THE EFFECT OF THE METHOD OF PREPARATION ON THE CALORIC VALUE OF BROILERS AND EGGS

by

ETHELIND SIGLOCH GIBSON

B. S., University of Rhode Island, 1951

A THESIS

submitted in partial fulfillment of the

requirements for the degree

MASTER OF SCIENCE

Department of Foods and Nutrition

KANSAS STATE COLLEGE
OF AGRICULTURE AND APPLIED SCIENCE

1956

TABLE OF CONTENTS

INTRODUCTION

Overweight and obesity are major problems in the United States, and limiting calories is important in weight control. When calories are restricted in the diet, the individual often has difficulty in planning well balanced menus with a reasonable amount of variety. Poultry and egg products should be valuable in such menus because they furnish essential nutrients, are relatively low in calories and lend themselves to various methods of preparation. Poultry contributes complete protein and some of the B-vitamins to the diet, and eggs, in addition to being an excellent source of complete protein, are rich in iron, phosphorus, vitamin A and riboflavin.

There is little specific information in the literature concerning the caloric value of cooked foods. Most food value tables contain information only for uncooked products, or if the nutritive value of the cooked food is given, the method of preparation used is not stated. Moreover, few references were found concerning the caloric value of poultry and eggs after different methods of cookery were employed. It was, therefore, considered desirable to obtain information on the caloric value of broilers and eggs prepared by several methods. Broilers were broiled, pan-fried and deep fat fried; whereas eggs were scrambled, poached and fried. Samples of broilers and eggs cooked by the given methods as well as raw samples were analyzed to determine the percentage of moisture, ash, fat and total nitrogen present. From these data the caloric value of each sample was calculated.

REVIEW OF LITERATURE

Determination of Caloric Values. The Atwater System

The energy value of a food may be determined directly by burning a sample of the food, or it may be calculated by applying previously determined figures which express heats of combustion to the composition of a food. According to Brody (1945), "Equivalent quantities of different forms of energy yield equal quantities of heat. All forms of energy may, therefore, be expressed in heat units." The unit used in nutrition work is the large calorie, and Chaney (1954) defined this as, "The amount of heat required to raise the temperature of one kilogram of water one degree Centigrade."

Chatfield and Adams (1940) pointed out that the first comprehensive tables on the composition of American foods were issued by Atwater and Bryant in 1896. These tables were based on extensive investigations carried out by Atwater and his colleagues at the Connecticut Agricultural Experiment Station. Merrill and Watt (1955) reviewed these classic experiments, which provided the basis for the method used in the United States to calculate the energy value of foods. Other authors such as Chaney (1954) and Sherman (1952) referred to them in textbooks on nutrition. Briefly, in Atwater's system, calories are calculated by multiplying grams of protein, fat and carbohydrate by the factors 4, 9, 4, respectively.

Determination of the Fuel Value for Protein. In the United States it is common practice to calculate the protein content of

a food from the nitrogen present. This is accomplished by applying a factor considered appropriate for converting nitrogen to the protein in the given food. The factor used depends on the nitrogen content of the predominating protein in the food, Merrill and Watt (1955). Since many of the commonly occurring proteins contain approximately 16 percent of nitrogen, for general purposes the factor used is 6.25. Holcomb and Maw (1934) stated that in their work the appropriate numerical factor to convert nitrogen to protein varied according to the type of tissue from which the sample was taken. These authors found that the factor for muscular tissue of chickens was 6.25 and for the skin and connective tissue, 5.55. As a result of this and other information, special factors have been derived for converting nitrogen to protein in foods for which there was sufficient information to justify their derivation.

Figures reported for protein in American tables of food composition generally represent crude protein. These data are derived by applying the appropriate factor to the total nitrogen in the food, but actually, all nitrogen present is not in the form of protein.

Merrill and Watt (1955) illustrated Atwater's procedure for obtaining the heat of combustion for the total nitrogen in a food. For example, Atwater determined that the proteins in cereal grains contained 17.5 percent of nitrogen, and the protein content of the grains was computed by multiplying the percentage of nitrogen by the factor 5.7. He assumed that not more than 96 percent of the nitrogen was protein nitrogen and not less than four percent was

non-protein nitrogen. Thus, one gram of protein nitrogen in cereal was considered equivalent to 5.47 grams of protein (0.96 grams of nitrogen x 5.7).

Merrill and Watt (1955) continued that for the heat of combustion for the protein in meat Atwater found that it was most satisfactory to use the figure 5.65 calories per gram, which is the value for the total nitrogen in fat free muscle. He estimated the heat of combustion for the nitrogenous portion of egg to be 5.75 calories per gram. His estimation for this value was based on data for the proteins in egg white and yolk and assumed that very little non-protein nitrogen was present.

In this country, heat of combustion factors are applied to total nitrogen treated as protein without regard to the nitrogen components present. Since the heat of combustion of true proteins is usually higher than that of other nitrogenous compounds, error will occur in calculating the caloric value of a food that is attributable to protein. Merrill and Watt (1955) stated that in terms of total energy value this error is not serious, because foods high in non-protein nitrogen usually contain relatively small amounts of total nitrogen.

Merrill and Watt (1955) as well as Sherman (1952) and Chaney (1954) reviewed Atwater's method for arriving at the fuel value of protein. Sherman (1952) explained that Atwater realized that it was necessary to correct the heat of combustion figures for protein. He stated that when proteins are burned, the carbon is given off as carbon dioxide, the hydrogen as water and the nitrogen as a gas. Since the nitrogen is given off as a gas, it

contributes nothing and removes nothing from the heat of combustion. Therefore, Atwater found it necessary to subtract 1.25 calories per gram from the heat of combustion figures obtained for protein. The 1.25 calories represented the heat of combustion of the nitrogenous end products excreted by the body per gram of protein. Atwater also found that only 92 percent of the protein taken into the body is used. To calculate the fuel value of protein in meat he subtracted 1.25 from the heat of combustion value, 5.65, and multiplied the difference, 4.4, by 0.92. In this way he arrived at the figure of 4.0 calories per gram of protein.

Determination of the Fuel Value for Fat. According to Merrill and Watt (1955) the heat of combustion of the ether extract from a food depends on the fatty acids peculiar to the triglycerides therein, and on the other ether extractable materials present. Lower figures for heats of combustion have been reported for total ether extracts than for triglycerides. Nevertheless, these workers pointed out that Atwater applied the heat of combustion figures for triglycerides to crude fat. He assumed that the error resulting from the use of the higher heat of combustion factors would offset, at least in part, any possible error resulting from incomplete extraction of fat.

Atwater's method for estimating the fuel value of a fat was explained by Sherman (1952). Atwater determined that the coefficient of digestibility of fat is about 95 percent, and the heat of combustion was 9.45 calories per gram. He arrived at the figure 9.0 (8.9775) calories per gram of fat by multiplying 9.45 x 0.95. Merrill and Watt (1955) reported the calculation to be 9.5 x 0.95 = 9.02.

Determination of the Fuel Value for Carbohydrate. Chaney (1954) pointed out that when Atwater burned a pure carbohydrate in the calorimeter it yielded 4.1 calories per gram. However, Sherman (1952) explained that only 98 percent of the carbohydrate taken into the body is used. Therefore, when Atwater multiplied 4.1 x 0.98 he arrived at the figure of 4.0 calories per gram. According to Merrill and Watt (1955) Atwater also calculated the caloric value of a food attributed to carbohydrate by difference. The difference between 100 and the sum of the crude protein, fat, moisture and ash was called "total carbohydrate" or "carbohydrate by difference".

Caloric Values Determined by Calculation and by Burning. Merrill and Watt (1955) reviewed an experiment in which Atwater determined the caloric value of 276 samples that included food of both animal and plant origin. In part of the samples the fuel values were calculated from data on the composition of the samples, whereas the values for the other samples were determined by directly burning the food. According to Merrill and Watt, the results of this experiment showed that the figures for the two methods were in good agreement and the few values that deviated from the mean were insignificant.

Methods of Calculating Caloric Values in the United States and the United Kingdom

World War II brought about serious food shortages in many countries of the world. In giving aid to these countries the United Nations found it necessary to determine the caloric needs

of the hungry people and to send food in terms of its caloric value. This brought up a question as to the most satisfactory method for calculating calories. The Atwater system had been used in the United States for almost 50 years. On the other hand the United Kingdom preferred the system devised by Rubner. The physiological fuel values Rubner derived are: protein, 4.1; fat, 9.3 and carbohydrate, 4.1 calories per gram.

One of the major differences between these two methods, as pointed out by Maynard (1944), is that Rubner did not allow for losses of protein, fat and carbohydrate during digestion, whereas Atwater did. However, if Rubner's figures are multiplied by the coefficients of digestibility they become approximately the same as the Atwater factors.

Rubner realized that figures for heat combustion of protein, carbohydrate and fat varied with individual foods. However, he thought it possible to derive an average figure for these nutrients that would be applicable to mixed diets. Morey (1936) showed that when the Rubner and Atwater factors were used in calculating the caloric values of mixed diets, the totals obtained with Rubner's figures were about three percent higher than those of Atwater. For individual diets, this difference is small, but in large scale feeding programs, the difference becomes too great to pass unnoticed.

Differences in the Rubner and Atwater Methods for Calculating Calories Attributable to Protein. Morey (1936) pointed out that Atwater's factor of 4.4 for one gram of available protein is higher than Rubner's 4.1. She explained that Atwater did not

consider the loss of protein in feces whereas Rubner did. Rubner also considered the differences in values for heat of combustion between animal and vegetable sources of protein. After much experimental work Rubner felt justified in averaging the figures he obtained for animal and vegetable proteins as a standard figure applicable to mixed diets, Morey (1936). The figure he derived was 4.1 calories per gram.

Differences in the Rubner and Atwater Methods for Calculating Calories Attributable to Fat. Atwater averaged the values for the heat of combustion for the triglycerides he found to occur most commonly in foods, and applied this figure to crude fat. Thus he arrived at 9.0 calories per gram for the fuel value of fat. Morey (1936) reported that Rubner allowed for the difference between animal and vegetable fats by averaging the heat of combustion values for olive oil, animal fat and butter fat. This average, according to Morey, was 9.31 calories per gram which Rubner designated as the fuel value for fat.

