THE CHEMICAL CHANGES TAKING PLACE IN THE FAT OF BROILERS DURING COLD STORAGE

by

MARVIN LEROY SCHREIBER

A. B., University of Kansas, 1942

A THESIS

submitted in partial fulfillment of the
requirements for the degree of

MASTER OF SCIENCE

Department of Chemistry

KANSAS STATE COLLEGE
OF AGRICULTURE AND APPLIED SCIENCE

1944

TABLE OF CONTENTS

INTRODUCTION

The chemical changes taking place in the fat of broilers during cold storage have become increasingly important with improvements in refrigeration and with increases in the storage, consumption and production of broilers. Although there are few regions in this country which are devoted exclusively to the production of poultry, the magnitude of this industry is usually not appreciated. Every state and a majority of the farms in this country contribute to the poultry supply. While the amounts produced per unit may be small, the aggregate is very large.

The total production of poultry meat in the United States has been relatively stable since the middle 1920's. The commercial broiler industry has had phenomenal development. It began during the late 1920's in the peninsula portion of Delaware, Maryland, and Virginia, the region known to poultrymen as the Del-Mar-Va area. In recent years other areas also have entered the broiler industry. Tentative estimates place the 1941 broiler output at 150 million birds or more. Many of the chickens in this category now, however, are friers or light weight birds, weighing three pounds or more, according to a report of Wickard (1941).

Since much of the poultry is being produced in the agricultural sections of the country and more specifically in the grain belt where feed is cheaper and more accessible, the problem of furnishing poultry for the more densely populated areas includes the factors of storage and shipment. The production of poultry and its consumption being somewhat seasonal, the problem of

storage is of major importance. The largest production of poultry occurs in the spring and summer months, while the consumption is spread over the year, with certain increases during the several holiday seasons.

Today, not only New York style poultry (only feathers removed) but also fully dressed poultry is being demanded by the consumer. The relative keeping quality of the fully dressed birds as compared with the New York style has not been thoroughly investigated. Yet the development of off flavors during storage has been attributed to rancidity and other chemical changes of the fat of the poultry, not only in the abdominal fat but also in the skin and subcutaneous fat. Therefore, the chemical changes taking place in the fat during cold storage were chosen as the subject of this study. The variables introduced were diet, style of dressing and conditions of storage. The investigation was limited to that type of chicken which is most likely to be subjected, in the greatest quantity, to storage, namely the broiler chicken.

REVIEW OF LITERATURE

Much study has been made on the relative merits of dressing of storage chickens, especially the New York dressed, wire drawn, and fully drawn. One of the first of these comparisons was reported by Pennington (1911) who experimented with a series of drawn and undrawn birds under two sets of conditions. Fully drawn poultry, that is, completely eviscerated with heads and feet removed, decomposed most rapidly. Boston drawn, or wire drawn, stood intermediate in the speed of decomposition.

Lowe (1939) studied the effect of the length of time between killing and drawing on the keeping quality, tenderness, and palatability of the birds. She found that over-night cooling before drawing added to the tenderness and palatability. Yet these properties were not affected by a longer time of cooling. Over a long period of storage, the total juiciness and flavor decreased.

The problem of desiccation is also very important. Cook (1939) made studies of the causes and prevention of surface desiccation. It was found that low temperatures of about -13° C. and high humidity of 95 to 100 percent would maintain the proper moisture content of the birds. Lower humidities caused a decrease in the moisture and an increase in the freezer burn. Various liners and wrappers were tried for the preservation of the moisture content. Sealing the joints in the paper liners commonly used in commercial poultry boxes was beneficial, regardless of the moisture permeability of the paper used. The better liners were parchment, heavy wax, and aluminum foil. Sealed moisture resistant liners were found to be effective.

Lea (1934) studied the chemical changes in the fats of chickens stored in an inert gas. Carbon dioxide practically eliminated mold and bacterial spoilage in chickens kept at 0° F.; however, autolysis of the tissue by enzymes prevented any extension of the storage life of the chicken. Oxidation took place unless the carbon dioxide approached 100 percent. Of properties such as peroxide value, free fatty acid value, aldehyde value, and refractive index, only the free fatty acid value showed a general tendency to increase as the holding period lengthened.

In Germany, Kiermeier and Karlsrube (1939) stored chickens at -8.5° C., -15° C., and -21° C. and found that the peroxide and aldehyde values decreased as the temperature of storage decreased.

According to Cook and White (1939), the free fatty acid content of poultry varies somewhat between birds, but is usually low, and shows no relation to the condition of storage. The storage temperature is the most important factor in determining the extent of the peroxide oxygen formation in the fat. Low relative humidities accelerate peroxide formation. The fatty acid and peroxide values seemed to be the most important factors in determining the condition of the fat of poultry following storage. However, it was shown that the fats from different birds vary in their susceptibility to oxidation. The acidity of the crude fat of the chicken is an excellent indicator of their freshness. The acidity of the visceral fat increases more markedly with the length of keeping time than does the subcutaneous fat.

