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The Vitamin Content of Chicken Tissue As Affected by the Method of Preparation and of Storage After Canning

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Table of Contents

	Page
Introduction	3
Experimental Procedure	4
Part I. Thiamine	4
Test Materials	4
Methods of Assay	4
Part II. Riboflavin, Niacin and Vitamin A	6
Test Materials	6
Methods of Assay	6
Results and Discussion	6
Part I. Thiamine	6
Thiamine Content of Cooked Chicken Tissue	6
Thiamine Content of Fresh Tissue	9
Effect of the Method of Preparation on Thiamine Retention	10
Effect of Canning and of Storage After Canning	11
Part II. Riboflavin, Niacin and Vitamin A	11
Riboflavin and Niacin Content of Fresh Chicken Tissue	11
Effect of the Method of Preparation on Riboflavin and Niacin Retention	12
Effect of Canning and Storage After Canning	13
Summary	14
Bibliography	15

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INTRODUCTION

It has been demonstrated that the process of cooking may influence significantly the quantity of nutrients, especially of some of the vitamins, which are retained in a food. Such data are available for a large variety of foods, however, only a limited number of studies have been reported on the effect of the method of preparation on the vitamin content of chicken meat. Hodson (1941) determined the effect of frying, broiling, stewing, and roasting on the riboflavin content of chicken thighs. Dann and Handler (1942) noted the effect of approximately these same methods of preparation on the niacin content of light and of dark meat of chicken. Lane, Johnson and Williams (1942) observed the effect of stewing on the thiamine content of chicken tissue. More recently Millares and Fellers (1949) and Morgan *et al.* (1949) have reported the effect of cooking and of some methods of preservation on the B-vitamins in chicken meat. Results obtained by these investigators will be discussed at the time the data are presented for this study.

The object of the investigation herein described was to supply information on the relative efficiency of the method of preparation in conserving the thiamine, riboflavin, niacin, and vitamin A content of chicken tissue and to determine the effect of a 9-month storage period, on these vitamins, in the canned meat. The cooking methods used were similar to those followed in common household practice—namely: frying, roasting, stewing and canning.

[1] Includes data from theses submitted by Audrey V. Erdsiek, Margaret S. Kanapaux, and Grace V. Richmond in partial fulfillment of the requirements for the degree of Master of Arts in the Graduate School of the University of Missouri.

EXPERIMENTAL PROCEDURE

Part I—Thiamine

Test Materials. Fifty-five, 11-week-old, Barred Plymouth Rock cockerels, which had been raised on a standard broiler mash, were secured from a commercial poultry farm. They were delivered dressed and averaged 2.5 pounds in weight. They were divided into four groups, selection for each group being made at random. Ten each were used for frying, roasting, and stewing and 25 for canning. More were included in the latter group to allow a sufficient sample for an assay of the canned meat after a 9-month storage period.

All chickens were divided into light and dark meat. The light meat consisted of wings and breast; the dark meat, legs (drumsticks), thighs, and back. For the fresh light meat assay, 32-gram samples were taken from each of the chickens in the canning group, 26 grams from the breast and 6 grams from the wing muscles; for the dark meat, 16 grams were taken from the legs and 16 grams from the thighs. Seven grams were removed from each of the 55 livers for the fresh sample. The remainder of the liver was used for stewing.

The light meat and the dark meat of each group was packaged separately. It was placed into cellophane bags, sealed, and wrapped in moisture impervious commercial wrapping paper. The meat was frozen at –24°C. and stored at –12°C. until cooked or assayed in the fresh state. Livers from all chickens were wrapped in one package, frozen, and stored as described above. Gizzards and hearts were treated similarly.

