A STUDY OF SOME FACTORS AFFECTING DETERIORATION AND CONTAMINATION OF NEW YORK DRESSED POULTRY

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William A. Aho

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THESIS

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William A. Aho

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By

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A THESIS

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A STUDY OF SOME FACTORS AFFECTING DETERIORATION AND CONTAMINATION OF NEW YORK DRESSED POULTRY

INTRODUCTION

Present day marketing channels for poultry meat require a large portion of it to pass through a number of distribution, storage and processing points before it is in the hands of the consumer. Poultry meat, like all perishable food deteriorates while in transit from producer to consumer.

The marketing of poultry meat is unique in that, unlike other meats, a large percentage of it is stored and shipped with the entrails intact. This factor complicates the problem of quality preservation, since there is the possible external bacterial contamination, fat rancidity and internal deterioration to consider.

Stewart, Lowe and Morr (1941) noticed in their experiments with storage chickens that New York dressed birds hung in the air at 35° Fahrenheit begun deteriorative changes within eight hours after killing. The first evidence of deterioration was the appearance of a bile stain on the liver, which eventually showed on edible portions near the gall bladder.

Nickerson and Fitzgerald (1939) discovered that "greenstruck poultry" was caused by hydrogen sulfide, produced by bacterial action in the intestine. They also reported that off-flavors occurring in the region of the vent or kidney may be due to decomposed products that effuse from the intestines.

Preservation of quality is a question of whether the consumer eats the meat or it is claimed by the bacteria. Poultry is usually either canned or frozen as a means of preservation. Freezing

New York dressed poultry is a more recent method of preservation, and it retains more of the original quality under proper storage conditions than does canning.

Freezing of poultry meat presents problems, such as dessication and fat rancidity which are the most troublesome. Usually freezing accomplishes the purpose of protecting the meat from bacterial action. Freezing is primarily a bacteriostatic action, in that it prevents further multiplication of bacteria, but has very slight killing effect in short holdings. The original contamination will multiple rapidly after the bird is thawed, thereby necessitating rapid movement on the part of the dealer and consumer.

LITERATURE REVIEW

A. Effect of Bile on Quality of Poultry Meat

New York dressed poultry when held at a temperature of about 35° Fahrenheit during the chilling period develop bile stains on the liver within eight hours according to Stewart, Lowe and Morr (1941). These stains extend to surrounding areas within three days.

I. Functions of Gall Bladder and Bile

Howell (1928) in explaining the action of bile relates that, "the physiological value of bile is probably of importance both as a medium of excretion and as a digestive secretion. .... As a digestive secretion the most important function attributed to the bile is the part it takes in the digestion and absorption of fats. It accelerates greatly the action of the lipase of pancreactic juice in splitting the fats to fatty acids and glycerin, and it aids materially in the absorption of the products of this hydrolysis. The action of bile may be referred directly to the fact that bile acids serve as a solvent for the fats and fatty acids."

Best and Taylor (1945) state, "the bile as it leaves the liver flows into the hepatic duct and thence into the common bile duct. During fasting its entrance into the duodenum is blocked by the sphincter of Oddi which remains tonically contracted. As the bile accumulates within the duct its pressure rises, and reaching a height of from 50 to 70 mm of water forces its way along the cystic duct into the gall bladder. During fasting therefore the viscus becomes gradually distended with retained bile."

Hawk, Oser and Summerson (1947) state, "There appear to be at least two mechanism active in gall bladder emptying. One of these involves the contraction of the gall bladder and the other the tone

of the sphincter of Oddi at the entrance of the common bile duct into the intestine. Cream or egg yolk cause an emptying of the gall bladder apparently by inducing an active contraction of this organ, probably accompanied by a relaxation of the sphincter at the same time. The active agent is the free fatty acid liberated on digestion of these foods. .... The contraction is apparently brought about through liberation from the intestinal mucosa of a hormone, cholecystokinin, whose chemical nature is not yet determined. .... Magnesium sulfate promotes evacuation by causing a dilation of the sphincter."

II. Control of Bile Stains

Maw and Nikolaiczuk (1942) in attempting to control bile stains by feeding fat enriched diets, prior to killing, concluded that, "the presence of post mortem surface discoloration on the liver or on the right abdominal wall would suggest that the bile sac, in post mortem state behaves as a semi-permeable membrane. Observation substantiates that size of the gall bladder, as determined by its contents and the length of the storage period, appears to determine the extent and intensity of visible staining." They found that the gall bladder could be partially depleted, and the liver stain reduced, if 25 percent refined cottonseed oil was included in the final feeding the day before being slaughtered. They suggest a more specific study to coordinate the rates of digestion of the different classes of stock with time of feeding and the level of oil fed for the most efficient application of the method in general practice. Jensen (1945) shows the influence of withholding feed prior to dressing on the weight of the liver and gall bladded. (Table I). It is highly probable that bile stains could be eliminated entirely, were the exact conditions known for bile depletion at the time of dressing.

TABLE I

Relation Between Time of Dressing After Feeding and Weight of Gall Bladder

Time Interval Between "Final" Feed and Dressing HOURS	Weight of gall bladder with bile Broiler Ave. (5 head) GRAMS	Light Roasters Ave. (5 head) GRAMS
0	0.92	1.28
1/6	0.98	1.12
2	0.62	0.40
4	0.42	0.60
6	0.42	0.70
8	0.82	--
12	1.28	1.58
24	0.75	1.66

B. Bacterial Contamination of Poultry

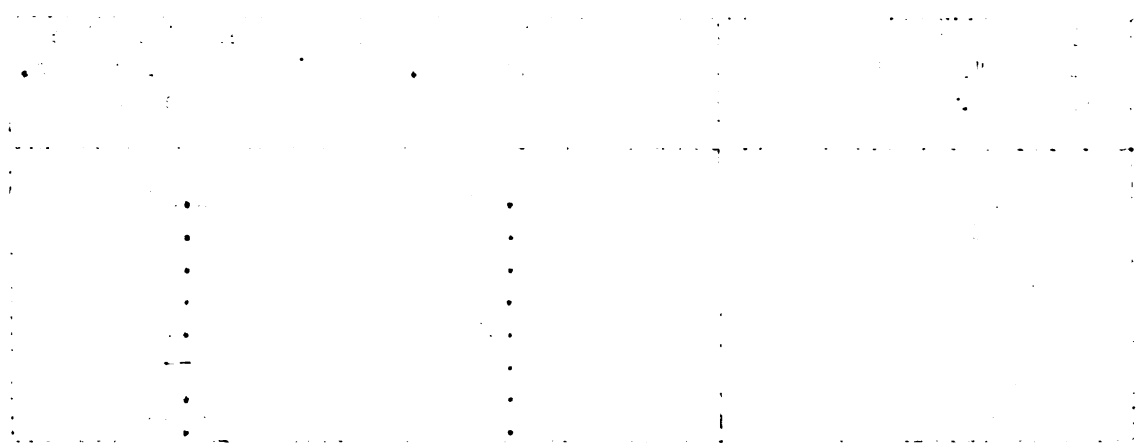
Contamination of New York dressed birds is usually confined to the skin. The bacteria penetrating the muscle only after prolonged storage at high temperatures. Lockhead and Landerkin (1935) took bacterial counts of New York dressed fowl and found that the muscle was for all practical purposes quite free of micro-organisms. (Table II). They perceived a decided odor when the count had risen to 2,500,000 per square cententimeter of skin but the flesh was still edible. From their work it can be seen that surface contamination is a controlling factor in respect to quality of New York dressed birds.

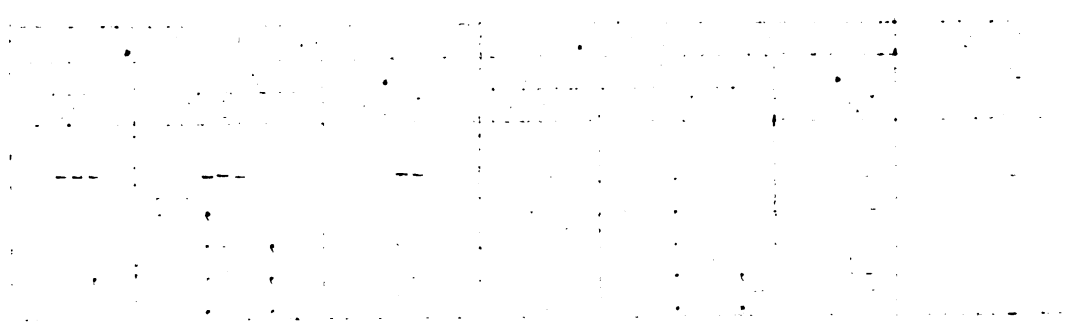
TABLE II

Summary of Bacterial Counts from Skin Surface and Inner Breast Muscle of 144 Birds

Storage Period Days	Stored at 30° F.			Stored at 32° F.		
	No. Birds	Bacterial Counts Skin*	Muscle*	No. Birds	Bacterial Counts Skin*	Muscle*
1	16	3,380	32	--	---	---
2	16	20,400	27	16	30,300	32
4	16	551,800	121	16	2,021,000	376
6	16	3,635,000	776	16	7,396,000	1,880
8	16	7,920,000	672	16	25,300,000	290

* per sq. cm.





Jensen (1945) observed that ante-mortem starvation increased the pH of the post-mortem dark meat and therefore he believed this would encourage greater bacterial growth. Actually lower bacterial counts were present after starving than feeding up to the time of killing. (Table III). He also believes that, "management of the birds prior to dressing with regards to sanitation of the range, coops or batteries may influence the number and kinds of bacteria contained on the skin at the moment of dressing."

TABLE III

Effect of Withholding Feed Prior to Dressing on Bacterial Growth Per Gram of Skin, White Meat, and Dark Meat

Availability of Feed Prior to Dressing	Days held at 10° C. (50° F.)	Average bacterial count per gram of tissue based on two birds		
		Skin	Dark Meat	White Meat
Available	1	2,500	215	155
Available	3	646,000	500	350
Available	6	4,700,000	39,000	2,000
Available	9	24,000,000	78,000	35,000
Withheld 24 hrs.	1	750	235	260
Withheld 24 hrs.	3	11,500	13,550	100
Withheld 24 hrs.	6	725,000	14,000	200
Withheld 24 hrs.	9	19,500,000	183,000	10,000

How to reduce bacterial counts on dressed birds, was a problem studied by Gunderson, Schwartz and Rose. (1946). They took comparative counts with spot plates* of utensils, equipment and poultry. Water samples were analyzed by standard methods. The principal sources of contamination found in processing New York dressed poultry were scalding tanks, wash tanks and vent leakage.

Sweet and Stewart (1942) indicate that birds cooled in a (20 per-cent solution) brine spray have very little bacterial multiplication

* Spot plates are shallow, agar filled aluminum pans 16 sq. cm. in area and 1 cm. deep. They were sterilized in petri dishes filled aseptically with a sterile culture.

because of the unfavorable brine medium and low temperature. Other investigators, Cook (1939), Stewart, Hanson and Lowe (1941) confirm the idea that chilling tanks held at low temperatures (about 32° Fahrenheit) are effective in reducing bacterial counts.

Freezing of poultry meat does not eliminate bacteria. Low temperatures slow biological processes and actually extend the life of an organism. Haines (1935) reports that quick freezing does not kill bacteria extensively but that temperatures ranging just below freezing are the most germicidal.

C. Quaternary Ammonium Compounds

Use of various germicides in ice for preservation of foods was reported by Jensen (1945). He investigated chlorine, azochloramide, katadyn silver, succinyl peroxide, calcium or sodium propionate ice and levulinic acid ice. Tarr and Sunderland (1938) report the use of salt brine and benzoic acid for preservation of fish in ice.

Quaternary ammonium compounds have not been used directly on food products as a germicide, but they have been found to be effective as germicides with very low toxicity. Mallmann and Churchill (1946) used these compounds to sanitize coolers and found them to be effective. They give some general characteristics which make them effective: (a) one to one thousand (1-1000) or greater use dilutions are relatively non-toxic, (b) they are cationic therefore good surface tension depressants, (c) and they will act in low temperatures.

Other investigators have found that quaternary ammonium compounds are effective germicides, Domagk (1935), Dunn (1937) and Heogerheide (1945).

McCulloch (1947) reports that, "bacterial populations exposed to quaternary ammonium compounds revealed a very high initial velocity

of disinfection, followed by a rapidly decreasing value of the velocity constant." Ridenour and Armbruster (1948) found that, "a persistent feature that seems to be significant with some of the quaternary ammoniums is that, in relation to chlorine the germicidal efficiency, toward apparently more resistable organisms drops rapidly."

D. Organoleptic Tests

Organoleptic tests are used by the food technologist to determine quality of foods. Questions have arisen as to their accuracy. Crist and Seaton (1931) concluded, "that the ordinary tasting-panel method as tested by the criterion of correlation in trials by duplication, is questionable. Either its improvement or its abandonment appears to be necessary and imperative."

Lowe and Stewart (1947) relate that, "subjective tests measure, in the expression of opinion, the qualities of food as they make their impression individually and collectively on the sensory organs. They are subjective because the individual is required to go through a mental process in giving his opinion as to qualitative and quantitative value of the characteristic or characteristics under study." They classified subjective tests into two categories (a) preference tests, and (b) difference tests. Lowe and Stewart are of the opinion that if your tasting panels are selected carefully and a minimum number of variables enter into your test, subjective tests are quite reliable.

Other investigators have used the organoleptic test in research work with poultry meats, Belle Lowe (1939), and Nickerson and Fitzgerald (1939).

REASONS FOR UNDERTAKING EXPERIMENT

The centralization of population necessitates longer channels of food distribution. This results in quality deterioration due to more and delayed delivery of perishable foods. This is especially true of poultry since it is processed in an environment where heavy bacterial contamination is possible. Scalding tanks operate at a temperature of 131° Fahrenheit or below (semi-scalding). The poultry remains in the scald tank such a short time and the temperature of the water is so low that there is little pasteurizing effect. The chilling tanks and rinse waters add to the contamination. When poultry is held at sub-zero temperatures bacterial multiplication is arrested, but temperatures above 32° Fahrenheit permit rapid multiplication of bacteria. A large percentage of poultry meat is held at temperatures above 32° Fahrenheit during some portion of its journey in trade channels.

Starvation may influence surface contamination since the digestive tract contains less material and possibly there is less chance for leakage from the vent and mouth. Starving birds will eliminate decropping birds after processing.

Bile stains on liver and adjacent areas lower the quality of poultry meat. Maw and Nikolaicsuk (1942) secured significant results from feeding a 25 percent oil containing feed on depletion of bile from the gall bladder.

Therefore, it was apparent that a test attempting to control bacterial multiplication with a non toxic disinfectant would be desirable. Bile depletion, another quality control problem could be studied concurrently since bile stain is an internal deterioration and would have no effect on surface contamination.

