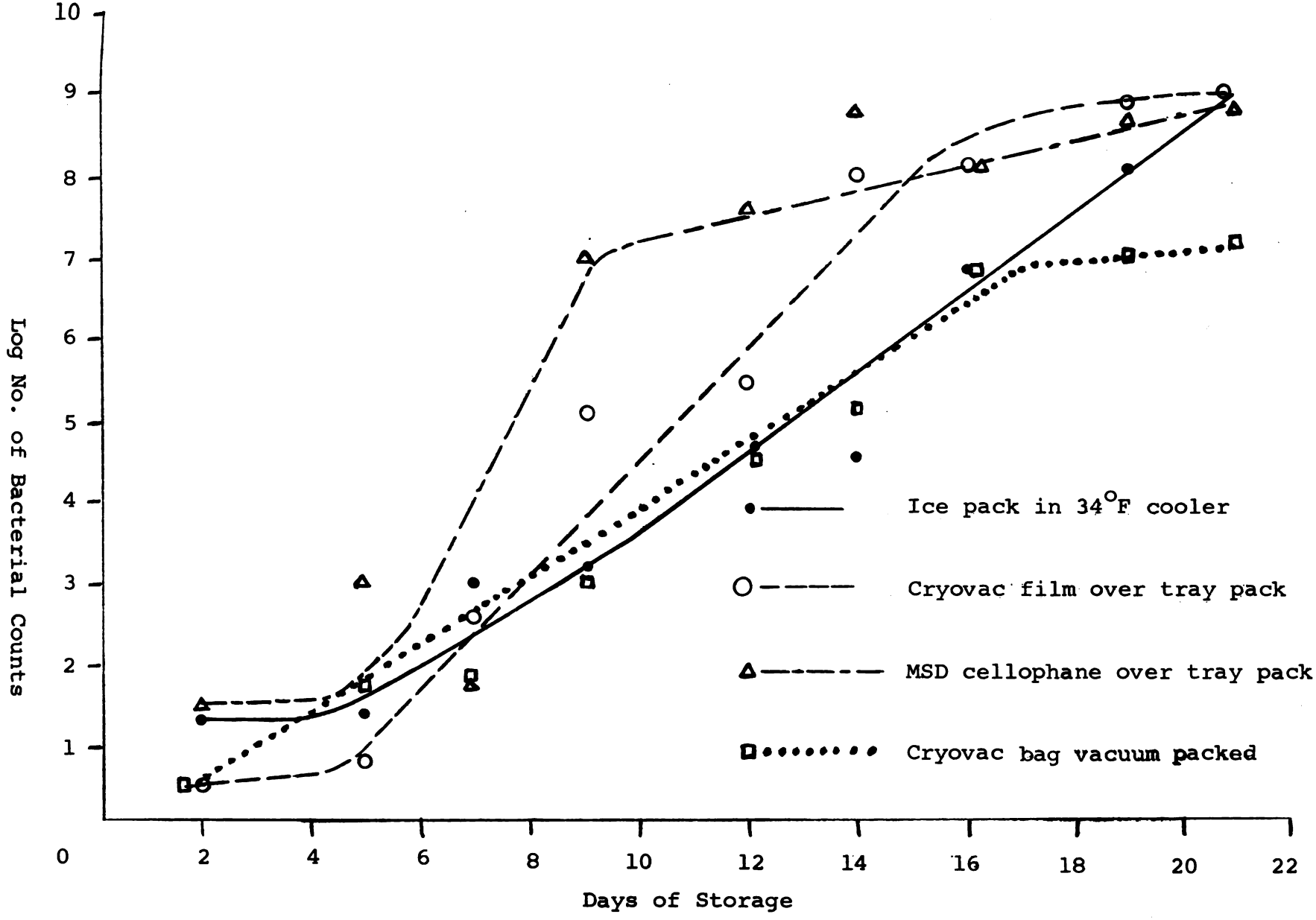

FIGURE 3. Psychrophilic bacteria counts per square inch of skin surface of fryers held at 36°F.

plates incubated at 20°C for 72 hours (Figure 2). Birds in Treatment C had higher bacterial counts after nine days storage than birds in other treatments. Fryers in Treatments A, B and C had total counts of 10^9 bacteria per square inch of skin area after 21 days of holding when the plates were incubated at 20°C. Treatment D had a total count of 10^7 after 21 days of storage.

The fryers in Treatment A, held in crushed ice, and in Treatment D, held in Cryovac (vacuum packed) had longer shelf-life than did fryers in Treatments B and C which were held in the meat cooler. This experiment showed that holding in ice or over-wrapping with Cryovac resulted in longer shelf-life than did tray packaging. On the basis of bacterial counts, the birds packaged in Cryovac bags had the longest shelf-life. Treatment C, overwrapped with cellophane, showed a rapid increase in the numbers of bacteria up to the ninth day of storage. It may be concluded that there was a rinsing effect exerted on half chickens held in ice so that the bacterial counts were lower from the action.

The total bacterial count showed that, after five days of holding, the number of bacteria on birds from each treatment were approximately the same. Between five and nine days of storage bacteria increased rapidly on fryers in Treatment C but increased gradually from seven to 21 days of holding. Fryers in Treatment D had the lowest bacterial count throughout 21 days of storage and fryers in Treatments A, B and C had similar counts after 21 days of holding. Overwrapping fryers with cellophane may provide a favorable environment for the growth of bacteria as indicated by

results of bacterial counts on birds in Treatment C. Since certain important spoilage bacteria (psychrophiles) are aerobic in nature, an adequate package limits available oxygen and retards growth. Relatively few psychrophilic bacteria were present on the fryers at the beginning of each storage period, but their number increased rapidly after the fifth day (Table 4).

Experiment 2

Sixty (60) White Rock fryers weighing 2 1/2 to 3 1/2 pounds each were slaughtered, picked, eviscerated and chilled in ice water for 24 hours. After chilling, they were drained while hanging on shackles for ten minutes and divided into four groups of 15 birds each. Each bird was cut into serving pieces and placed on separate pieces of butcher paper until packaged in molded cardboard trays. Birds in Treatment A were overwrapped with MSD cellophane and heat sealed; Treatment B with R-1 Pliofilm; Treatment C with Cryovac film; and Treatment D with MSD cellophane in which eight holes (1/4 inch in diameter) had been punched in the top area of the film. The packaged fryers were placed in an open display type meat refrigerator similar to that used in retail stores. Air at 32°F was agitated within this cooler during the test and temperature inside the packages in the cooler was 36°F.