The meat was cooked according to one of the following processes: (1) stewed in a pressure cooker saucepan, with 2 tablespoons of distilled water for 10 minutes at 15 pounds pressure; (2) roasted in a gas oven at 160°C. for one hour and twenty minutes, to an internal temperature of 85°C.; or (3) fried in hydrogenated fat at 170 - 175°C. for 25 minutes. The livers, plus one-third cup of distilled water, were cooked in a pressure cooker saucepan at 15 pounds pressure for 10 minutes. Gizzards were prepared the same as the livers except that they were cooked for 25 minutes. Preliminary to the canning process, the chicken was cooked at 10 pounds pressure for 5 minutes. The bones, with the exception of those of the legs and wings, were removed. The meat was packed into pint jars, hot broth was added to within one inch of the tops, lids were adjusted and the filled jars were processed at 10 pounds for 65 minutes.

After the various cooking procedures had been completed, the meat was ground and the cooking liquid, from which the fat had been removed, was added. The mixture was spread in a thin layer on porcelain trays and dried in a current of warm air at 38 - 41°C. for approximately 7 hours. The dried meat was ground fine to insure an homogenous mixture and then stored in glass containers at 5°C. until assayed.

Methods of Assay used to determine the thiamine content of the samples were as follows: (1) the biological (rat-growth) method and (2) the thiochrome method.

BIOLOGICAL ASSAY

The basal diet consisted of:

	Per Cent
Casein (B-free)	20
Argo Cornstarch	67
Crisco	3
Solka Flock[2]	4
Osborne and Mendel Salt Mixture	4
Cod Liver Oil	2
	100

The following solution, recommended by Supplee and Bender (1938) and modified by Flumerfelt (1941) to include pantothenic acid, supplied all known necessary B-vitamins except thiamine.

Labco Rice Polish II[3]	116.6 gm.
Vitamin B_6	11.66 mg.
Vitamin B_2	11.66 mg.
Pantothenic Acid	58.83 mg.

Made up to one liter with distilled water.

Rats weighing approximately 40 grams at the time of weaning were fed the thiamine-free basal diet, distilled water, and the thiamine-free B-vitamin solution (6 ml. per rat per week), until they became constant or declined slightly in weight. At this time they were divided into groups, taking care to balance the groups in regard to sex, weight, and distribution of litter mates. They were placed in separate cages with raised screen bottoms and fed the proper reference thiamine dosage or food supplement to be assayed.

Gains in weight of rats receiving the basal died *ad libitum*, the thiamine-free B-vitamin supplement, and a graduated dose of reference thiamine, were recorded weekly during the 4-week experimental period. The average gain made by each group (10 rats per group) was plotted against the thiamine intake (0.0, 1.5, 3.0, 6.0, and 12.0 mcg. per rat per day) to form the reference growth curve.

Amounts of room-dried chicken meat supplements fed, per rat per week, were as follows: (1) dark meat—stewed, roasted, or fried, 9 grams; canned, 12 grams; (2) light meat—stewed, roasted, fried or canned, 12 grams; and (3) liver—stewed, 2.4 grams. The liver, in conjunction with the rice polish, was fed 3 times per week. The meat supplement, mixed with a small portion of the basal diet, was fed twice weekly. After this mixture was consumed the basal diet was allowed *ad libitum*. The average gain in weight of each test group was plotted on the reference growth curve and the amount of reference thiamine required to produce the same gain was read from the graph.

[2] Obtained from The Brown Company, Berlin, New Hampshire.
[3] From The Borden Company, Labco Products Department, 350 Madison Avenue, New York, N. Y.

CHEMICAL ASSAY

Samples of cooked meat were taken from the same room-dried tissue composites as were used in the biological assay. The fresh meat, kept frozen until analyzed, was ground fine in the frozen state. After it was thoroughly blended, aliquots were removed for the chemical assay. The thiochrome method described by the Association of Vitamin Chemists (1947), was followed.

Part II—Riboflavin, Niacin and Vitamin A

Test Materials. Sixty, 11-week-old, White Rock cockerels provided the tissues for these assays. These chickens, as was the case for those used in Part I, had been raised on a standard broiler mash on a commercial poultry farm. They were dressed at the laboratory under the supervision of Professor E. M. Funk of the Department of Poultry Husbandry, University of Missouri.

Selection for each of the groups—frying, roasting, stewing, and canning, was again made at random. Cooking and drying procedures were the same as described for the thiamine assays.

Methods of Assay. The methods used were as follows: (1) riboflavin, (a) the microbiological method of Strong and Carpenter (1942)—a modification of the Snell and Strong (1939) procedure, and (b) an adaptation of the fluorometric method described by the Association of Vitamin Chemists (1947); (2) niacin, the microbiological method of Krehl, Strong, and Elvehjem (1943); and (3) Vitamin A, a modification of the biological (rat-growth) method of Sherman and Munsell (1925).

Moisture and fat determinations were made on all tissues assayed in Part I and Part II. They were done according to the methods described by the Association of Official Agricultural Chemists (1945).

RESULTS AND DISCUSSION

Part I—Thiamine

Thiamine Content of Cooked Chicken Tissue (Biological vs. Chemical Assay). The rats used to establish the thiamine reference growth curve averaged 52 grams in weight at the beginning of the experimental period. Those receiving the reference thiamine survived the 4-week period during which supplements were fed, while the negative controls lived only 17 days. The average gain of each group fed a measured amount of thiamine is plotted in Figure 1.

All rats receiving the test materials as sources of thiamine, except two of the group which received the canned dark meat, survived the 4-week experimental period. In appearance and autopsy findings, those receiving the chicken tissue supplements resembled the animals in the reference groups to which their respective weight gains corresponded. Average gains during 4 weeks, the deviation of the individual weights from the mean (S.D.), and the coefficient of variation for each group are recorded in Table 1.

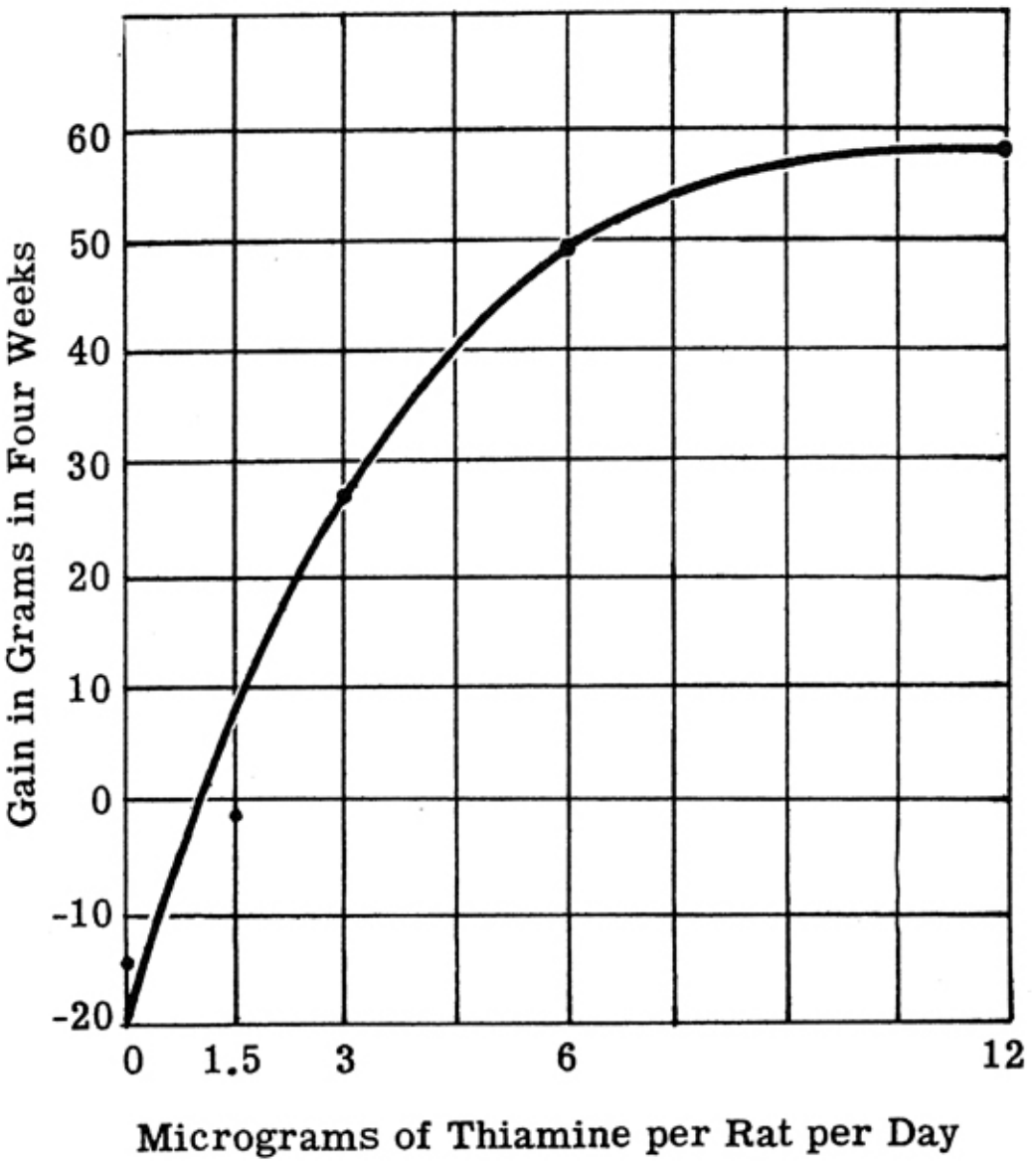

Fig. 1.—Reference curve of the growth response of rats to graded portions of thiamine.

The thiamine values obtained by the biological method are reported in micrograms per gram of sample on the room-dried basis (as fed in the biological assay), and on the moisture-free, fat-free basis (Table 2). Values obtained by the thiochrome method have been included for comparison.

On the average, the amount of thiamine found in these samples was approximately one-third higher when determined by the biological method than when determined by the thiochrome method. Similar differences have been reported by other investigators (Lane, Johnson, and Williams, 1942; Brown, Hamm, and Harrison, 1943; Jentsch and Morgan, 1949; Fardig, Guerrant, and Dutcher, 1951).

TABLE 1--SUMMARY OF GROWTH RECORDS OF RATS RECEIVING THE THIAMINE-FREE DIET ALONE* OR PLUS GRADED AMOUNTS OF THIAMINE OR OF CHICKEN MEAT

Thiamine-free Diet Alone or Plus Supplement		No. of Rats	Gain in Weight in 4 Weeks		
Materials	Amounts per Rat per Week		Av. Gain	S. D.	C. V.
	mcg.		grams	grams	per cent
Negative controls	0.0	10	-14.8	3.0	20.2
Thiamine	10.5	10	- 1.2	5.5	455.0
Thiamine	21.0	10	26.4	4.2	16.0
Thiamine	42.0	10	49.1	2.4	5.0
Thiamine	84.0	10	57.5	8.5	14.8
Light Meat	gm.				
Stewed	12.0	9	38.4	4.2	11.1
Roasted	12.0	10	35.7	6.1	17.1
Fried	12.0	8	24.8	3.9	15.8
Canned	12.0	9	8.0	7.0	88.0
Dark Meat					
Stewed	9.0	10	43.5	5.7	13.1
Roasted	9.0	10	38.7	5.7	14.[illegible]
Fried	9.0	10	25.6	8.1	3[illegible]
Canned	12.0	10	13.7	11.8	
Liver	2.4	10	46.8	6.4	13.7

*This Diet included a solution of all known B-vitamins other than thiamine.