There has been some use of iodine numbers as an index of the rancidity of the fat, yet Lea (1938) stated that the iodine value gives a useful measure of gross chemical decomposition, but it has been shown repeatedly that a relatively advanced state of deterioration, from the point of view of odor and flavor, must be reached before any appreciable change in the iodine value is detectable.

MATERIALS AND METHODS

Two groups of 177 White Rock cockerels each were placed in brooder houses 12 by 12 ft., with an outside run of eight by 12 ft.

Lot I was fed the following all mash ration:

Meat scrap	5%
Fish meal	5
Soybean meal	5
Dried skim milk	2.5
Dehydrated alfalfa leaf	5
Ground limestone	1.3
Salt	0.85
Manganese sulfate	0.006
Cracked corn	40
Cracked wheat	20
Bran	10
Ground oats	5
Vitamin D	200 A.O.A.C. units per pound as Delsterol

Lot II was fed a diet identical except that ether extracted meat scrap, fish meal, and soybean meal were used. The analytical data for the feeds are given in Tables 1 and 2.

At 15 weeks of age, 165 birds of lot I survived, with an average live weight of 3.18 pounds. In lot II, 151 birds survived with an average live weight of 3.28 pounds.

The birds were killed and dressed by the Perry Packing Company by standard commercial methods. They were washed one hour in running water, and packed in ice for three hours, then racked and hung in the packing room at 32-35° F. for 24 hours. A group (I) of the birds from each lot was then packed in boxes and another group (II) packed in 30 pound egg cans. The remaining birds were eviscerated by splitting them through the back. The lungs and kidneys were removed carefully so as not to damage the remaining tissue. The oil gland was removed from all eviscerated birds. After evisceration, part of the birds from each lot were scratched on the inside of the body cavity with the tool used for removing kidneys. These birds were not scratched as extensively

as many commercially eviscerated birds. One group of unscratched birds from each lot was wrapped in M. A. T. cellophane and packed in standard wooden boxes. The rest of the eviscerated birds were wrapped in plain cellophane and half of these were packed in boxes and half in cans. After packing, all birds were placed in the storage room at 10° F. The maximum elapsed time between killing and storage was 48 hours. To summarize, birds from each lot were packed in the following ways:

	Box	Can
New York dressed, unwrapped	x	x
Eviscerated, plain cellophane	x	x
Eviscerated, scratched, plain cellophane	x	x
Eviscerated, M. A. T. cellophane	x	

As storage progressed, the effect of differences of diet, box and can packing, eviscerating, eviscerating and scratching, and kinds of cellophane wrapping were studied. From each group one bird was cooked (in an air oven at 300° F. until the internal temperature reached 190° F.) and the following qualities recorded by a committee of seven staff members: aroma; flavor, juiciness and tenderness of the breast and thigh flesh; and flavor of the breast and thigh skin. Each quality was graded on a scale of one to 10 and the total recorded as total organoleptic quality. A total of 90 was possible. The total aroma and flavor qualities were recorded as flavor and aroma. This had a possible total of 50.

Two birds from each group were used for fat analysis. The birds were skinned and half of the skin, from the middle of the breast to the middle of the back and from the neck to the tail,

of each of the two birds was cut up and placed into a 500 cc distilling flask. All obtainable fat from the interior of the body cavity was placed in a similar flask. To each flask 100 cc of ethylene chloride was added and distillation was carried out over a low flame for one hour; then the flame was turned up and the solution boiled until the water ceased to distill off. Frequent replacements of the solvent were necessary. Slow distillation seemed to be about as effective as rapid and required less solvent. When water no longer came over, the ethylene chloride was filtered hot through filter paper into a volumetric flask and boiled until the fat concentration was about 10 to 20 percent. It was usually boiled to this concentration before filtration.

The concentration of the fat in the solution was determined by evaporation of 1.0 cc of the solution on a watch glass in an air oven at 105-110° C. for one hour. A 5.0 cc aliquot of the solution was used for the determination of peroxides by the method of Lea (1938). The results are expressed in equivalents of peroxide per 100 grams of fat. Aliquots of 1.0, 0.5, 0.2, 0.1, 0.05, 0.02, and 0.01 cc were used for the determination of fat aldehydes by the modification of the Schibsted method described by Lea (1938). The color intensity was determined by a photo-electric colorimeter using a 520 mm filter. The results are expressed in arbitrary aldehyde units. One unit is defined as such a concentration of aldehyde that one gram of fat will produce a solution having an optical density ($\text{Log } I_0/I$) of 0.05 per cm. An aliquot of 5.0 cc was used to determine the free fatty acids by the method of Lea (1938). These results are expressed in equivalents of free fatty acid per 100 g of fat.

DATA

The data of Tables 1 and 2 represent the results of the analysis of the feeds. Table 1 shows an analysis of the feeds of rations I and II with the ether extract of various components which contained the more unstable fats of rations I and II. Table 2 gives an analysis of the extracted fats of the feed of rations I and II and those various components.

The next seven tables, Tables 3, 4, 5, 6, 7, 8, and 9 represent the results of the analysis of the internal and skin fats and the results of the organoleptic quality of the birds stored. Such analyses were carried out every three months, from the fresh to those stored 18 months. The individual tests relative to the skin and internal fat of birds, such as tests for free fatty acid values, peroxide values, and aldehyde units, are plotted against time of storage in Figs. 1 to 18 and show the effects of time of storage on the chemistry of the fats and associated changes.

The oxidation induction period of all samples of fat extracted from the birds was also determined. In the freshly killed birds it was found to be 23 hours for lot I and 94 hours for lot II determined at 70° C. by the method of French, Olcott and Mattill (1936). The induction periods of the fat from the stored birds were extremely erratic, and are not included in the tabulated data.

Table 1. Feeding stuffs analysis (percents).

Rations	Moisture	Protein	Ether ext.	Crude fiber	Ash	N.F.E.
Ration I	10.56	19.31	4.77	3.80	6.60	54.96
Fish meal			17.65			
Soybean meal			5.77			
Meat scrap			10.88			
Ration II	11.05	20.56	3.19	3.83	6.84	54.55
Extracted fish meal			0.52			
Extracted soybean meal			0.51			
Extracted meat meal			0.40			

Table 2. Analysis of fats of the ration.

Extract of	Free acid millimols per 100 g	Peroxides millimols per 100 g	Aldehydes	Iodine number
Ration I	200	1.56	222	115.5
Ration II	187	2.38	125	119.2
Fish meal	56	0.00	58	112.6
Soybean meal	21.6	2.83	38	132.5
Meat meal	22.7	0.00	13	57.5

Table 3. Comparison of birds stored three months.

	Samples	Total organo-leptic	Flavor and aroma	Skin			Internal		
				Free fatty acid*	Per-oxide value*	Alde-hyde units	Free fatty acid*	Per-oxide value*	Alde-hyde units
Lot I	7	56.4	30.2	6.19	.263	3.83	3.00	2.55	84.9
Lot II	7	56.0	28.5	5.67	.233	2.54	5.52	1.70	78.9
Box	6	55.7	29.2	6.71	.190	3.78	3.21	1.86	70.9
Can	6	54.0	28.2	5.54	.206	2.35	4.95	2.29	47.1
New York dressed	4	53.1	27.0	6.21	.172	1.70	4.18	0.06	2.4
Eviscerated	4	54.6	29.2	5.88	.200	2.67	5.24	2.30	84.6
Eviscerated and scratched	4	56.9	30.0	6.29	.222	4.82	3.21	2.87	170.5
Plain cellophane	2	56.3	30.8	6.28	.210	3.30	4.81	1.15	27.5
M.A.T. cellophane	2	63.9	33.2	4.75	.525	3.95	4.57	2.41	58.1
Fresh controls	4-10	61.3	32.6	1.12	.000	1.00	1.16	0.00	2.7

Table 4. Comparison of lots I and II at time of killing.

	Total organo-leptic	Flavor and aroma	Skin fat				Internal fat			
			Free fatty acid*	Per-oxide value*	Alde-hyde units	Iodine number	Free fatty acid*	Per-oxide value*	Alde-hyde units	Iodine number
Lot I	61.3	32.4	0.93	0.00	1.3	83.4	0.89	0.00	2.8	80.5
Lot II	61.3	32.7	1.31	0.00	0.8	80.0	1.43	0.00	2.6	79.2
Mean	61.3	32.6	1.12	0.00	1.0	81.7	1.16	0.00	2.7	79.9

* Units expressed in equivalents per 100 g of fat.

Table 5. Comparison of birds stored six months.

	Samples	Total organoleptic	Flavor and aroma	Skin			Internal		
				Free fatty acid*	Peroxide value*	Aldehyde units	Free fatty acid*	Peroxide value*	Aldehyde units
Lot I	7	58.6	32.0	4.39	0.48	7.00	4.35	4.12	159.0
Lot II	7	57.8	31.2	6.09	0.40	9.39	8.48	3.22	32.9
Box	6	57.3	31.5	5.04	0.58	8.35	5.71	3.94	95.9
Can	6	59.0	31.5	5.08	0.36	9.78	6.80	3.51	53.0
New York dressed	4	56.3	30.2	4.64	0.42	10.65	5.67	0.00	1.1
Eviscerated	4	58.6	32.0	6.11	0.52	7.47	6.58	2.79	55.6
Eviscerated and scratched	4	59.5	32.3	4.43	0.47	9.27	6.52	10.02	166.7
Plain cellophane	2	58.8	32.0	5.80	0.63	12.00	5.71	3.19	91.2
M.A.T. cellophane	2	57.4	31.5	6.33	0.25	2.95	7.38	3.47	225.3

* Units expressed in equivalents per 100 g of fat.

Table 6. Comparison of birds stored nine months.

	Samples	Total organo-leptic	Flavor and aroma	Skin			Internal		
				Free fatty acid*	Per-oxide value*	Alde-hyde units	Free fatty acid*	Per-oxide value*	Alde-hyde units
Lot I	7	58.1	30.8	6.01	0.66	18.5	6.32	5.28	291.0
Lot II	7	53.4	26.8	8.93	0.63	11.0	8.97	8.32	233.0
Box	6	55.1	29.7	7.42	0.71	18.3	6.97	6.84	285.0
Can	6	57.1	29.6	7.40	0.61	11.9	8.56	5.24	163.0
New York dressed	4	50.7	25.8	8.20	0.48	6.0	11.11	0.00	1.0
Eviscerated	4	58.4	32.1	7.50	0.74	11.8	6.36	5.82	113.0
Eviscerated and scratched	4	56.6	31.2	6.53	0.76	27.5	6.02	12.30	558.0
Plain cellophane	2	55.9	30.9	8.57	0.88	11.9	5.14	2.76	86.0
M.A.T. cellophane	2	58.7	30.1	7.89	0.56	12.8	6.89	11.38	492.0

* Units expressed in equivalents per 100 g of fat.

Table 7. Comparison of birds stored 12 months.

	Samples	Total organo-leptic	Flavor and aroma	Skin			Internal		
				Free fatty acid*	Per-oxide value*	Alde-hyde units	Free fatty acid*	Per-oxide value*	Alde-hyde units
Lot I	7	56.9	29.8	6.65	0.80	15.30	5.15	3.61	43.40
Lot II	7	56.3	29.2	6.68	1.17	20.02	7.56	5.36	137.55
Box	6	58.8	30.7	6.89	0.90	15.80	7.22	4.18	87.80
Can	6	55.2	28.8	6.93	1.22	20.79	6.55	4.55	76.16
New York dressed	4	56.3	29.1	8.51	1.05	15.15	9.33	0.86	6.70
Eviscerated	4	57.2	30.2	7.41	1.21	23.17	5.48	6.82	55.60
Eviscerated and scratched	4	57.4	29.9	5.65	0.93	16.54	5.84	5.42	183.58
Plain cellophane	2	62.8	33.2	6.39	1.02	19.70	6.73	5.30	84.97
M.A.T. cellophane	2	53.4	28.0	5.17	0.53	18.89	3.18	4.86	141.66

* Units expressed in equivalents per 100 g of fat.

Table 8. Comparison of birds stored 15 months.

	Samples	Total organo-leptic	Flavor and aroma	Skin			Internal		
				Free fatty acid*	Per-oxide value*	Alde-hyde units	Free fatty acid*	Per-oxide value*	Alde-hyde units
Lot I	7	57.6	29.4	6.35	2.48	26.90	7.46	6.04	151.6
Lot II	7	58.3	30.7	10.94	1.39	29.87	14.08	3.08	148.7
Box	6	58.0	30.2	7.16	1.43	34.40	9.94	3.85	121.1
Can	6	58.4	30.3	10.39	1.96	26.50	7.80	3.80	145.0
New York dressed	4	55.6	29.7	7.00	1.37	35.00	9.26	0.23	249.0
Eviscerated	4	58.6	30.1	9.51	1.45	39.00	9.59	5.78	291.5
Eviscerated and scratched	4	60.3	30.2	9.81	2.26	18.90	7.78	5.48	105.0
Plain cellophane	2	57.6	30.3	6.24	1.76	44.30	11.01	4.51	207.0
M.A.T. cellophane	2	56.6	28.8	6.84	3.38	15.30	21.70	8.94	171.3

* Units expressed in equivalents per 100 g of fat.

Table 9. Comparison of birds stored 18 months.

	Samples	Total organo-leptic	Flavor and aroma	Skin			Internal		
				Free fatty acid*	Per-oxide value*	Alde-hyde units	Free fatty acid*	Per-oxide value*	Alde-hyde units
Lot I	7	55.3	28.3	8.29	1.45	45.5	5.91	4.41	186.2
Lot II	7	56.6	28.6	7.74	2.83	85.2	5.82	7.33	681.3
Box	6	55.0	27.5	7.97	1.96	49.1	6.29	4.17	194.1
Can	6	55.4	28.1	8.11	2.34	71.6	8.16	5.35	250.6
New York dressed	4	53.1	25.6	6.79	1.29	23.2	7.31	0.78	0.7
Eviscerated	4	56.3	28.8	8.39	2.39	86.0	8.01	4.43	238.8
Eviscerated and scratched	4	56.8	29.0	5.11	2.78	72.0	6.35	11.79	427.6
Plain cellophane	2	54.9	28.3	7.32	2.16	84.9	5.55	6.06	373.6
M.A.T. cellophane	2	59.4	32.1	7.84	2.12	79.5	4.64	8.53	1702.0

* Units expressed in equivalents per 100 g of fat.