After four, seven, eight and 11 days storage, one bird from each treatment was evaluated for odor scores and for fluorescence. Bacterial counts were not determined in this and subsequent experiments, since it has been demonstrated that the panel scores, in conjunction

TABLE 4. Psychrophilic bacterial counts of fryers held at 36°F.

Days of Storage	Treatments[1]			
	A	B	C	D
	Log of bacterial counts			
2	1.36	.57	1.57	.57
5	1.45	1.92	3.10	1.73
7	3.04	2.60	1.79	1.85
9	3.54	5.12	7.10	3.08
12	4.71	5.54	7.62	4.50
14	4.73	8.01	8.77	5.27
16	6.80	8.19	8.27	6.79
19	8.18	8.95	8.57	7.01
21	9.06	9.05	8.87	7.21

[1]Treatments

A Ice pack in 34°F cooler

B Cryovac film over tray pack (heat shrunk)

C MSD cellophane over tray pack

D Cryovac bag (vacuum packed)

with fluorescent scores, are an adequate method of evaluating acceptable shelf-life.

The odor scores are reported in Table 5. Odor of fryers in all treatments remained acceptable for seven days of holding; however, fryers in Treatment C maintained a more acceptable odor than did other fryers in this experiment.

In Table 6 are reported the visible fluorescent scores for the birds evaluated. After four days of holding (first evaluation date), small fluorescing colonies of bacteria were seen on the bird from Treatment A. Fluorescence developed about equally on birds in Treatments A, B and D, but those in Treatment C showed only slight fluorescence at any time during the holding period.

Fryers in Treatment C, which were overwrapped with Cryovac film, maintained about two days longer acceptable shelf-life than did fryers in Treatments A, B and D (Figure 4). The result of the impermeability of Cryovac film to air and gases had a pronounced effect on the storage life of the fryers. The shrinking of this material after packaging results in only a small amount of air in the package. These characteristics of this film probably caused these birds to have a longer shelf-life than birds from the other treatments.

Experiment 3

Sixty (60) fryers were processed, chilled for 48 hours, drained and cut-up as described before. The birds were divided into four groups of 15 birds each. Birds in Treatment A were

TABLE 5. Odor scores of tray packed fryers held at 36°F.

Days of Storage	Treatments[1]			
	A	B	C	D
	Average odor score			
4	1.25	1.25	1.00	1.25
7	2.37	1.62	2.00	1.62
9	4.62	4.50	3.37	4.75
11	6.00	5.50	4.50	5.25

[1]Treatments

A MSD cellophane--sealed

B R-1 Pliofilm--sealed

C Cryovac--sealed and heat shrunk

D MSD cellophane--eight holes per package--sealed

TABLE 6. Fluorescent scores of fryers held at 36°F.

Days of Storage	Treatments[1]			
	A	B	C	D
	Fluorescent score			
4	1	0	0	0
7	2	2	1	1
9	3	3	1	3
11	3	3	0	3

[1]Treatments

A MSD cellophane--sealed

B R-I Pliofilm--sealed

C Cryovac--sealed and shrunk

D MSD cellophane--eight holes per package--sealed

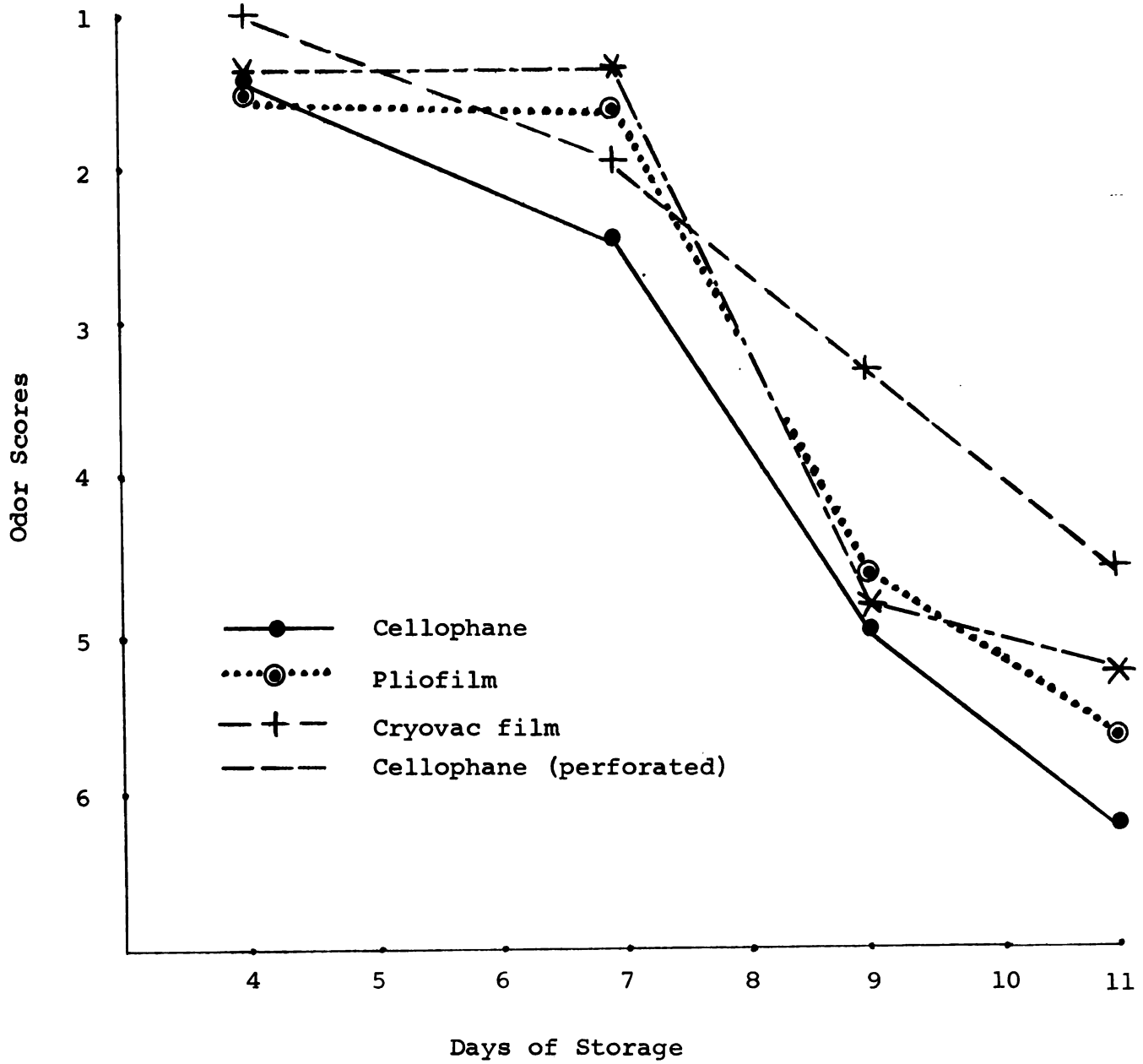

FIGURE 4. Influence of packaging material on odor scores of tray packed chicken fryers held at 34°F.