Differences in the Rubner and Atwater Methods for Calculating Calories Attributable to Carbohydrate. Atwater calculated "carbohydrate by difference". Rubner, as stated by Morey (1936), analyzed many foods and found that carbohydrate was present mainly as starch. As a result he determined the heat of combustion for starch to be 4.12 calories per gram, and used this figure as the fuel value for carbohydrates.

McCance and Widdowson (1940) modified Rubner's system and devised a method called "available carbohydrate". Maynard (1944)

described "available carbohydrate" as the directly determined values for starch, sugars and dextrins. McCance and Widdowson (1940) expressed all these carbohydrates as glucose and used 3.75, the fuel value of this sugar, as the heat of combustion for carbohydrate. This method is used extensively in the United Kingdom today, Maynard (1944).

Composition of Broilers

Very few references were found in the American literature concerning the composition of poultry with specific reference to caloric value. Most figures for the composition of poultry meat were for the raw product; very little data were found for cooked birds. Watt and Merrill (1950) included for the first time, in their food composition tables, figures for the composition of cooked foods. These authors stated that although their values were in tentative form and were based on very little experimental work, they approximated the nutritive value of food as eaten more closely than did figures for uncooked foods.

Among the references reviewed on the composition of poultry was that of Watt and Merrill (1950) who gave the average composition of 100 grams of edible raw meat from broilers to be as follows: water, 71.2; protein, 20.2; fat, 7.2 and ash, 1.1 grams. The average fuel value for such a sample was reported as 151.0 calories. McLester and Darby (1952) reported these same figures for composition of raw broilers.

Generally the figures in food value tables are based on 100 grams of edible food. However, this is not always true; Bowes and

Church (1951) reported the following figures for certain constituents in 170.0 grams of a fried broiler half: protein, 45.3; fat, 27.2; carbohydrate, 6.2 grams and calories 464.0. If these figures were based on 100 grams of meat the results would be: protein, 26.6; fat, 16.0; carbohydrate, 3.6 grams and calories, 272.9. As another example, Bradley (1931) gave the composition of 160.0 grams of broiled meat from broilers as: protein, 20.0; fat, 2.19; carbohydrate, 0.0 grams and calories, 100.0. When the composition of the same broiler meat is based on 100 grams of meat the figures are: protein, 12.5; fat, 1.4 and calories, 62.5. The values of Bowes and Church (1951) for fried broilers are considerably higher than those reported by Watt and Merrill (1950) for raw meat. The percentages reported by Bradley (1931) for broiled birds, are lower than those reported for either raw or fried meat.

It was pointed out by Pennington (1951) that feeding chickens before slaughter changed the composition of the edible portion of the bird. Fat replaced some of the water in the tissues and the relative amount of protein was decreased after feeding. She gave the following percentages for broilers before and after feeding, which were taken from the work of Hepburn and Broomell:

	Water	Fat	Protein
Before feeding	70.87	7.23	20.11
After feeding	63.39	16.91	17.44

Hepburn (1950) carried on a study involving the changes in moisture, ether extract, ash, protein, basic nitrogen and amino acid content of light and dark meat from broilers and roasters

stored at -9.4° C. to -12.2° C. for periods of four to six months. Usually the ether extract was higher and the protein lower in dark than in light meat. The light meat usually had a higher value than the dark for the total nitrogen in an aqueous extract, amino acids, basic nitrogen and peptone nitrogen, and a lower value for proteose nitrogen. With the exception of moisture changes during storage, there were no significant differences noted between broilers and roasters. In storage the moisture content of the roasters decreased more in the light than in the dark meat. This was not true of the broilers.

Composition of Eggs

Romanoff and Romanoff (1949) wrote, "Compared with the hen's egg, no other food of animal origin is eaten and relished by so many people the world over; none is served in such a variety of ways. Its popularity is justified not only because it is so easily procured and has so many uses in cookery, but also because it is almost unsurpassed in nutritive excellence."

Romanoff and Romanoff (1949) reported the average composition of a raw egg to be: water, 38.0; protein, 6.6; carbohydrate, 0.5 and fat, 6.1 grams. These authors gave the caloric value of a 58 gram egg (with shell) as 92.4. McLester and Darby (1952) gave the percentage composition of 100 grams of raw eggs as: water, 74.0; protein, 12.8; fat, 11.5 and ash, 1.0 grams. Sweetman and MacKellar (1954) cited these same figures for the percentage composition of raw eggs; they closely resemble those of Romanoff and Romanoff (1949). If the percentages given by McLester and Darby

(1952) had been based on 50 grams they would have been: water, 37.0; protein, 6.4; fat, 5.8 and ash, 0.5.

The protein and fat content of 52 grams of scrambled eggs were reported by Bradley (1931) to be 6.03 and 9.0 grams, respectively. The values recorded by this author for 45 grams of raw egg were: protein, 6.03 and fat 4.72 grams. The fuel values given for these same samples were 105 calories for the 52 grams of scrambled and 66 calories for the 45 grams of raw eggs. McCance and Widdowson (1940) reported the following figures for 100 grams of eggs given several treatments:

Eggs	Protein grams	Fat grams	Calories
Fried	14.1	19.5	239.0
Poached	12.4	11.7	160.0
Raw	11.9	12.3	163.0

The following values for eggs prepared by various methods were presented by Bowes and Church (1951):

Eggs	Weight grams	Protein grams	Fat grams	Carbohydrate grams	Calories	Remarks
Boiled	54	6.1	5.5	0.3	77	
Fried	50	6.1	9.2	0.3	110	1 t. marg.
Poached	48	6.1	5.5	0.3	77	
Scrambled	65	6.6	9.8	1.0	120	1 T. milk 1 t. fat
Raw	54	6.1	5.5	0.3	77	

Chemical Methods Used to Analyze Broilers

Chemical methods for the analyses made in the present study were reviewed; namely, methods for the determination of moisture, ash, fat and protein in meat and eggs. Several methods for the analysis of each of these components were presented in the literature, some of which will be discussed briefly.

Preparation of Sample. According to Jacobs (1951) the analysis of meat is usually done on the lean portion, therefore, the skin, bones and visible fat are removed. The meat is then ground at least three times and any liquid that is squeezed out is reincorporated with the sample. The ground meat is kept in hermetically sealed containers and stored until the analyses are made.

Moisture. Jacobs (1951) reported that the procedure commonly used for the determination of moisture in meats is the "Direct Heating" method. With this method the sample is dried in an oven maintained at 75° C. to 80° C. for 24 hours. The difference in the weight of the sample before and after drying is designated as moisture. For very accurate results this author recommended the "Sulfuric Acid" method in which the sample is placed in a vacuum desiccator containing 200 milliliters of concentrated sulfuric acid. The sample is left in the desiccator for 24 hours and then weighed. As in the "Direct Heating" method the loss in weight is reported as moisture.

Jacobs (1951) pointed out that the "Immiscible Solvent Distillation" method also may be used to determine moisture in meat. This method distinguishes between water and volatile matter.

The sample is placed in a flask and covered with toluene or another solvent immiscible with water. The mixture is then distilled. The percent moisture is calculated from the reading of the volume of water in the distillate.

Ash. Ash is the residue that remains after a food has been ignited to the temperature of red heat and is free of carbon. According to Woodman (1941) the determination of ash by the "Total Ash" method is generally used for food products. The sample is placed in a weighed platinum dish which is then placed in a muffle furnace. It is heated to a low redness until a white ash is obtained. The residue is weighed and reported as ash.

Fat. According to Woodman (1941) the percentage of fat in foods is measured by extracting the fat with ether and weighing it. This material is usually reported as fat, but the more specific term is ether extract, because the ether will dissolve liquids other than fat. One of the most common ways to extract fat from a sample is by means of a Soxhlet extraction apparatus. A dried sample is placed in an "extraction thimble," the thimble is plugged with cotton and placed in the apparatus which contains ether. The ether is heated and siphoned over the material in the thimble. After the extraction period, the ether is carefully evaporated and the residue dried and weighed.

Jacobs (1951) explained that in the "Ether Extract" method for the determination of fat in meat, the proteins are dissolved and the fat is liberated. A weighed sample of meat is placed into a tall form 100-milliliter beaker and to this is added water and ammonium hydroxide. The mixture is warmed until the meat is

thoroughly softened, after which hydrochloric acid and sand are added. The sample is then boiled until the meat is completely dissolved. The solution is cooled and transferred to a Mojonnier extraction tube. The beaker is rinsed with small portions of ethyl ether; these washings are added to the solution in the Mojonnier tube, and the tube is stoppered and shaken to mix the contents. The washings are repeated, but this time petroleum ether is used in place of the ethyl ether. The polar and non-polar layers are allowed to separate and then the ether layer is drawn off into a tared fat flask. At this point the "Roese-Gottlieb" method for fat determination is followed. After the ether layer is drawn off it is transferred to a Mojonnier extraction tube and to this ammonium hydroxide is added. After a series of water, ether and alcohol additions, filtering and shaking, the ether is evaporated off on a steam bath. The flask is then heated in an oven maintained at a temperature of 100° C. to 105° C., cooled in a desiccator and weighed. The weight of the material in the flask is the amount of fat in the sample.

According to Jacobs (1951) the "Gerber" method is considered a fairly accurate method for the determination of fat in meats. He explained that a sample of meat is weighed and placed into a cheese butyrometer and to this is added a specific amount of borax solution, the mixture is then heated in a water bath. When the meat is soft, amyl alcohol and a specially prepared solution of sulfuric acid is added. The mixture is then centrifuged and the butyrometer is read for the percentage fat.

Another common method for the determination of fat in meat

is the "Modified Babcock" method, Jacobs (1951). The sample of finely ground meat is placed in a Waring blendor with cracked ice and oakite. After thorough mixing the mixture is placed in a Babcock flask with glacial acetic acid; sulfuric acid and water are added alternately with centrifuging. The flask is then immersed in water and the amount of fat is read from the calibrations on the flask.

