PRODUCT QUALITY AND CONSUMER PREFERENCE AS AFFECTED BY ALTERNATIVE METHODS OF HANDLING AND PACKAGING CHICKEN

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

HIGHLIGHTS OF FINDINGS

- Four treatments were evaluated: Ice Pack, Cool Pack, Deep Chill and frozen.
- The ice pack, cool pack and deep chill treatments resulted in similar microbiological counts while counts on frozen treatments were significantly lower.
- Carcasses subjected to ice pack and cool pack treatments retained a greater percentage of tissue moisture during storage.
- Deep chill treated carcasses showed the greatest weight loss during storage at retail temperatures.
- Carcasses subjected to cool pack and ice pack conditions lost less weight than deep chill treated carcasses during storage at retail temperatures.
- Length of storage period did not affect weight loss of frozen carcasses, but cooking loss was greatest from this treatment.
- Tissues from carcasses subjected to cool pack conditions lost less weight during cooking than all other treatments while frozen tissues lost the greatest.
- Cool pack and ice pack treatments produced higher storage and cooking yields than were obtained from deep chill and frozen treatments.
- The organoleptic evaluation showed no significant advantage of any treatment in flavor, tenderness, moistness or overall quality.

PRODUCT QUALITY AND CONSUMER PREFERENCE AS AFFECTED BY ALTERNATIVE METHODS OF HANDLING AND PACKAGING CHICKEN

Fred Gardner and John Nichols[1/]

For a number of years chicken broilers have been moved through the normal market channels and have been delivered to retail outlets packed with crushed ice either in cardboard boxes or wooden crates. This method of handling broilers results in the need to transport up to 30% additional weight in ice, yields a product of relatively short shelf life, and presents a handling and packaging problem to the retail outlet. Several publications have reported results obtained with alternative methods of packaging and marketing broilers (1, 3, 4, 5, 7). These have included chill pack, CO_2 pack, warm pack and additional reports concerning the consumer acceptance of various frozen packages.

The study presented here was designed to evaluate selected alternative methods of packaging, handling and marketing broilers on the basis of both physical and organoleptic characteristics of the product. This study was not designed to examine the economic aspects of the alternative methods. More specifically, the objectives of the study were as follows:

1. To examine the effect of four packaging methods, ice pack, deep chill method, cool pack and frozen, on selected chemical and microbiological evaluations.[2/]
2. To examine the effect of these same packaging methods on organoleptic characteristics as evaluated by a consumer taste panel.

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[2/] See p. 5 for a description of each treatment.

The research reported here was conducted by the Texas Agricultural Market Research and Development Center at Texas A&M University and was supported in part by a grant from the Pillsbury Company. The following sections of this report describe the treatments and procedures used in the experiments. The data is evaluated and discussed in the third section followed by conclusions drawn from the study. Highlights preceed the text of this report to provide a quick summary of significant findings. All Analysis of Variance tables are presented in the appendix.

PROCEDURE

Approximately two hundred chicken broilers were purchased from a commercial poultry processing plant which normally supplies all poultry and egg products for about sixty branch stores of a large retail marketing chain. The plant's processing capacity is about 3000 broilers per hour and has been under the USDA Grading and Inspection Services for a number of years.

Following evisceration, the broilers were placed in a spin chill for approximately 45 minutes. Water uptake as reported by the USDA Inspector was 10.2%. Immediately post-chilled, the broilers were placed on an overhead drain line and were directly packed in ice. Efforts were made to obtain broilers which weighed between 2.75 and 3.00 lbs. eviscerated. Twenty broilers were packed in each box, completely iced and then transported for a period of two hours to the laboratory for evaluation. Immediately after the broilers were delivered to the laboratory, twelve carcasses were randomly taken for evaluation. Each carcass was halved and twelve drumsticks used for microbiological evaluation, seven for chemical evaluation and five for electrophoretic analysis. Each of the remaining carcasses was halved, weighed, and placed into treatment groups as indicated in Table 1. This system was continued until 96 carcass halves had been placed in each treatment group. The individual halves of each carcass were not tagged for additional identification. Each treatment group was then handled as described in the "Treatment Description" section.

After the treatment period, an initial evaluation was conducted and a storage period was begun which lasted twelve days. During this storage period temperatures for the three non-frozen treatments were held at 35°F

TABLE 1

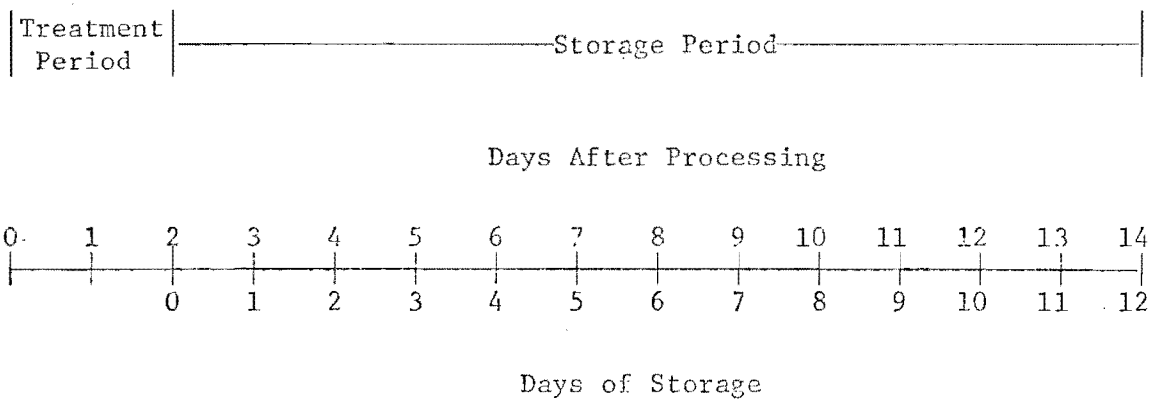
DISTRIBUTION OF CARCASS HALVES INTO THE FOUR TREATMENT GROUPS[1/]

Carcass	Treatment			
	Ice Pack	Deep-Chill Method	Cool Pack	Frozen
1	X	X		
2	X		X	
3	X			X
4		X	X	
5		X		X
6			X	X

1/ This procedure was continued until 96 halves had been assigned to each treatment.

to represent typical retail shelf conditions. This period can be thought of as a simulation of the temperature conditions normally found on the retail shelf.

Additional evaluations were made after five, eight and twelve days of this storage period. A chronological sequence of events is shown below.



Treatment Description

1. Ice Pack. After each half had been weighed, 32 halves were placed in each of three boxes and the halves thoroughly iced. The carcass halves were kept iced and held at 35°F. for two days. Following this two day treatment period, 24 halves were selected for the first storage evaluation. The remaining 72 carcasses were again weighed and then tray packed using styrofoam trays that had been marked for later identification, absorbant pads and a pliofilm sack. Each package was then heat sealed and placed in storage at 35°F. for later storage evaluations.

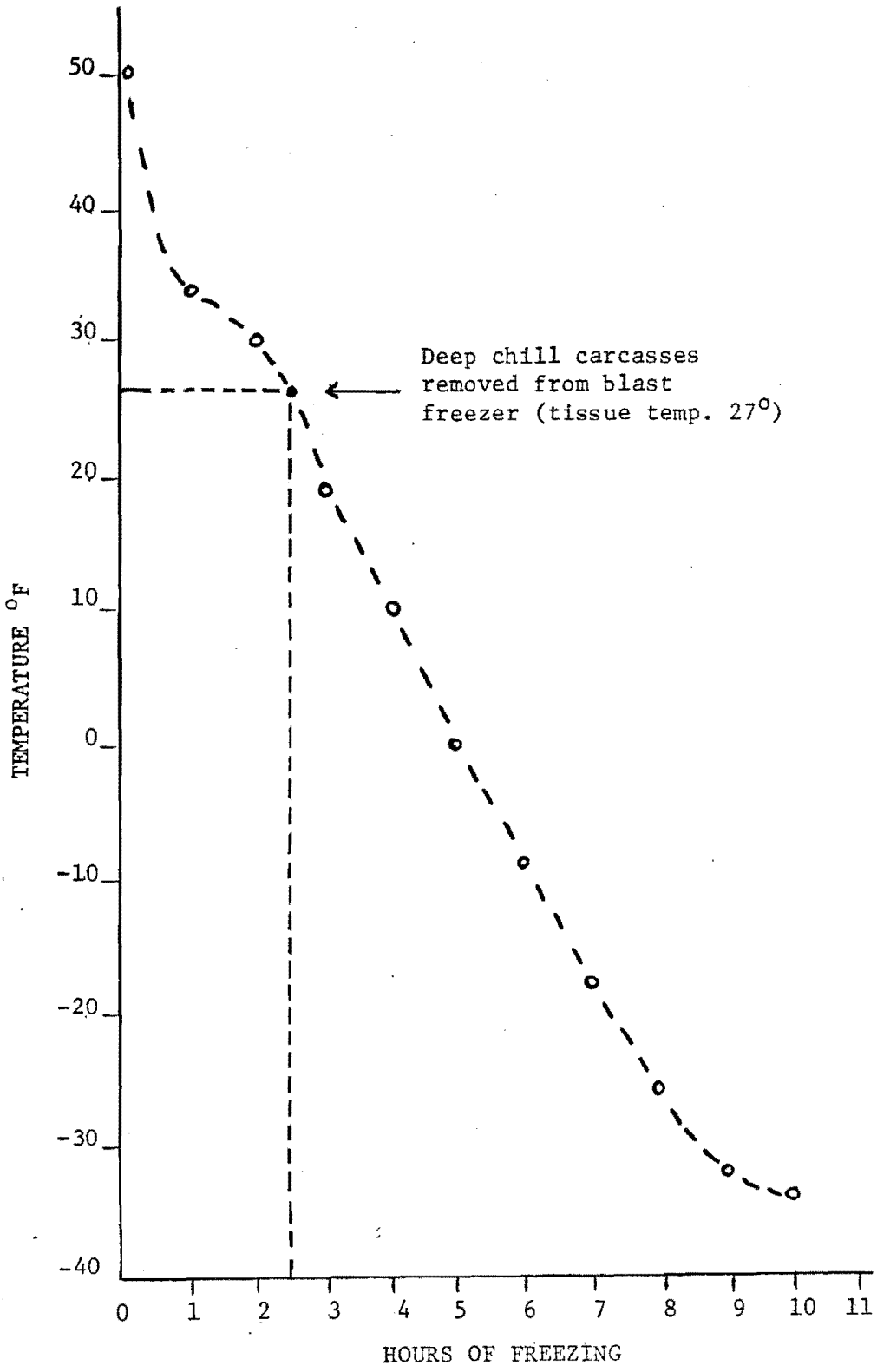
2. Deep-Chill Method. After each carcass half had been weighed, each half was tray packed using a styrofoam tray which had been marked for later identification, an absorbant pad and a pliofilm sac. Each package was then

heat sealed and placed in a blast freezer maintained at -34°F. Tissue temperature was continuously monitored during the chilling process (Figure 1). Approximately two and one-half hours at -34°F. were required to attain 27°F. tissue temperature. Each package was then placed in a walk-in freezer maintained at 28°F. for the remainder of the two-day treatment period. After this treatment period, 24 halves were selected for the first storage evaluation. The remaining packages were then transferred to a large cooler maintained at 35°F. for the storage evaluation period.

3. Cool Pack. After each carcass half had been weighed, 32 halves were placed in each of three corrigated boxes and placed at 28°F. for a 12 hour period. During this holding period, approximately 2.3% weight loss was obtained. It is estimated that an additional 4% loss was realized between packing at the plant and the time the carcasses were placed at 28°F. for the cool pack holding period. Therefore, weight loss during transportation and the "cool pack" holding period was approximately 6.3%. Since 10.2% weight gain was obtained in the chilling process, the net weight gain for the entire chilling through the cool pack holding period was 3.9%. Following this 12 hour holding period, each carcass was weighed, and tray packed using a styrofoam tray which had been marked for later identification, an absorbant pad and a pliofilm sack. Each package was heat sealed and placed in storage at 28°F. for the remainder of the two day treatment period. Twenty-four halves were then selected for the first storage evaluation. The remaining packages were then transferred to a large walk-in cooler maintained at 35°F. for the storage evaluation period.

4. Frozen. After each carcass half had been initially weighed, each half was tray packed using a styrofoam tray which had been previously marked

FIGURE 1. CHANGES IN TISSUE TEMPERATURE DURING BLAST FREEZING



for later identification, an absorbant pad and a pliofilm sac. Each package was then heat sealed and placed in a blast freezer maintained at -34°F. Tissue temperature changes were monitored continuously during the freezing process (Figure 1). After approximately 15 hours of exposure to the blast freezer environment all packages were transferred to an upright freezer maintained at 0°F. for the balance of the two-day treatment period. Twenty-four halves were then selected for the first storage evaluation while the remaining packages were held in the freezer for the storage evaluation period. Each package removed from frozen storage was placed at 73°F. for a four-hour thaw period prior to evaluation.