packaged in Cryovac bags, vacuum packed with 15 inches of vacuum, and then the bags were heat-shrunk. Birds in Treatment B were placed in trays and the tray packed birds were placed in Cryovac bags and vacuum packed with 15 inches of vacuum and then sealed. Birds in Treatment C were placed on trays and then overwrapped with MSD cellophane and heat sealed. Fryers in Treatment D were placed in plastic trays measuring 8" x 5" x 2", and then overwrapped with MSD cellophane and heat sealed. All fryers were placed in an open type egg cooler similar to that used in retail stores. The temperature within the cooler ranged from 48 to 50°F.

After holding periods of four, five, six, seven and 10 days, one bird from each treatment was evaluated for odor and fluorescence and rated as acceptable or rejected.

On the fourth day of storage, (Table 7), the fryers from Treatment C were rejected for odor by at least three panel members. Birds in Treatment B scored only 2.75 after four days; birds in Treatments A and B scored 3.0 or less through six days storage; whereas, the odor score of fryers in Treatments C and D declined more rapidly. Fryers in Treatment A maintained a lower score throughout the study than did birds in any of the other three treatments. The birds in Treatments A and B were rejected after seven days storage; whereas, fryers in Treatments C and D were rejected after four and five days respectively (Figure 5).

After 10 days of holding, fryers in Treatments A and B showed no fluorescence while those in Treatments C and D were given a fluorescent score of 3 (Table 8).

TABLE 7. Odor scores of tray packed fryers held at 48°F.

Days of Storage	Treatments[1] A	B	C	D
	Average odor score			
1	2.50	2.75	2.25	4.25
4	3.75	2.75	4.25[3]	3.25
5	3.00	3.00	5.00[3]	6.00[3]
6	3.00	3.00	5.00[3]	6.00[3]
7	4.75[3]	5.00[3]	6.00[3]	6.00[3]
10	5.00[3]	6.00[3]	6.00[3]	6.00[3]

[1]Treatments

A Cryovac bag--evacuated, sealed, shrunk

B Cryovac bag over tray pack, evacuated, sealed, shrunk

C MSD cellophane over tray pack, sealed

D MSD cellophane over plastic tray, sealed

[3]Rejected for acceptability by at least three panel members.

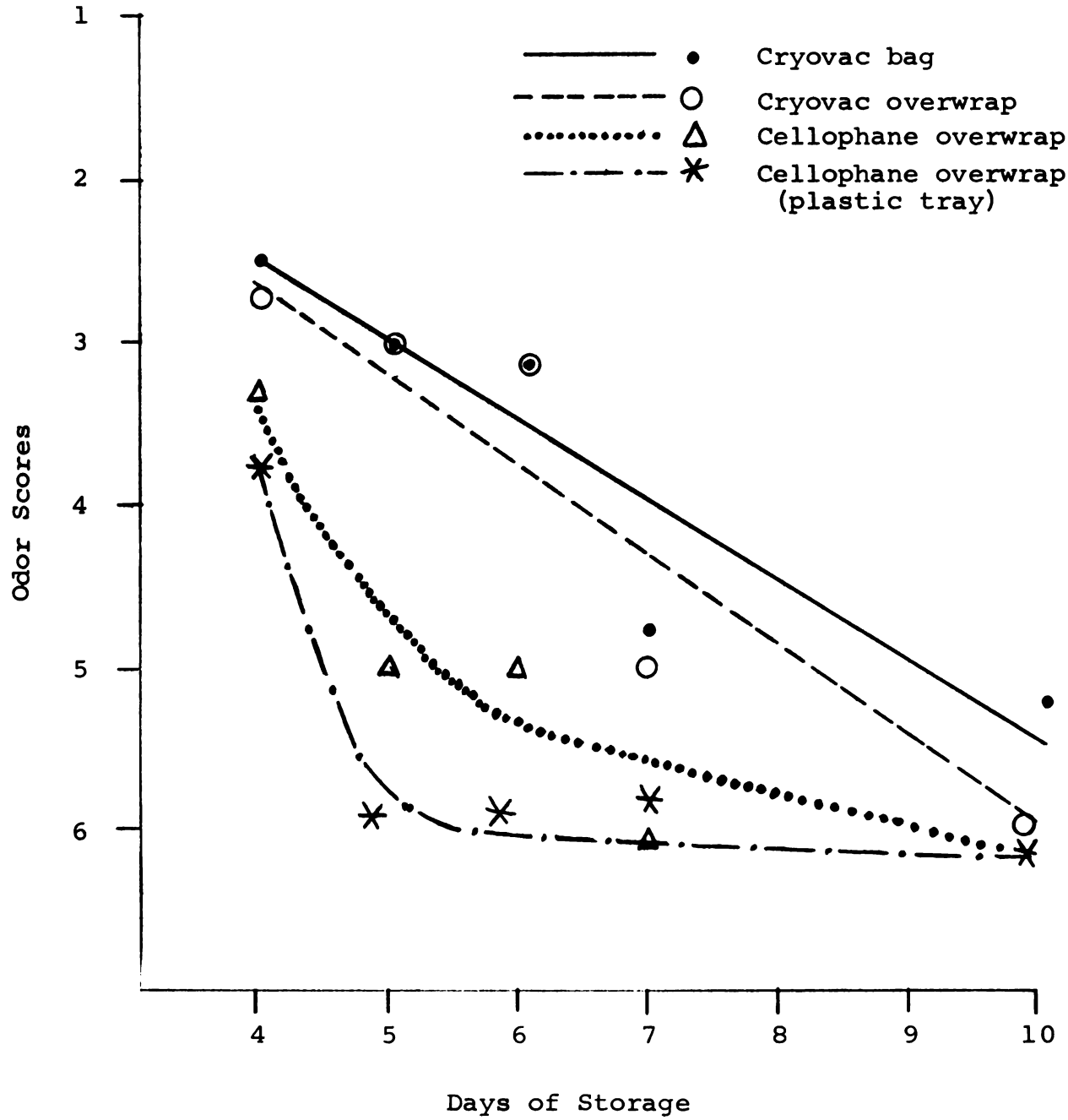

FIGURE 5. Influence of packaging material and method on odor scores of chicken fryers held at 48°F.

TABLE 8. Fluorescent scores of fryers held at 48°F.

Days of Storage	Treatments[1] A	B	C	D
	Fluorescent score			
1	1	1	2	3
4	1	1	2	3
5	1	2	3	3
6	0	1	3	3
7	0	1	3	3
10	0	0	3	3

[1]Treatments

A Cryovac bag, vacuum packed, sealed, shrunk

B Cryovac over tray packs, vacuum packed, sealed shrunk

C Cellophane over tray pack

D Cellophane over plastic tray

The fryers packaged in Cryovac bags exhibited the longest shelf-life of any birds in this test. Vacuum packing with 15 inches of vacuum appeared to increase the shelf-life. A limited atmosphere in the package appeared to lengthen the storage time of the fryers.

Experiment 4

Thirty (30) White Rock fryers were processed and halved as in Experiment 3 and divided into four groups of 15 halves each. Fryers in Treatments B and D were chilled for two hours in slush ice containing 20 ppm Acronize[3] which lowers to about 10 ppm with addition of fryers and ice, and Treatments A and C were chilled for two hours in slush ice. Fryers in Treatments A and B were tray packaged and overwrapped with MSD cellophane, and those in Treatments C and D were tray packed and placed in Cryovac bags and vacuum packed with 15 inches of vacuum. All fryers were placed on slatted shelves in a walk-in cooler maintained at 34°F.

Starting on the second day after processing, on every Monday, Wednesday and Friday until the 22nd day of holding, one package from each treatment was removed and evaluated for odor. Each bird was rated as either acceptable or not acceptable.

Odor scores are reported in Table 9 and Figure 6. After two days of holding, fryers in all treatments had odor scores of 1. After 22 days of storage, fryers in Treatments A, B, C, and D were scored 4.5, 2.5, 3.5, and 2.75 respectively. At the 16th

[3]A trade name for the antibiotic chlortetracycline, produced by American Cyanamid Company.

TABLE 9. Odor scores of fryers held at 34°F.

Days of Storage	Treatments[1] A	B	C	D
	Average odor scores			
2	1.00	1.00	1.00	1.00
5	1.75	1.00	1.00	1.00
7	1.25	1.00	1.00	1.25
9	2.75	2.25	1.25	2.00
12	1.50	1.00	2.50	2.00
14	2.00	2.75	2.00	0.50
16	2.00	2.00	2.00	2.00
19	4.00	1.75	2.50	3.00
21	4.75	2.25	2.50	2.50
22	4.50	2.50	3.50	2.75

[1]Treatments

A Cellophane tray

B Cellophane tray, Acronize

C Cryovac bag, vacuum packed

D Cryovac bag, vacuum packed, Acronize

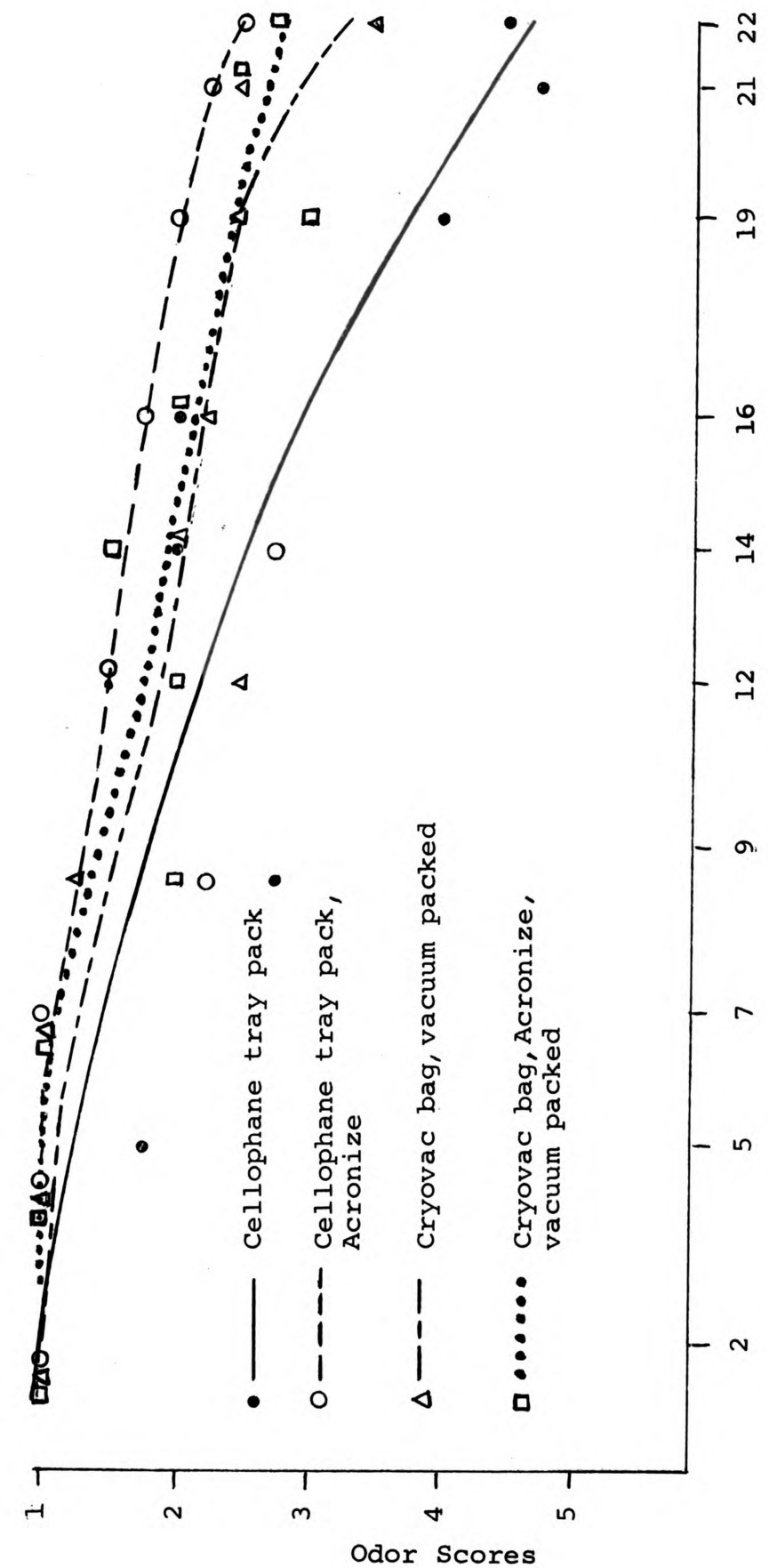

FIGURE 6. Odor scores of fryers held at 34°F.

day of holding, birds in all treatments were given the same odor score by the panel. Average odor scores for birds in Treatment A decreased rapidly after the 16th day.

Fryers in Treatments B and D, treated with Acronize, had the longest shelf-life in this experiment. Birds in both treatments were acceptable by the panel after 22 days of storage. Birds in the control Treatments A and C were rejected after 19 and 21 days, respectively. A short chill time and low temperature seemed to increase the shelf-life of the fryers.

Experiments 5 and 6

Results of these experiments will be discussed together because of certain combinations used. In Experiment 5, 30 White Rock fryers weighing between 2 1/2 and 3 1/2 pounds each were processed, and chilled in slush ice for two hours. The 30 birds were divided into four lots of 15 halves each and tray packaged. Each broiler was halved before packaging. Fryers in Treatment A were overwrapped with Cryovac film; in Treatment B overwrapped with "Mylar";[4] in Treatment C were overwrapped with Cryovac bags and vacuum packed with 15 inches of vacuum; and birds in Treatment D were placed in Mylar tubes and vacuum packed. All birds were placed on slatted shelves in a 34°F walk-in type cooler equipped with a blower.

Starting on the second day after processing and on every

[4]A polyester film produced by the DuPont Corporation.

second day thereafter including the 30th day, one package from each treatment was removed to another room and scored for odor by four panel members as previously described. Fluorescent scores were assigned each carcass as described before.

In Experiment 6, the procedure was the same as that described for Experiment 5, except that only 14 halves were used for each group instead of 15 halves and the tray packed fryers in Treatment D of this experiment were placed in Mylar tubes instead of Mylar bags. However, fryers in the Mylar tubes were vacuum packed as was done in Treatment D of Experiment 5.

Because of the identical handling of Experiments 5 and 6, the results have been combined.

Odor scores of birds in these experiments are reported in Figure 7 and Table 10. After 30 days of storage there was only a slight decrease in odor scores of birds in all treatments. After 30 days storage, the average scores were 2.15, 1.25, 1.75, and 3.0, respectively.

No fluorescent bacterial colonies were visible until after the 14th day of storage (Table 11). The degree of fluorescence increased rapidly on birds in Treatment A between the 14th and 30th day of holding, as shown in Figure 8. Fluorescence on birds in Treatment D increased rapidly after 22 days of holding. Fryers in Treatments B and D were scored two for fluorescence after 30 days of storage, while birds in Treatment C were given a fluorescent score of only one after 30 days of storage. Treatment A received an average score of 2.5 after 30 days holding.