Protein. The protein in a food is usually determined from the nitrogen content of the sample. Many protein foods contain approximately 16 percent of nitrogen, therefore, in general the factor 6.25 is used in the conversion of nitrogen to protein. The Kjeldahl method is employed most commonly for the determination of nitrogen. Many modifications have been made to the original Kjeldahl method, however, the basic principles are the same. Jacobs (1951) stated that the Kjeldahl method depends on the decomposition of organic nitrogen compounds by boiling with sulfuric acid. The carbon and hydrogen in the organic material are oxidized to carbon dioxide and water. The sulfuric acid is reduced to sulfur dioxide which reduces the nitrogenous material to ammonia. The sulfuric acid and ammonia combine to form ammonium sulfate, but the addition of sodium hydroxide liberates the ammonia. The ammonia is distilled into a known amount of standard acid and the excess acid is determined by titration with a standard base.

The Kjeldahl-Gunning-Arnold method is based on the same principles as the Kjeldahl with only a few changes, Jacobs (1951). Copper sulfate or mercury is added to act as a catalyst in the

reaction. To speed up digestion potassium sulfate or sodium sulfate is added; these compounds are added to raise the temperature of the mixture.

Chemical Methods Used to Analyze Eggs

The chemical methods used to determine the amount of moisture, ash, fat and protein in meats also are used, with some modifications, for eggs.

Moisture. Jacobs (1951) stated that the moisture content of eggs is determined in the same manner as that for the other foods. However, for accurate results this author suggested that the egg sample be evaporated to dryness before placing in the vacuum oven.

Ash. Before determining the percentage of ash in egg samples, Jacobs (1951) stated that it is necessary to make the eggs alkaline by adding a 10 percent sodium carbonate solution. After the desired degree of alkalinity is obtained any of the methods for determining ash content in meats are applicable to eggs.

Fat. Jacobs (1951) pointed out that the determination of fat in eggs is generally done by an acid hydrolysis modification of the "Roese-Gottlieb" method. With this method a weighed sample of egg is placed in a separatory flask and to this, water and ammonium hydroxide are added. The mixture is heated, then hydrochloric acid and a pinch of sand are added, and the entire mixture is brought to a boil. After boiling, the mixture is allowed to cool and water and two types of ether are added. The polar and non-polar layers are allowed to separate and the ether layer is drawn off. From this point on the regular "Roese-Gottlieb"

procedure that was described under broilers is followed.

Protein. Jacobs (1951) reported that the nitrogen in eggs is usually determined by the "Kjeldahl-Gunning-Arnold" method.

MATERIALS AND METHODS

Source of Broilers and Eggs and Treatments Applied to Them

Broilers. Ready-to-cook broilers weighing approximately one and one-half pounds were purchased from a commercial broiler farm. Half birds were wrapped in aluminum foil, frozen in still air at 0° F. and held in frozen storage at 0° F. until they were cooked and prepared for chemical analyses.

The frozen half birds, chosen at random, were defrosted in a refrigerator (38° F.) for 48 hours. The thawed broilers were cooked by: (1) broiling, (2) pan-frying and (3) deep fat frying, or (4) they were left raw. The fourth treatment provided uncooked meat for a reference point in drawing conclusions concerning the other three treatments.

Eggs. Twelve dozen eggs from a flock of single comb, White Leghorn, ghostly strain hens, were obtained from the Department of Poultry Husbandry, Kansas State College. The eggs were stored in a refrigerator at 37° F. until the samples were cooked and prepared for chemical analyses. The preparation of the samples was completed within a period of ten days.

The eggs, chosen at random, were cooked by: (1) poaching, (2) scrambling and (3) pan-frying, or (4) they were left raw. The data from the raw eggs were used as a reference point for

drawing conclusions concerning the other three treatments.

Design for Assigning the Treatments

Broilers. The work on broilers was divided into two parts. In each part 40 half birds, chosen at random from those available for the experiment, were divided equally among the four treatments. In part I the samples prepared for chemical analyses included the skin of the bird, whereas in part II the samples were prepared without skin. In both parts, the light and dark meat from each half bird were prepared separately.

Eggs. Twelve dozen eggs were assigned at random to the four treatments. Ten samples of four eggs each were cooked by each of the three methods, and then subjected to chemical analyses. Two dozen raw eggs were blended and ten aliquots of 100 grams each were removed for chemical analyses.

Methods of Cooking

All methods of cookery used for both broilers and eggs were standardized by preliminary work.

Broilers. The birds that were broiled were placed skin side up on a rack three inches high and set in an aluminum roasting pan. The pan was placed in a rotary gas oven maintained at a temperature of 375° F. and cooked for 60 minutes. Total cooking losses were calculated for all the cooked birds.

The pan-fried broilers were fried in 30 grams of fat for 50 minutes in an electric frying pan maintained at a temperature of 375° F. The bird was browned, skin side down, for five minutes,

then it was turned over and cooked for 20 minutes with the lid on the pan. For the last 25 minutes the bird was cooked skin side down with the lid off.

The deep fat fried birds were cooked in a Wells F-30 fryerlator at 325° F. for 25 minutes; ten minutes with the skin side up and 15 minutes with the skin side in the fat. After cooking, the bird was drained on a slotted spatula for 30 seconds; 15 seconds skin side up and 15 seconds with the skin side down.

Eggs. For scrambled eggs the following recipe was used:

Eggs	200 grams
Milk	82 grams
Margarine	18 grams

The milk and eggs were blended with a fork and cooked in the 18 grams of margarine in an electric frying pan maintained at a temperature of 320° F. for one minute and 15 seconds. During the cooking the eggs were stirred lightly with a slotted spatula.

Four eggs were poached at one time. They were placed in a covered poacher and cooked for three minutes. One cup of water was kept simmering in the bottom of the poacher during the cooking period.

Four eggs were fried for two minutes in 25 grams of fat in an electric frying pan maintained at a temperature of 300° F. The pan was covered during the cooking period. When the eggs were removed from the pan they were allowed to drain for three seconds on a slotted spatula.

Approximately 1200 grams of raw eggs were mixed until the yolks and whites were thoroughly blended. Ten aliquot portions of 100 grams each were prepared for chemical analyses. Data from

these samples were used as a reference point in interpreting the data from the other samples.

Preparation of Samples for Chemical Analyses

Broilers. All meat was removed from the bones keeping the light and dark portions separate. When the skin was not to be included, it was carefully removed from the meat and discarded. The meat was ground twice with a medium knife in a Universal (No. 3) food grinder, placed in a Waring Blendor equipped with three cutting blades, and blended until the sample was homogeneous. Raw meat and that from pan-fried and deep fat fried birds was blended for one minute on low and two minutes on high speed. Broiled meat was blended for three minutes on low speed; this meat was juicier than that cooked by the other methods, and it was more difficult to blend the sample. By blending on low speed less strain was placed on the motor of the blendor. After blending, the meat was placed in sample bottles and held in a home freezer at -20° F. until the chemical analyses were done.

Eggs. After cooking, the eggs were placed in a Waring Blendor equipped with three cutting blades and blended on low speed. Scrambled eggs were blended four minutes; fried eggs, three minutes; and poached and raw eggs for two minutes. After blending they were sieved through a fine mesh tea strainer to break up any large pieces of coagulated protein. After sieving they were placed in sample bottles, and held in a home freezer at -20° F. until the chemical analyses were made.

Chemical Analyses and Calculation of Caloric Values

All chemical analyses were done by the Chemical Service Laboratory at Kansas State College. The methods followed were those described in the Official and Tentative Methods of Analyses of the Association of Official Agricultural Chemists, 5th edition, 1950, with certain modifications that the Chemical Service Laboratory found useful to them. The percentage of moisture and ash were determined for all samples of broilers and eggs. The percentage of ether extract and total nitrogen (Kjeldahl) in all samples of broilers, and the percentage of organic and ammoniacal nitrogen, and fat by acid hydrolysis in the egg samples were measured. The details of the methods used are presented in the Appendix.

Caloric values for both broilers and eggs were computed on the basis of the Atwater physiological fuel value figures for protein and fat, and were based on 100 grams of food. Specifically protein was calculated as follows:

Nitrogen x 6.25 = crude protein
Crude protein in grams x 4.0 calories per gram = calories of protein

The calculation for fat was:

Fat in grams x 9.0 calories per gram = calories of fat

Statistical Analyses

Broilers. Analyses of variance were run on the caloric values for broilers subjected to each of the treatments. The analysis

used to determine whether or not there were differences in the caloric values of broilers that were attributable to the treatments (methods of cooking) and to serving the skin with the meat was:

Source of variation	D/F
Treatments	3
Skinned vs unskinned	1
Treatment x skinned vs unskinned	3
Samples	72
Total	79

In order to study differences in the caloric values of light and dark meat as well as differences that could be attributed to the treatments and the skin over the meat the following analysis was run:

Source of variation	D/F
Treatments	3
Light vs dark	1
Skinned vs unskinned	1
Treatment x light vs dark	3
Treatments x skinned vs unskinned	3
Light vs dark x skinned vs unskinned	1
Treatment x light vs dark x skinned vs unskinned	3
Samples	144
Total	159

Eggs. The caloric values for eggs given the four treatments were analyzed as follows:

Source of variation	D/F
Treatments	3
Samples, same treatment	36
Total	39

If the analysis of the data relative to broilers and eggs showed that there were significant differences attributable to the main effects or to interactions, two-way tables of means were analyzed by least significant differences.

RESULTS AND DISCUSSION

Broilers

Samples of 100 grams each from raw, broiled, pan-fried and deep fat fried broiler halves were analyzed for the percentage of moisture, ash, ether extract and nitrogen therein. Samples of light and dark meat, skinned and unskinned, were analyzed separately. These data are presented in Tables 6 through 13 (Appendix).

Because of the small quantity of carbohydrate in broiler meat no chemical analysis for this component was made. It was not possible to calculate the percentage of carbohydrate by difference, because for some samples the sum of the figures for moisture, ash, ether extract and nitrogen equalled more than 100. This discrepancy was attributed to experimental error.

The figures for ether extract and for nitrogen, converted to protein by multiplying by the factor 6.25, were used to calculate the caloric value of each sample. The Atwater physiological fuel

values were used in the computations. Data for the percentage of moisture and ash helped to provide an over-all picture for the composition of the samples, but they will not be discussed in this manuscript.

Mean caloric values for light and dark meat from raw, broiled, pan-fried and deep fat fried broiler halves are presented in Tables 1 and 2, and detailed data are given in Tables 14 and 15 (Appendix). All methods of cookery used in this experiment increased the caloric value of the meat. One of the reasons for this probably is that during cooking, moisture was lost into the drippings and through evaporation, and as a result there was a concentration of the fat and protein.

Table 1. Mean caloric values for skinned light and dark meat from broiler halves given four treatments.

Treatment	From fat		From protein		Total calories		
	Light	Dark	Light	Dark	Light	Dark	Light + dark
Raw	12.6	32.5	96.5	86.0	109.1 ns	118.5 *	227.6 *
Broiled	23.3	47.0	129.9	119.7	153.2 * ns	166.7 ns	319.9 ns
Pan-fried	30.3	55.6	131.5	124.5	161.8 *	180.1 ns	341.9 ns
Deep fat fried	45.6	54.0	133.7	124.3	179.3 ns	178.3	357.6

* = Significant at the 5.0% level
ns = Non-significant
lsd* (Total calories, light vs dark and treatment comparisons) = 13.0
lsd* (Total calories, light plus dark and treatment comparisons) = 29.3.

Table 2. Mean caloric values for unskinned light and dark meat from broiler halves given four treatments.

Treatment	From fat		From protein		Total calories		
	Light	Dark	Light	Dark	Light	Dark	Light + dark
Raw	39.2	63.8	91.9	81.1	131.1 *	145.0 *	276.1 *
Broiled	48.5	79.4	137.9	132.0	186.4 * ns	211.8 ns	398.2 ns
Pan-fried	66.5	80.9	124.4	130.6	190.9 * *	211.5 *	402.4 *
Deep fat fried	103.3	99.1	154.6	138.2	257.9 *	237.3	495.2

* = Significant at the 5.0% level
ns = Non-significant
lsd* (Total calories, light vs dark and treatment comparisons) = 13.0
lsd* (Total calories, light plus dark and treatment comparisons) = 29.3.

Analysis of variance as presented in Table 17 (Appendix) indicated no significant differences in caloric values of the samples that were attributable to treatments (methods of cooking), or between the light and dark meat or the skinned and unskinned meat. The over-all differences among samples that could be ascribed to these factors were not significant because of the very highly significant interaction for treatment x skinned.

However, calculation of least significant differences between means showed that the mean value for the total calories in samples from broiler halves (light and dark meat combined) that were broiled was significantly higher than the mean value for samples of raw meat. The mean caloric value for pan-fried broiler halves was higher than that for half birds that were broiled, but the difference was not statistically significant. Likewise the

mean value for skinned deep fat fried broilers was greater than that for pan-fried halves, but again the difference was non-significant. However, the difference between unskinned pan-fried and deep fat fried meat was significant, and the mean caloric value for deep fat fried broiler halves was significantly higher than that for the broiled meat.

When the mean caloric values for the light and dark meats from birds given the four treatments were analyzed separately, the differences in the light meat and those in the dark meat followed about the same pattern of significance as the caloric values for combined light and dark meat (Tables 1 and 2). The only exception occurred between the mean values for skinned, dark, pan-fried and deep fat fried meat. The difference between these values was non-significant, whereas the difference between mean caloric values for combined light and dark meat was significant (Table 1). Mean values for dark meat were significantly higher than those for light meat with the exception of those for skinned raw and deep fat fried skinned and unskinned meat (Tables 1 and 2). Further information is given in Table 18 (Appendix).

Mean values for the calories from fat and protein were not analyzed statistically. However, it was calculated from the data in Tables 1 and 2 that fat and protein contributed to the total calories as indicated by the percentages given in Table 3.

Table 3. Percentage of the total calories provided by fat and protein for skinned and unskinned meat from broiler halves given four treatments.

Treatment	Fat		Protein	
	Skinned	Unskinned	Skinned	Unskinned
Raw	19.8	37.3	80.2	62.7
Broiled	22.0	32.1	78.0	67.8
Pan-fried	25.1	36.6	74.9	63.4
Deep fat fried	27.9	40.9	72.1	59.1

The proportion of the total calories that was attributable to fat and protein depended on the treatment given the half broilers and whether or not the skin was included in the samples analyzed. Fat provided the smallest proportion of the calories in the skinned raw meat, and the percentage of calories furnished by fat gradually increased with skinned broiled, pan-fried and deep fat fried meat, in that order. When the meat was unskinned, fat supplied the smallest proportion of the calories in broiled meat, and this percentage increased in the other samples in the following order: pan-fried, raw and deep fat fried meat. Fat contributed a higher proportion of calories in unskinned meat prepared by all methods than it did in the skinned meat. In all samples, as the percentage of the calories ascribed to fat increased, the proportion attributable to protein decreased.

The effect of including the skin on the total caloric value of broiler meat is illustrated by the data presented in Table 4.

Table 4. Mean caloric values for skinned and unskinned light and dark meat from broiler halves given four treatments.

Treatment	:	Skinned	:	Unskinned	
Raw					
Light		109.1	*	131.1	
		ns		*	
Dark		118.5	*	145.0	
Total		227.6	*	276.1	
Broiled					
Light	*	153.2	*	186.4	*
		*		*	
Dark		166.7	*	211.8	
Total		319.9	*	398.2	
Pan-fried					
Light	ns	161.8	*	190.9	ns
		*		*	
Dark		180.1	*	211.5	
Total		341.9	*	402.4	
Deep fat fried					
Light	ns	179.3	*	257.9	*
		ns		*	
Dark		178.3		237.3	
Total		357.6	*	495.2	

* = Significant at the 5.0% level
ns = Non-significant
lsd* (Light skinned or unskinned vs dark skinned or unskinned; light or dark skinned vs light or dark unskinned) = 13.0
lsd* (Total skinned vs total unskinned; comparisons between treatments) = 29.3.

The mean caloric values were always significantly lower for the skinned than for the unskinned meat. The remaining data in this table were discussed previously relative to the data given in Tables 1 and 2.

Eggs

The percentage of moisture, ash, fat by acid hydrolysis and nitrogen were determined for 100-gram samples of raw, poached, scrambled and fried eggs. Analyses were made on 40 samples, ten samples of four eggs each for each of the treatments. The data resulting from these analyses are presented in Tables 19 through 22 (Appendix). The discussion regarding similar data for broilers applies to the work on eggs.

Mean caloric values for eggs given four treatments are reported in Table 5. The detailed data are given in Table 24 (Appendix).

Table 5. Mean caloric values for eggs given four treatments.

Treatment	From fat		From protein		Total
	Calories	% of total	Calories	% of total	
Raw	97.5	64.5	53.6	35.5	151.1 ns
Poached	101.7	65.0	54.9	35.1	156.5 *
Scrambled	125.9	73.8	44.8	26.2	170.7 *
Fried	154.6	77.5	44.8	22.5	199.5

* = Significant at the 5.0% level
ns = Non-significant
lsd* = 6.3.

Analysis of variance showed that there were very highly significant differences among the caloric values for eggs subjected to the four treatments (Table 24, Appendix). Calculation of least significant differences between mean caloric values showed that the difference in the mean caloric values for raw and poached eggs was

not great enough to be significant. However, the differences between the mean values for poached and scrambled eggs and between scrambled and fried eggs were significant.

Mean values for the calories from fat and protein were not analyzed statistically. However, it was calculated that fat and protein contributed to the total calories as indicated by the percentages given in Table 5. The treatment determined the proportion of the total calories attributable to fat and protein. Fat provided the largest proportion of the calories in fried eggs and the percentage decreased with scrambled, poached and raw eggs, in that order. In all samples, as the percentage of the calories ascribed to fat decreased, the proportion attributable to protein increased.

CONCLUSIONS

Broilers

All the methods of cookery employed in this experiment raised the caloric value of broiler halves significantly above that for raw meat. Of these cooking methods broiling raised the caloric value the least. Values for pan-fried birds were only slightly higher than those for broiled halves and this difference was non-significant. It was also found that when the skin was removed after the meat was cooked, the caloric value of the skinned halves was significantly lower than that for the unskinned. Therefore, when broilers are included in low calorie diets it is recommended that they be prepared by the methods described in this manuscript

for broiling or pan-frying, and that the meat be skinned before eating.

Eggs

The caloric values of the cooked eggs were higher than the values for the raw samples. However, the mean caloric value of poached eggs was not significantly higher than that for the raw. Therefore, it is suggested that poaching is the most appropriate of the methods of cooking used in this study for preparing eggs for low calorie diets. It is postulated that eggs cooked in the shell would be similar in caloric value to poached eggs, and also may be recommended for low calorie diets. Although the mean caloric value of the scrambled eggs in this study was significantly higher than that for the poached eggs, the actual difference in calories, per 100 grams, was 14.2. Perhaps for variety, scrambled eggs, prepared as described in this manuscript, could be used in diets restricted in calories.

SUMMARY

The purpose of the experiment was to obtain data on caloric values for broilers and eggs prepared by different methods. Eighty half broilers each weighing approximately three-quarters of a pound were cooked by (1) broiling, (2) pan-frying and (3) deep fat frying, or (4) they were left raw. Twelve dozen eggs were cooked by (1) poaching, (2) scrambling and (3) pan-frying, or they were left raw. Half birds and eggs were assigned at

random to the given treatments. The fourth treatment provided data for a reference point in drawing conclusions concerning the other three treatments. Cooking losses were calculated for the cooked broiler halves.

Light and dark meat from each half broiler were prepared separately for chemical analyses. Half of the samples included the skin of the bird and the other half were prepared without the skin. The samples were analyzed for the percentage of moisture, ash, ether extract (broilers), or fat by acid hydrolysis (eggs) and nitrogen. The caloric values for the samples from both broilers and eggs were computed on the basis of 100 grams of edible food by means of the Atwater physiological fuel value figures for protein (4.0 calories per gram) and fat (9.0 calories per gram).

Cooking losses for the deep fat fried birds were the highest of any of those for the broilers prepared by the various methods, and losses from the pan-fried birds were the least. Cooking increased the caloric value of broiler halves significantly above that for raw meat. The difference between the caloric value of broiled and pan-fried birds as well as that between skinned pan-fried and deep fat fried meat was non-significant, but deep fat frying raised the caloric value of the unskinned meat significantly above that of pan-fried meat.

In all the treatments skinning significantly reduced the caloric value of broiler halves. Generally the dark meat was higher in caloric value than the light meat. The exception was the skinned raw and deep fat fried skinned and unskinned meat.

The treatment given to the half broilers and whether or not the skin was included in the sample analyzed, determined the proportion of the total calories that was attributable to fat and protein. For both skinned and unskinned meat, fat provided the smaller proportion of the calories. However, the percentage of calories attributable to fat was higher in the unskinned than in the skinned meat. In all samples, as the percentage of the calories ascribed to fat increased, the proportion belonging to protein decreased.

Broiler halves prepared by broiling or pan-frying as described in this manuscript, with the skin removed after cooking, are recommended for use in low calorie diets.

The caloric values of poached, scrambled and fried eggs were all higher than the values obtained for the raw samples. The differences in caloric value between poached and raw eggs were non-significant. However, the differences in caloric value between poached and scrambled and poached and fried eggs were significant, with the value for scrambled being higher than that for poached and the value for fried higher than that for both poached and scrambled.

As in broilers, the treatment determined the proportion of the total calories attributable to fat and protein in the egg samples. Fat provided the largest proportion of calories in all the samples and as the proportion of calories attributable to fat increased, those for protein decreased.

Poached or eggs cooked in the shell were suggested for menus where calories are restricted because of their relatively low

caloric value. It was suggested that for variation, scrambled eggs prepared as described in this manuscript, could be used in low calorie diets.

ACKNOWLEDGMENTS

The author wishes to express her deep appreciation to Dr. Dorothy L. Harrison, Major Professor and Head of the Department of Foods and Nutrition for her advice and guidance in the experimental work and the preparation of this manuscript; to Dr. H. C. Fryer, Professor of Mathematics in charge of the Statistical Laboratory, for his assistance in the analysis of the data; to Dr. W. S. Ruliffson, Assistant Professor of Chemistry in his guidance in the Chemical Analyses of the samples; to S. N. Rogers, Assistant Instructor of Chemistry for the chemical analyses and to Dr. Grayce Goertz, Associate Professor of Foods and Nutrition for constructive criticism.

LITERATURE CITED

Albritton, E. C.
Standard values in nutrition and metabolism. Philadelphia: W. B. Saunders Company, 1954.

Bowes, A. P., and C. F. Church.
Food values of portions commonly used. 7th ed. Philadelphia: College Offset Press, University of Pennsylvania, 1951.

Bradley, A. V.
Tables of food values. Peoria: The Manual Arts Press, 1931.

Brody, S.
Bioenergetics and growth with special reference to the efficiency complex in domestic animals. New York: Reinhold Publishing Corp., 1945.

Chaney, M. S.
Nutrition. 5th ed. Boston: Houghton Mifflin Company, 1954.

Chatfield, C., and G. Adams.
Proximate composition of American food materials. U. S. Dept. of Agr. Circular No. 549. 1940.

Hepburn, J. S.
The influence of the temperature and the period of keeping upon the biochemical changes in the common fowl, Gallus-domesticus. Jour. Franklin Inst. 249:393-407. 1950.

Holcomb, R., and W. A. Maw.
The analysis and composition of the flesh of the domestic fowl. Canad. Jour. Res. 11:613. 1934.

Jacobs, M. B.
The chemical analysis of foods and food products. 2nd ed. New York: D. Van Nostrand Company, Inc., 1951.

Maynard, L. A.
The Atwater system of calculating the caloric value of diets. Jour. of Nutr. 28:443, 1944.

Merrill, A. L., and B. K. Watt.
Energy value of foods... basis and derivation. U. S. Dept. of Agr. Handbook No. 74. 1955.

McCance, R. A., and E. M. Widdowson.
The chemical composition of foods. New York: Chemical Publishing Company, Inc., 1940.

McLester, J. S., and W. J. Darby.
Nutrition and diet in health and disease. 6th ed. Philadelphia: W. B. Saunders Company, 1952.

Morey, N. B.
An analysis and comparison of different methods of calculating the energy value of diets. Nutr. Abstracts and Rev. 6:1, 1936.

Pennington, M. E.
Poultry and eggs. 2nd ed. In Jacobs, M. B. The chemistry and technology of food and food products. New York: Interscience Publishers, Inc., 1951.

Romanoff, A. L., and A. J. Romanoff.
The avian egg. New York: John Wiley & Sons, Inc., 1949.

Sherman, H. C.
Chemistry of food and nutrition. 8th ed. New York: The Macmillan Company, 1952.

Sweetman, M. D., and I. MacKellar.
Food selection and preparation. 4th ed. New York: John Wiley & Sons, Inc., 1954.

Watt, B. K., and A. L. Merrill.
Composition of foods-- raw, processed, prepared. U. S. Dept. of Agr. Handbook No. 8, 1950.

Woodman, A. G.
Food analysis, typical methods and the interpretation of results. 4th ed. New York: McGraw-Hill Book Company, Inc., 1941.

APPENDIX

Procedures Used for the Chemical Analyses

All procedures used for the chemical analyses were those described in the Official and Tentative Methods of Analysis of the Association of Official Agricultural Chemists, 5th edition, 1950, with modifications made by the Chemical Service Laboratory, Kansas State College. The procedures used in this study are outlined in the following paragraphs.

Meats and Meat Products

Moisture: 22.3. Dry to constant weight at 50 to 55° C., in a vacuum oven under pressure not to exceed 100 mm of mercury, a quantity of sample representing about 2 g of material. Use a 30 ml open porcelain crucible, and report loss in weight as moisture.

Ether Extract: 22.25. Extract about 2 g of sample, dried as for moisture, with anhydrous ether for 16 hours. Dry the extract at a temperature of boiling water for 30 minutes; cool in a desiccator and weigh. Continue at 30-minute intervals this alternate drying and weighing until constant weight is attained. This is done in a vacuum oven at 110° C.

Ash: 20.9. Heat a sample of appropriate weight for the product being examined (usually 5 to 10 g) in a 30 ml porcelain crucible at 100° C. until the water is expelled. Place the crucible in a muffle furnace at approximately 525° C. and leave it until a white ash is obtained. Moisten the ash with water, dry on a steam bath and then on a hot plate, and re-ash in the muffle

furnace at 525° C. to constant weight.

Nitrogen: Kjeldahl-Wilfarth-Gunning, 2.24. Place one g of sample in a 800 ml digestion flask. Add 15 to 18 g of K_2SO_4. $CuSO_4 \cdot HgO$ digestion mix. Add 37.5 ml H_2SO_4. Place on an electric digestion rack. Heat until clear and continue digestion for a total of 3 hours. Cool, and add 400 ml of water. Add a pinch of zinc (20 mesh). Make strongly alkaline with NaOH solution containing K_2S and $Na_2S_2O_3$, pouring it down the side of the flask so that it does not mix at once with the acid solution.

Distillation: 2.22. Connect the flask to a condensor by means of a Kjeldahl connecting bulb, taking care that the tip of the condensor extends below the surface of the standard acid in the receiver beaker. Mix the contents by shaking. Distill until all the NH_3 has passed into the measured quantity of the standard acid (the first 150 ml of distillate generally contains all the NH_3). Titrate with standard alkali solution using methyl red indicator.

Eggs and Egg Products

In this study the procedures standardized for the analysis of moisture, nitrogen, fat and ash in raw eggs also were used for analyzing the cooked samples of eggs.

Moisture: Determination of Total Solids, 16.3. Weigh about 2 g of sample, in a covered dish that previously was dried at 98 to 100° C. cooled in a desiccator and weighed soon after attaining room temperature. Place about 2 g of the sample in a vacuum oven and dry at 98 to 100° C. to constant weight (about 5 hours).

Admit dry air into the oven to bring it to atmospheric pressure. Immediately tighten the cover of the dish, transfer to a desiccator containing fresh, efficient desiccant, and weigh soon after room temperature is attained. Report as percentage moisture or as total solids.

Organic and Ammoniacal Nitrogen: Preparation of Sample, 16.4. Weigh 2 to 3 g of a well mixed sample, by difference, into a 500 ml Kjeldahl flask.

Determination: 16.5. Follow the same procedure as for meats (2.24).

Fats by Acid Hydrolysis: Preparation of solution, 16.8. From a well mixed sample, weigh accurately by difference, about 3 g of whole egg into a Mojonnier fat extraction tube. Add slowly with vigorous shaking 10 ml of HCL, set the tube in a water bath heated to 70° C.; bring to boiling and continue heating at boiling temperature for 30 minutes, shaking the tube with care at 5-minute intervals. Remove the tube from the water bath, add water nearly to fill the lower bulb of the tube, and cool to room temperature.

Determination: 16.9. To the extraction tube containing the treated sample, 16.8, add 25 ml of ether and mix. Add 25 ml of redistilled petrol ether (boiling point below 60° C.), mix, and allow to stand until the solvent layer is clear.

Fat: Acid hydrolysis, 13.19. Draw off as much as possible of the ether-fat solution through a filter consisting of a pledget of cotton packed just firmly enough in the stem of the funnel to allow free passage of the ether into a weighed 125 ml breaker-flask

containing porcelain chips or broken glass. Before weighing the beaker-flask, dry it and a similar flask as a counterpoise in a drying oven at 100° C. and allow both to stand in air to constant weight. Re-extract the liquid remaining in the tube twice, each time with only 15 ml of each kind of ether. Shake well on addition of each ether. Draw off the clear ether solutions through a filter into the same flask as before, and wash the tip of the spigot, funnel, and the end of the funnel stem with a few ml of a mixture of equal volumes of the two ethers free from suspended water. Evaporate the ethers slowly on a steam bath, then dry the fat in a drying oven at 100° C. to constant weight (about 90 minutes). Remove the flask and the counterpoise from the oven, allow to stand in air to constant weight (about 30 minutes), and weigh. Because of the size of the flask and the nature of the material, there is less error by cooling in air than by cooling in a desiccator. Correct this weight by a blank determination on the reagents used. Report as percentage fat by acid hydrolysis.

Ash: 29.9. Follow the same procedure as for meat.

Table 6. Percentage moisture, ash, nitrogen and protein for light and dark meat of raw, skinned broiler halves.

Sample	Moisture		Ash		Fat		Nitrogen		Protein	
	Light	Dark	Light	Dark	Light	Dark	Light	Dark	Light	Dark
I	75.1	75.6	0.9	1.0	0.8	2.6	3.8	3.5	24.0	21.9
II	74.9	74.5	0.8	0.9	0.8	3.2	3.9	3.5	24.4	21.8
III	74.4	74.0	0.8	0.9	1.6	5.2	3.9	3.4	24.4	21.1
IV	74.7	75.6	0.9	0.9	0.9	2.8	3.8	3.4	23.9	21.4
V	73.1	73.4	1.0	1.0	1.9	4.1	4.0	3.6	24.7	22.3
VI	74.2	76.6	0.9	0.9	0.8	1.9	3.9	3.3	24.1	20.9
VII	72.4	73.2	0.9	0.9	3.7	5.7	3.7	3.3	23.3	20.8
VIII	73.9	74.0	0.9	1.0	1.8	4.4	3.8	3.4	23.9	21.0
IX	74.5	75.3	1.0	1.0	0.8	2.2	3.8	3.5	23.8	21.8
X	73.5	74.2	0.8	0.9	1.4	3.5	4.0	3.5	24.8	22.1
Av.	74.1	74.6	0.9	0.9	1.5	3.6	3.9	3.4	24.1	21.5

Table 7. Percentage moisture, ash, nitrogen and protein for light and dark meat of raw, unskinned broiler halves.

Sample	Moisture		Ash		Fat		Nitrogen		Protein	
	Light	Dark	Light	Dark	Light	Dark	Light	Dark	Light	Dark
I	71.9	71.8	0.9	0.9	4.8	7.6	3.6	3.3	22.2	20.4
II	72.7	71.2	0.8	0.8	2.7	8.7	3.8	3.2	23.6	19.8
III	73.4	72.8	0.9	0.9	4.1	6.6	3.6	3.3	22.6	20.4
IV	70.8	72.9	0.9	0.9	4.7	6.0	3.9	3.4	24.3	21.4
V	74.3	74.4	0.8	1.0	4.0	4.3	3.3	3.2	20.7	20.0
VI	73.6	76.1	0.8	0.9	2.4	3.0	3.8	3.3	23.8	20.4
VII	68.2	65.0	0.8	0.9	8.6	16.6	3.8	3.0	23.4	18.9
VIII	74.8	75.3	0.8	0.9	3.1	4.9	3.5	3.3	22.1	20.3
IX	71.3	69.9	1.0	1.0	4.9	8.5	3.8	3.4	23.8	20.9
X	73.3	74.2	0.8	0.8	4.2	4.8	3.7	3.2	23.4	20.2
Av.	72.4	72.4	0.8	0.9	4.4	7.1	3.7	3.2	23.0	20.3

Table 8. Percentage moisture, ash, nitrogen and protein for light and dark meat of broiled, skinned broiler halves.

Sample	Moisture		Ash		Fat		Nitrogen		Protein	
	Light	Dark	Light	Dark	Light	Dark	Light	Dark	Light	Dark
I	64.6	64.6	1.1	1.2	2.6	4.8	5.2	4.8	32.5	30.2
II	66.2	65.5	1.1	1.1	2.3	4.2	4.9	4.8	30.9	29.8
III	64.0	62.7	1.0	1.1	2.7	6.7	5.4	4.8	33.7	30.1
IV	65.0	64.2	1.2	1.1	2.6	4.3	5.1	4.9	31.8	30.6
V	64.8	64.7	1.1	1.2	2.4	5.0	5.1	4.8	31.7	29.9
VI	62.0	62.3	1.1	1.1	5.1	7.1	5.0	4.8	31.4	29.8
VII	59.5	62.2	1.2	1.1	2.0	5.4	5.8	5.1	36.3	31.6
VIII	66.4	67.6	1.2	1.2	0.6	2.4	5.1	4.6	31.9	28.7
IX	62.8	64.8	1.2	1.3	2.3	4.5	5.3	4.8	33.1	30.1
X	64.7	65.3	1.2	1.2	3.2	5.2	5.1	4.6	31.6	28.6
Av.	64.0	64.4	1.1	1.2	2.6	5.0	5.2	4.8	32.5	29.9

Table 9. Percentage moisture, ash, nitrogen and protein for light and dark meat of broiled, unskinned broiler halves.

Sample	Moisture		Ash		Fat		Nitrogen		Protein	
	Light	Dark	Light	Dark	Light	Dark	Light	Dark	Light	Dark
I	59.3	58.5	1.3	1.3	2.8	7.7	5.8	5.4	36.4	33.4
II	55.5	53.3	1.3	1.3	7.9	13.6	5.6	5.1	35.3	32.0
III	61.2	58.8	1.2	1.2	5.9	8.0	5.1	5.2	32.0	32.5
IV	54.7	55.0	1.4	1.3	6.5	9.7	5.9	5.6	36.8	34.8
V	61.6	57.2	1.2	1.4	2.5	5.8	5.5	5.7	34.1	35.3
VI	58.9	57.0	1.3	1.3	5.3	9.0	5.5	5.4	34.4	33.7
VII	56.0	54.6	1.2	1.2	8.6	10.8	5.5	5.4	34.2	33.5
VIII	58.4	59.7	1.3	1.3	5.5	8.3	5.6	5.0	34.9	31.2
IX	58.4	55.5	1.1	1.3	6.7	10.7	5.4	5.4	34.0	33.7
X	61.8	62.7	1.2	1.2	2.2	4.8	5.3	4.9	33.3	30.8
Av.	58.6	57.2	1.3	1.3	5.4	8.8	5.5	5.3	34.5	33.1

Table 10. Percentage moisture, ash, nitrogen and protein for light and dark meat of pan fried, skinned broiler halves.

Sample	Moisture		Ash		Fat		Nitrogen		Protein	
	Light	Dark	Light	Dark	Light	Dark	Light	Dark	Light	Dark
I	60.1	62.2	1.2	1.1	3.9	6.4	5.5	5.2	34.1	32.3
II	62.5	63.4	1.1	1.1	4.6	6.5	5.1	4.9	32.1	30.8
III	63.5	64.9	1.1	1.1	3.9	5.8	5.3	4.7	32.9	29.6
IV	64.8	65.7	1.1	1.1	3.1	6.1	5.0	4.5	31.5	28.0
V	63.8	60.6	1.1	1.1	3.0	6.5	5.2	5.2	32.6	32.4
VI	64.3	63.3	1.1	1.2	3.0	5.2	5.2	5.1	32.2	31.8
VII	62.1	59.8	1.2	1.2	3.0	5.2	5.6	5.4	34.9	34.0
VIII	61.2	62.9	1.1	1.1	2.7	6.1	5.6	4.7	35.1	29.6
IX	64.7	60.2	1.1	1.1	3.5	7.5	4.9	5.0	30.6	31.1
X	63.4	61.9	1.1	1.1	3.0	6.4	5.3	5.1	32.9	31.9
Av.	63.0	62.5	1.1	1.1	3.4	6.2	5.3	5.0	32.9	31.1

Table 11. Percentage moisture, ash, nitrogen and protein for light and dark meat of pan fried, unskinned broiler halves.

Sample	Moisture		Ash		Fat		Nitrogen		Protein	
	Light	Dark	Light	Dark	Light	Dark	Light	Dark	Light	Dark
I	60.9	58.4	1.0	1.2	6.4	8.3	5.2	5.1	32.7	32.1
II	61.6	57.9	1.4	1.2	5.9	8.5	5.0	5.4	31.3	33.4
III	61.8	58.6	1.1	1.2	7.5	9.8	4.7	4.6	29.5	28.5
IV	57.4	58.5	1.2	1.1	10.7	10.4	5.0	5.0	31.1	31.4
V	57.3	57.6	1.1	1.2	9.6	10.6	5.2	4.8	32.5	29.9
VI	59.3	54.0	1.1	1.3	7.2	10.6	5.2	5.4	32.3	33.6
VII	61.1	60.5	1.2	1.1	5.8	7.2	5.2	5.1	32.4	31.7
VIII	63.5	58.5	1.2	1.2	3.9	6.6	5.0	5.4	31.4	33.6
IX	60.1	57.2	1.1	1.3	9.2	8.7	4.6	5.2	28.9	32.3
X	61.9	57.9	1.1	1.2	7.9	9.3	4.6	5.2	28.9	32.3
Av.	60.5	57.9	1.1	1.2	7.4	9.0	5.0	5.1	31.1	31.9

Table 12. Percentage moisture, ash, nitrogen and protein for light and dark meat of deep fat fried, skinned broiler halves.

Sample	Moisture		Ash		Fat		Nitrogen		Protein	
	Light	Dark	Light	Dark	Light	Dark	Light	Dark	Light	Dark
I	66.4	62.5	1.2	1.1	3.3	7.5	4.9	4.6	30.5	28.9
II	62.7	61.1	1.1	1.2	3.8	6.2	5.3	5.1	33.2	32.1
III	58.9	63.4	1.2	1.2	6.8	5.5	5.5	4.8	34.1	29.8
IV	61.4	62.0	1.1	1.2	3.7	4.8	5.5	5.3	34.5	32.9
V	57.0	59.5	1.1	1.2	7.1	6.6	5.7	5.2	35.5	32.7
VI	62.7	63.9	1.2	1.2	3.3	3.1	5.3	5.1	33.0	31.6
VII	60.1	61.1	1.2	1.2	5.2	7.8	5.5	4.9	34.3	30.8
VIII	61.8	61.3	1.3	1.3	4.3	6.6	5.3	5.0	32.9	31.3
IX	59.3	62.1	1.2	1.3	5.8	6.1	5.5	4.9	34.6	30.5
X	60.4	63.1	1.3	1.2	7.4	5.9	5.1	4.8	31.7	30.1
Av.	61.1	62.0	1.2	1.2	5.1	6.0	5.3	5.0	33.4	31.1

Table 13. Percentage moisture, ash, nitrogen and protein for light and dark meat of deep fat fried, unskinned broiler halves.

Sample	Moisture		Ash		Fat		Nitrogen		Protein	
	Light	Dark	Light	Dark	Light	Dark	Light	Dark	Light	Dark
I	44.6	52.0	1.9	1.3	11.4	9.8	6.9	5.7	43.2	35.4
II	49.1	54.7	1.5	1.2	10.9	9.2	6.3	5.6	39.6	34.8
III	49.4	52.9	1.4	1.4	10.2	10.9	6.4	5.7	39.7	35.4
IV	52.2	54.1	1.4	1.3	8.8	11.4	6.0	5.3	37.4	33.1
V	56.4	53.9	1.4	1.4	7.0	8.9	5.8	5.7	36.0	35.4
VI	51.4	54.9	1.4	1.3	11.4	10.2	5.8	5.4	35.9	33.8
VII	45.1	52.7	1.6	1.4	13.7	10.3	6.3	5.8	39.6	36.5
VIII	46.2	49.8	1.9	1.4	12.9	13.9	6.3	5.4	39.5	33.6
IX	40.2	51.8	2.1	1.4	15.8	11.6	6.8	5.6	42.6	34.9
X	53.0	52.5	1.2	1.2	12.7	13.9	5.3	5.2	33.2	32.6
Av.	48.8	52.9	1.6	1.3	11.5	11.0	6.2	5.5	38.7	34.6

Table 14. Caloric values of light and dark meat for skinned raw, broiled, pan fried and deep fat fried broiler halves.

Treatment	Fat		Protein		Calories		
	Light	Dark	Light	Dark	Light	Dark	Total
	6.8	23.3	96.0	87.8	102.8	111.1	213.9
	7.4	28.8	97.8	87.2	105.1	116.0	221.2
	9.3	51.8	97.5	84.2	106.8	136.0	242.8
	8.5	25.2	95.8	85.8	104.2	111.0	215.2
Raw	16.9	37.1	98.8	89.0	115.7	126.1	241.8
	7.2	16.6	96.2	83.5	103.4	100.2	203.6
	33.6	51.2	93.2	83.2	126.8	134.5	261.3
	16.5	39.5	95.8	84.0	112.2	123.5	235.7
	7.5	19.9	95.2	87.0	102.7	106.9	209.6
	12.3	31.5	99.0	88.2	111.3	119.7	231.1
Av.	12.6	32.5	96.5	86.0	109.1	118.5	227.6
	23.7	43.2	130.0	120.8	153.7	164.0	317.7
	20.5	37.6	123.5	119.0	144.0	156.6	300.6
	24.5	66.3	134.8	120.5	159.2	186.8	346.0
	23.0	60.1	127.2	122.2	150.2	182.3	332.5
Broiled	21.9	44.7	126.8	119.5	148.6	164.2	312.8
	46.2	63.5	125.5	119.0	171.7	182.5	354.2
	18.2	48.9	145.3	126.5	163.5	175.4	338.9
	5.4	21.4	127.5	114.8	132.9	136.2	269.1
	20.4	43.3	132.2	120.2	152.7	163.5	316.2
	29.0	41.2	126.5	114.5	155.5	155.7	311.2
Av.	23.3	47.0	129.9	119.7	153.2	166.7	319.9
	35.1	57.2	136.5	129.2	171.6	186.5	358.1
	41.5	58.1	128.2	123.2	169.7	181.3	351.0
	34.7	52.0	131.5	118.5	166.2	170.5	336.7
	28.2	55.2	126.0	112.0	154.2	667.2	321.3
Pan fried	27.0	58.8	130.2	129.5	157.2	188.3	345.5
	26.6	47.2	128.8	127.0	155.3	174.2	329.5
	26.6	46.4	139.5	136.0	166.1	182.4	348.4
	24.7	55.3	140.2	118.2	164.9	173.5	338.4
	31.8	67.7	122.5	124.5	154.3	192.2	346.5
	27.2	57.8	131.8	127.2	158.9	185.0	343.9
Av.	30.3	55.6	131.5	124.5	161.8	180.1	341.9

Table 14 (concl.).

Treatment	Fat		Protein		Calories		Total
	Light	Dark	Light	Dark	Light	Dark	
	29.9	67.9	122.0	115.5	151.9	183.4	335.3
	34.1	55.6	132.8	128.5	166.9	184.1	351.0
	61.3	49.1	136.5	119.0	197.8	168.1	366.0
	33.7	42.9	138.0	131.5	171.7	174.4	344.1
Deep fat	63.6	59.1	142.0	130.8	205.6	189.9	395.5
fried	30.1	27.8	132.0	126.5	162.1	154.3	316.4
	46.6	70.1	137.2	123.2	183.9	193.4	377.2
	37.9	59.2	131.8	125.2	169.6	184.4	354.1
	51.8	54.7	138.2	122.0	190.0	176.7	366.7
	66.6	53.5	126.8	120.5	193.4	174.0	367.3
Av.	45.6	54.0	133.7	124.3	179.3	178.3	357.6

Table 15. Caloric values of light and dark meat for unskinned raw, broiled, pan fried and deep fat fried broiler halves.

Treatment	Fat		Protein		Calories		
	Light	Dark	Light	Dark	Light	Dark	Total
	43.1	68.6	88.8	81.8	131.9	150.3	262.0
	24.7	78.1	94.2	79.2	118.9	157.4	276.3
	37.1	59.5	90.2	81.5	127.3	141.0	268.3
	42.6	53.8	97.2	85.5	139.8	139.3	279.2
Raw	36.0	39.0	82.8	80.0	118.8	119.0	237.0
	21.2	26.9	95.0	81.5	116.2	108.4	225.0
	77.6	149.5	93.8	75.8	171.4	225.3	396.6
	28.3	43.7	88.5	81.2	116.8	124.9	241.7
	44.0	76.6	95.0	83.8	139.0	160.4	299.4
	37.6	42.8	93.5	80.8	131.1	123.6	254.7
Av.	39.2	63.8	91.9	81.1	131.1	145.0	276.1
	25.0	69.6	145.8	133.8	170.8	203.3	374.1
	71.1	122.5	141.0	128.0	212.1	250.5	462.6
	52.7	72.0	128.0	130.0	180.7	202.0	382.7
	58.9	87.5	147.0	139.0	205.9	226.5	432.3
Broiled	22.2	52.2	136.5	141.2	158.7	193.4	352.2
	48.0	80.9	137.5	134.8	185.5	215.7	401.2
	77.3	97.4	136.8	132.0	214.1	229.4	443.5
	50.3	74.7	137.8	124.8	188.1	199.5	387.5
	60.3	96.1	136.0	134.8	196.3	230.9	427.2
	19.5	42.9	133.0	123.2	152.5	166.2	318.7
Av.	48.5	79.6	137.9	132.2	186.4	211.8	398.2
	57.5	74.4	130.7	128.5	188.3	203.0	391.2
	52.8	76.1	125.2	133.8	178.1	209.8	387.9
	67.5	88.5	118.0	114.0	185.5	202.5	388.0
	96.5	93.2	124.2	157.2	220.7	250.4	471.1
Pan fried	86.1	95.8	130.0	119.8	216.1	215.5	431.7
	64.6	95.0	129.2	134.2	193.9	229.3	423.1
	52.1	64.7	129.5	126.8	181.6	191.5	373.1
	34.9	59.0	125.8	134.2	160.7	193.2	353.9
	82.4	78.0	115.8	129.0	198.1	207.0	405.1
	70.8	83.5	115.5	129.0	186.4	212.5	398.9
Av.	66.5	80.8	124.4	130.6	190.9	211.5	402.4

Table 15 (concl.).

Treatment	Fat		Protein		Calories		Total
	Light	Dark	Light	Dark	Light	Dark	
	102.4	88.6	172.8	141.8	275.2	230.3	505.5
	98.1	82.4	158.2	139.2	256.3	221.6	477.9
	91.4	97.7	158.8	141.8	250.2	239.4	489.5
	79.4	102.6	149.5	132.5	228.9	235.1	464.0
Deep fat	62.8	79.7	144.0	141.5	206.8	221.3	428.1
fried	102.9	91.8	143.8	135.0	246.7	226.8	473.4
	123.6	92.9	158.5	146.0	282.1	238.9	521.0
	115.7	125.3	158.0	134.5	273.7	259.8	533.5
	142.4	104.0	170.2	139.5	312.6	243.6	556.2
	114.0	125.5	132.8	130.5	246.8	256.0	502.8
Av.	103.3	99.1	154.6	138.2	257.9	237.3	495.2

Table 16. Total cooking losses, in percent for broiler halves.