MATERIALS AND EXPERIMENTAL PROCEDURE

Sixty-four birds were used in this experiment. They were secured from the college flock and from a local dressing plant. The birds were "fowl" ranging from 3.1 pounds to 7.1 pounds, consisting of Rhode Island Reds, Single Comb White Leghorns, White Plymouth Rocks and Barred Plymouth Rocks. No bird was selected that appeared emaciated or otherwise in poor condition.

General Procedure

Bacteria counts were taken on a comparative basis similar to the method used by Gunderson et al (1945). Instead of spot plates of surface area, swabs of a 2 square inch area were taken. An aluminum sheet, with a cut out one by two inches, was placed over the area to be swabbed. Sterile swabs were used and then put into a swab bottle containing 10 cc. of saline solution. The samples were plated as soon as possible. Samples were plated in tryptone glucose agar and incubated at 37° Centigrade for 48 hours.

Dilutions of 1-4000 and 1-3000 were made of the quaternary ammonium compound, by putting distilled water in a 5 gallon earthen ware crock and adding the quantity of the quaternary ammonium compound to make the desired dilution. The birds were immersed in the solution for approximately five seconds.

The birds were injected with 10 cc. of cottonseed oil thirty minutes before killing, since preliminary tests, on broilers, had indicated that thirty minutes would be the approximate time required for the oil to affect the gall bladder. The oil was warmed in a water bath before injection so that it was less viscous and near the body temperature of the bird.

A representative sample of each group was taken to the Home Economics Department and prepared for organoleptic tests under the direction of Dr. Pauline Paul. A taste panel consisting of three members from the Poultry Husbandry Department and three members from the Home Economics Department scored the birds for aroma, flavor, tenderness and juiceness.

Experiment I

Twenty-four birds were selected at random from a cooling rack of a local dressing plant and used in this experiment. The birds were divided into four groups of six birds each. Two groups were dipped in a 1-4000 dilution of a commercial quaternary ammonium compound called "Roccal". Two groups were left as controls. Swabs for bacterial counts were taken of each bird at this time. This trial was run for the purpose of studying the effect of a quaternary ammonium on the surface bacterial counts of fowl, both at freezing temperatures and at 33° Fahrenheit.

Groups 1 and 2 were paired to determine the effect of quaternary ammonium compound at 33° Fahrenheit. Group 2 was dipped in the quaternary ammonium and Group 1 was used as a control. Groups 1 and 2 underwent numerous temperature changes to increase the rigor of the test. They were frozen immediately after dressing and held for 99 days under varying conditions. During this storage period they were defrosted twice in a walk-in refrigerator held at an average 33° Fahrenheit. Swabs were taken from each chicken, each time that they were defrosted, and plated to determine the bacterial counts.

Groups 3 and 4 were paired to determine the effect of quaternary ammonium on surface contamination of stored poultry at -4° Fahrenheit.

Group 4 was dipped in quaternary ammonium compound and Group 3 was used as the control. They were frozen immediately after dressing (July 24) and kept at -4° Fahrenheit until the end of the experimental period for that experiment (October 21). Swabs for bacterial counts were taken at the beginning and at the end of the experiment. The birds were examined at the end of the experiment for bile stains and organoleptic tests were conducted on representive samples.

Experiment II

Twenty birds secured from the college flock were used in this experiment. They were divided into four groups of five birds each. Groups 1 and 2 were starved for 12 hours and oil was injected into the gizzards prior to killing. Groups 3 and 4 were considered as controls for Groups 1 and 2; they were left on feed until slaughtered, and were not oil-injected. The groups were paired so as to make possible a study of the effect of bile depletion and its relationship to bile stains.

The groups to be given oil were taken off feed 12 hours prior to killing. Thirty minutes before killing they were given 10 cc. of cottonseed oil, injected into the gizzard, with a catheter. All birds were killed by sticking, dipped into water (130° Fahrenheit) for 25 seconds, picked on a mechanical picker and then rinsed with cold water from a hose. They were then hung on a rack to drain, and swabs were taken at that time. Groups 2 and 4 were dipped in a quaternary ammonium compound after being rinsed.

The birds were killed on August 28 and hung in a walk-in cooler held at an average temperature of 33° Fahrenheit for 13 days. After 13 days they were frozen and stored at -4° Fahrenheit until the end of the experiment (October 7). Bacterial counts were taken on the

first two days and then on the last day that they were held at 33° Fahrenheit. On September 11 they were cut up and examined for bile stains and external deterioration. The gall bladders and livers were weighed and representative samples were cooked for organoleptic tests.

Experiment III

Twenty birds secured from the college flock were divided into four groups. The treatment leading up to and the processing was identical with groups in Experiment II. After dressing the birds were put into a -4° Fahrenheit freezer and held there until the end of the experiment (August 8 to October 14). Bacterial counts were taken on the day of killing, immediately after withdrawal from the freezer, and 24 hours after removal from the freezer when they were completely thawed. The carcasses in this trial were examined externally and internally for stains and deterioration and then cut up. Liver and gall bladder weights were taken. Organoleptic tests of samples were conducted for this experiment.

SUMMARY OF EXPERIMENTAL TREATMENT

Groups	Experiment I	Experiment II	Experiment III
1	(1) 6 birds (2) Controls for Group 2 (3) Frozen and defrosted repeatedly (4) Secured from commercial plant (5) Experimental time 99 days	(1) 5 birds (2) Starved 12 hrs. (3) Oil-injected (4) Stored at 33°F. for 13 days (5) Secured from college flock	(1) 5 birds (2) Starved 12 hrs. (3) Oil-injected (4) Stored at -4° F. (5) Secured from college flock
2	(1) 6 birds (2) Treated with quaternary ammonium (3) Frozen and defrosted repeatedly (4) Secured from commercial plant (5) Experimental time 99 days	(1) 5 birds (2) Starved 12 hrs. (3) Oil-injected (4) Treated with quaternary ammonium (5) Stored at 33°F. for 13 days (6) Secured from college flock	(1) 5 birds (2) Starved 12 hrs. (3) Oil-injected (4) Stored at -4° F. (5) Secured from college flock (6) Treated with quaternary ammonium
3	(1) 6 birds (2) Controls for Group 3 (3) Stored at -20°C. (4) Secured from commercial plant (5) Experimental time 99 days	(1) 5 birds (2) Full feed (3) Stored at 33°F. for 13 days (4) Secured from college flock	(1) 5 birds (2) Full feed (3) Stored at -4° F. (4) Secured from college flock
4	(1) 6 birds (2) Treated with quaternary ammonium (3) Stored at -20°C. (4) Secured from commercial plant (5) Experimental time 99 days	(1) 5 birds (2) Full feed (3) Stored at 33°F. for 13 days (4) Treated with quaternary ammonium (5) Secured from college flock	(1) 5 birds (2) Full feed (3) Stored at -4° F. (4) Treated with quaternary ammonium (5) Secured from