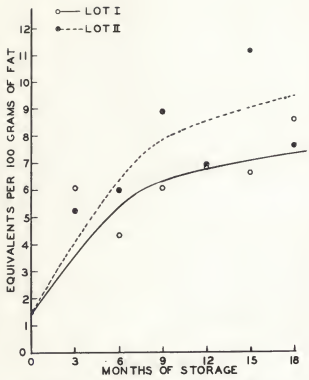

FIGURE 1. FREE FATTY ACID OF THE SKIN

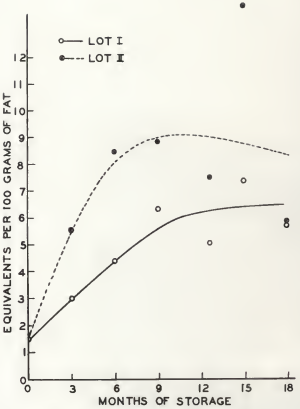

FIGURE 2. FREE FATTY ACID OF THE INTERNAL FAT

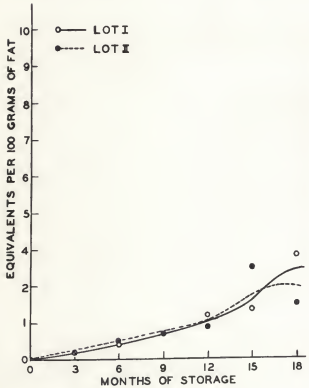

FIGURE 3. PEROXIDE OF THE SKIN

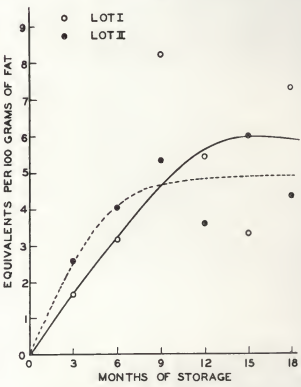

FIGURE 4. PEROXIDE OF THE INTERNAL FAT

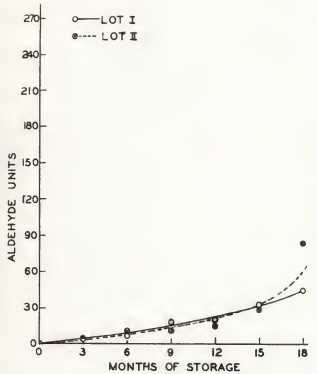

FIGURE 5. ALDEHYDES OF THE SKIN

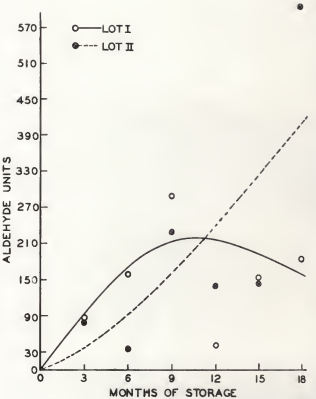

FIGURE 6. ALDEHYDES OF THE INTERNAL FAT

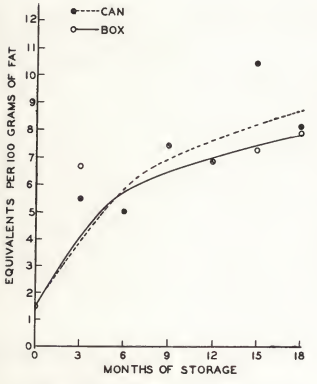

FIGURE 7. FREE FATTY ACID OF THE SKIN

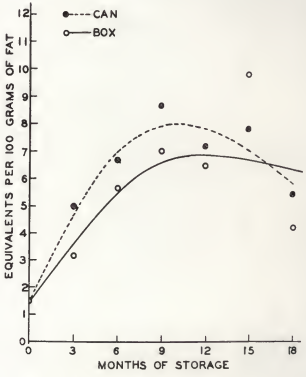

FIGURE 8. FREE FATTY ACID OF THE INTERNAL FAT

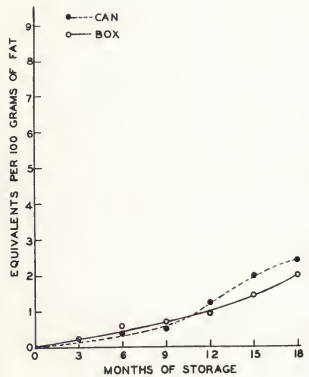

FIGURE 9. PEROXIDES OF THE SKIN

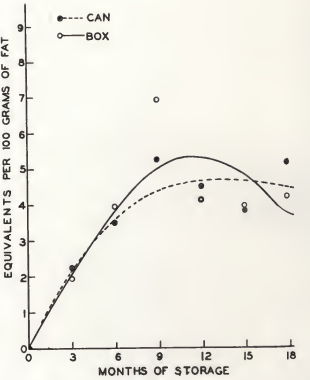

FIGURE 10. PEROXIDES OE THE INTERNAL FAT

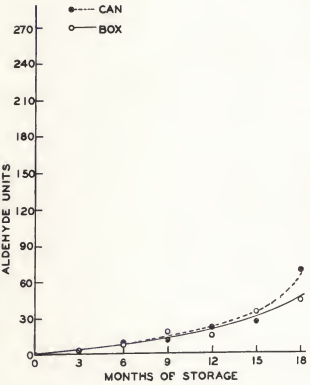

FIGURE 11. ALDEHYDES OF THE SKIN

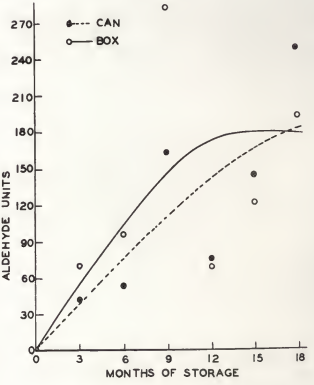

FIGURE 12. ALDEHYDES OF THE INTERNAL FAT

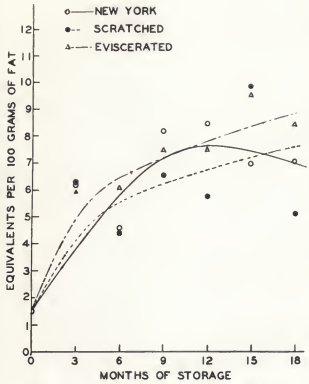

FIGURE 13. FREE FATTY ACID OF THE SKIN

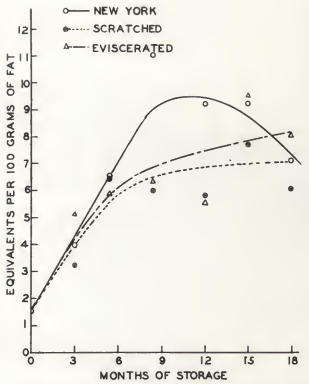

FIGURE 14. FREE FATTY ACID OF THE INTERNAL FAT

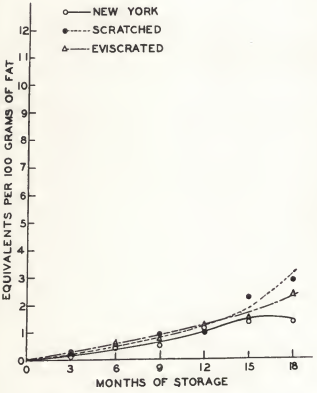

FIGURE 15. PEROXIDES OF THE SKIN

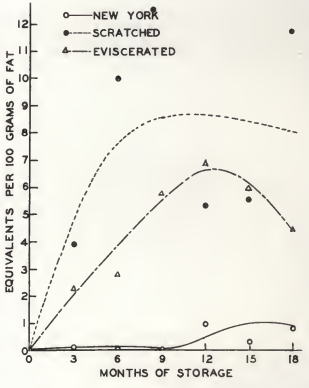

FIGURE 16. PEROXIDES OF THE INTERNAL FAT

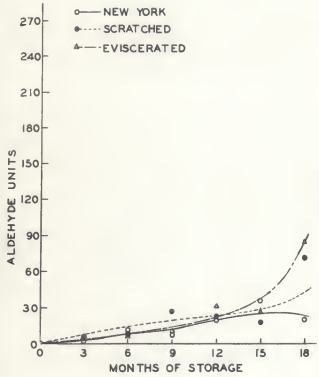

FIGURE 17. ALDEHYDES OF THE SKIN

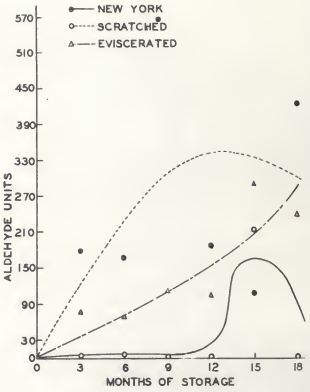

FIGURE 18. ALDEHYDES OF THE INTERNAL FAT

DISCUSSION AND CONCLUSIONS

In general the organoleptic quality of the birds show little change over the 18 months of storage, while the free fatty acids, peroxides, and aldehydes show certain changes. The aldehyde values and peroxide values rise slowly at first and more rapidly at the end of the 18 months, with several going through an apparent maximum. Free fatty acid values show the greatest rise during the first six months of storage and rise only slightly thereafter. The difference in the rate of appearance of the peroxide and aldehyde and free fatty acid values may be due to the fact that the fatty acids may be freed as a result of autolysis of the fat which takes place during the early stages of storage. Peroxide values and aldehyde values on the other hand are dependent on the degree of fat oxidation and develop in the later months of storage.

