TABLE IV—(*Continued*).

	Description of sample.	Percentage ammoniacal nitrogen evolved.	Cu. ft. of air used.	Time consumed (in hours).	Percentage of ammoniacal nitrogen obtained by distilling 1 hour with MgO
C	No. 303—Same as No. 302.	0.019	6,700	6	0.030
	No. 253—Chicken of known history, two years in storage.	0.027	5,175	3.66	.....
	Aqueous extract of No. 253.	0.025	5,175	3.66	.....
	No. 254—Chicken of known history, two years in storage. Slightly gnawed by mice.	0.032	4,820	3.66	.....
	No. 256—Same as 254.	0.031	11,130	4.5	.....
	No. 298—Same as 254.	0.030	7,350	5	.....
	No. 258—Same as 254.	0.029	5,988	4.25	.....
	No. 299—Chicken of known history, two years in storage. Excellent condition.	0.023	11,610	8	0.036
	Aqueous extract 299.	0.022	11,610	8	.....
	No. 304—Chicken of unknown history in storage six years.	0.058	12,978	6	0.109

[CONTRIBUTION FROM THE FOOD RESEARCH LABORATORY, BUREAU OF CHEMISTRY, UNITED STATES DEPARTMENT OF AGRICULTURE.]

THE DETERMINATION OF THE ACID VALUE OF CRUDE FAT AND ITS APPLICATION IN THE DETECTION OF AGED FOODS.

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During the study of the handling of poultry intended for food, at present under way in this laboratory, it has been found necessary to devise methods for a more accurate estimation of changes in the composition of flesh than have been in common use and which would be sufficiently prompt to permit of the testing of a larger number of samples each day than is ordinarily accomplished with a moderate laboratory force. The acidity of the fat of the chicken has been found to be a sensitive index of the state of preservation of the whole bird. It increases from a very low value in the freshly killed specimen to forty or fifty times the original number, according to the method of preservation and the length of the keeping period. However, the usual procedure for the estimation of the amount of free acid in the fat, that is, extraction with a suitable solvent, drying, etc., was so time-consuming that its use was greatly restricted. It seemed desirable, therefore, to so modify the method that accurate results could be obtained without such an expenditure of time.

It is a common practice in packing-house work to render by a low heat beef or mutton fat and store for commercial purposes. The acid value of such a rendered fat is determined directly in hot alcoholic solution. The rendering of crude fat as a preparation for analysis is mentioned by Dieterich[1] and Pastrovich[2] studying the autohydrolysis of raw tallow rendered it on the water bath with the addition of a few drops of sulphuric acid to decompose the ammonium soaps which had formed in the decomposition. Several washings with hot water freed the fat from excess of mineral acid and it was then dried, weighed, and its acidity determined.

Rendering a fat to free it from enclosing membranes must be carefully done else the heat will cause a splitting, and oxidation must also be considered.

A determination of the amount of water present in the gizzard fat or subcutaneous fat of chickens shows but 5 per cent., or less. This quantity of water, when samples of 10 grams are taken for the determination of the acidity, can be disregarded. The supporting membranes are also a negligible quantity. Accordingly, the fat, both that from the gizzard and from beneath the skin, separated mechanically is ground in a meat chopper and weighed directly into a 250 cc. Erlenmeyer flask. To this is added 50 cc. of alcohol which is neutral to phenolphthalein. This dye is then added as an indicator and the whole brought to brisk boiling, preferably on an electric stove which gives an even heat. The hot alcohol dissolves the fat. It is titrated immediately with 0.1 *N* sodium hydroxide, shaking vigorously, until a pink color appears. The color is not permanent. Indeed it fades very rapidly; hence, a color persisting for one-fourth of a minute can be taken as the end reaction. From the amount of sodium hydroxide used the acid value can be calculated or, if the result is to be expressed as free oleic acid, the latter is found by multiplying the acid value by the factor 0.503.

A simultaneous determination of the acidity of the fat by this method and by extraction with petroleum ether according to the official method of the Association of the Official Agricultural Chemists,[3] as modified by this laboratory, namely, using heat with the solvent to ensure thorough extraction,[4] has been made on fat from chickens kept for varying lengths of time after slaughter and from which the animal heat had been removed both by cold air and by water and ice. The acid value has been determined, also, for both gizzard and subcutaneous fat. The results are collected in Table I.