TABLE 2--THIAMINE CONTENT OF COOKED CHICKEN TISSUE

Tissue and Treatment	Thiamine (mcg./gm.)			
	Biological Method		Thiochrome Method	
	Room-dried Basis	Fat-free Dry Basis	Room-dried Basis	Fat-free Dry Basis
Light Meat				
Stewed	2.5	3.3	1.1	1.4
Roasted	2.3	3.1	1.0	1.4
Fried	1.7	2.7	0.7	1.1
Canned	0.9	1.3	0.4	0.6
Dark Meat				
Stewed	3.9	6.0	3.4	5.2
Roasted	3.3	5.1	2.8	4.3
Fried	2.3	3.8	2.3	3.8
Canned	1.1	1.7	0.8	1.2
Liver				
Stewed	16.3	21.6	10.2	13.5

Fardig, Guerrant, and Dutcher (1951) state that thiamine values obtained by the two methods agree well for some foods, but that in the case of high protein foods, especially meat, there is a pronounced difference. Their work shows that the growth-stimulating activity of chopped ham fed to thiamine-deficient rats is due to two factors (1) thiamine in a form readily liberated by the usual extraction procedure in the analytical method and (2) a factor with properties differing from thiamine which stimulates growth in the thiamine-deficient rat. Whether this substance is present in the meat itself, or is synthesized by the intestinal flora of the rat as the result of ingesting the meat supplement, is not definitely known. However, the latter is indicated, since a reduction in the apparent thiamine activity of the ham was observed when the basal diet contained phthalylsulfathiazole.

A possible explanation may be that a physiological inter-relationship exists between thiamine and one of the amino acids, such as the relationship between nicotinic acid and trypophane which has been reported by Rosen, Huff, and Perlzweig (1946). The fact that such large differences in results have been found, suggests the desirability for a thorough investigation as to the causes, and caution when comparing thiamine values obtained by the biological and chemical methods.

Thiamine Content of Fresh Tissue. Only the chemical (thiochrome) method was used to determine the amount of thiamine present in the fresh tissues. Results of these assays as well as the results of the moisture and fat analyses are recorded in Table 3. Vitamin values are given on the fresh basis to facilitate comparison with those from other laboratories. They are expressed on the moisture-free, fat-free basis in order to afford a reliable comparison of the efficiency of the method of preparation in retaining the vitamins in the tissues (Table 4).

TABLE 3--THIAMINE, MOISTURE, AND FAT CONTENT OF UNCOOKED CHICKEN TISSUE

Tissue	Moisture	Fat	Thiamine (thiochrome)	
			Fresh Basis	Fat-free Dry Basis
	Per cent	Per cent	mcg./gm.	mcg./gm.
Uncooked				
Light Meat	73.97	2.48	0.7	3.0
Dark Meat	75.09	5.39	1.5	7.7
Liver	76.60	2.31	3.2	15.2
Gizzard	79.61	----	0.2	1.0

It will be observed in the following summary that the results for the light meat, dark meat, and liver (Table 3) are in good agreement with those given by Millares and Fellers (1949) and by Morgan *et al.* (1949).

The thiamine content of gizzard (0.2 mcg./gm.) is much lower than the values (0.97 and 1.0-2.0 mcg./gm.) reported by the two latter groups of investigators; it agrees more closely with the value, 0.4 mcg. per gram of fresh chicken gizzard, reported by Rice *et al.* (1946).

Vitamin and Method	Fresh Chicken Tissue				Investigators
	Light Meat	Dark Meat	Liver	Gizzard	
	mcg./gm.	mcg./gm.	mcg./gm.	mcg./gm.	
Thiamine (thiochrome)	0.7	1.5	3.2	0.2	This Laboratory
	0.97	1.76	2.70	0.97	Millares and Fellers (1949)
	0.4 to 0.6	0.5 to 0.8	2.3 to 3.1	1.0 to 2.0	Morgan et al. (1949)

TABLE 4--RELATIVE EFFICIENCY OF THE METHOD OF PREPARATION IN CONSERVING THE THIAMINE PRESENT IN CHICKEN TISSUE

Tissue and Treatment	Thiamine (thiochrome)	
	Fat-free Dry Basis	Retention in Terms of Fresh
	mcg./gm.	Per cent
Light Meat		
Fresh	3.0	--
Stewed	1.4	47
Roasted	1.4	47
Fried	1.1	37
Canned (freshly)	0.6	20
Canned (9 months)	0.3	10
Dark Meat		
Fresh	7.7	--
Stewed	5.2	68
Roasted	4.3	56
Fried	3.8	49
Canned (freshly)	1.2	16
Canned (9 months)	0.4	5
Liver		
Fresh	15.2	--
Stewed	13.5	89

Effect of the Method of Preparation on Thiamine Retention. It is realized that the effect of drying on the vitamin content of the cooked tissue may be appreciable, especially in the case of thiamine. Nevertheless, for the biological assay, it was necessary to dry the cooked chicken tissue to prevent spoilage before the supplement was consumed by the rat. Since the drying process was the same for all tissues, a comparison of the relative efficiency of the method of preparation in preserving the vitamin content remains valid. According to Rice and Robinson (1944), dehydration caused an 8 per cent loss of thiamine in cooked pork and a 15 per cent loss in cooked beef.

Values given in Table 4 indicate that stewing, roasting, or frying cause a slightly greater destruction of thiamine in the light than in the dark meat. If a 10 per cent loss is attributed to the drying process, an average of 54

and 68 per cent of the thiamine is retained in cooked light and dark chicken meat, respectively.

Stewing gave the highest retention of thiamine, followed closely by roasting and drying; these differences, however, are not considered significant. McIntire *et al.* (1943) reported that the total retention of thiamine in pork tissue was about the same for all methods (roasting, braising, and broiling)—an average of 70 per cent.

Effect of Canning and Storage After Canning. Rice and Robinson (1944) found 67 - 68 per cent of the thiamine retained in commercially canned pork products. They state, "The findings are markedly different from those of Stanley (1941) who claims the thiamine retention of commercially canned or home canned pork to be only 20 per cent." The results obtained for the thiamine retention in chicken tissue (Table 4), canned according to the method advocated by the U.S.D.A. for home canning, are in good agreement with those of Stanley (1941).

Chicken meat which had been canned in pint jars and stored in pasteboard cartons at room temperature (78°F.) for 9 months lost approximately one-half of the thiamine which it contained when freshly canned. Rice and Robinson (1944) reported a 48 per cent loss of thiamine in canned pork stored at 80°F. for 293 days.

Part II—Riboflavin, Niacin, and Vitamin A

Riboflavin and Niacin Content of Fresh Chicken Tissue. The amount of riboflavin and niacin present in fresh, non-dried tissues, as well as the moisture and fat content of aliquots of the samples are recorded in Table 5. Riboflavin values obtained by the microbiological method are slightly lower than those obtained by the fluorometric method. The difference between the two methods was greatest in the sample which contained the lowest amount of riboflavin. A similar observation was made by Emmett, Bird, Peacock, and Vandenbelt (1941) who compared results obtained for the riboflavin content of the samples assayed by visual fluorescence, photoelectric fluorescence,

TABLE 5--RIBOFLAVIN, NIACIN, MOISTURE, AND FAT CONTENT OF UNCOOKED CHICKEN TISSUE

Tissue	Moisture	Fat	Riboflavin				Niacin	
			Microbiological		Fluorometric		Microbiological	
			Fresh Basis	Fat-free Dry Basis	Fresh Basis	Fat-free Dry Basis	Fresh Basis	Fat-free Dry Basis
	Per cent	Per cent	mcg./gm.	mcg./gm.	mcg./gm.	mcg./gm.	mcg./gm.	mcg./gm.
Uncooked								
Light Meat	75.80	0.41	1.1	4.6	1.7	7.1	119.2	501.1
Dark Meat	77.20	1.60	2.0	9.4	2.4	11.3	57.8	272.6
Liver	44.63	1.81	20.4	86.6	18.4	78.1	116.8	495.8
Gizzard	79.20	0.90	2.5	12.6	2.8	14.1	53.0	266.3
Heart	76.55	7.04	10.6	64.6	10.4	63.4	59.4	362.0

biological, and microbiological methods. They state that generally these methods give similar results and that the greatest differences are observed in samples of low potency.

As indicated in the following summary, the amount of riboflavin and niacin present in the tissues assayed in this study are in close agreement with those reported in the literature.

Vitamin Method	Light Meat	Dark Meat	Liver	Gizzard	Investigators
	mcg./gm.	mcg./gm.	mcg./gm.	mcg./gm.	
Riboflavin (microbiological)	1.1	2.0	20.4	2.5	This Laboratory.
	0.8	2.6	---	---	Waisman and Elvehjem (1941).
	1.2	2.6	---	---	Cheldelin and Williams (1942).
	0.9	1.8	---	1.8	Millares and Fellers (1949).
	0.7 to 0.9	1.8 to 2.7	28.3 to 32.0	0.1 to 2.6	Morgan et al. (1949).
Niacin (microbiological)	119.2	57.8	116.8	53.0	This Laboratory.
	97.0	48.0	97.0	48.0	Millares and Fellers (1949).
	92.0 to 102.0	46.0 to 54.0	84.0 to 129.0	41.0 to 56.0	Morgan et al. (1949).

Effect of the Method of Preparation on Riboflavin and Niacin Retention. Since no significant losses of riboflavin and of niacin were observed by Rice and Robinson (1944) when cooked beef and cooked pork tissues were dehydrated, the losses of these vitamins in the cooked, dried chicken as indicated in Table 6 are considered to be due entirely to the cooking process. The average loss resulting from the three methods of preparation (stewing, roasting, and frying) was riboflavin, 20 and 25 per cent; niacin, 26 and 29 per cent; for dark and light meat, respectively. The differences in the loss of riboflavin and niacin, in light compared to dark tissues, are within the limits of experimental error and are not considered significant.

Frying appeared to be slightly more effective than stewing for conserving the riboflavin. The average retention in light and dark meat was 87 and 66 per cent for frying and stewing, respectively. Retention of riboflavin in the meat alone has been reported to vary from 76 to 100 per cent for roasted pork loin, and 75 to 90 per cent for broiled loin (McIntire *et al.*, 1943). According to Cheldelin, Wood and Williams (1943) the loss of riboflavin due to frying leg and breast of chicken was 5.9 and 0.0 per cent. The data of Morgan *et al.* (1949) show an average riboflavin loss of 22 per cent in broiled leg and breast muscle of chicken. Results from this laboratory (Table 6), as well as those of the other investigators cited, are not in agreement with those of Hodson (1941) who found that frying, roasting, broiling, or stewing caused no measurable destruction of riboflavin in chicken (thighs).

In this study, niacin losses were about the same for stewed, roasted, or fried tissues, an average of 28 per cent. Dann and Handler (1942) observed that cooking light and dark meat of poultry caused niacin losses of 31 to 64 per cent for frying, 26 to 37 per cent for roasting, and 34 to 46 per cent for steaming. McIntire *et al.* (1943) found that 75 to 90 per cent of the niacin was retained in the meat of roasted or broiled pork loin. A niacin loss of approximately 20 per cent was reported by Morgan *et al.* (1949) for broiled light and dark meat of chicken.

Due to variations in cooking procedures and the basis on which results are reported, it is difficult to compare results obtained in one laboratory with those of another. Since riboflavin and niacin are resistant to destruction by heat, losses of these vitamins due to cooking are greater than would be expected.