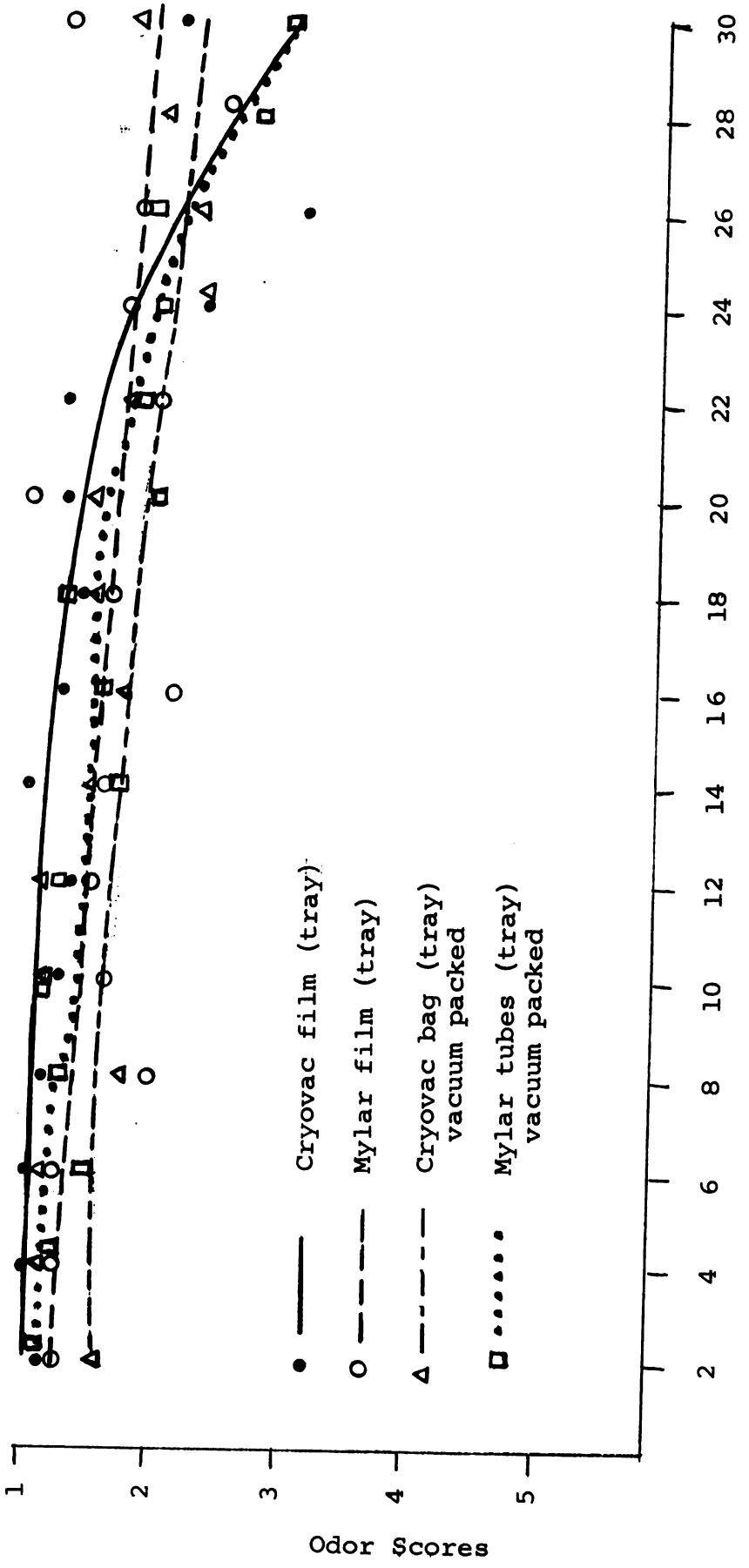

FIGURE 7. Odor scores of fryers held at 34°F.

TABLE 10. A comparison of raw odor scores of fryers held at 34°F.

Days of Storage	Treatments[1] A	B	C	D
	Average 6dor score			
2	1.15	1.25	1.50	1.00
4	1.00	1.25	1.15	1.15
6	1.00	1.25	1.15	1.50
8	1.15	2.00	1.75	1.40
10	1.25	1.60	1.15	1.15
12	1.40	1.50	1.15	1.25
14	1.00	1.60	1.50	1.60
16	1.25	2.15	1.75	1.50
18	1.40	1.60	1.50	1.25
20	1.25	1.00	1.50	1.75
22	1.25	2.00	1.75	1.75
24	2.15	1.75	2.40	2.00
26	3.15	1.85	2.25	1.60
28	2.50	2.50	2.00	2.75
30	2.15	1.25	1.75	3.00

[1]Treatments

A Cryovac film (tray)

B Mylar film (tray)

C Cryovac bag (tray) vacuum packed

D Mylar tubes (tray) vacuum packed

TABLE 11. A comparison of average fluorescent scores of fryers held at 34°F.

Days of Storage	Treatments[1] A	B	C	D
	Fluorescent score			
16	0	0	0	0
18	.50	0	0	0
20	1.00	0	0	0
22	1.00	0	0	1.00
24	1.50	1.50	0	1.00
26	2.00	1.50	1.50	1.50
28	2.00	2.00	1.50	2.00
30	2.50	2.00	1.50	2.25

[1]Treatments

A Cryovac film (tray)

B Mylar film (tray)

C Cryovac bag (tray) vacuum packed

D Mylar tubes (tray) vacuum packed

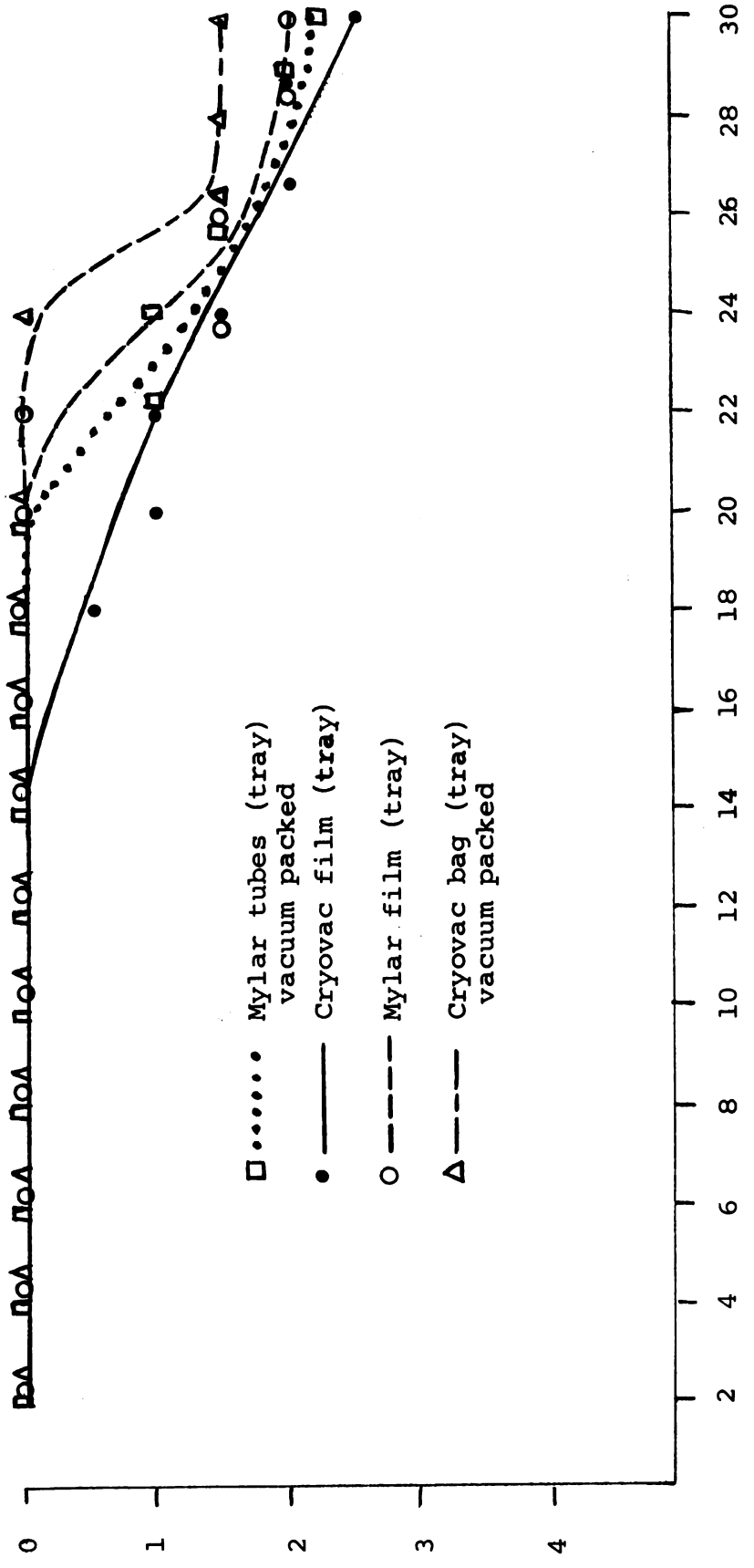

FIGURE 8. A comparison of fluorescent scores of fryers held at 34°F.

The average odor score for birds in each treatment remained similar until after the 18th day of holding. Birds in Treatments A and C maintained the highest score for the 30 day holding period. These results would indicate that the gas and moisture-proof characteristics of Cryovac overwrap influenced shelf-life at 34°F.

DISCUSSION

Influence of Temperature on the Shelf-Life of Fryers

The temperature at which fresh fryers are held is one of the most important single factors in the determination of shelf-life. Initial numbers of bacteria influenced by dressing procedure and length of chill time also affect keeping qualities. Figure 9 illustrates the changes in odor of fryers as influenced by the holding temperature. Odor scores indicated a rapid deterioration of fryer halves held at 48°F and 36°F after the fryers had been held in the chill tank for 24 hours. Fryers held in crushed ice (temperature approximately 33°F) maintained odor scores slightly better than did those held at 34°F. At the end of 21 days the average scores of fryers from these two treatments were about equal. At the holding temperature of 36°F (following a prolonged chill period) the fryer halves deteriorated rapidly after the fifth day and the fryers held at 48°F deteriorated very rapidly.

The optimum holding temperature for fresh fryers is at or near the freezing temperature of 32°F. Any variation above this temperature will cause a rapid increase in odor scores and a decrease in acceptability. The spoilage bacteria will be inhibited to the extent that they will not cause the development of off odor and slime quickly at the lower temperature.

In Experiment 2, a relatively short shelf-life was exhibited by the packaged fryer halves. Each treatment was held in an open display type meat refrigerator with circulated air. Contributing

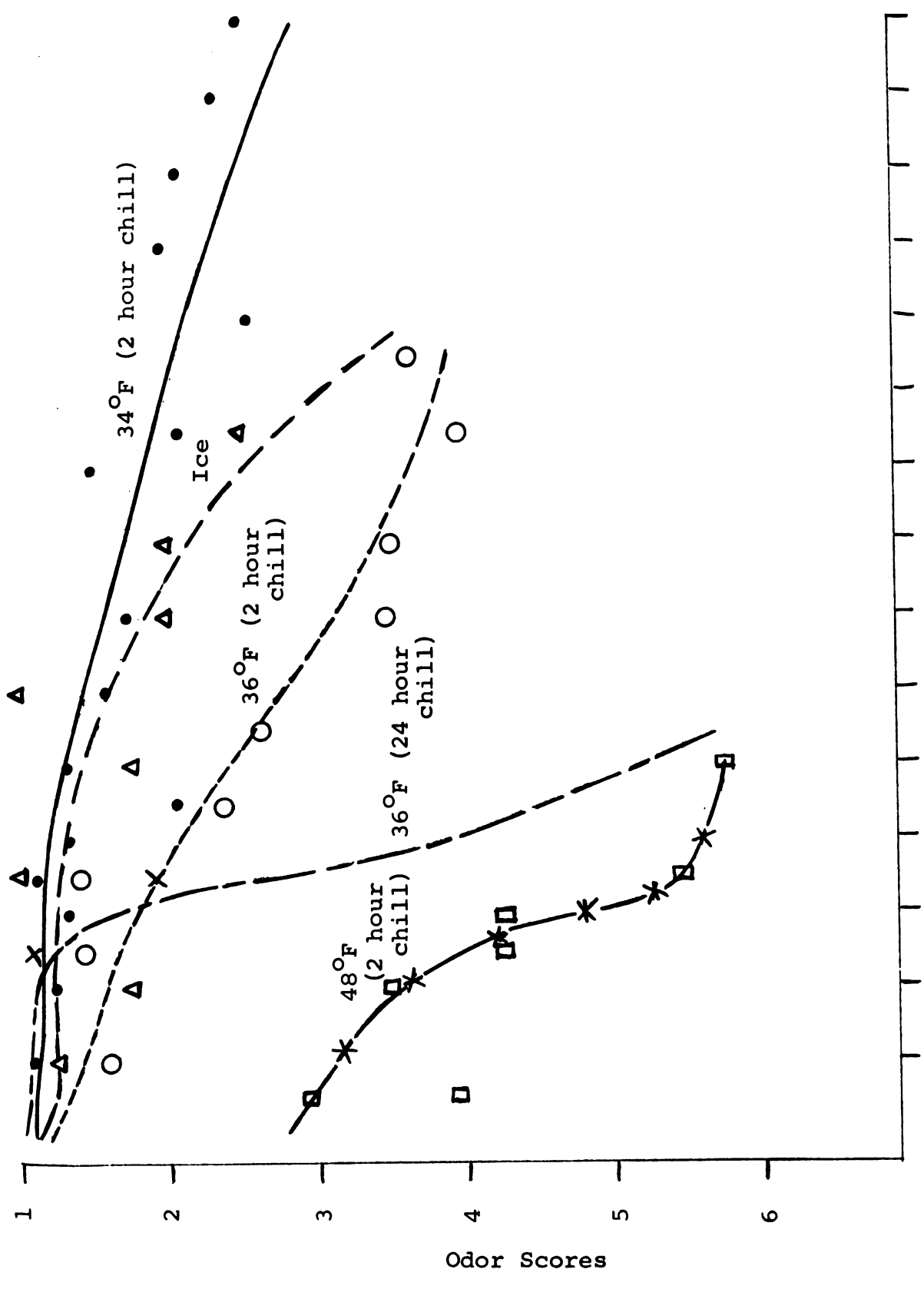

FIGURE 9. Odor scores of fryers held at different temperatures.

factors to the short shelf-life could have been a result of the mechanical operation of the refrigeration unit. Room temperature, room drafts and the cycling of the unit may have caused a higher holding temperature than was indicated. Similarly in Experiment 3, in which fryers were held at 48-50°F in an open type egg cooler, the birds may have been subjected to the same variations. In Experiments 4, 5, and 6 fryers were held at 34°F on slatted shelves in a walk-in type cooler. The fact that the fully automatic operation of this cooler minimized variation in temperature resulted in a longer shelf-life of the fryers.