EXPERIMENTAL RESULTS

Experiment I - Groups 1 and 2

Contamination

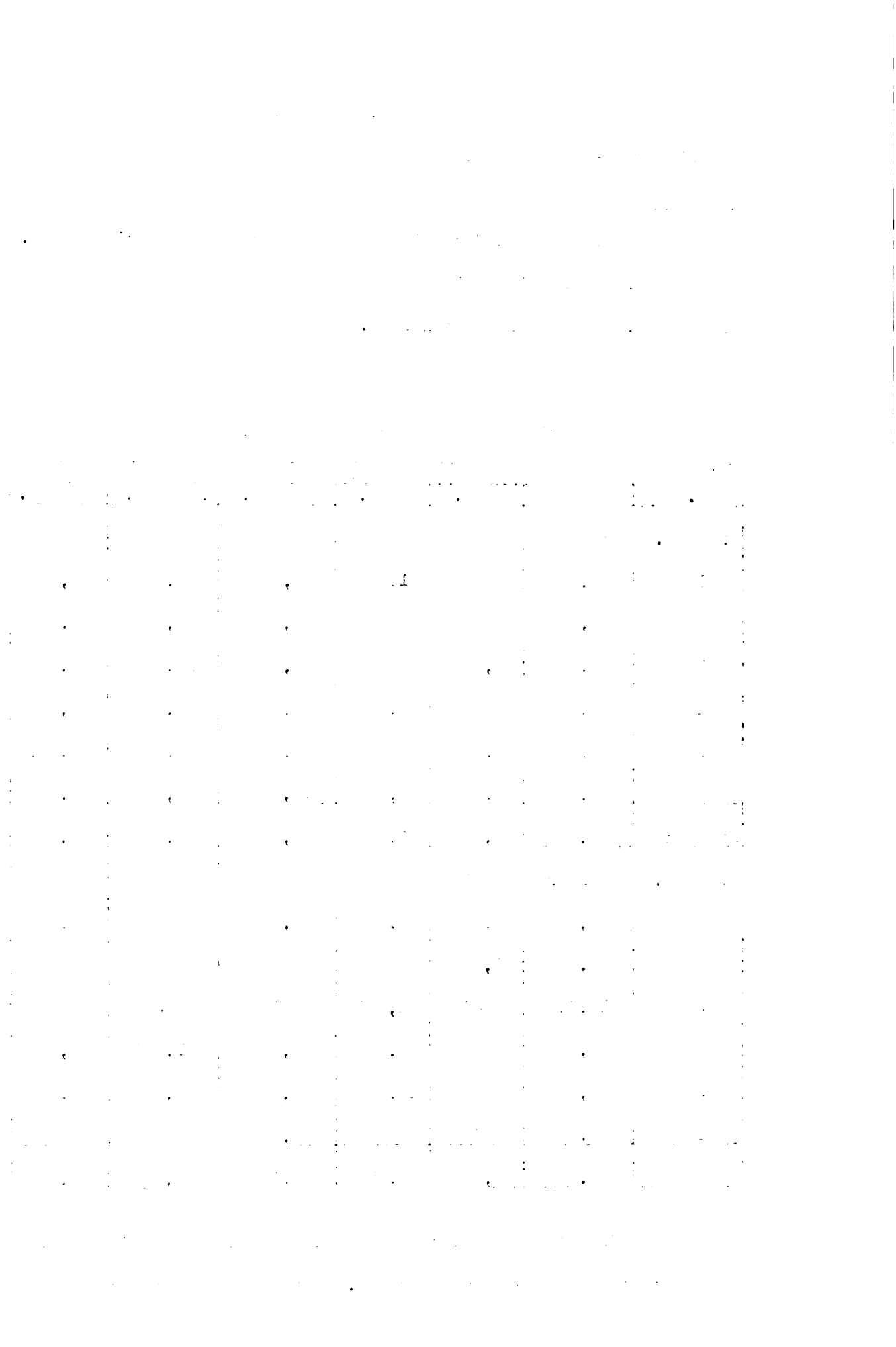
Birds were secured for this experiment from a commercial plant. Group 2 birds were dipped in a quaternary ammonium compound and Group 1 birds were held as controls.

TABLE IV

Bacterial Counts of Groups 1 and 2, Experiment I

Bird No.	Bacterial Counts					
	24 July	3 Aug.	4 Aug.	15 Sept.	15 Sept.	21 Oct.
Group 1. Controls						
1	10,000	600	1,500	15,000	5,000	3,000
2	11,500	400	200	7,000	4,500	1,800
3	21,000	2,000	200	5,000	15,000	16,800
4	89,000	700	7,000	26,000	26,000	2,000
5	5,000	4,000	700	12,500	4,900	7,300
6	39,000	6,000	7,000	15,000	4,500	1,800
Average	29,250	2,283	2,766	13,416	9,816	5,450
Group 2. Quaternary Ammonium						
1	5,000	3,500	3,000	5,000	300	1,400
2	57,000	1,300	400	300	0	800
3	13,000	400	1,000	100	300	600
4	5,000	0	4,000	3,500	1,500	1,000
5	4,500	670	10,000	5,500	5,500	3,900
6	10,000	400	500	4,500	500	300
Average	15,750	1,045	3,150	3,150	1,350	1,350

Table IV records the bacterial counts taken from different areas of the carcass on the days indicated. A two square inch area was



swabbed. A large drop in bacterial count was noticed from the initial count, and no appreciable increase in bacterial numbers was noticed from the second count to the final count. One reason for the relatively static count may be that the walk-in refrigerator in which the birds were periodically defrosted had a mean temperature of 33° Fahrenheit and the air was kept in constant motion with a fan. It is possible that bacterial counts of New York dressed birds may vary for differnt skin areas. In every count, with the exception of the August 4 count, the average number of bacteria was lower when the birds had been dipped in the quaternary ammonium compound. The initial bacterial count for the control birds was larger than for the treated birds.

A bacterial sample was taken on October 20 but was not included with the data in Table IV because of the complete absence of bacteria in the quaternary ammonium compound dipped group. The birds at this time were in a frozen condition, and the swab technique may have failed to pick up the micro-organisms.

Experiment I - Groups 3 and 4

Contamination

Group 4 was dipped in a quaternary ammonium compound and Group 3 was the control. Table V shows the bacterial counts of the three samples taken. The initial counts were high, with counts of the controls being much higher than the counts of the treated. These birds were frozen shortly after dressing and only three bacterial counts were taken during the experimental time. The October 20 bacterial count was low and again it may be attributed to the failure of the swab technique to pick up the bacteria from the unthawed skin. The average counts for the treated birds were lower in each instance.

Bile Stains in Experiment I

Although the birds in this experiment were primarily used to study the effect of quaternary ammonium compound on the bacterial count, observations of bile stains were made. A bile stain was found on the abdominal wall in only one case and the majority of the bile stains were limited to small areas on the liver. Prompt cooling and freezing of the birds may explain the relatively minor bile stains.

TABLE V

Bacterial Counts of Groups 3 and 4, Experiment I

Bird No.	Bacterial Counts		
	23 July	20 October	21 October
Group 3. Controls			
7	140,000	1,800	12,200
8	30,000	---	800
9	75,000	1,100	6,300
10	35,000	2,100	17,200
11	20,000	200	32,000
12	77,000	600	4,400
Average	62,833	1,160	12,150
Group 4. Quaternary Ammonium			
7	100,000	0	1,600
8	60,000	300	1,900
9	9,000	200	4,400
10	1,000	1,000	---
11	60,000	500	3,300
12	8,000	0	7,600
Average	59,666	333	3,760

Liver stains were scored from 1 to 4, with 1 representing a liver with insignificant stain and 4 as a large liver stain. The average scores were as follows: Group 1, 3.3; Group 2, 3.0; Group 3, 3.0; and Group 4, 2.8. Body stains were indicated with a score of 5. (Table V-A).

Organoleptic Tests of Experiment I

Table V-B records the results of the organoleptic tests conducted on birds from Experiment I. Of a maximum possible score of 7, the majority of the birds averaged about 5. A score of 3 or less usually indicates an unacceptable product.