Effect of Canning and Storage After Canning. An average of 38 per cent of the riboflavin and 26 per cent of the niacin was lost when the light and the dark meat were canned. This is greater than reported (1) for ham canned in 12-ounce cans, (Rice and Robinson, 1944); and (2) for chicken canned in tin or glass jars (Millares and Fellers, 1949).

According to Rice and Robinson (1944) canned pork stored for 293 days at a temperature of 99°F. lost very little riboflavin and niacin. This is in keeping with results obtained in this study, in fact, the canned meat stored for 9 months at 78°F. gave higher assay values for riboflavin than when it was freshly canned (Table 6). No reason can be given to explain these results, other than that the vitamin might have been more readily extracted from the

TABLE 6--RELATIVE EFFICIENCY OF THE METHOD OF PREPARATION IN CONSERVING THE RIBOFLAVIN AND NIACIN PRESENT IN CHICKEN TISSUE

Tissue and Treatment	Riboflavin (microbiol.)		Niacin	
	Fat-free Dry Basis	Retention in Terms of Fresh	Fat-free Dry Basis	Retention in Terms of Fresh
	mcg./gm.	Per cent	mcg./gm.	mcg./gm.
Light Meat				
Fresh	4.6	--	501.1	--
Stewed	2.8	61	367.2	73
Roasted	3.6	78	348.2	69
Fried	4.0	87	355.6	71
Canned (freshly)	2.6	57	348.1	69
Canned (9 months)	3.4	74	329.1	66
Dark Meat				
Fresh	9.4	--	272.6	--
Stewed	6.6	70	202.4	74
Roasted	8.0	85	217.9	80
Fried	8.1	86	183.9	67
Canned (freshly)	6.4	68	214.7	79
Canned (9 months)	8.2	87	216.2	79
Liver				
Fresh	86.6	--	495.8	--
Stewed	66.7	77	451.6	91

stored canned meat. Niacin assay values were the same for the stored canned meat as for the freshly canned meat.

Vitamin A. The amount of Vitamin A in the chicken tissues was too small to be measured; hence the effect of the method of preparation in retaining this vitamin could not be ascertained.

SUMMARY

A study was made of the efficiency of the method of preparation in conserving the thiamine, riboflavin, niacin, and Vitamin A content of heart, gizzard, liver, light meat, and dark meat of chicken and to determine the effect of a 9-month storage period on these vitamins in light and dark canned meat. Methods of preparation included frying, roasting, stewing (pressure cooker sauce pan), and canning. Procedures were comparable to those used in common household practice.

The vitamin content of the fresh chicken tissues, expressed in mcg. per gram, is shown in the following summary.

Vitamin and Method	Light Meat	Dark Meat	Liver	Gizzard	Heart
Thiamine					
(thiochrome)	0.7	1.5	3.2	0.2	---
Riboflavin					
(microbiological)	1.1	2.0	20.4	2.5	10.6
(fluorometric)	1.7	2.4	18.4	2.8	10.4
Niacin					
(microbiological)	119.2	57.8	116.8	53.0	59.4

The thiamine content of cooked chicken tissues determined by the biological (rat-growth) method was approximately one-third higher than when determined by the chemical (thiochrome) method.

Thiamine was retained slightly better by stewing and riboflavin by frying; however, the differences in retention of thiamine, riboflavin, and niacin as affected by stewing, roasting or frying were not considered significant. Losses resulting from the three methods of preparation were: thiamine, 32 and 46 per cent; riboflavin, 20 and 25 per cent; and niacin, 26 and 29 per cent, for dark and light meat respectively.

An average of 72 per cent of the thiamine, 38 per cent of the riboflavin and 26 per cent of the niacin were lost in canning. Storage of the canned meat for 9 months at 78°F. caused a further loss of approximately 50 per cent of the thiamine but no loss of riboflavin or niacin.

The tissues were devoid of measurable amounts of Vitamin A.

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