The Influence of Packaging on the Shelf-life of Fryers

In Table 12 the average shelf-life (in days) of all fryers in the six experiments is reported. Although holding temperature appears to be most influential in determining fryer shelf-life, the packaging treatment also appears to have considerable effect, particularly when birds were held at temperatures above the ideal. In Experiment 1, the birds packaged in heat shrinkable bags (Cryovac) had two days longer shelf-life than the birds packaged in ice; seven days longer than those tray packed and overwrapped with Cryovac, and 12 days longer than those tray packed and overwrapped with cellophane.

In Experiment 2, in which birds were chilled 24 hours before packaging, little differences in shelf-life were noted. In Experiment 3, when held at 48°F, the birds packaged in Cryovac remained acceptable two to five days longer than those tray packed

TABLE 12. Shelf-life of fryers in relation to packaging material, chill time and holding temperature.

Experiment	Package	Chill time	Temperature	Shelf-life days
		Hours	°F	
5 & 6	Cryovac film	2	34	30
5 & 6	Mylar overwrap	2	34	30
5 & 6	Cryovac bag	2	34	30
5 & 6	Mylar bag	2	34	30
4	CTC Cellophane overwrap	2	34	22
4	CTC Cryovac overwrap	2	34	22
4	Cryovac overwrap	2	34	21
4	Cellophane overwrap	2	34	16
1	Cryovac bag	2	36	21
1	Ice pack	2	36	19
1	Cryovac overwrap	2	36	12
1	Cellophane overwrap	2	36	9
2	Cellophane overwrap	24	36	9
2	Pliofilm overwrap	24	36	7
2	Cryovac overwrap	24	36	7
2	Cellophane overwrap (holes)	24	36	7
3	Cryovac bag	48	48	6
3	Cryovac overwrap	48	48	6
3	Cellophane overwrap	48	48	1-4
3	Plastic tray cello overwrap	48	48	1

and overwrapped with cellophane. In Experiment 4, little differences in acceptable shelf-life were noted and in Experiments 5 and 6, no differences were found for 30 days.

Those fryers packaged well in shrinkable, heat sealable, and moisture-vapor proof materials remained acceptable longer than all other birds.

The results of these experiments indicate that an extension in shelf-life of fryers will result from adequate packaging which includes close fitting moisture and gas impermeable material and vacuum packing. The package must retain tightness and minimize transmission of gases or moisture. Packaging also provides a physical barrier to prevent contamination of the product through handling or from air movement over the packages. A limited oxygen atmosphere within a vacuum packaged product may have retarded the growth of odor and slime bacteria.

The Effect of Antibiotics in Relation to Packaging on the Shelf-life of Fryers

For the limited experimental work done in this report on antibiotics a few remarks are warranted. Figure 6 (Experiment 4) illustrates the change in odor scores as influenced by packaging overwrap and antibiotic treatment. The fryer halves treated with Acronize in the chill water maintained better odor scores than the untreated fryers packaged in the same manner. The Acronize treated fryer halves tray packaged and overwrapped with cellophane were not vacuum packed as were the Cryovac packaged fryers. Microorganisms

attempting to multiply on the fryers which were packaged in cellophane covered trays appear to have been inhibited to some extent by the Acronize treatment. Fryers in Treatment D which were treated with Acronize and vacuum packed in Cryovac bags decreased in odor scores at about the same rate as the cellophane packaged Acronize treated halves. From this experiment it may be concluded that antibiotics were of value in extending the shelf-life of fryers.

These findings are in accord with the work of Spencer et al. (1956), Carlin, Hall and Walker (1957), and Wells, Spencer and Stadelman (1958).

Chill Time

A difference in the acceptable shelf-life as found in Experiments 1 and 2 (21 and 11 days respectively), is reported in Tables 1 and 2. One of the contributing factors to this difference in shelf-life was the length of chill time. Approximately two hours are sufficient time to chill fryers using slush ice, and chill periods longer than two hours result in a decrease in shelf-life.

All fryer halves in these tests were chilled by using cold water and chip ice in a large cooling tank. Chill tanks have been shown to harbor microorganisms in large numbers, and fryer halves have varying degrees of contamination after the processing operation. Variations in initial bacterial counts result from these factors.

Fryers stored at a temperature of 36°F after a 24 hour chill time had a shelf-life of seven to nine days (Table 12), whereas

fryers stored at a temperature of 48°F after a 48 hour chill time had a shelf-life of only one to six days. In all tests in which a two hour chill time was used, the shelf-life ranged from nine to 30 days.

SUMMARY

The most important single factor evaluated in this study which influenced the shelf-life of fryers was holding temperature. The optimum temperature for holding fryers was found to be at or near the temperature of melting ice (approximately 33°F). This low temperature will retard the growth of slime and odor bacteria. Higher temperatures cause a rapid increase in odor scores and a shorter shelf-life of the product. Fryers held at 34°F were usually acceptable for one week longer than those held at 36°F (under conditions of this experiment) and about two weeks longer than those held at 48°F.

A packaging technique using a material that is impermeable to both gas and moisture effectively extended the shelf-life of fresh fryers. Materials that were loose fitting and did not exclude air were not as effective in extending shelf-life of fryers as were those tight fitting packages in which fryers were vacuum packed. In this study fryers properly packaged in Cryovac had the longest shelf-life and the lowest bacterial counts.

Fryers packaged in Cryovac sealed bags (vacuum packed) kept longer than those packaged in heat sealed Cryovac sheets. Cellophane was usually not as satisfactory an overwrap as was Cryovac or Mylar.

In Experiments 5 and 6, all fryers had a minimum shelf-life of 30 days. This long shelf-life can be attributed to low initial bacterial counts, a short chilling time, careful packaging using

each of the packaging materials, and a low controlled holding temperature. Although none of the birds were judged unacceptable after 30 days, the fluorescent scores and odor scores were more favorable for the birds tray packaged in Cryovac bags, Mylar sheets, Mylar tubes, and Cryovac sheets, respectively.

A short, (two hour) chill time after evisceration gave the longest shelf-life at each of the holding temperatures. Length of chill time seems to materially affect the initial bacterial population on the surface of fresh poultry meat. Both a long chill period and a high holding temperature resulted in a reduced acceptable shelf-life. Fryers similarly packaged and chilled two hours, remained acceptable for five days longer than those chilled for 24 hours, and six days longer than those chilled for 48 hours.

Under the conditions of this experiment, the antibiotic aureomycin (Acronize) was effective in extending shelf-life of laboratory processed fryers from one to five days longer than similarly packaged untreated birds.

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