TABLE V-A

Bird Weights, Gall Bladder Weights, Bile Stains of Birds
In Experiment I

Bird No.	Bird Wts. (lbs)	Gall Bladder Wts. (grams)	Bile Stain Scores	
			Liver	Body
Group 1.	Controls			
1	4.4	2.7	4	5
2	3.8	1.6	4	0
3	4.3	3.0	3	0
4	5.2	2.1	3	0
5	4.4	1.0	3	0
6	5.0	2.1	3	0
Average	4.5	2.0	3.5	
Group 2.	Quaternary Ammonium Compound			
1	4.5	1.8	4	0
2	4.1	2.2	3	0
3	4.3	0.8	3	0
4	4.7	1.1	3	0
5	4.1	0.5	3	0
6	4.4	0.6	2	0
Average	4.3	1.1	3.0	
Group 3.	Controls			
7	4.7	1.4	3	0
8	4.4	3.4	3	0
9	4.4	1.8	3	0
10	3.7	1.0	3	0
11	4.0	1.6	3	0
12	3.3	2.1	3	0
Average	4.0	1.8	3.0	
Group 4.	Quaternary Ammonium Compound			
7	5.1	3.7	3	0
8	5.1	1.6	3	0
9	4.1	1.4	3	0
10	4.4	1.4	1	0
11	5.2	2.9	3	0
12	5.5	2.3	4	0
Average	4.9	2.2	2.8	

1. Insignificant stain on liver
2. Very slight stain on liver
3. Slight stain on liver
4. Large stain on liver
5. Body stain

TABLE V-B

Organoleptic Tests of Experiment I

Group No.	Aroma Av.	Flavor Skin Av.	Flavor Lean Av.	Juiciness Av.	Tenderness Av.	General Concl Av.
White Meat						
1	5.5	4.2	4.7	4.8	5.5	4.5
2	6.2	3.8	4.7	4.2	5.0	4.8
3	5.3	4.2	4.8	3.7	4.5	4.7
4	6.0	6.0	5.8	4.2	5.3	5.7
Dark Meat						
1	4.7	3.7	5.0	4.3	5.5	4.7
2	5.3	4.0	4.8	4.5	5.5	4.8
3	5.3	4.2	4.8	4.2	4.3	4.3
4	5.7	5.3	5.0	4.2	5.0	5.0
Broth						
	Aroma Fat	Flavor Fat				
1	5.3	5.7				
2	5.0	4.7				
3	4.8	4.5				
4	5.7	5.3				

Maximum possible score is 7, a score of 3 or less usually indicates an unacceptable product.

Experiment II

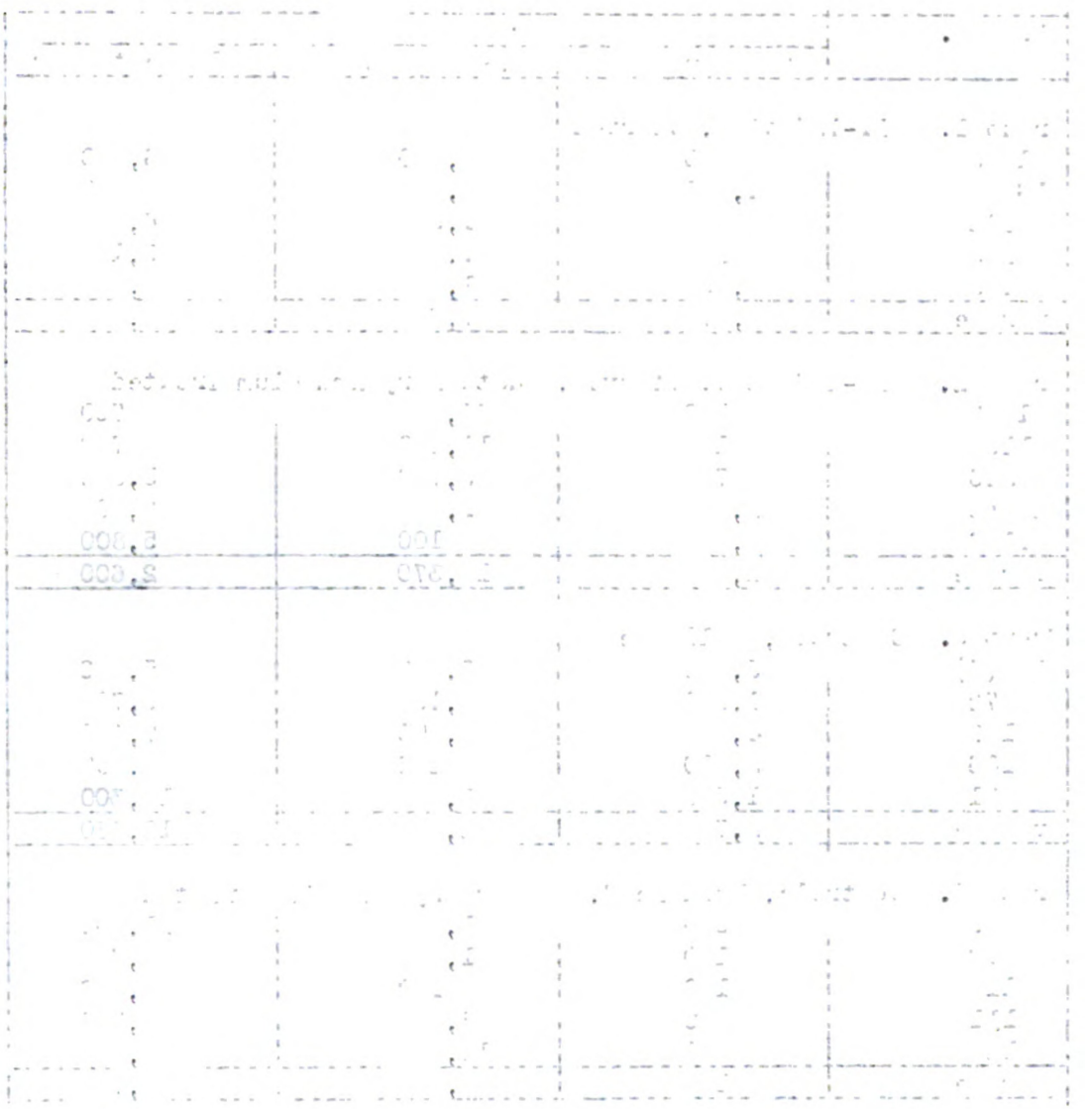
Contamination

Two groups in this trial were treated with the quaternary ammonium compound and two groups were not. Table VI gives the actual bacterial counts of the four groups on three different days. These birds were kept at an average temperature of 33° Fahrenheit over a period of 13 days. The initial counts were much lower in Experiment II than in Experiment I.

TABLE VI

Bacterial Counts of Birds in Experiment II

Bird No.	Bacterial Counts		
	28 August	29 August	11 September
Group 1. Oil-injected, Starved			
1203	800	5,500	8,500
LG (1)	4,000	28,000	600
882	500	1,500	6,300
983	900	1,850	3,100
433	3,650	1,200	2,600
Average	1,970	7,610	4,220
Group 2. Oil-injected, Starved, Quaternary Ammonium Treated			
1257	100	35,000	700
1155	100	11,600	700
546	700	3,750	3,800
LG (2)	2,000	1,400	2,000
1196	2,500	100	5,800
Average	1,080	10,370	2,600
Group 3. Controls, Full Feed			
LG (3)	5,200	3,500	5,000
872	1,000	4,100	5,700
109	4,200	2,000	7,400
106	2,000	600	26,000
71	1,500	3,800	18,300
Average	2,780	2,800	12,480
Group 4. Controls, Full Feed, Quaternary Ammonium Treated			
69	500	1,000	21,000
62	100	1,000	2,700
110	100	100	6,000
111	0	8,000	3,300
122	0	14,000	1,300
Average	140	4,820	11,720



The birds in this trial were dressed in the Poultry Department's poultry products laboratory, where it may be expected that the counts would normally be lower since fewer birds were scalded in the same water and each bird was separately rinsed. In all groups the final count was greater than the initial count. The average bacterial counts from the quaternary ammonium compound treated birds were generally lower than those untreated, with the exception of the August 29 counts. The difference was never great. In comparing Group 1 (starved) with Group 3 (fed until time of slaughter) the average bacterial count was slightly in favor of the starved group. In comparing Group 2 with Group 4 the average bacterial count was slightly in favor of the starved group.

Bile Depletion in Experiment II

In an effort to study the correlation between the weights of the birds and the size of the gall bladder a scatter-gram was made with body weights on the x axis and gall bladder weights on the y axis. Little correlation was noted between these factors. (Table VI-B).

Bile stains were limited to the liver on all birds with the exception of one bird in Group 1. The gall bladder of one bird in Group 2 was completely depleted and no bile stain was evident. Groups 3 and 4 (not treated with oil) had six birds with bile stains extending to the abdominal wall. The average bile stain scores for the livers were: Group 1, 4.0; Group 2, 2.8; Group 3, 4.0; and Group 4, 4.0. (Table VI-A). Average gall bladder weights were less in oil-injected groups.

Organoleptic Tests

Birds from all groups tested were acceptable except for a slightly below average return from Group 4, which was low in juiciness. (Table VI-C).

Body Weights

Loss in body weight from the time they were starved to slaughtering averaged 0.2 of a pound in Group 1, 0.4 of a pound in Group 2, 0.1 of a pound in Group 3, and 0.1 of a pound in Group 4. There was a slightly greater average loss in the starved groups than that found in the groups from which feed was not withheld. (Table VI-A).

TABLE VI-A

Bird Weights, Gall Bladder Weights and Bile Stains
Experiment II

Bird No.	Wt. Before Starving Lbs.	Wt. Before Slaughter Lbs.	Wt. of Gall Bladder Grams	Bile Stain Scores	
				Liver	Body
Group 1. Oil-injected, Starved					
1203	5.5	5.0	1.6	4	0
LG (1)	3.1	3.0	0.4	4	0
882	5.2	5.0	1.2	4	0
983	6.9	6.6	2.2	4	0
433	4.2	4.0	1.1	4	5
Average	4.9	4.7	1.3	4.0	1
Group 2. Oil-injected, Quaternary Ammonium Compound Treated					
1257	5.3	5.1	1.3	4	0
1155	4.0	3.8	1.0	4	0
546	5.4	5.1	1.2	2	0
LG (2)	3.3	3.0	1.2	3	0
1196	4.2	4.0	0.9	1	0
Average	4.4	4.0	1.12	2.8	0
Group 3. Controls, Full Feed					
LG (3)	3.5	3.4	1.8	4	0
872	5.4	5.4	1.7	4	0
109	4.0	4.0	1.5	4	0
106	4.4	4.3	3.5	4	0
71	3.9	3.8	1.0	4	5
Average	4.2	4.1	1.9	4.0	1
Group 4. Controls, Full Feed, Quaternary Ammonium Compound Treated					
69	4.0	4.0	1.7	4	0
62	4.7	4.6	2.0	4	5
110	4.4	4.2	1.4	4	5
111	4.5	4.3	1.6	4	5
122	4.3	4.2	2.5	4	5
Average	4.3	4.2	1.3	4.0	4.0

1. The gall bladder was empty and no stain visible
2. Very slight stain in liver
3. Slight stain on liver
4. Large liver stains
5. Body stains

TABLE VI-b

CORRELATION OF BODY WEIGHTS TO GALL BLADDER WEIGHTS

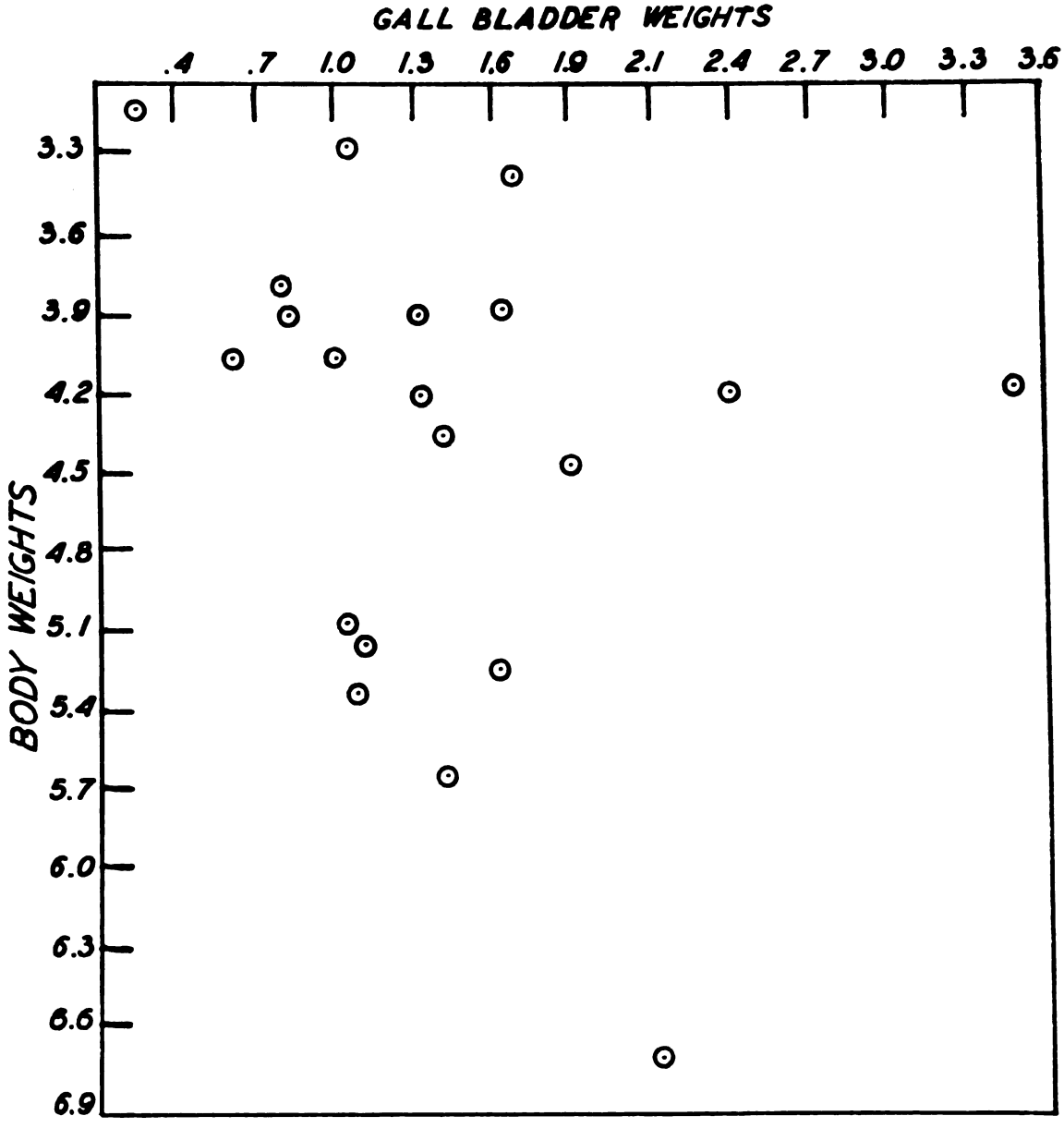


TABLE VI-C

Organoleptic Tests of Experiment II

Group No.	Aroma Av.	Flavor Skin Av.	Flavor Lean Av.	Juiciness Av.	Tenderness Av.	General Concl. Av.
			White Meat			
1	5.3	4.2	4.5	3.8	5.7	4.7
2	5.7	5.5	5.5	3.7	5.3	5.2
3	6.0	5.3	5.3	3.7	5.2	5.2
4	5.5	5.2	5.7	3.2	5.5	5.2
			Dark Meat			
1	4.8	3.8	4.0	3.3	5.2	4.3
2	5.5	4.7	4.3	3.8	5.0	4.7
3	5.8	4.2	5.2	4.8	5.0	4.7
4	4.8	4.2	4.3	3.8	5.0	4.7
			Broth			
		Flavor Fat				
1	5.4	5.3				
2	5.6	6.0				
3	4.8	5.5				
4	5.4	5.3				

Maximum possible score is 7, a score of 3 or less usually indicates an unacceptable product.

Experiment III

Contamination

Two groups were treated with a quaternary ammonium compound and two groups were not. Table VII shows the actual bacterial counts on the four groups on three different days. These birds were stored at an average temperature of -4° Fahrenheit. In all cases the average

TABLE VII

Bacterial Counts of Birds in Experiment III

Bird No.	Bacterial Counts		
	8 August	13 October	14 October
Group 1. Oil-injected, Starved			
8769	8,300	100	5,600
8792	7,400	50	7,000
8	3,700	150	5,600
8668	6,800	620	7,000
8751	7,300	410	5,500
Average	6,700	266	6,140
Group 2. Oil-injected, Starved, Quaternary Ammonium Compound			
8684	500	90	16,000
9057	1,950	320	600
127	800	160	6,300
133	6,300	110	800
134	3,100	240	2,300
Average	2,500	184	5,220
Group 3. Controls, Full Feed			
195	4,900	140	2,000
8821	16,000	3,680	1,200
198	9,500	1,440	53,000
8871	1,300	80	58,400
8820	9,000	240	30,400
Average	8,140	1,116	25,100
Group 4. Control, Full Feed, Quaternary Ammonium Compound			
8715	850	90	1,400
197	0	290	500
6292	2,150	360	1,000
8859	1,100	90	1,500
8694	700	30	60,000
Average	960	172	12,650

bacterial counts of the treated groups were lower than those of the untreated groups. There were some increases in bacterial numbers from the initial to the final count. The starved groups had slightly lower counts than the unstarved groups.

TABLE VII-A

Bird Weights, Gall Bladder Weights, Bile Stains
Experiment III

Bird No.	Wt. Before Starving Lbs.	Wt. at Killing Lbs.	Wt. of Gall Bladder Grams	Bile Stain Scores	
				Liver	Body
Group 1.	Oil-injected, Starved				
8769	5.1	4.9	3.3	3	0
8792	7.1	6.8	2.6	2	0
8	5.9	5.6	1.7	2	0
8668	5.8	5.4	2.0	3	0
8751	6.2	6.0	1.5	1	0
Average	6.0	5.7	2.2	2.2	
Group 2.	Oil-injected, Starved, Quaternary Ammonium Compound				
8684	5.0	4.8	0.2	1	0
9057	6.4	6.2	2.0	4	5
127	4.8	4.7	2.7	3	0
133	4.7	4.6	2.2	2	0
134	3.3	3.3	2.2	3	0
Average	4.8	4.7	1.8	2.6	1
Group 3.	Controls, Full Feed				
195	4.1	4.0	3.6	3	0
8821	4.2	4.1	1.8	1	0
198	6.1	5.9	2.1	4	0
8871	5.9	5.8	2.7	3	0
8820	6.4	6.1	2.2	3	0
Average	5.3	5.1	2.4	2.8	
Group 4.	Control, Full Feed, Quaternary Ammonium Compound				
8715	6.8	6.5	1.9	3	0
197	4.0	3.9	2.4	1	0
6292	5.5	5.5	3.0	2	0
8859	5.2	5.2	2.3	1	0
8694	6.2	6.1	2.9	1	0
Average	5.5	5.4	2.5	1.6	

1. Insignificant stain on liver
2. Very slight stain on liver
3. Slight stain on liver
4. Large liver stain
5. Body stain

TABLE VII-B

Organoleptic Tests of Experiment III

White Meat						
Group No.	Aroma Av.	Flavor Skin Av.	Flavor Lean Av.	Juiciness Av.	Tenderness Av.	General Concl. Av.
1	5.7	4.0	5.2	3.2	4.7	4.0
2	5.8	4.3	5.7	3.8	4.8	4.6
3	6.2	5.2	5.7	4.0	5.0	4.8
4	6.2	4.5	4.7	3.3	4.8	4.2
Dark Meat						
1	5.7	4.6	5.3	3.8	4.5	4.4
2	5.7	4.6	4.5	3.7	5.0	4.2
3	5.5	4.2	5.0	4.7	4.8	4.4
4	6.0	4.4	5.3	5.2	5.0	4.8
Broth						
	Aroma Fat	Flavor Fat				
1	5.4	5.2				
2	5.6	6.0				
3	4.8	5.5				
4	5.4	5.3				

Maximum possible score is 7, a score of 3 or less usually indicates an unacceptable product.

Bile Stains in Experiment III

Bile stains were slight in Experiment III. In one instance the stain affected the body abdominal wall. The stains in the remaining birds were localized on the liver, and in most cases were relatively small. Average bile stain scores of the liver were as follows: Group 1, 2.2; Group 2, 2.6; Group 3, 2.8; Group 4, 1.6. The average gall bladder weight of the treated birds were lower than those in the untreated birds.

Body Weights of Experiment III

The average loss in weight for the starved groups was: Group 1, 0.3; Group 2, 0.1. The average loss in weight for the groups that did not have feed withheld from them was: Group 3, 0.2; Group 4, 0.1. Water was available for all groups until time of slaughter. (Table VII-A).

Organoleptic Tests

Organoleptic tests were favorable in all groups, with the exception of juiciness in Groups 1, 2 and 3. (Table VII-B).

Statistical Analysis

The data were analyzed statistically by Fisher's method of variance. (Fisher, 1930). Six of the 21 observations showed some degree of significance between the bacterial counts of the birds treated with quaternary ammonium compound and those that were untreated. Three of these were found in Experiment I, one in Experiment II and two in Experiment II. Two experiments were conducted on depletion of bile from the gall bladder. Experiment II showed some degree of significance and Experiment II was not significant. (Tables VIII, IX, and X).