[1] *Helfenberger Annalen*, II Bd., II *Dezennuims*, **138** (1897).
[2] *Monatshefte für Chem.*, **25**, 335 (1904).
[3] U. S. Department of Agriculture, Bureau of Chemistry, *Bull.* **107**, revised 1908.
[4] *Ibid.*, *Bull.* **115**, 66.

TABLE I.—COMPARISON OF ACIDITY OF CRUDE AND EXTRACTED CHICKEN FAT.

Number and description of sample.	Gizzard fat.				Subcutaneous fat.			
	Acid value of crude fat.	Acid value of extracted fat.	Per cent. of free acid as oleic. Crude fat.	Per cent. of free acid as oleic. Extracted fat.	Acid value of crude fat.	Acid value of extracted fat.	Per cent. of free acid as oleic. Crude fat.	Per cent. of free acid as oleic. Extracted fat.
No. 194—Near-by farm. Cold-air-chilled	0.89	0.82	0.45	0.41	....	....	....	....
No. 198—Same as No. 194	0.59	0.53	0.30	0.27	0.78	0.54	0.39	0.27
No. 200—Same as No. 194	0.71	0.63	0.36	0.32	0.84	0.46	0.42	0.23
No. 223—Same as No. 194	0.56	0.65	0.28	0.33	0.47	0.69	0.24	0.35
No. 226—Same as No. 194	0.66	0.51	0.33	0.26	0.60	0.66	0.30	0.33
No. 228—Same as No. 194	0.78	0.71	0.39	0.36	0.69	1.08	0.35	0.54
No 230—Market chicken. Water-cooled, ice-packed. Age unknown, but at least 7 days after killing	2.63	0.68	1.32	0.34	1.73	0.53	0.87	0.27
No. 237—Fowl, air-chilled 32° F. for 24 hrs	0.76	....	0.38	....	0.98	....	0.49	....
No. 238—Wet-packed broilers. History unknown	0.83	....	0.42	....	0.54	....	0.27	....
MIXED GIZZARD AND SUBCUTANEOUS FAT.								
No. 295—Near-by farm. Cold-air-chilled	0.70	0.21	0.35	0.11	....	....	....	....
No. 305—Chilled at 32° F. for 24 hours. Kept at lab. temp. for 2 days	1.55	1.27	0.78	0.64	....	....	....	....
No. 302—11 months in cold storage	3.40	2.85	1.71	1.43	....	....	....	....
No. 303—Chicken of known history. In freezer 11 months. Thawed by cool air	3.69	3.63	1.86	1.83	....	....	....	....
No. 298—Chicken of known history. 2 years in freezer	7.32	4.69	3.68	2.36	....	....	....	....
No. 299—Same source as No. 298.	7.72	6.56	3.88	3.30	....	....	....	....

It will be observed that the acidity of the crude fat of a chicken chilled in dry air at about 0° C. for 24 hours after slaughter is less than one—generally 0.8, or, reckoned as oleic acid, 0.40 per cent. A comparison of the values obtained from the same fat after extraction shows either absolute agreement or a close duplication so long as the fat has not aged.

When the fat ages the acidity of the crude material is frequently higher than when extracted by petroleum ether. In a few cases the crude fat has been found to give a lower figure than the extracted. Be the comparative values higher or lower, agreement is uncommon, as is indicated in the latter part of Table I.

In the fresh chicken the acid value of the gizzard fat is generally a little less than that of the subcutaneous fat. It may occasionally be very slightly higher. Even so, the acidity of the fat from the two sources is, in the fresh condition, nearly the same.

As the fat ages, it increases in acidity, whether at a temperature below the freezing point, at the temperature of the usual packing-house chill room or the housewife's refrigerator. This increase is pronounced long before the usual signs of deterioration become manifest and for that reason it is of value as a gauge of incipient decomposition.

TABLE II.—CHANGES IN THE ACIDITY OF CRUDE CHICKEN FAT UNDER VARYING CONDITIONS.