During the 18 months of storage the birds of lot I and lot II show negligible change in the total organoleptic scoring and in the flavor and aroma scoring. Minor changes appear between the fresh birds and those subjected to three months' storage. No significant differences between the three months' testing and the 18 months' testing were observed. The free fatty acid and peroxide values of both the internal and the skin fat show a variable increase during the 18 months. Lot II shows slightly higher free fatty acid values than lot I (Figs. 1 and 2). A significant difference is seen between the lots in the internal free fatty acid values. The internal aldehyde values of lot I and lot II rise, with lot I apparently reaching a maximum after 12 months of

storage while lot II continued to rise (Fig. 6). The internal aldehyde values show much unexplained variation. Maximum values of the skin aldehydes (Fig. 5) were not reached in the 18 months of storage but gradually rise, with those of lot II reaching a higher value.

The close similarity in the results of the tests carried out on lots I and II may be explained in that the differences in diets may not have been great enough to overshadow the other factors which affected the birds. An analysis of the feed (Table 1) shows that the diet of lot I contained only about 1.5 percent more fat than that of the diet of lot II. However, this difference represents great qualitative difference, since the extracted fat was quite unstable and produced a great difference in the stability of the fat of two groups of birds, although this difference did not appear in the stability of the intact carcasses.

In drawing a comparison between the birds stored in boxes and in cans, little difference is found. Minor differences that are noted in the flavor and aroma show higher scorings for the birds which are stored in boxes. This may be due in part to the inability of the objectionable flavors and odors to escape from the can. The free fatty acid values of the skin and internal fat of the birds stored in the can have a greater rate of increase than of those stored in boxes (Figs. 7 and 8). This is related to the flavor and aroma scoring.

In general, the differences between the box and can stored birds were so small that little can be said as to their relative keeping quality. It was noted at various times of testing that the birds stored in the cans tended to retain more of their natural moisture.

Similarly, small differences were found in the comparison of the total organoleptic scoring and the flavor and aroma scoring of the various styles of dressing. It appeared that the New York dressed birds were decidedly inferior early in the study, and the differences gradually disappeared, although some erratic results were observed. Internal fatty acid values (Fig. 14) show that the New York style contained the most fatty acid while the eviscerated and eviscerated and scratched were intermediate and lowest, respectively. The peroxide values of both skin and internal fat (Figs. 15 and 16) show that the New York style dressed birds contained the least peroxides while the eviscerated and eviscerated and scratched follow as in the case of the internal fatty acids, except for greater differences in the three styles of dressing.

A comparison was also made of birds stored in plain cellophane and M. A. T. cellophane. Erratic results were obtained in the scoring of the organoleptic quality of the birds, but it appeared that the birds stored in M. A. T. cellophane maintained superior quality for the first nine months, after which the plain cellophane was better. This may have been due to the fact that since the M. A. T. cellophane was less permeable, it retained the freshness for the earlier storage periods but in the later periods retained the objectionable odors which affected the quality. It was also noted that the birds stored in the M. A. T. cellophane retained more of their natural moisture, like those stored in the cans. The M. A. T. cellophane birds show slightly higher values both in the quantity of the free fatty acid and in the quantity of the peroxide values of the skin and internal fat.

Iodine numbers were determined of the fats of the various groups of birds tested but no correlation was found between the values and the length of time stored.

SUMMARY

The tests indicated that in none of the birds had rancidity of the fat become so pronounced as to render the fowls unfit for consumption. In the total organoleptic scoring and flavor and aroma scorings, the greatest decline came between the fresh and the three months of storage. Occasionally a group of birds would rate almost equivalent to the fresh birds. In most cases the beginning of rancidity, as evidenced by a rapid rise in the acid values and peroxide values, appeared only after 15 months of storage. In some comparisons the aldehyde values never reached their maxima as evidenced in the beginnings of rancidity.

The maximum time of this experiment was insufficient for the attainment of rancidity of the fat. This keeping quality was unusual, considering that commercially stored birds and birds of other experiments developed rancidity long before this time. The birds of this experiment differed in several respects from the commercially stored birds. First, the birds were starved for 16 hours before killing. The significance of this would need further investigation, but it is conceivable that birds absorbing and actively metabolizing fat contain fat that is less stable than that found in birds not producing fat. Second, only male birds were used. It was frequently noticed during the experiment that fatter

birds had less stable fat. Perhaps pullets would have fat less stable than that of cockerels. Third, the birds were frozen 24 hours after killing. Commercial birds are usually held for a longer time at 32° F. before freezing. Du Bois and Tressler (1943) working with beef, found that rancidity takes place more rapidly the longer the meat is held at 32° F. before being frozen. This may also be a factor in the stability of the fat of the birds studied. Further investigations should be made to determine the relative effect of starvation time, more pronounced differences in diet, holding time before freezing, and the types of birds used.

ACKNOWLEDGMENT

Indebtedness is acknowledged to Dr. Ralph M. Conrad for directing the study; to Professor L. F. Payne, Head of the Poultry Department, for the management of the raising of the birds; to Dr. Gladys Vail, of the Home Economics Department, for the preparation of the birds and the direction of the tasting committee; and to Mr. H. J. Reynolds, of Armour and Company, for the direction of the evisceration of the birds.

BIBLIOGRAPHY

Cook, W. H.
Precooling poultry. Food Res. 4:245-258. 1939

Surface drying of frozen poultry during storage. Food Res. 4:407-417. 1939.

Frozen storage of poultry, II. Bloom. Food Res. 4:419-424. 1939.

Cook, W. H. and White, W. H.
Frozen storage of poultry. III. Peroxide oxygen and free fatty acid. Food Res. 4:433-440. 1939.

Du Bois, C. W. and Tressler, D. K.
Seasonings, their effect on maintenance of quality in storage of frozen ground pork and beef. Proceedings of the Institute of Food Technologists, p. 202-207. 1943.

Fenningan, W. J.
Quick freezing of poultry. Part I. Refrig. Engin. 41:91-93. 1941.

Quick freezing of poultry. Part II. Refrig. Engin. 41:175-178. 1941.

Fitzgerald, G. A. and Nickerson, J. T. R.
Effect of time and temperature of holding poultry upon its quality. Proceedings of the Seventh World's Poultry Congress, p. 509-512. 1939.

French, R. B., Olcott, H. S. and Mattill, H. A.
Antioxidants and the Autooxidation of fats, IV. Lecithins as an antioxidant. Oil and Soap, 13:98-100. 1936.

Halman, E. T.
Symposium of papers on egg and poultry storage. Some observations of the effect of pre-storage on the storage of eggs and poultry. Procedures Brit. Assoc. Refrig. 34:5-12, 37-41. 1937.

Harshaw, Harold M., Hale, Walter S., Swenson, T. L., Alexander, Lucy M., and Slocoum, R. R.
Quality of frozen poultry as affected by storage and other conditions. U. S. Dept. Agri., Tech. Bul. 768. p. 41. April, 1941.

Heitz and Swenson
Quick freezing of dressed poultry. Poultry Products Conference Proceedings. p. 52. 1935.

Hepburn, J. S.
Studies of chicken fat, V. The occurrence of catalase, oxidase and reductase in the fat. U. S. Dept. Agri., Bur. Chem., Circ. 103:6-12. 1914.

Hilditch, Thomas P., Jones, Edwin C. and Rhead, Arthur J.
The body fat of the hen. Biol. Chem. Jour., 28:786-795. 1943.

Kiermeier, von F., and Karlsrube
The storage of soup hens at different temperatures. Vorrats Pflege and Libensmittal Forschung. 1939.

Koonz, C. H. and Ramsbottom, J. M.
Susceptibility of frozen defrosted poultry to drip. Foods Res. 4:485-492. 1939.

Lea, C. H.
The cold storage of poultry, II. Chemical changes in the fat of gas stored chickens. Jour. Soc. Chem. Ind., 53:347T-349T. 1934.

Rancidity in edible fats. London, H. M. Stationery Off. (Printed by Eyre and Spottiswoode Limited). 1938.

Nickerson, John R. and Fitzgerald, Gerald A.
Problems arising during holding of poultry prior to evisceration and freezing. Proc. Seventh World's Poultry Congress. p. 505-509, 1939.

Pennington, M. E.
Changes taking place in chickens in cold storage. Yearbook of U. S. Dept. Agri., p. 197-206. 1907.

Market cold storage chickens. U. S. Dept. Agri., Bur. Chem., Bul. 115:57-99. 1908.

Comparative rate of decomposition in drawn and undrawn poultry. U. S. Dept. Agri., Bur. Chem., Circ. 70, 1911.

Studies of poultry from the farm to the consumer. U. S. Dept. Agri., Bur. Chem., Circ. 64, 1910.

Pennington, M. E. and Hepburn, J. S.
The determination of the acid value of crude fat and its application in the detection of aged foods. Jour. Am. Chem. Soc., 32:568-572. 1910.

Studies of chicken fat. I. The occurrence and permanence of lipase in the fat of the common fowl. Jour. Am. Chem. Soc., 34:210-222. 1912.

Pennington, M. E. and Sherwood, C. M.
The greening of poultry. Poultry Science, 1:114-124. 1922.

Pennington, M. E. and St. John, E. Q.
A study of the changes taking place in the muscles of chickens when preserved at low temperatures. Science, 27:295. 1908.

Smith, E. C.
The cold storage of poultry. I. Gas storage of chickens. Jour. Soc. Chem. Ind. 53:345T-347T. 1934.

Stewart, G. F., Lowe, Bell, and Morr, Mary.
Post mortem changes in New York dressed poultry at 35° F. U. S. Egg and Poultry Magazine, 47:542-544, 571-572. 1941.

Swain, A. A.
Problems that will be met in the full dressing of poultry. Poultry Products Conference Proceed. p. 118. 1935.

Tressler, Donald K.
Freezer burn on refrigerated poultry. Ice and Refrigeration, 89:373-374. 1935.

Wickard, C. H.
Report of the Secretary of Agriculture. 649 p. 1941.

Zarotschenzeff, M. T.
Full drawn poultry quick frozen in the "Flexible Froster". Ice and Refrig., 98:329. 1940.