Microbiological Evaluation

Twelve drumsticks from each treatment on each of the four storage evaluation days were sampled for total aerobic counts. Also, as previously noted 12 drumstick samples were evaluated for base (initial) data. Swab samples were taken from each drumstick and serial dilutions made in sterile saline blanks. Duplicate platings of each dilution were made using Plate Count Agar as the growth substrate. Total psychrophilic counts were obtained from plates incubated at 20°C. for four-five days. Total mesophilic counts were taken from plates incubated at 35°C. for two days. Bacterial concentrations are expressed as the number of bacterial per square centimeter of surface area.

Chemical Evaluation

Seven drumsticks from each treatment on each of the four storage evaluation days were taken for moisture content determination. Also, as previously noted, seven drumstick sample were analyzed for base (initial) data. The tissue was carefully removed from the bone and efforts made to eliminate

tendenous and fatty material. The tissue taken was then cut into small pieces and duplicate 10 gram samples taken for moisture determination. All determinations were made using toluene extraction methods. All tissues remained on the extraction apparatus for six hours reflux time. Moisture is reported as percent of total tissue weight. The remaining five drumsticks from each treatment were used for protein electrophoresis analysis which have not been incorporated as a part of this overall study.

Weight Loss During Treatment and Storage

All carcass halves were weighed initially on arrival at the laboratory and when removed from storage for evaluation. In addition, cool pack carcass halves were weighed after the 12 hours cool pack holding period. All weighings were taken to the nearest gram. Weight losses were determined by difference.

Cooking Evaluation

After each drumstick was removed from the carcass half, the remaining breast and thigh samples were prepared for cooking. Each breast and each thigh was individually weighed and then placed in a cooking pan in such a way that the post-cooking weight for each piece could be determined. Each pan contained a cooking rack which permitted the liquid cooking loss to drain from the chicken during the cooking process. Separate pans were used for the thigh and breast samples of each treatment. All samples were placed in a rotary oven maintained at 350°F. and were cooked, uncovered, to a final tissue temperature of 178°F. The individual pieces were then weighed, each pan covered and placed in a thermotainer which maintained a temperature of 130°F. Cooking loss was determined by subtracting the post-cooking weight from the pre-cooking weight.

Organoleptic Evaluation

Organoleptic evaluation was done by a panel of 48 judges selected from the population of the Bryan-College Station, Texas area. A stratified sampling procedure was employed to assure a panel representative of the area.

Each judge was initially presented with two pieces of chicken (either two thighs or two breats) accompanied by two evaluation forms (see Appendix). The judge was asked to rate each piece individually on four factors; overall quality, moistness, flavor and tenderness. After completing these evaluations each judge was presented two additional pieces of chicken selected so that, in total each judge evaluated two breasts and two thighs at each evaluation.

Of the four pieces presented to each judge at each evaluation period, one was drawn from each of the four treatments. The order of tasting was varied from judge to judge so that all possible combinations were included. Instructions were given to the panel regarding proper methods of tasting.

The procedure described above was repeated three times, first immediately following the two-day treatment period and then after 5 and 8 days of the storage period. The 12 day organoleptic evaluation was discontinued because of deterioration in the condition of the meat. In all there were 562 pieces of chicken evaluated during the three sessions.

Statistical Analysis

All data has been subjected to analysis by standard Analysis of Variance methods (6). Where Analysis of Variance indicated significant main effects the treatment means have been separated using Duncan's Multiple Range Test (2).

RESULTS AND DISCUSSION

Microbiological Quality

Bacterial concentrations, expressed in terms of the logarithm of the number of viable cells per cm^2, for both the psychrophilic and mesophilic populations are presented in Tables 2 and 3. Visual observations of this data indicates only minor differences in the microbiological patterns obtained from the ice pack, deep chill and cool pack treatments. However, the microbiological populations of the carcasses subjected to the frozen storage treatment remained at relatively low levels throughout the entire evaluation period (Figure 2, 3). This difference between the frozen and the remaining groups resulted in a highly significant interaction between treatment and days when the results were subjected to statistical analysis (Appendix Tables 1 and 2). This effect was noted in both the mesophilic and the psychrophilic counts. Therefore, an additional analysis was run in which all data from the frozen treatment was eliminated. This revised analysis presents a comparison of the three non-frozen treatments only (Appendix Table 3). The significant interaction obtained between days and treatments is attributable primarily to the fact that the growth of bacterial populations on the cool pack treated carcass halves was greater between the first and second storage evaluations than that observed on either the ice pack or the deep chill packed carcasses. However, the difference between the treatments was not significant. It should be noted however, that in the five, eight and twelve day evaluation periods the cool pack carcasses contained a greater concentration of viable cells than did any of the other treatments (Figures 2 and 3). This can probably be explained by considering the mechanisms inherent in the cool pack procedures

TABLE 2

SURFACE BACTERIAL POPULATIONS ON BROILERS AS AFFECTED BY PACKAGING TREATMENT - PSYCHROPHILIC BACTERIA*

Days of Storage Period	Treatment			
	Ice Pack	Deep Chill	Cool Pack	Frozen
0	4.54	4.09	4.21	3.82
5	4.86	4.35	5.23	3.85
8	7.03	5.97	7.28	4.44
12	7.76	7.75	8.41	4.08

*Logarithm of number of viable cells per cm^2 of surface area. Base value for all treatments is 4.29.

TABLE 3

SURFACE BACTERIAL POPULATIONS ON BROILERS AS AFFECTED BY PACKAGING TREATMENT - MESOPHILIC BACTERIA*

Days of Storage Period	Treatment			
	Ice Pack	Deep Chill	Cool Pack	Frozen
0	4.39	4.61	4.17	3.82
5	4.38	4.20	4.91	4.40
8	6.04	5.44	6.55	4.28
12	7.02	7.11	7.93	4.04

*Logarithm of number of viable cells per cm^2 of surface area. Base value for all treatments is 4.56.

FIGURE 2. SURFACE BACTERIAL COUNTS AS AFFECTED BY PACKAGING TREATMENT AND LENGTH OF STORAGE - PSYCHROPHILIC COUNT

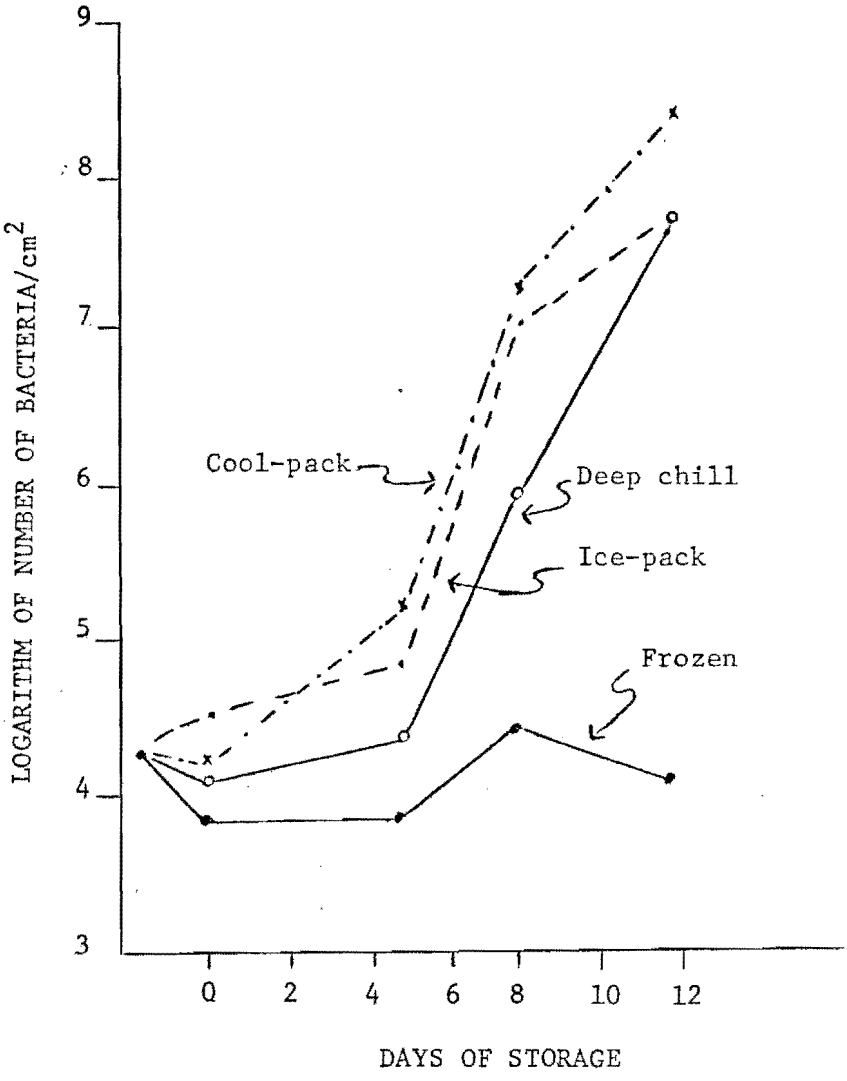
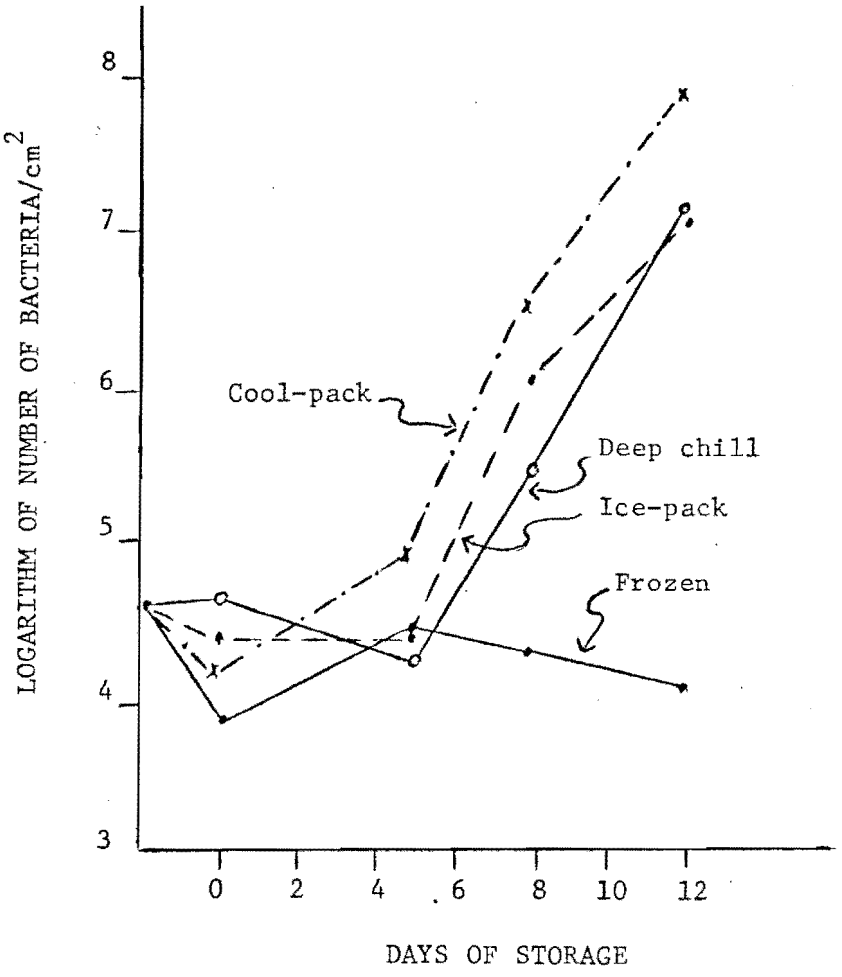


FIGURE 3. SURFACE BACTERIAL COUNTS AS AFFECTED BY PACKAGING TREATMENT AND LENGTH OF STORAGE - MESOPHILIC COUNT



as opposed to the mechanisms inherent in the other treatments. Both deep chill and frozen treatments expose the carcass to at least three hours of low surface temperature and a relatively severe dehydration effect. These treatments, in all probability, result in at least a delayed growth phase if not a reduction in bacterial numbers. The ice pack procedures create an environment in which cooling rates are greater (slush-ice enviroment vs. dry air environment) than in cool pack which might result in a delay in the normal growth patterns. In addition the melting ice may tend to wash bacteria from the carcass which would therefore yield a lower surface count. The cool pack treatment on the other hand, offers a twelve hour period in which surface bacteria are not adversely affected by freezing temperature or by a washing action. In addition, the extra handling required during this initial period may potentially present additional contamination avenues. In all of these considerations, however, it should be remembered that the differences between the three non-frozen treatments were not statistically significant.

Weight Yields

One of the major areas of interest concerning the comparative results of the four packaging treatments concerns the loss in weight during subsequent storage at retail temperatures. The weight obtained for each carcass half in each of the four treatments on each of the four evaluation days has been expressed as a percent of the base weight and presented in Table 4 and Figure 4. As expected the weight yield of the post-thaw frozen carcasses remained fairly constant over the 14 day evaluation period. On the average the frozen carcasses lost about 3.5% of their initial weight and the relative yield was not affected by storage time. The yield of all

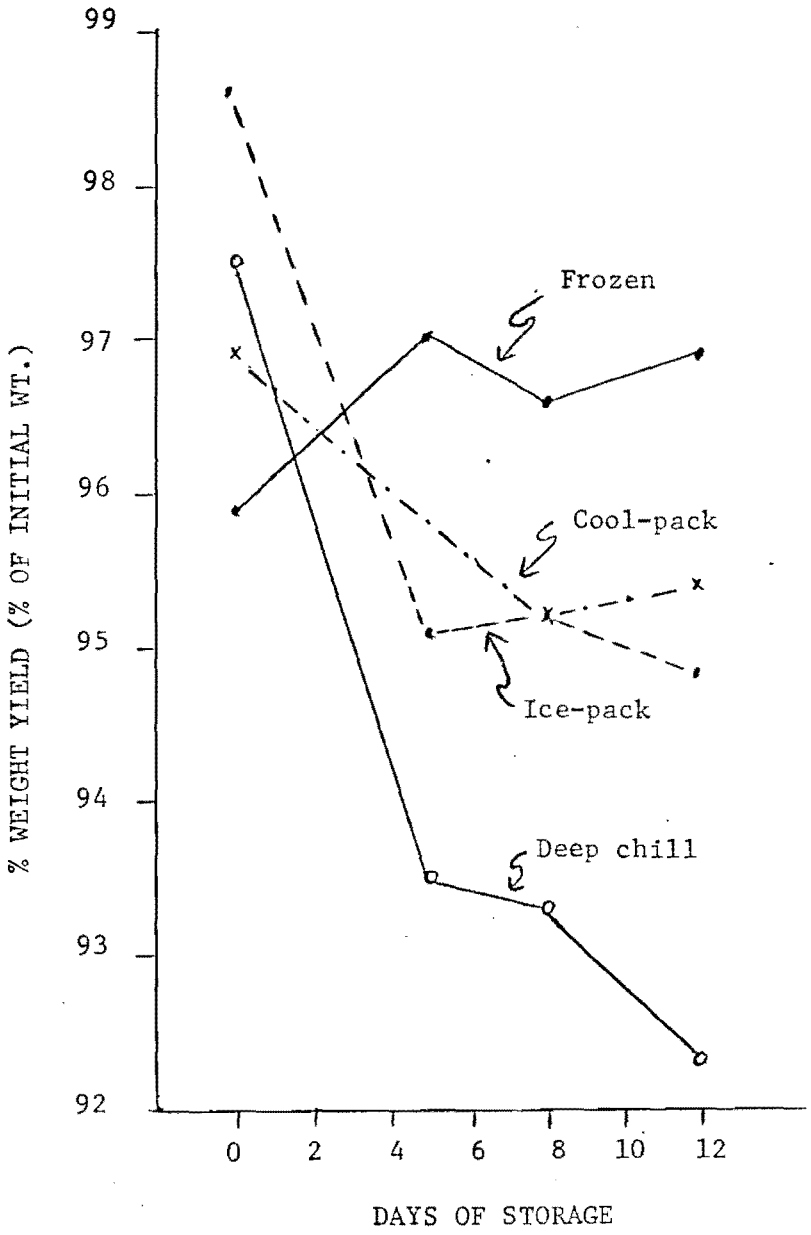
TABLE 4

WEIGHT YIELD AS AFFECTED BY PACKAGING TREATMENT AND STORAGE TIME

Days of Storage Period	Treatment			
	Ice Pack	Deep Chill	Cool Pack	Frozen
0	98.6*	97.5	96.9	95.9
5	95.1	93.5	95.8	97.0
8	95.2	93.3	95.2	96.6
12	94.8	92.3	95.4	96.9

*Percent of initial carcass weight.

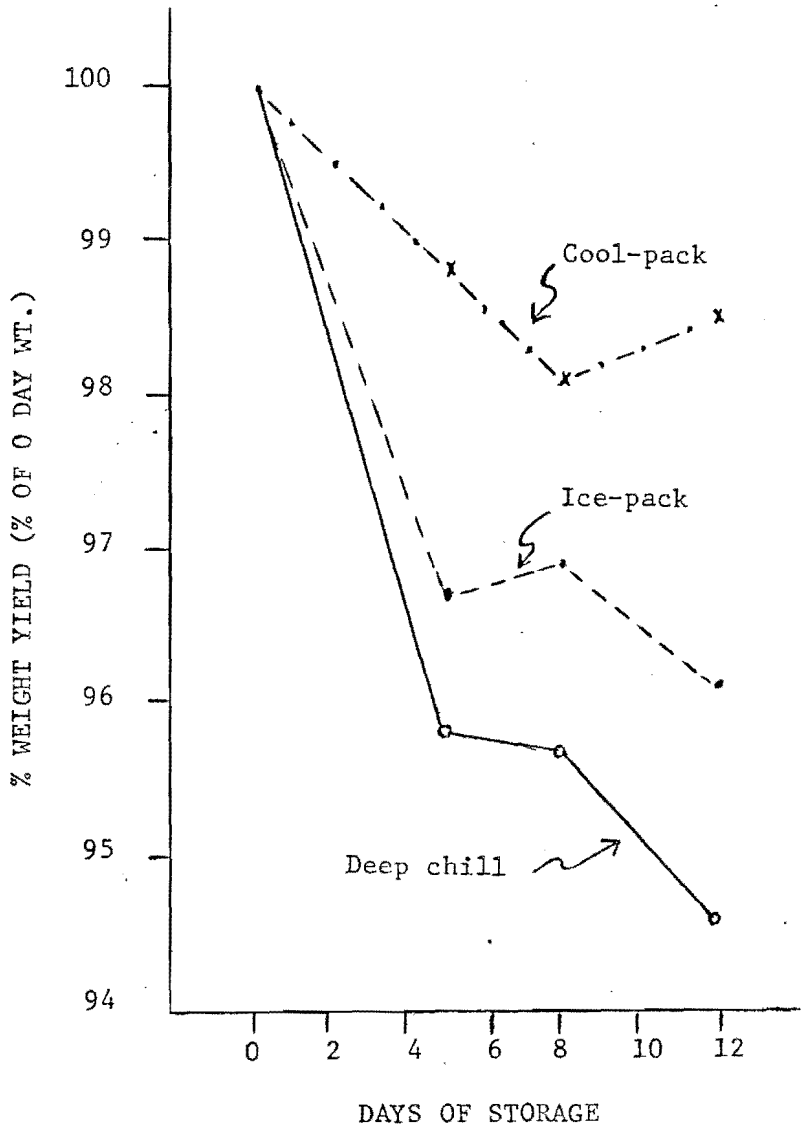
FIGURE 4. WEIGHT YIELD AS AFFECTED BY PACKAGING TREATMENT AND LENGTH OF STORAGE



other treatments however, decreased with increasing storage time. The differences in storage effects on yields of frozen carcasses and non-frozen carcasses resulted in a highly significant interaction between treatment and days where the yields of the four treatments were analyzed by analysis of variance methods (Appendix Table 4). Therefore, an additional analysis was run in which yield data from the three non-frozen treatments only was used. The results reveal a significant interaction and significant main effect (Appendix Table 5). Separation of treatment means by Duncan's Multiple Range Test indicates that there was no difference between ice pack and cool pack yields. However, yields from both of these treatments were significantly greater than the yield obtained from the deep chill pack carcasses. As expected, in all non-frozen treatments, yields decreased with increases in storage time.

Weight data from the three non-frozen treatments was also expressed as the percent yield of the weight on the zero storage day. This analysis therefore, represents weight changes that would normally be expected during storage at retail temperatures. It is important to realize that weight changes which occurred during the two day pre-storage treatment period will not be reflected directly in this data. Only treatment effects on subsequent weight loss will be reflected. Analysis of variance and separation of means by Duncan's Multiple Range Test indicates that carcasses exposed to cool pack conditions lost less weight during subsequent storage than either ice pack or deep chill carcasses (Appendix Table 6). Deep chill carcasses lost significantly more weight during storage than was lost by carcasses from either cool pack or ice pack treatments (Figure 5). This data suggests that although the carcasses exposed to cool pack conditions

FIGURE 5. WEIGHT YIELD AS AFFECTED BY PACKAGING TREATMENT AND LENGTH OF STORAGE AT 35°F.



for two days lost relatively more weight than either the ice pack or the deep chill carcasses during the two day treatment period, subsequent weight loss during storage was less than that obtained from ice pack or deep chill carcasses. In addition, although pre-storage relative weight loss was average in the deep chill carcasses subsequent weight loss under retail storage conditions was significantly greater than that of ice pack or cool pack carcasses.

Cooking Yield

On each of three evaluation days 24 breast samples and 24 thigh samples of each treatment were cooked. Weight yields indicate that cooking yields were higher from carcasses subjected to cool pack conditions than in carcasses subjected to any of the other treatments (Table 5). Cooking yields obtained from carcasses exposed to the frozen treatment were lower than those from carcasses exposed to the non-frozen treatments. Differences between treatments, however, were not significant when the data was subjected to analysis of variance methods (Appendix Table 7). Cooking yields were also greater in breast samples than in thigh samples, although the difference was not significant. The data obtained also indicates that cooking yields were lowest from samples stored at retail temperatures for eight days prior to cooking. Visual examination of the data presented in Figure 6 emphasizes the effects of storage period on yield and also suggests that the major treatment effects on cooking yield are obtained in yield of cooked breast tissue rather than yield of cooked thigh tissue.

If the percent yields obtained from storage and from cooking are combined, the cooked weight expressed as a percentage of the base weight is obtained (Table 6). Analysis of these average figures indicates only a

TABLE 5

COOKING YIELDS OF BROILER TISSUE AS AFFECTED BY FOUR PACKAGING METHODS AND STORAGE TIME*

Storage	Treatment							
	Ice Pack		Deep Chill		Cool Pack		Frozen	
	Thigh	Breast	Thigh	Breast	Thigh	Breast	Thigh	Breast
	- - - - - - - - - - - - - - - - percent - - - - - - - - - - - - - - - -							
0	73.85	76.33	73.30	72.36	74.25	78.82	67.98	73.88
5	74.62	73.57	75.07	75.99	75.41	77.32	77.61	70.61
8	68.44	71.03	67.77	70.31	67.77	73.77	64.67	69.07

*Selected Mean Values:

Tissue	Treatment	Days Storage
Thigh - 71.73	Ice Pack - 72.97	Day 0 - 73.85
Breast - 73.58	Deep Chill - 72.47	Day 5 - 75.02
	Cool Pack - 74.56	Day 8 - 69.10
	Frozen - 70.63	

FIGURE 6. EFFECT OF PACKAGING TREATMENT AND STORAGE PERIOD ON THE COOKING YIELD OF THIGH AND BREAST TISSUE

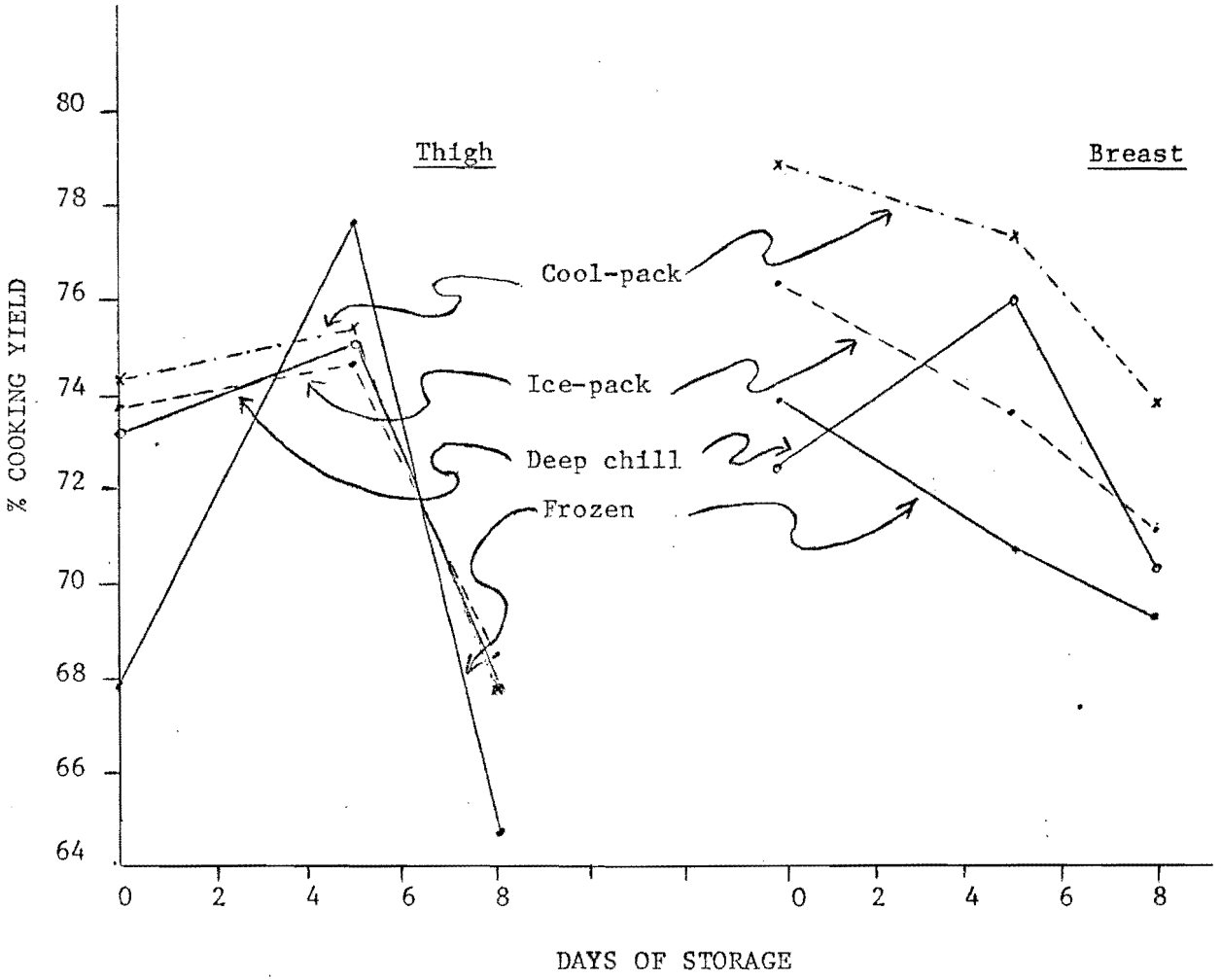


TABLE 6

COOKING YIELD (AS A PERCENTAGE OF BASE WEIGHT) AS AFFECTED BY PACKAGING TREATMENT AND STORAGE TIME

Days Storage	Treatment			
	Ice Pack	Deep Chill	Cool Pack	Frozen
	- - - - - - - - - percent - - - - - - - - -			
0	74.04	71.01	74.16	68.02
5	70.46	70.62	73.15	71.89
8	66.38	64.41	67.37	64.57

significant day effect (Appendix Table 8). Separation by Duncan's Multiple Range again indicates a significantly lower yield from samples stored for eight days prior to cooking than for samples stored for either zero or five days. Although statistically significant treatment effects were not obtained, the data suggests higher yields from the cool pack treatments than from deep chill, ice packed, or frozen (Figure 7).

Moisture Content

Results obtained from the toluene extraction of thigh tissue from each treatment on each of four evaluation days reveals an overall decrease in the moisture content of the tissue associated with increased storage time at retail temperatures (Table 7). Visual analysis indicates that the moisture content of ice pack and cool pack tissues was generally higher than that of either deep chill or frozen (Figure 8). However, Analysis of Variance indicates only that the moisture content of ice pack tissues was significantly higher than that of either deep chill or frozen (Appendix Table 9). Differences between the ice pack and cool pack were not significant.

Organoleptic Evaluation

Several factors were used in the organoleptic evaluation of the tissues. Data are presented on each in the following sections. It should be noted that organoleptic evaluations were conducted three times during the storage period while other evaluations were done at four intervals. Due to deterioration of tissue, organoleptic evaluations were discontinued after 8 days of storage.

Overall Quality: Very few meaningful differences were observed in the evaluation of overall quality of the product (Table 8). While cool pack

FIGURE 7. COOKING YIELD (% OF BASE WT.) AS AFFECTED BY PACKAGING TREATMENT AND STORAGE TIME

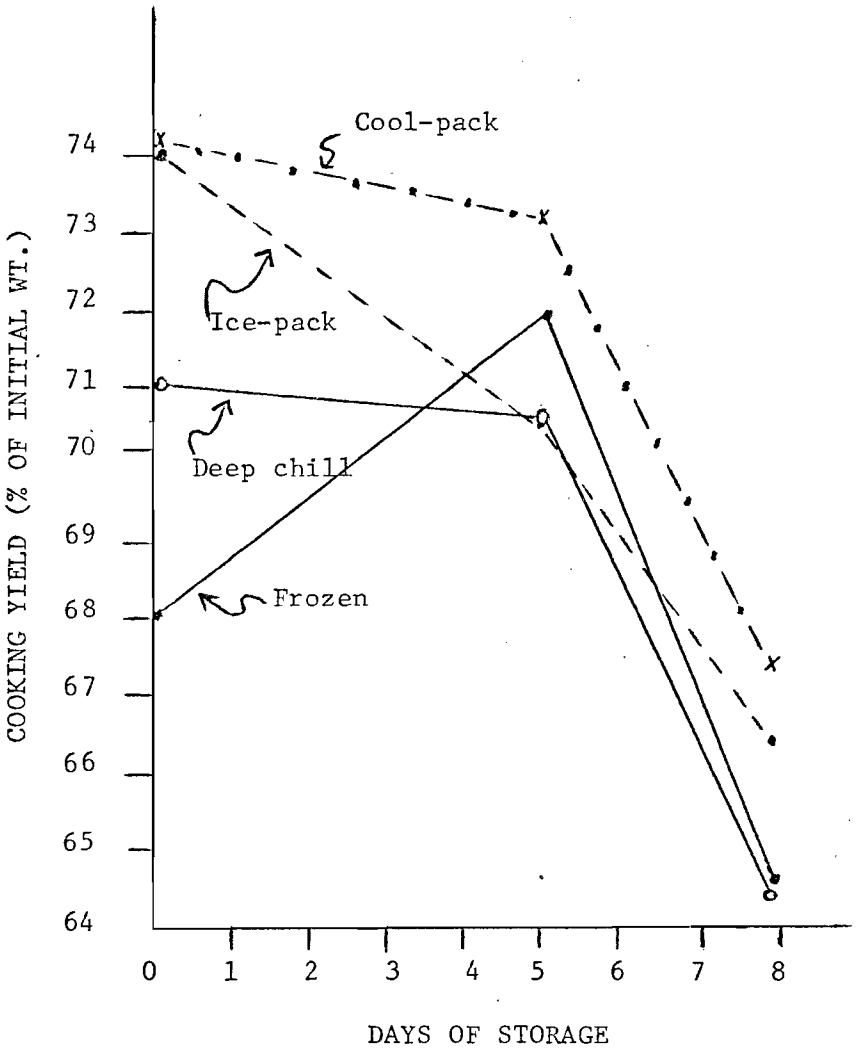


TABLE 7

MOISTURE CONTENT OF TISSUE AS AFFECTED BY PACKAGING TREATMENT AND STORAGE TIME*

Days of Storage	Treatment			
	Ice Pack	Cool Pack	Deep Chill	Frozen
	- - - - - - - -percent - - - - - - - -			
0	77.28	76.94	76.27	76.64
5	76.74	76.28	75.70	75.56
8	76.20	75.50	75.80	74.70
12	76.28	75.71	75.56	75.48

*Base value for all tissue = 77.02 percent

FIGURE 8. MOISTURE CONTENT OF TISSUE AS AFFECTED BY PACKAGING TREATMENT AND STORAGE PERIOD

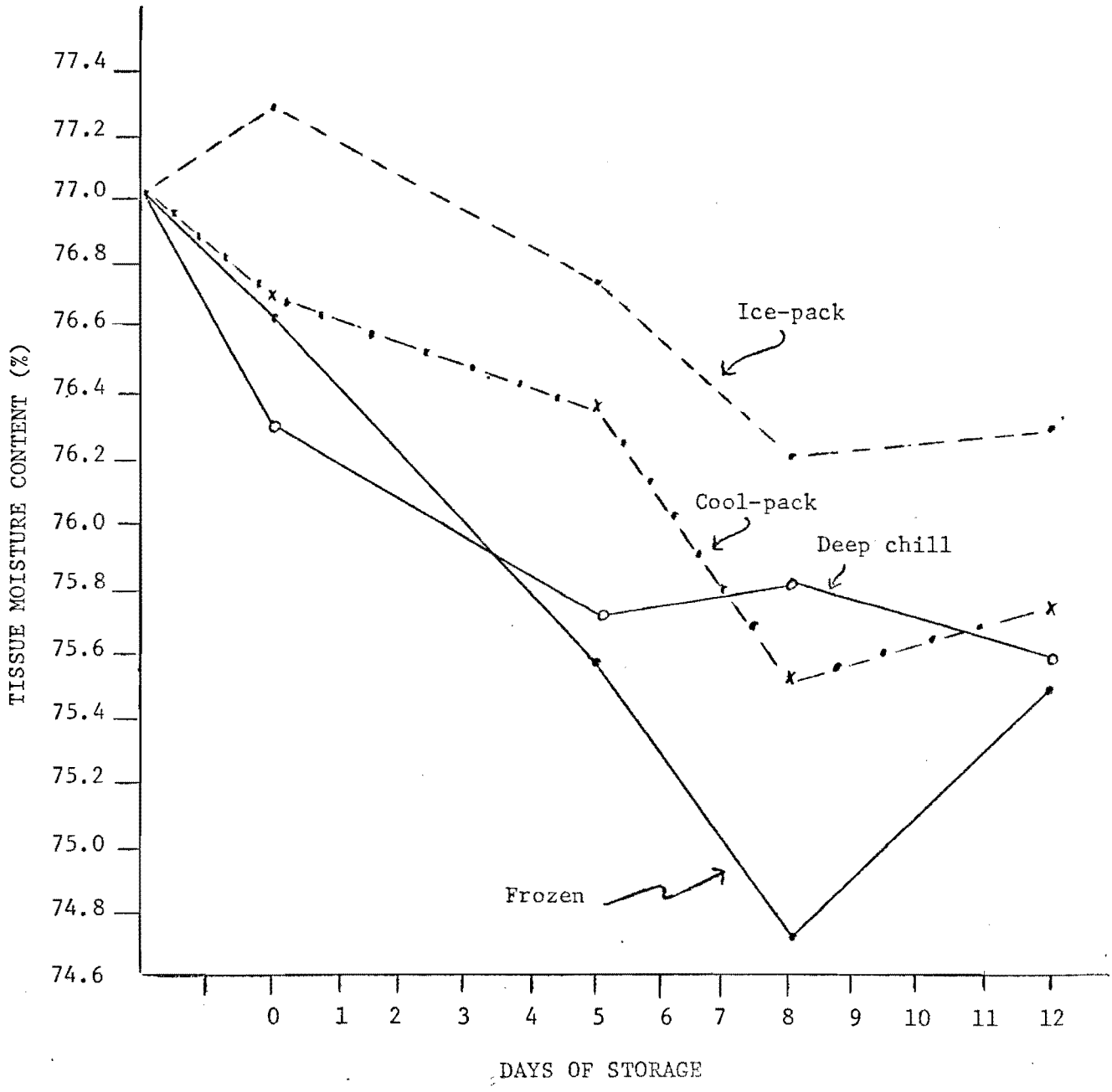


TABLE 8

MEAN RATINGS ON OVERALL QUALITY AS AFFECTED BY TREATMENT, TISSUE AND STORAGE PERIOD[1/*]

Days of Storage Period	Treatment							
	Ice Pack		Deep Chill		Cool Pack		Frozen	
	Breast	Thigh	Breast	Thigh	Breast	Thigh	Breast	Thigh
0	6.00	4.96	6.00	4.92	5.65	5.83	5.12	5.78
5	5.65	5.61	5.41	4.92	6.04	5.61	5.79	5.18
8	5.04	5.08	5.04	5.66	4.46	5.83	5.33	5.04

[1/] Higher the score the better the estimated quality. Source: 48 member taste panel.

* Selected mean values:

Tissue	Treatment	Days Storage
Thigh - 5.37	Cool Pack - 5.56	Day 0 - 5.53
Breast - 5.46	Ice Pack - 5.39	Day 5 - 5.53
	Frozen - 5.38	Day 8 - 5.19
	Deep Chill - 5.32	

ranked highest and deep chill the lowest the differences were not found to be statistically significant (Figure 9, Appendix Table 10). Similarly no significant differences were found among the evaluation days or between breasts and thighs although the breast tissue ranked slightly higher and some decline in overall quality appeared after eight days of storage. The interaction of tissue and days of storage was significant as may be seen in Figure 10. No change was noted in overall quality of thigh as the storage period progressed, but the quality of the breast tissue declined significantly thus creating a significant interaction. No other interactions were found to be important.

Moistness: Ratings on moistness were consistently high for ice pack treated chicken while frozen treatments were consistently lowest (Figure 11). Cool pack chicken was rated high at the first two evaluations but declined noticeably at the 8 day evaluation (Table 9). The differences among treatments, however, were not found to be significant (Appendix Table 11).

A highly significant difference in moistness between breast and thigh tissue was detected (Figure 12) with the thighs being rated consistently as more moist. While this was expected, it is noteworthy in that it indicates the ability of the panel to detect consistent real differences.

Flavor: The frozen treatments were observed to have consistently the best flavor while the deep chill treated chicken was judged to have generally the poorest flavor (Table 10 and Figure 13). When examined by Analysis of Variance, however, the treatment means were not found to be significantly different (Appendix Table 12). There were no significant first-order interactions while the second-order interaction was found to be significant at the 5 percent level.

FIGURE 9. OVERALL QUALITY RATINGS FOR TREATMENTS AS AFFECTED BY STORAGE PERIOD

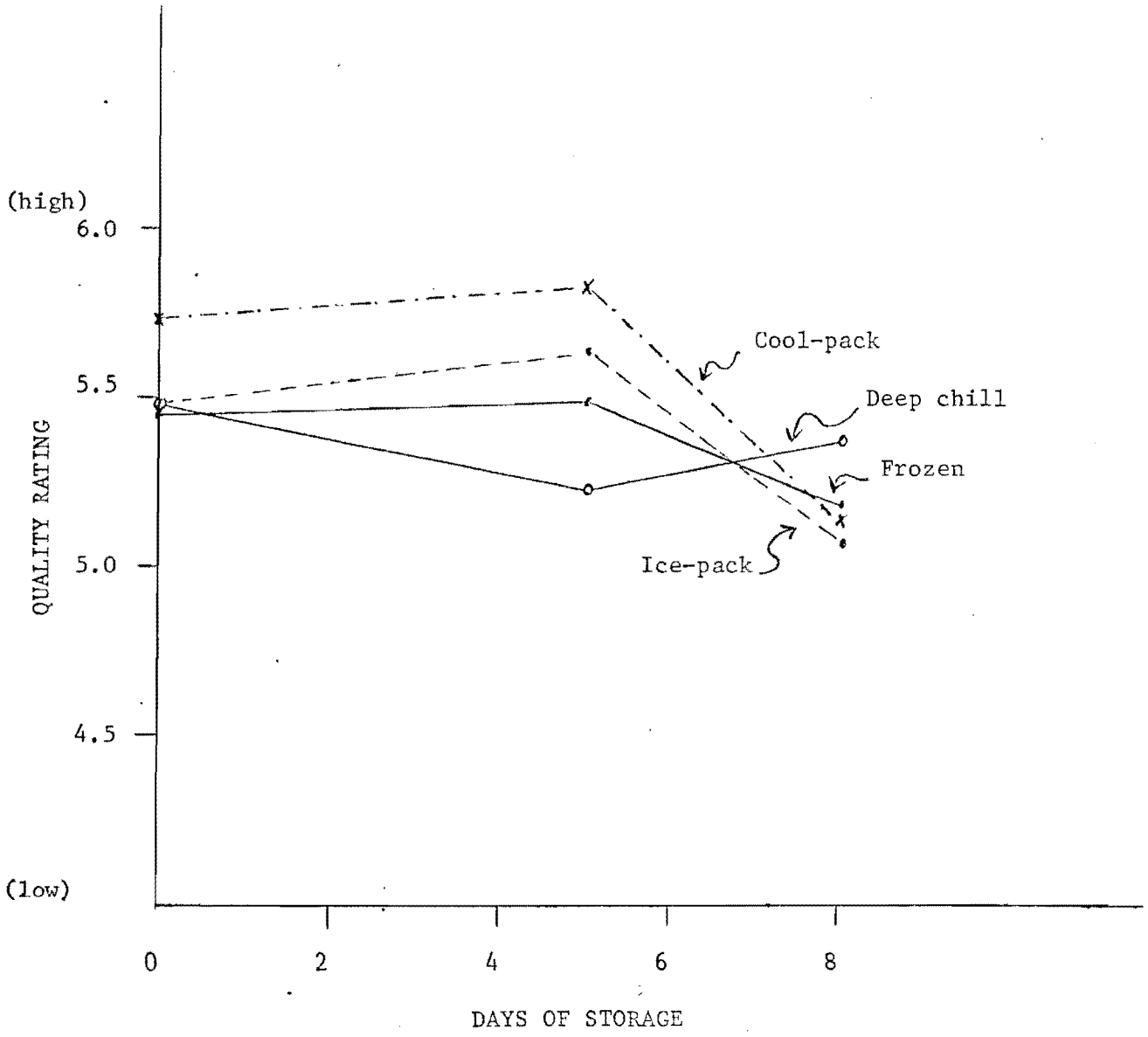


FIGURE 10. OVERALL QUALITY OF TISSUE AS AFFECTED BY STORAGE PERIOD

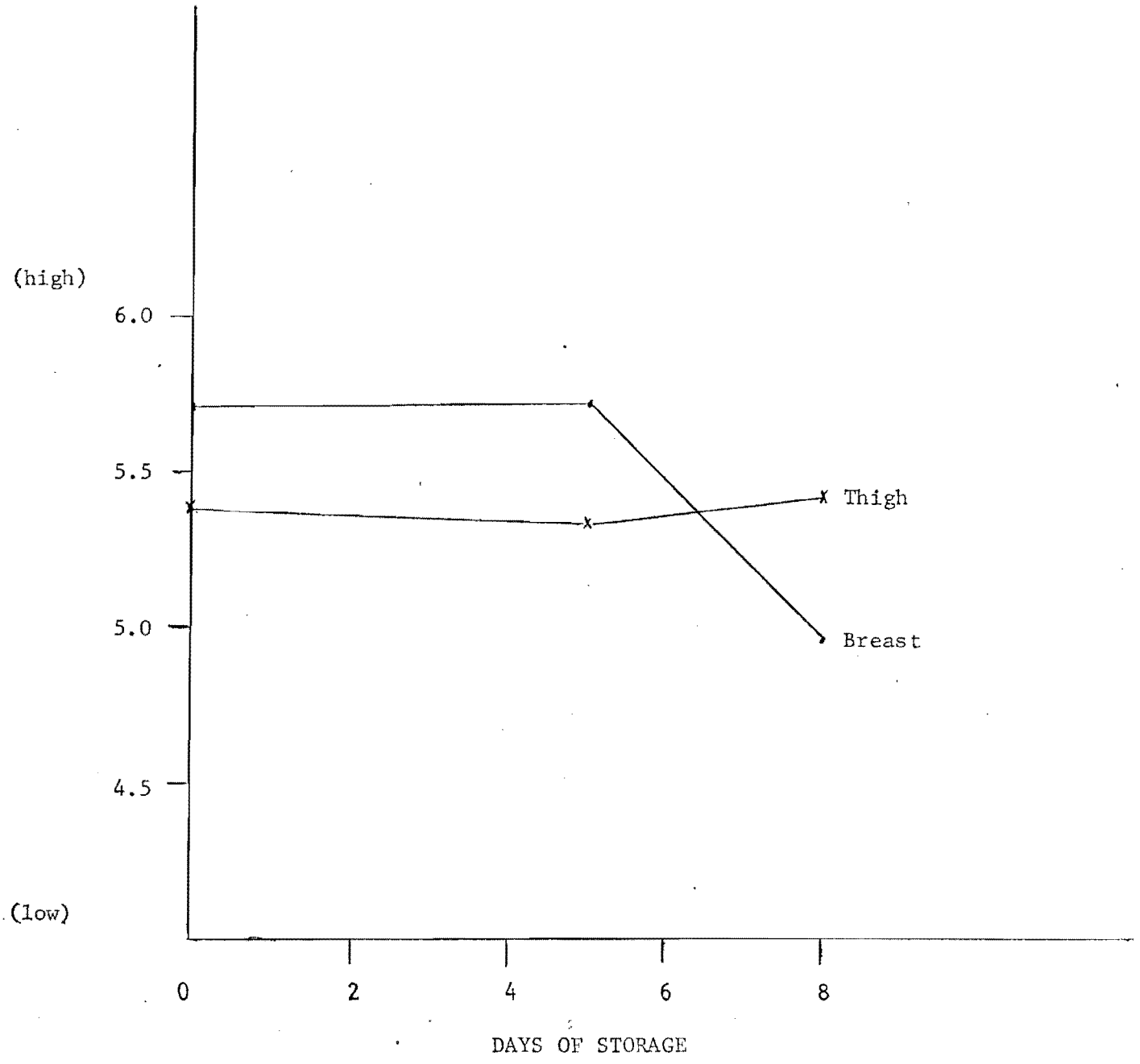


FIGURE 11. MOISTNESS RATING BY TREATMENT AS AFFECTED BY STORAGE PERIOD

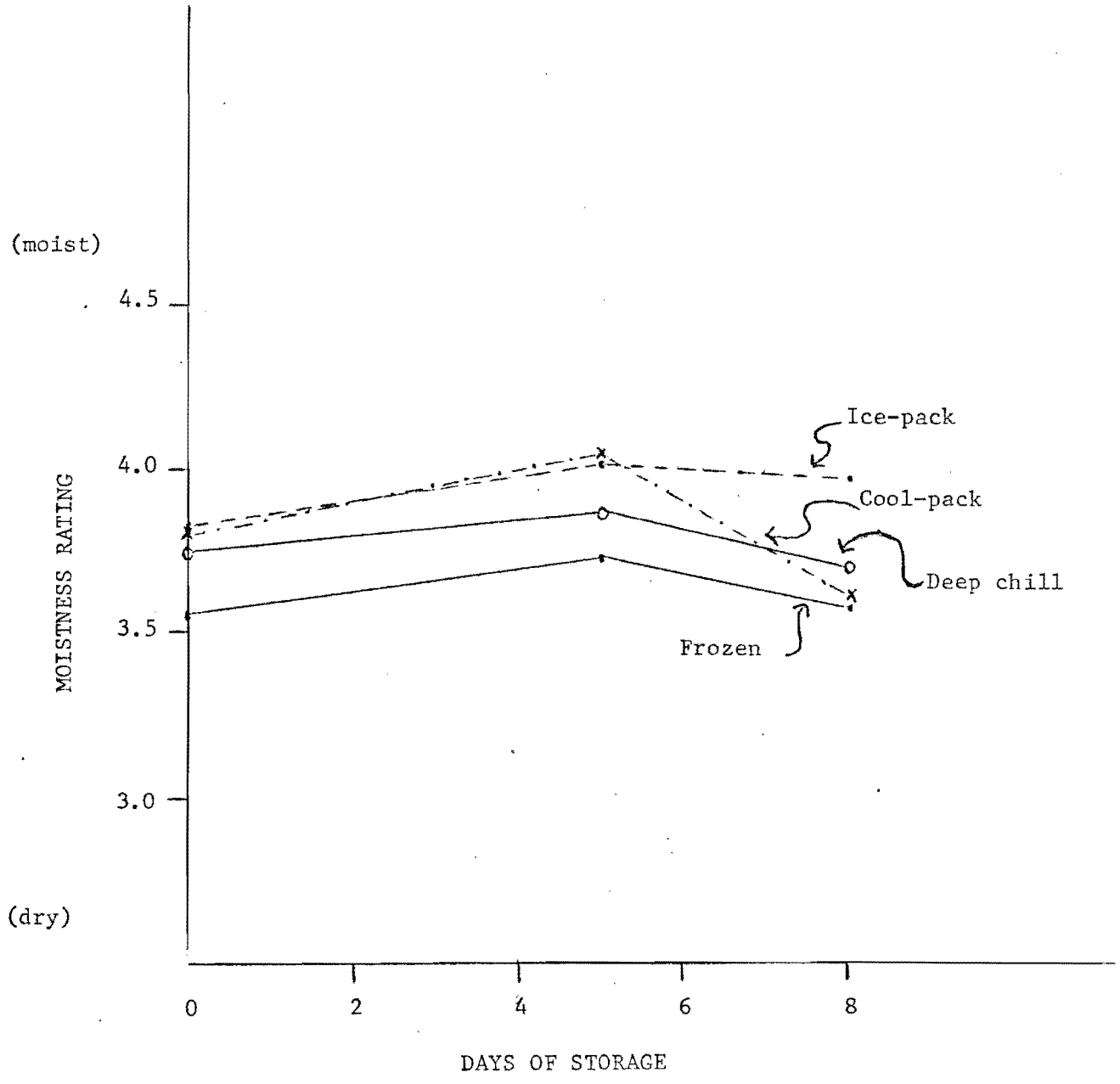


TABLE 9

MEAN RATINGS ON MOISTNESS AS AFFECTED BY TREATMENT, TISSUE AND STORAGE PERIOD[1/*]

Days of Storage Period	Treatment							
	Ice Pack		Deep Chill		Cool Pack		Frozen	
	Breast	Thigh	Breast	Thigh	Breast	Thigh	Breast	Thigh
0	3.69	3.96	3.56	3.92	3.78	3.83	3.50	3.61
5	3.74	4.30	3.54	4.17	3.83	4.26	3.37	4.14
8	3.71	4.25	3.62	3.79	3.58	3.66	3.66	3.54

[1/] Higher the score the greater the estimated moistness. Source: 48 member taste panel.