TABLE VIII

Statistical Analysis and Significance of Bacterial Counts Between Birds Dipped in Quaternary Ammonium Compound and Controls

Experiment I - Groups 1 and 2

Date of Counts	Sum of Squares		Degrees of Freedom	t-Value
	Checks	Quats		
24 July	1,036,525	442,205	10	.779*
30 August	570,100	147,089	10	1.200*
4 August	10,082	12,641	10	.080*
15 September	135,625	8,785	10	3.025**
16 September	93,951	3,293	10	2.360**
20 October	-----	-----	--	-----
21 October	35,501	1,926	10	1.65 *

Experiment I - Groups 3 and 4

23 July	33,679	17,346	10	.667*
20 October	926	138	10	3.82 ***
21 October	152,837	9,418	10	1.895*

* Not Significant
** Slightly Significant to Significant
*** Significant to Highly Significant

TABLE IX

Statistical Analysis and Significance of Bacterial Counts
Between Birds Dipped in Quaternary Ammonium Compound and Controls

Experiment II - Groups 1 and 2

Date of Counts	Sum of Squares		Degrees of Freedom	t-Value
	Checks	Quats		
11 September	12,867	5,306	8	.943*
29 August	8,213,625	13,755,925	8	.333*
28 August	310,225	107,600	8	.978*
Experiment II - Groups 3 and 4				
28 August	5,193	27	8	3.21 ***
29 August	4,786	26,201	8	.727*
11 September	112,314	121,858	8	.248*
Statistical Analysis and Significance of Gall Bladder Weights Of Birds Oil-Injected and Controls Groups 1 & 2 vs. 3 & 4				
	1,659	3,929	18	2.495**

* Not Significant
** Slightly Significant to Significant
*** Significant to Highly Significant

TABLE X

Statistical Analysis and Significance of Bacterial Counts
Between Birds Dipped in Quaternary Ammonium Compound and Controls

Experiment III - Groups 1 and 2

Date of Counts	Sum of Squares		Degrees of Freedom	t-Value
	Checks	Quats		
8 August	23,687	5,380	8	3.185***
13 October	5,875	2,058	8	.805*
14 October	19,097	30,198	8	.336*
Experiment III - Groups 3 and 4				
8 August	45,295	675	8	2.890**
13 October	156,996	2,308	8	1,365*
14 October	721,312	360,546	8	.958*
Statistical Analysis and Significance of Gall Bladder Weights Of Birds Oil-Injected and Controls Groups 1 & 2 vs. 3 & 4				
	4,780	6,481	18	1.40 *

* Not Significant
** Significant
*** Significant to Highly Significant

DISCUSSION

Contamination

It would appear from the data collected that there is a possibility of controlling bacterial multiplication by using quaternary ammonium compounds. The concentrations of disinfectant used in this experiment were low enough so as not to cause toxic effects. The duration of the treatment was slight (about 5 seconds). If greater concentrations and longer exposure times were employed when dipping birds, the results might be more favorable. Of the 21 observations made between the treated and untreated groups, six showed significant decreases in bacterial counts.

In these experiments no appreciable increases in bacterial counts were noticed on birds held at 33° Fahrenheit for 13 days, and no slime formation or off-odors developed. Birds that were repeatedly frozen and defrosted at 33° Fahrenheit gave similar bacterial counts, as the above mentioned birds, indicating that very little multiplication bacteria occur under the conditions of this experiment. Lockhead and Landerkin (1935) found that bacterial counts increased from 30,300 to 25,300,000 in eight days on New York dressed birds held at 32° Fahrenheit (1 cm skin area). In accord with Jensen (1945) bacterial counts were lower when the birds were starved before slaughtering.

Birds secured from the commercial dressing plant had higher initial counts than birds dressed at the Poultry Department's poultry products laboratory. The percent reduction was greater on carcasses with heavier contamination when the quaternary ammonium compound was used than on the lighter contaminated birds. The dipping of birds in greater concentrations of quaternary ammonium compounds may possibly prove more valuable on carcasses held at higher temperatures.

Further work will be necessary to substantiate this statement.

Organoleptic tests were conducted by having a taste panel score stewed portions of the experimental birds. The birds were cooked without the usual spices and salt used in home cooking. These tests indicated no apparent off-odors or flavors of the quaternary ammonium compound, in dilutions used in this experiment. This may indicate that greater concentrations might be used without affecting consumer acceptance.

Oil Injection

Maw and Nikolaiczuk (1942) stated that, "size of the gall bladder, as determined by its contents and the length of the storage appears to determine the extent and intensity of visible staining." Experiment II where Groups 1 and 2 received 10 cc oil injected into the gizzard 30 minutes before slaughter, the mean gall bladder weights were smaller than in Groups 3 and 4 which were untreated. The carcasses in this trial were held at an average 33° Fahrenheit for 13 days during which time intense staining should have developed normally. Stewart, Lowe and Morr (1941) noticed bile stains on areas around the breast and side of New York dressed birds in three days at 35° Fahrenheit. Groups 1 and 2 except for one bird, had only liver stains whereas Groups 3 and 4 had six birds that developed body stains along with liver stains, indicating that the oil injection was of some benefit in the reduction of bile stains. The gall bladder of one bird in Group 2 was depleted of bile entirely and completely free of stains. There were differences in average liver stain scores in favor of the starved and oil injected birds over those left on feed until time of slaughter. This suggests that there may be a physiological time to slaughter, after oil injection, when the gall

bladder is completely evacuated. More work on time of treatment before slaughter is necessary as well as dosages in relation to body weight.

Jensen (1945) states that starved birds have lower bacteria counts but that increased size of gall bladders of starved birds cause staining. In this experiment the birds in Experiment II, Groups 1 and 2 were starved for 12 hours, but with the oil injection staining and average gall bladder weights were less than full fed birds of Groups 3 and 4.

In Experiment III when the birds were prepared in a similar manner as in Experiment II but were frozen immediately, there was little evidence of bile stains in any group. The mean weights of the gall bladders and "Fisher's t-value" for them indicate that there was little difference in the weights of the gall bladders between oil injected groups and full fed groups. In six birds stains were so slight that they were hardly distinquishable. Four of these were in the full fed groups and two in the oil injected groups. This would indicate that prompt freezing of poultry will reduce the extent of staining and that temperatures above freezing hasten the development of bile stains.

In preliminary work, with fryers that were injected with large dosages of cottonseed oil, the oil effused through the skin sufficiently to coat the skin of the birds. This coating of oil may offer some antioxidant value since it is high in Vitamin E. It may also have some bearing on the presence of bacteria. This phenomena should be investigated further.

Organoleptic tests indicated that none of the bile stains were great enough, under conditions of this experiment, to render the meat

unacceptable. The length of storage may not have been an adequate test of the prevention of rancidity.

Loss of weight in the starved birds was not appreciably greater than loss of weight of birds from which feed was not withheld. Water was available at all times for both groups until the time of slaughter, and this may explain the small weight losses.

A few birds that were supposedly starved were noted with full crops. Upon examination the crops were found to be full of feathers. Feather eating by starved birds can cause darkened crop areas.

SUMMARY

Sixty-four birds were used in these experiments to study the effect of dipping New York dressed birds in a quaternary ammonium compound, and the effect of injecting cottonseed oil prior to killing.

Six of the 21 samples taken showed some significance in reducing bacterial numbers under varying conditions of storage. No appreciable increases were noted in bacterial numbers under the storage conditions of this experiment. Organoleptic tests showed all groups acceptable.

Average gall bladder weights were smaller in the oil injected groups than in the groups not treated with oil, and in one experiment stored at 33° Fahrenheit showed "significant t-values" while the one experiment stored at -20° Centigrade was not "significant".

Loss in weight was very small in both the starved and unstarved groups, indicating that if birds have sufficient water the loss in weight will be slight.

The results of this experiment indicate that there is a possibility of reducing contamination on New York dressed birds with quaternary ammonium compounds. More work must be done to determine the concentrations and length of immersion times. Bile stain scores (liver) were slightly lower when the birds were starved and given cottonseed oil thirty minutes before slaughtering. Depletion of the gall bladder by use of oil seems feasible.

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