Sample	Broiled	Pan fried	Deep fat fried
1	31.1	28.8	34.0
2	29.1	26.9	34.4
3	29.4	25.2	37.2
4	31.8	29.6	34.9
5	25.1	29.9	35.7
6	29.5	27.7	38.0
7	34.9	28.7	36.0
8	29.7	29.1	36.8
9	34.2	29.5	38.8
10	30.8	26.1	36.3
11	27.8	33.4	32.0
12	27.4	30.7	31.6
13	28.9	29.7	35.2
14	29.6	25.3	34.5
15	29.2	33.3	37.5
16	29.3	27.4	33.5
17	33.1	35.7	35.6
18	24.1	30.4	34.5
19	26.1	27.3	37.5
20	28.4	24.6	31.7
Av.	29.5	29.0	35.3

Table 17. Analysis of variance of total caloric values for broiler halves.

Sources of variation	D/F	Mean square and significance
Treatments	3	108,101.0
Skinned vs unskinned	1	129,278.0
Treatment x skinned	3	8,099.7***
Samples	72	1,072.6
Total	79	

*** = Significant at the 0.1% level.

Table 18. Analysis of variance of caloric values for light and dark meat from broiler halves.

Sources of variation	D/F	Mean square and significance
Treatments	3	54,051.0
Light vs dark meat	1	4,240.0
Skinned vs unskinned	1	64,639.0
Treatment x light vs dark	3	2,114.0
Treatment x skin	3	4,049.9
Light vs dark x skinned vs unskinned	1	0.0976
Treatment x light vs dark x skin vs unskinned	3	6,607.1***
Samples	144	210.44
Total	159	

*** = Significant at the 0.1% level.

Table 19. Percentage moisture, ash, fat, nitrogen and protein in raw eggs.

Sample	Moisture	Ash	Fat	Nitrogen	Protein
I	74.7	0.9	10.9	2.1	13.3
II	74.7	0.9	11.2	2.2	13.5
III	74.7	0.9	11.2	2.2	13.4
IV	74.1	0.9	11.0	2.1	13.1
V	74.5	0.9	10.8	2.1	13.4
VI	74.6	0.9	10.7	2.2	13.4
VII	74.6	0.9	10.8	2.1	13.4
VIII	74.6	0.9	10.8	2.2	13.4
IX	74.5	0.9	10.6	2.1	13.4
X	74.5	0.9	10.5	2.2	13.6
Av.	74.5	0.9	10.8	2.1	13.4

Table 20. Percentage moisture, ash, fat, nitrogen and protein in poached eggs.

Sample	Moisture	Ash	Fat	Nitrogen	Protein
I	73.0	1.0	11.9	2.2	13.8
II	73.6	1.0	11.4	2.2	13.8
III	72.8	1.0	11.8	2.2	14.0
IV	73.1	1.0	11.3	2.2	13.8
V	73.4	1.0	11.3	2.2	13.6
VI	74.2	0.9	10.8	2.2	13.7
VII	73.8	0.9	11.2	2.2	13.6
VIII	74.2	0.9	10.5	2.2	13.6
IX	73.3	0.9	11.1	2.2	13.9
X	72.8	0.9	11.5	2.2	13.6
Av.	73.4	1.0	11.3	2.2	13.7

Table 21. Percentage moisture, ash, fat, nitrogen and protein in scrambled eggs.

Sample	Moisture	Ash	Fat	Nitrogen	Protein
I	72.0	1.1	13.5	1.8	11.2
II	72.0	1.1	14.3	1.8	11.3
III	71.7	1.1	14.5	1.8	10.9
IV	71.4	1.1	13.7	1.9	11.6
V	71.7	1.1	13.8	1.9	11.7
VI	71.1	1.1	14.2	1.9	11.8
VII	72.7	1.1	14.2	1.7	10.9
VIII	72.6	1.1	14.1	1.8	10.9
IX	72.5	1.1	13.4	1.8	11.0
X	71.8	1.1	14.3	1.7	10.8
Av.	72.0	1.1	14.0	1.8	11.2

Table 22. Percentage moisture, ash, fat, nitrogen and protein in fried eggs.

Sample	Moisture	Ash	Fat	Nitrogen	Protein
I	67.0	1.0	18.1	2.2	13.6
II	68.0	0.9	17.6	2.1	13.4
III	66.3	1.0	19.0	2.2	13.6
IV	66.6	1.0	19.0	2.2	13.9
V	68.7	0.9	15.9	2.2	13.9
VI	67.0	1.0	17.4	2.3	14.2
VII	66.9	1.0	17.7	2.3	14.1
VIII	68.9	1.0	15.7	2.2	13.8
IX	68.2	1.0	16.4	2.2	13.8
X	69.8	0.9	15.2	2.2	13.6
Av.	67.7	1.0	17.1	2.2	13.7

Table 23. Caloric values for raw, poached, scrambled and fried eggs.

Treatment	Fat	Protein	Total
	98.2	53.0	151.2
	100.1	54.0	154.1
	100.1	53.8	153.9
	98.9	52.5	151.4
Raw	96.9	53.5	150.5
	96.2	53.8	150.0
	97.5	53.5	151.0
	97.3	53.8	151.1
	95.6	53.5	149.1
	94.6	54.2	148.8
Av.	97.5	53.6	151.1
	107.1	55.2	162.3
	103.0	55.2	158.2
	105.8	56.0	161.8
	102.1	55.0	157.1
Poached	101.9	54.2	156.1
	97.5	54.8	152.2
	100.9	54.2	155.1
	94.7	54.2	148.9
	100.2	55.5	155.7
	103.5	54.5	158.0
Av.	101.6	54.9	156.5
	121.4	44.8	166.2
	128.3	45.2	173.5
	130.3	43.8	174.1
	123.6	46.5	170.1
Scrambled	124.0	46.8	170.8
	127.5	47.0	174.5
	127.7	43.5	171.2
	127.1	43.8	170.8
	120.5	44.0	164.5
	128.6	43.0	171.6
Av.	125.9	44.8	170.7

Table 23 (concl.).

Treatment	Fat	Protein	Total
	162.5	44.8	207.3
	158.4	45.2	203.6
	171.3	43.8	215.0
	171.1	46.5	217.6
Fried	142.7	46.8	189.4
	156.2	47.0	203.2
	158.9	43.5	202.5
	140.9	43.8	184.6
	147.8	44.0	191.8
	136.5	43.0	179.5
Av.	154.6	44.8	199.5

Table 24. Analysis of variance of caloric values for poached, scrambled and pan fried eggs.

Source of variation	D/F	Mean square and significance
Treatments	3	4,683.0***
Samples, same treatment	36	47.744
Total	39	

*** = Significant at the 0.1% level.

THE EFFECT OF THE METHOD OF PREPARATION ON THE CALORIC VALUE OF BROILERS AND EGGS

by

ETHELIND SIGLOCH GIBSON

B. S., University of Rhode Island, 1951

AN ABSTRACT OF A THESIS

submitted in partial fulfillment of the

requirements for the degree

MASTER OF SCIENCE

Department of Foods and Nutrition

KANSAS STATE COLLEGE
OF AGRICULTURE AND APPLIED SCIENCE

1956

INTRODUCTION

Overweight and obesity are major problems in the United States, and limiting calories is important in weight control. When calories are restricted in the diet, the individual often has difficulty in planning well balanced menus with a reasonable amount of variety. Poultry and egg products should be valuable in such menus because they furnish essential nutrients, are relatively low in calories and lend themselves to various methods of preparation. Few references were found concerning the caloric value of poultry and eggs after different methods of cookery were employed. It was, therefore, considered desirable to obtain information on the caloric value of broilers and eggs prepared by several methods.

PROCEDURE

Eighty half broilers each weighing approximately three quarters of a pound were cooked by: (1) broiling, (2) pan-frying and (3) deep fat frying, or (4) they were left raw. Twelve dozen eggs were cooked by: (1) poaching, (2) scrambling and (3) pan-frying, or (4) they were left raw. Half birds and eggs were assigned at random to the given treatments. The fourth treatment provided data for a reference point in drawing conclusions concerning the other three treatments. Cooking losses were calculated for the cooked broiler halves.

Light and dark meat from each half broiler were prepared separately for chemical analyses. Half of the samples included

the skin of the bird and the other half were prepared without the skin. The samples were analyzed for the percentage of moisture, ash, ether extract (broilers) or fat by acid hydrolysis (eggs) and nitrogen. The caloric values for the samples from both broilers and eggs were computed on the basis of 100 grams of edible food by means of the Atwater physiological fuel value figures for protein (4.0 calories per gram) and fat (9.0 calories per gram).

RESULTS

Cooking losses for the deep fat fried birds were the highest of any of those for the broilers prepared by the various methods, and losses from the pan-fried birds were the least. Cooking increased the caloric value of broiler halves significantly above that for raw meat. The difference between the caloric value of broiled and pan-fried birds as well as that between skinned pan-fried and deep fat fried meat was non-significant, but deep fat frying raised the caloric value of the unskinned meat significantly above that of pan-fried meat.

In all the treatments skinning significantly reduced the caloric value of broiler halves. Generally the dark meat was higher in caloric value than the light meat. The exception was the raw skinned and deep fat fried skinned and unskinned meat.

The treatment given to the half broilers and the inclusion or exclusion of skin in the sample analyzed, determined the proportion of the total calories that was attributable to fat and protein. For both skinned and unskinned meat, fat provided the

smaller proportion of the calories. However, as the percentage of the calories ascribed to fat increased, the proportion belonging to protein decreased. Broiler halves prepared by the methods of broiling or pan-frying used in this study, and with the skin removed after cooking, are recommended for use in low calorie diets.

The caloric values of poached, scrambled and fried eggs were all higher than the values obtained for the raw samples. The differences in caloric value between poached and raw eggs were non-significant. However, the differences in caloric value between poached and scrambled and poached and fried eggs were significant, with the value for scrambled being higher than that for poached and the value for fried higher than that for both poached and scrambled eggs.

As in broilers, the treatment determined the proportion of the total calories attributable to fat and protein in the egg samples. Fat provided the largest proportion of calories in all the samples and as the proportion of calories attributable to fat increased, those for protein decreased.

Poached eggs or eggs cooked in the shell, which were assumed to be similar in caloric value to poached eggs, were suggested for menus where calories are restricted because of their relatively low caloric value. It was suggested that for variation, scrambled eggs as prepared in this study, could be used in low calorie diets.