* Selected Means Values:

Tissue	Treatment	Days Storage
Thigh - 3.95	Ice Pack - 3.94	Day 0 - 3.73
Breast - 3.63	Cool Pack - 3.82	Day 5 - 3.92
	Deep Chill - 3.77	Day 8 - 3.73
	Frozen - 3.63	

FIGURE 12. MOISTNESS RATING OF TISSUE AS AFFECTED BY STORAGE PERIOD

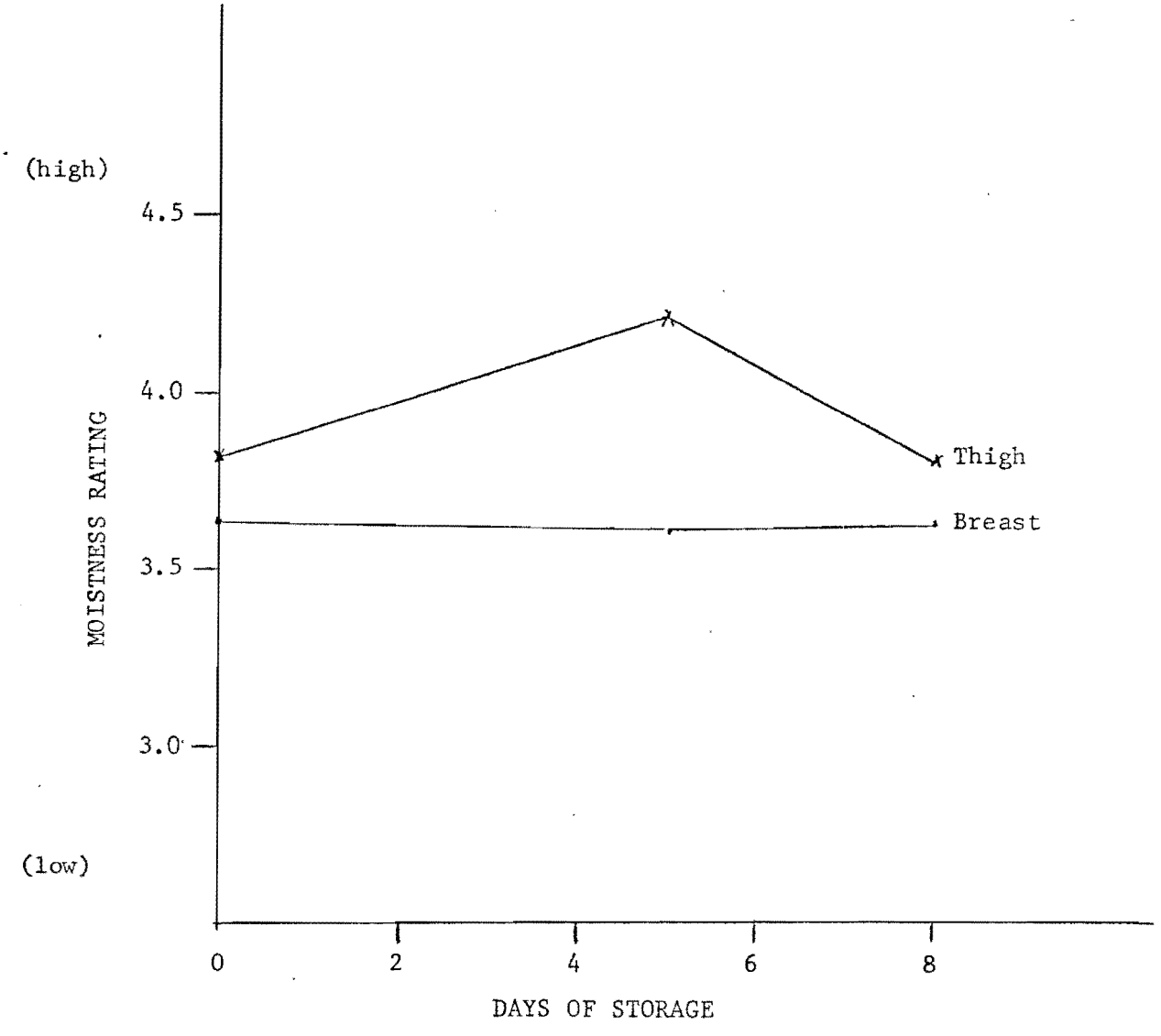


TABLE 10

MEAN RATINGS ON FLAVOR AS AFFECTED BY TREATMENT, TISSUE AND STORAGE PERIOD[1/*]

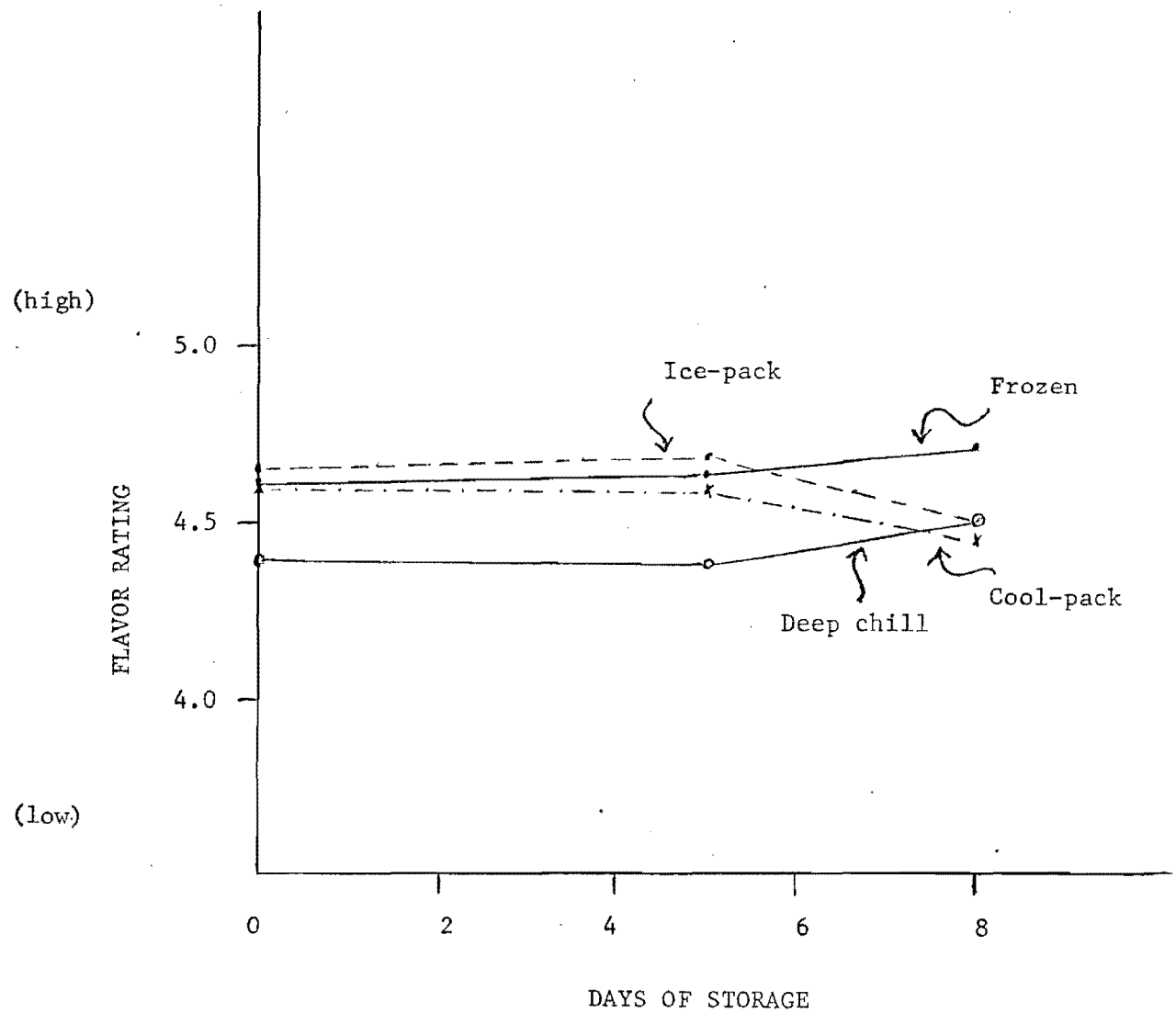
Days of Storage Period	Treatment							
	Ice Pack		Deep Chill		Cool Pack		Frozen	
	Breast	Thigh	Breast	Thigh	Breast	Thigh	Breast	Thigh
0	4.78	4.43	4.91	3.87	4.39	4.78	4.78	4.42
5	4.56	4.78	4.45	4.29	4.61	4.56	4.71	4.54
8	4.54	4.46	4.12	4.87	4.33	4.58	4.83	4.58

[1/] The higher the score the better the flavor was judged to be. Source: 48 member taste panel.

*Selected mean values:

Tissue	Treatment	Days Storage
Breast - 4.57	Frozen - 4.65	Day 0 - 4.55
Thigh - 4.53	Ice Pack - 4.60	Day 5 - 4.56
	Cool Pack - 4.54	Day 8 - 4.54
	Deep Chill - 4.42	

FIGURE 13. FLAVOR RATINGS BY TREATMENT AS AFFECTED BY STORAGE PERIOD



Tenderness: It may be observed in Figure 14 that the ice pack and cool pack treated chicken was generally regarded as more tender than either deep chill treated or frozen chicken (Table 11). Both of these latter treatments involved a freezing process. It must be recognized, however, that once again these differences were not found to be statistically different (Appendix Table 13).

A highly significant interaction between tissues and days was found (Figure 15). The thigh pieces were judged to be more tender at each succeeding evaluation while the breast pieces were judged as increasingly tough.

The second-order interaction was also found to be highly significant (Figure 16). While the reason is not clear it is apparent in Figure 16 that the thighs and breasts reacted differently over time for the frozen treatment as compared to other treatments. While on the average, the thighs increased in tenderness with each succeeding evaluation, with the frozen treatment the thigh tissue became tougher over time.

FIGURE 14. TENDERNESS RATING OF TREATMENTS AS AFFECTED BY STORAGE PERIOD

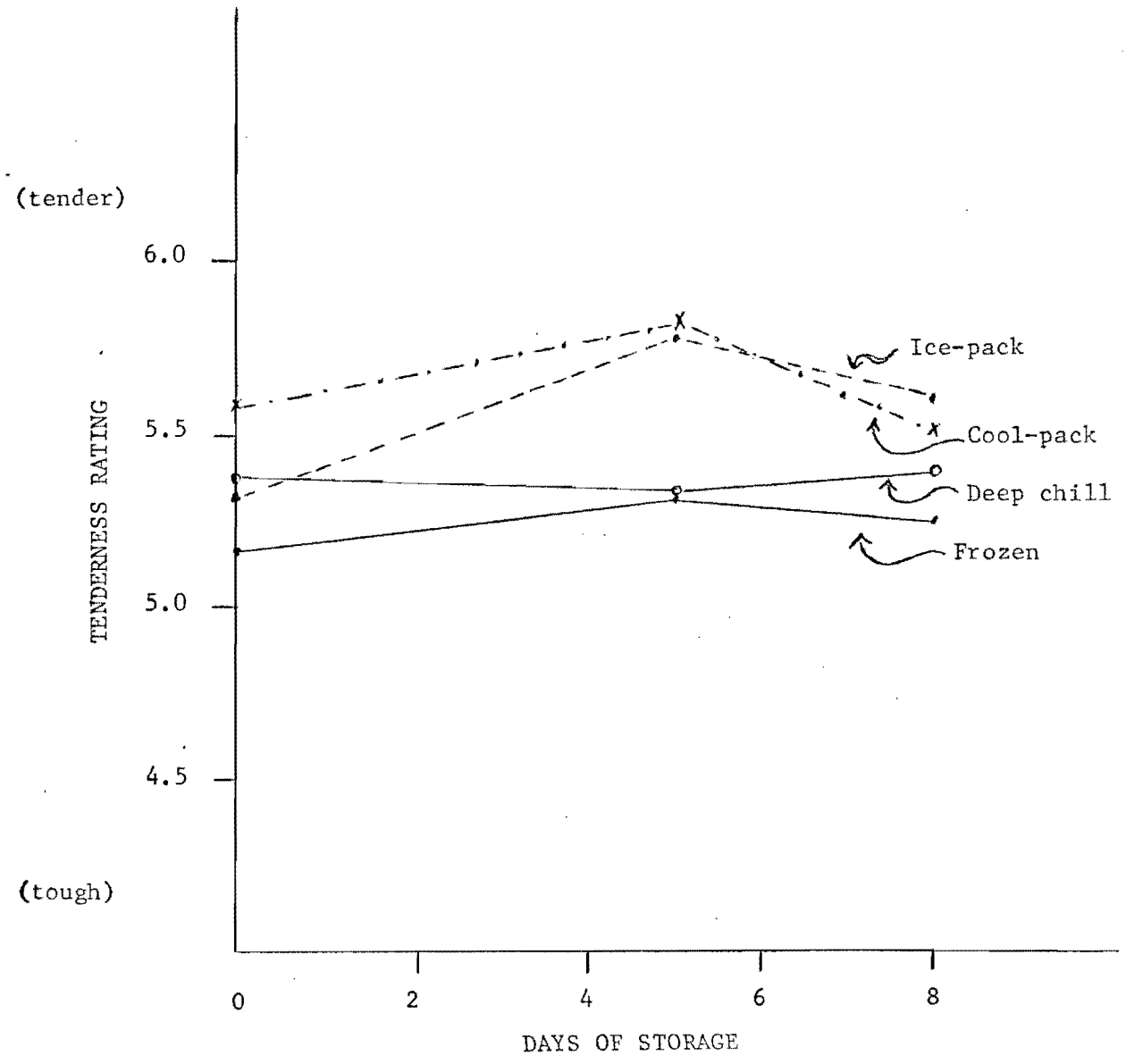


TABLE 11

MEAN RATINGS ON TENDERNESS AS AFFECTED BY TREATMENT, TISSUE AND STORAGE PERIOD[1/*]

Days of Storage Period	Treatment							
	Ice Pack		Deep Chill		Cool Pack		Frozen	
	Breast	Thigh	Breast	Thigh	Breast	Thigh	Breast	Thigh
0	5.74	4.87	5.83	4.92	5.91	5.26	5.04	5.25
5	5.65	5.91	5.18	5.50	5.87	5.74	5.46	5.18
8	5.21	6.00	5.12	5.66	5.04	5.96	5.42	5.08

[1/] Higher scores indicate greater estimated tenderness. Source: 48 member taste panel.

* Selected mean values:

Tissue		Treatment		Days Storage	
Thigh	- 5.47	Cool Pack	- 5.63	Day 0	- 5.35
Breast	- 5.43	Ice Pack	- 5.56	Day 5	- 5.57
		Deep Chill	- 5.37	Day 8	- 5.44
		Frozen	- 5.24		

FIGURE 15. TENDERNESS RATING OF BREAST AND THIGH TISSUES AS AFFECTED BY STORAGE PERIOD

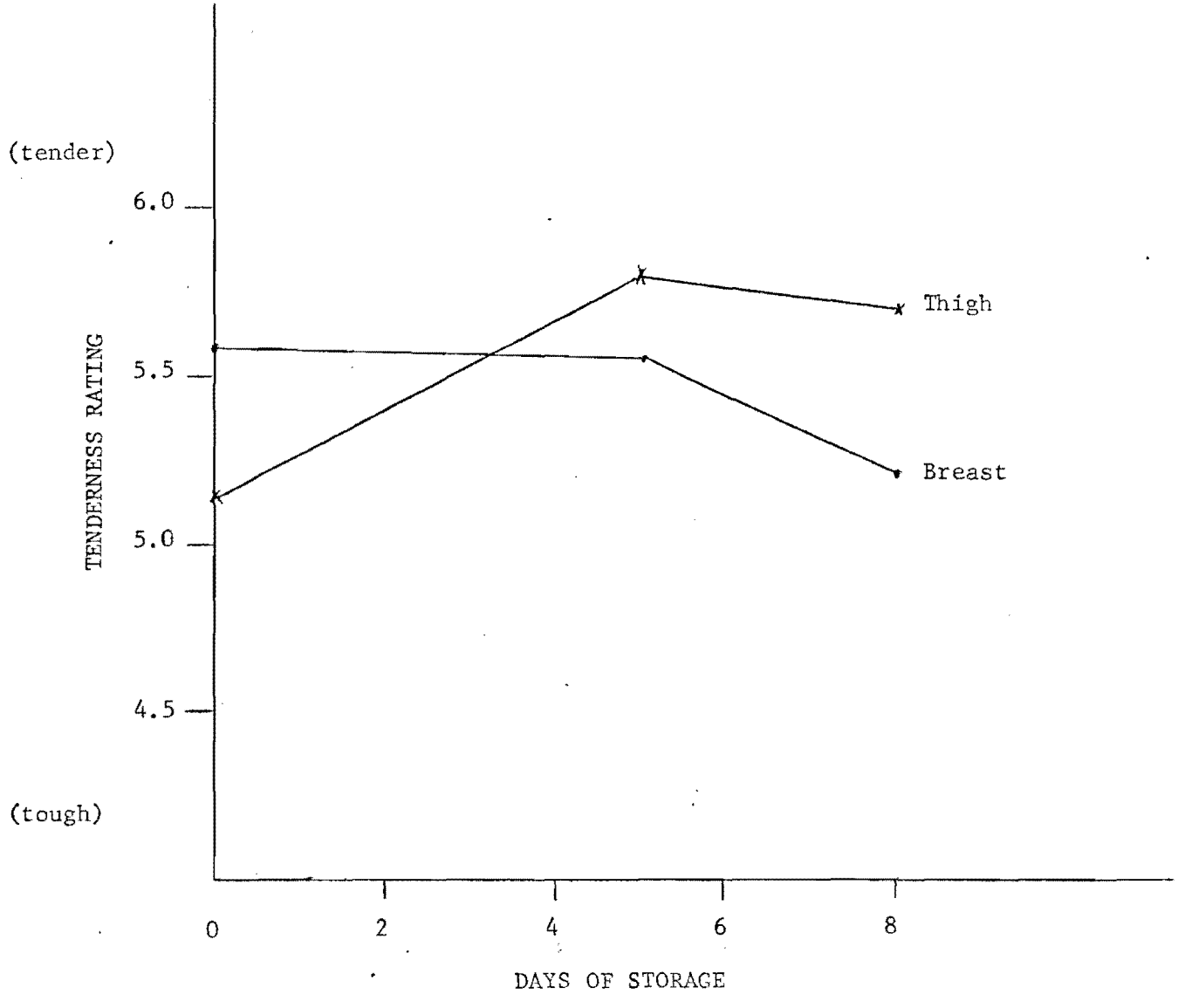
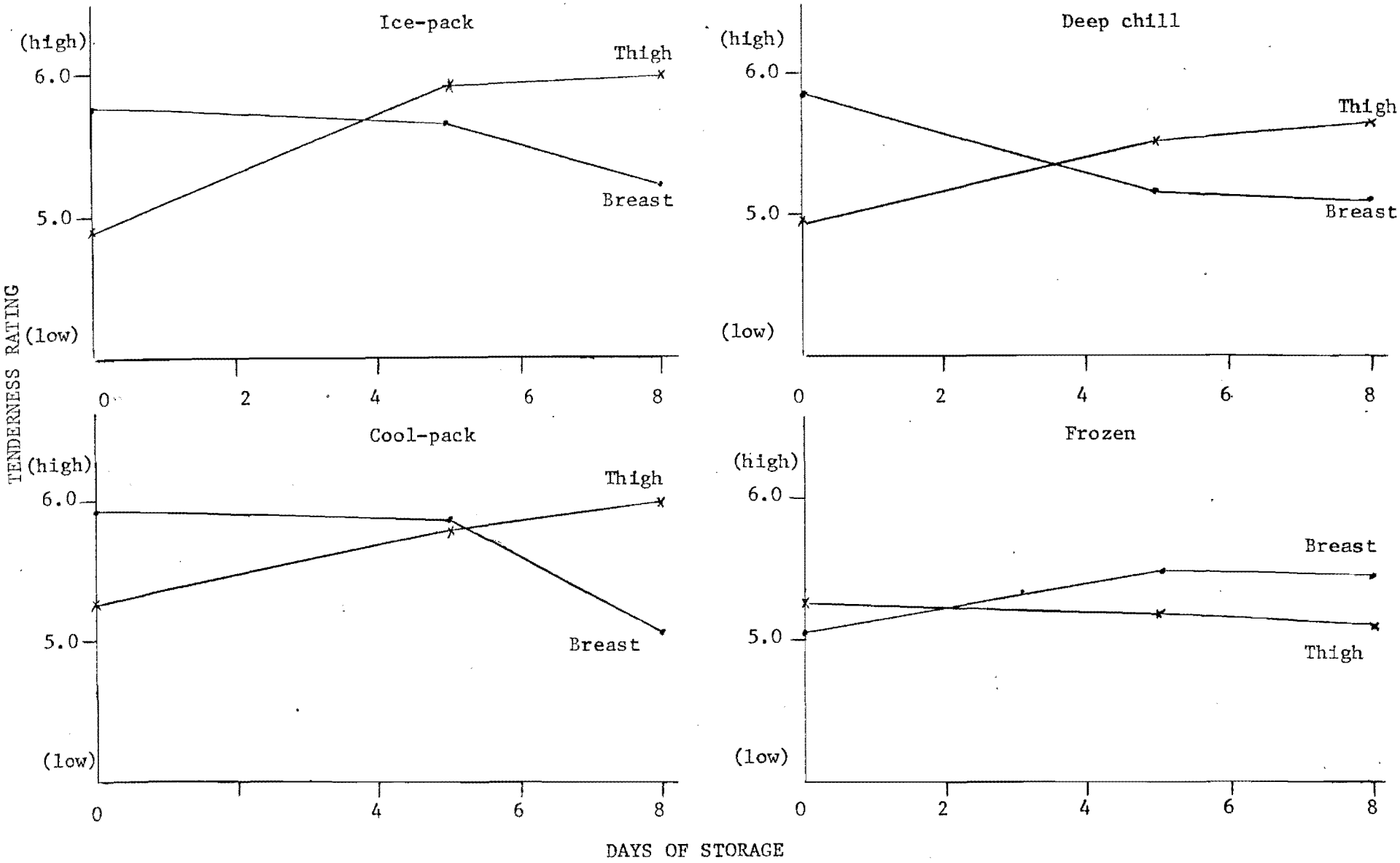


FIGURE 16. TENDERNESS RATINGS BY TISSUE FOR EACH TREATMENT AS AFFECTED BY STORAGE PERIOD



SUMMARY AND CONCLUSIONS

The data and analysis discussed in the preceeding section indicate several general conclusions may be drawn. First, with regard to microbiological evaluations, no significant differences among treatments appeared until eight days of storage, at which time only the frozen product was still acceptable. Weight loss in storage was less for the ice pack and cool pack treated carcasses than for deep chill carcasses. Cool pack treated tissues lost less weight than other treatments during cooking. Organoleptic evaluation indicated that no treatment showed any clear overall advantage.

A more specific summary of the results is given below:

1. Only minor differences exist in the microbiological support characteristics of ice pack, deep chill, and cool pack carcasses. In all cases, carcasses which were held under frozen conditions yielded much lower total surface counts. All treatments tested maintained a microbiologically acceptable product through 8 days of storage at retail temperatures. Twelve days storage yielded microbiologically unacceptable product in all but the frozen carcasses.
2. Carcasses subjected to ice pack and cool pack treatment conditions retained a greater percentage of the tissue moisture content over the 12 day storage period.
3. Deep chill packed carcasses lost only about 2.5% of their weight during the two day treatment period. However, weight loss during the subsequent storage periods was much greater than that obtained from the other treatments.

4. The length of the storage period did not affect weight loss of frozen carcasses. However, cooking loss was greater from carcasses subjected to the frozen treatments than from the other treatments tested.

5. Carcasses subjected to cool pack or ice pack conditions lost less weight during subsequent retail storage than did the deep chill treated carcasses.

6. Tissues from carcasses subjected to cool pack conditions lost relatively less weight during cooking than all other treatments tested. Cooking loss was greatest in tissues which had been held under frozen storage conditions.

7. Although carcasses subjected to ice pack or cool pack conditions generally contained more moisture than carcasses subjected to either of the other treatments tested, these same treatments generally produced higher storage yields and higher cooking yields than were obtained from the deep chill and the frozen carcasses. This would indicate an interaction of free and bound water in the tissue with the treatment imposed.

8. The organoleptic evaluation in general revealed very few significant differences. While cool pack showed the highest average rating on overall quality, it declined enough in the last evaluation period so the difference could not be considered statistically significant. The ice pack treatment was consistently judged as the most moist while the frozen was the least. Thighs were judged, as expected, significantly more moist than breasts.

The flavor and tenderness evaluation revealed no important differences. It can be generally stated that no treatment showed any clear advantage over the others in the organoleptic evaluation.

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A P P E N D I X

APPENDIX TABLE 1

ANALYSIS OF VARIANCE OF SURFACE BACTERIAL COUNTS OF ICE PACK, DEEP CHILL, COOL PACK AND FROZEN BROILERS HELD THROUGH 14 DAYS STORAGE - PSYCHROPHILIC COUNTS

Source	d.f.	S.S.	M.S.	F
Total	191	486.3036		
Treatment	3	135.5692	45.1897	5.87*
Days	3	248.7500	82.9166	10.77**
Tr x Day	9	69.3136	7.7015	41.50**
Error	176	32.6708	0.1856	

* Significant at the 0.05 level of probability.

** Significant at the 0.01 level of probability.

Duncan's MRT for Treatment and Day Means

Treatment

Cool Pack	Ice Pack	Deep Chill	Frozen
(6.28)	(6.05	(5.54)	(4.05)

Days

Day 12	Day 8	Day 5	Day 0
(7.00)	(6.18)	(4.57)	(4.16)

APPENDIX TABLE 2

ANALYSIS OF VARIANCE OF SURFACE BACTERIAL COUNTS OF ICE PACK, DEEP CHILL, COOL PACK AND FROZEN BROILERS HELD THROUGH 14 DAYS STORAGE - MESOPHILIC COUNTS

Source	d.f.	S.S.	M.S.	F
Total	191	360.7622		
Treatment	3	81.5398	27.1799	3.75**
Days	3	160.3823	53.4607	7.37**
Tr x Day	9	65.2694	7.2521	23.83**
Error	176	53.5707	0.3043	

** Significant at the .01 probability level.

Duncan's MRT for Day Means

Day 12	Day 8	Day 5	Day 0
(6.52)	(5.58)	(4.48)	(4.25)

APPENDIX TABLE 3

ANALYSIS OF VARIANCE OF SURFACE BACTERIAL COUNTS OF ICE PACK, DEEP CHILL AND COOL PACK BROILERS HELD THROUGH 14 DAYS STORAGE

A. PSYCHROPHILIC COUNTS

Source	d.f.	S.S.	M.S.	F
Total	143	346.2783		
Treatment	2	10.1199	5.0599	4.7484
Days	3	308.7376	102.9125	96.5770**
Tr x Day	6	6.3935	1.0656	6.6854**
Error	132	21.0304	0.1593	

** Significant at the 0.01 level of probability.

B. MESOPHILIC COUNTS

Source	d.f.	S.S.	M.S.	F
Total	143	275.3326		
Treatment	2	8.1663	4.0831	2.4648
Days	3	213.2849	71.0949	42.9187**
Tr x Day	6	9.9395	1.6565	4.9774**
Error	132	43.9419	0.3328	

** Significant at the 0.01 level of probability.

APPENDIX TABLE 4

ANALYSIS OF VARIANCE OF PERCENT WEIGHT YIELD AS AFFECTED BY FOUR PACKAGING TREATMENTS AND BY STORAGE TIME

Source	d.f.	S.S.	M.S.	F
Total	383	1871.41		
Treatment	3	320.87	106.96	2.84
Days	3	343.31	114.44	3.03**
Tr x Days	9	339.28	37.70	15.97**
Error	368	867.95	2.36	

** Significant at the 0.01 level of probability.

APPENDIX TABLE 5

ANALYSIS OF VARIANCE OF PERCENT WEIGHT YIELD AS AFFECTED BY THREE NON-FROZEN PACKAGING TREATMENTS AND BY STORAGE TIME

Source	d.f.	S.S.	M.S.	F
Total	287	1514.02		
Treatment	2	194.60	97.30	5.60*
Days	3	558.88	186.29	10.71**
Tr x Days	6	104.33	17.39	7.31**
Error	276	656.21	2.38	

* Significant at the 0.05 level of probability.

** Significant at the 0.01 level of probability.

Duncan's MRT for Treatment and Day Means

Treatment		
Ice Pack	Cool Pack	Deep Chill
(95.93)	(95.83)	(94.14)

Days			
Day 0	Day 5	Day 8	Day 12
(97.67)	(94.80)	(94.57)	(94.17)

APPENDIX TABLE 6

ANALYSIS OF VARIANCE OF WEIGHT YIELD AS A PERCENTAGE OF THE TWO DAY WEIGHT AS AFFECTED BY THREE PACKING METHODS AND STORAGE TIME

Source	d.f.	S.S.	M.S.	F
Total	215	763.83		
Treatment	2	353.75	176.88	97.72**
Days	2	19.80	9.90	5.47**
Tr x Days	4	15.42	3.86	2.13
Error	207	374.86	1.81	

** Significant at the 0.01 level of probability.

Duncan's MRT for Treatment and Day Means

Treatment		
Cool Pack	Ice Pack	Deep Chill
(98.5)	(96.6)	(95.3)

Days		
Day 5	Day 8	Day 12
(97.08)	(96.91)	(96.37)

APPENDIX TABLE 7

ANALYSIS OF VARIANCE OF COOKING YIELD OF BROILER TISSUE AS AFFECTED BY FOUR PACKAGING METHODS AND STORAGE TIME

Source	d.f.	S.S.	M.S.	F
Total	575	13812.6662		
Treatment	3	1131.1388	377.0462	3.09
Days	2	3778.4018	1889.2009	15.48**
Tissue	1	495.4890	495.4890	4.06
Tr x Day	6	325.6556	54.2759	0.45
Tr x Ti	3	259.5095	86.5031	0.71
Day x Ti	2	736.8229	368.4114	3.02
Tr x Day x Ti	6	732.1387	122.0231	10.60**
Error	552	6353.5099	11.5099	

** Significant at the 0.01 level of probability.

APPENDIX TAB

ANALYSIS OF VARIANCE OF COOKING YI (PERCENTAGE OF INITIAL WEIGHT) AS AFFECTED BY PACKAGING T ENT AND STORAGE PERIOD

Source	d.f.	S.S	M.S.	F
Total	11	132.13		
Treatment	3	21.6	7.2208	2.94
Days	2	95.7	47.8572	19.46**
Error	6	14.75	2.4592	

** Significant at the 0.01 level o bility.

Duncan's MRT for ans

Days		
0 Days	5 Da	8 Days
(71.81)	(71.5	(65.68)

APPENDIX TABLE 9

ANALYSIS OF VARIANCE OF TISSUE MOISTURE CONTENT AS AFFECTED BY PACKAGING TREATMENT AND STORAGE TIME

Source	d.f.	S.S.	M.S.	F
Total	223	332.70		
Treatment	3	33.06	11.02	9.50**
Days	3	48.86	16.28	14.03**
Tr x Days	9	10.03	1.11	.96
Error	208	240.75	1.16	

** Significant at the 0.01 level of probability.

Duncan's MRT for Treatment and Day Means

Treatment

Ice Pack	Cool Pack	Deep Chill	Frozen
(76.62)	(76.12)	(75.83)	(75.59)

Days

Day 0	Day 5	Day 8	Day 12
(76.78)	(76.09)	(75.76)	(75.55)

APPENDIX TABLE 10

ANALYSIS OF VARIANCE OF OVERALL QUALITY RATINGS OF CHICKEN TISSUE AS AFFECTED BY PACKAGING METHOD AND STORAGE TIME

Source	d.f.	S.S.	M.S.	F
Total	561	1881.05		
Treatment	3	4.74	1.58	
Tissue	1	1.11		
Days	2	14.57	7.28	2.199
Tr x Ti	3	11.88	3.96	
Tr x Day	6	11.31	1.88	
Ti x Day	2	20.36	10.18	3.076*
Tr x Ti x Day	6	36.05	6.01	1.816
Error	538	1781.03	3.31	

*Significant at the 0.05 level of probability.

APPENDIX TABLE 11

ANALYSIS OF VARIANCE OF PANEL EVALUATION RATINGS OF TISSUE MOISTNESS AS AFFECTED BY PACKAGING TREATMENT AND STORAGE TIME

Source	d.f.	S.S.	M.S.	F
Total	561	538.64		
Treatment	3	7.00	2.333	2.500
Tissue	1	14.09	14.09	15.118**
Day	2	4.39	2.195	2.355
Tr x Ti	3	1.51	.503	.540
Tr x Day	6	2.24	.373	.400
Ti x Day	2	5.42	2.71	2.908
Tr x Ti x Day	6	2.43	.405	.434
Error	538	501.56	.932	

** Significant at the 0.01 level of probability.

APPENDIX TABLE 12

ANALYSIS OF VARIANCE OF PANEL EVALUATION RATINGS OF TISSUE FLAVOR AS AFFECTED BY PACKAGING TREATMENT AND STORAGE TIME

Source	d.f.	S.S.	M.S.	F
Total	561	747.		
Treatment	3	4.08	1.36	
Tissue	1	.25	.25	
Day	2	.05	.025	
Tr x Ti	3	2.73	.91	
Tr x Day	6	2.05	.34	
Ti x Day	2	4.27	2.14	
Tr x Ti x Day	6	18.44	3.073	2.312*
Error	538	715.13	1.329	

*Significant at the 0.05 level of probability.

APPENDIX TABLE 13

ANALYSIS OF VARIANCE OF PANEL EVALUATION RATINGS OF TISSUE TENDERNESS AS AFFECTED BY PACKAGING TREATMENT AND STORAGE TIME

Source	d.f.	S.S.	M.S.	F
Total	561	1083.100		
Treatment	3	13.368	4.456	2.379
Tissue	1	0.139	0.139	
Day	2	4.348	2.174	
Tr x Ti	3	.167	.056	
Tr x Day	6	4.117	.686	
Ti x Day	2	20.006	10.003	5.341**
Tr x Ti x Day	6	33.349	5.558	2.967**
Error	538	1007.606	1.873	

** Significant at the 0.01 level of probability.

TEXAS AGRICULTURAL MARKET RESEARCH
AND DEVELOPMENT CENTER
DEPARTMENT OF POULTRY SCIENCE

JUDGE NUMBER _____
JUDGE NAME _____
CODE _____

July 1970

CHICKEN TASTE TEST

1. Please taste the chicken. "X" the one one statement which best describes how much you like or dislike the chicken. "X" ONE ONLY.

Like Extremely . . . . . ( )

Like Strongly . . . . . ( )

Like Very Well . . . . . ( )

Like Fairly Well . . . . ( )

Like Moderately . . . . ( )

Like Mildly . . . . . ( )

Neutral . . . . . ( )

Dislike Moderately . . . ( )

Dislike Intensely . . . ( )

2. "X" the one statement which best describes the moistness or dryness of the chicken meat. "X" ONE ONLY.

Much too moist . . . . . ( )

Somewhat too moist . . . ( )

Slightly too moist . . . ( )

Just about right . . . . ( )

Slightly too dry . . . . ( )

Somewhat too dry . . . . ( )

Much too dry . . . . . ( )

3. "X" the one statement which best describes the flavor of the chicken. "X" ONE ONLY.

Excellent . . . . . ( )

Very Good . . . . . ( )

Good . . . . . ( )

Fair . . . . . ( )

Poor . . . . . ( )

Very Poor . . . . . ( )

Extremely Poor . . ( )

4. "X" the one statement which best describes the tenderness or toughness of the chicken meat. "X" ONE ONLY.

Extremely Tender . ( )

Very Tender . . . . ( )

Moderately Tender . ( )

Slightly Tender . . ( )

Slightly Tough . . ( )

Moderately Tough . ( )

Very Tough . . . . ( )

Extremely Tough . . ( )