Number and description of sample.	Gizzard fat.		Subcutaneous fat.	
	Acid value.	Per cent. of free acid as oleic.	Acid value.	Per cent. of free acid as oleic.
No. 231—Broilers, dry-air-chilled for 24 hours. 24-hr. haul	0.95	0.48	....	....
No. 231(*a*)—Same lot after keeping 4 days at 32°.	2.10	1.06	....	....
No. 231(*b*)—Same lot after 12 days at 32° F.	4.74	2.38	....	....
No. 232—Same shipment as No. 231, but water-chilled and ice-packed	0.88	0.44	....	....
No. 232(*a*)—Same lot after 4 days in cracked ice.	4.57	2.30	....	....
No. 232(*b*)—Same lot after 7 days in cracked ice.	4.71	2.37	....	....
No. 233—Fowl, same history as No. 231. Kept at 32° F. for 8 days	1.65	0.83	1.16	0.58
No. 233(*a*)—Same lot after 12 days at 32° F.	2.41	1.21	1.51	0.76
No. 234—Fowl, same history as No. 232. Kept in cracked ice for 8 days	4.55	2.29	2.12	1.07
No. 234(*a*)—Same lot after 10 days in cracked ice.	8.86	4.46	2.48	1.25
No. 235—Fowl, air-chilled at 32° F. and kept in chill room 3 days	0.80	0.40	0.88	0.44
No. 235(*a*)—Same lot after 6 days in chill room	1.41	1.71	1.05	0.53
No. 236—Fowl, water-cooled, ice-packed and kept in ice three days	2.20	1.11	2.09	1.05
No. 236(*a*)—Same lot kept 6 days in cracked ice.	2.70	1.36	1.26	0.63
No. 237—Fowl, air-chilled at 32° F. for 24 hours	0.76	0.38	0.98	0.49
No. 237(*a*)—Same lot after two days at 32° F.	0.87	0.44	0.83	0.42
No. 218—Fowl from near-by farm. Kept in house refrigerator 3 days	2.18	1.10	1.47	0.74
No. 240—Air-chilled, dry-packed broilers. 2 days railroad haul in refrigerator car	2.47	1.24	....	....
No. 192—Market chicken, not salable	5.99	3.01	....	....
No. 191—Market chicken, no history. Low quality, not fit for sale	6.02	3.03	....	....
No. 193—Market chicken. Stale when purchased. Kept at room temperature for 5 days. Advanced putridity	25.54	12.85	....	....
MIXED FAT.				
No. 284—Just killed when purchased. Kept 6 days in house refrigerator	1.60	0.80	....	....

Table II shows the acid value of the crude fat of fowls of varied history. In a number of cases several analyses have been made of the same lot of fowls at different periods. These experiments show a progressive increase in the acid value as the time lengthens, and they also show that the more perfect the prompt removal of the animal heat, the lower the acidity. The figures are also sufficiently delicate to show the difference between birds dry-air-chilled, and chilled with water and ice, all other conditions being the same. This fact is of service in determining the best methods for the handling of poultry intended for food and is being used in the examination of market poultry dressed and transported and stored in various ways.

It has been stated that in the fresh chickens the subcutaneous fat tends toward a slightly higher acidity than does that of the gizzard. In the aging chicken, on the contrary, the visceral fat is distinctly more acid and is a better indicator of the condition of the rest of the bird.

Conclusions.

The acidity of the crude fat of chickens is an excellent indicator of their freshness. The results obtained on the crude material are more reliable than after extraction with fat solvents. The acidity of the visceral fat increases with length of keeping time or bad handling more markedly than does the subcutaneous fat.

NEW BOOKS.

The Fundamental Principles of Chemistry. *An Introduction to All Textbooks of Chemistry.* By WILHELM OSTWALD. Authorized translation by HARRY W. MORSE. 341 pp. Longmans, Green & Co. Price, $2.25.

This book is a departure from conventional standards, but readers who are familiar with the author's writings will recognize that it is a natural development of ideas which he has long been known to hold. A chemistry has been worked out "in the form of a rational scientific system without bringing in the properties of individual substances." The fundamental concepts and principles of the science are presented in a logical order and "as free as possible from irrelevant additions." The author considers that the development of the methodical side of chemistry has been greatly retarded on account of the fundamental error of using hypothetical assumptions as an aid to experimental work. The end sought "is the discovery of final truths and the relations between them,—. This does not mean the setting up of analogies and hypotheses, but the careful analysis of concepts and indication of the general facts of experience from which they are derived."

The selection of material and the order in which it is presented is shown by the following list of chapters: