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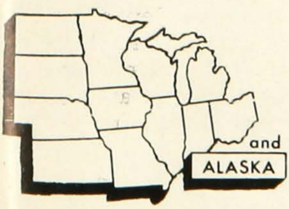
FACTORS AFFECTING POULTRY MEAT YIELDS



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This regional publication brings together recent information on factors affecting poultry meat yields. Not all of the research reported was done by members of the Regional Poultry Technology Committee. Nevertheless, many of the 111 publications cited can be directly related to people who have been connected with this committee. So a significant portion of the work reported was supported or inspired by those who received funds made available under this regional project.

In addition to encouraging work by regular staff members, regional research funds have provided major support for graduate students who later have played important roles in the field of poultry technology. Therefore, this regional project has afforded a training ground for many of those now responsible for research in the field.

The authors of this publication intentionally limited themselves to research done mainly since 1950, a period that roughly coincides with the life of this technical committee. Omission of citations from earlier research should not be interpreted as a slight or discredit of such research. But many factors such as rate of growth and processing methods have so changed conditions that earlier research results have little application. This fact significantly illustrates the principle that research much continue because of a changing environment.

The authors made every effort to make a complete review. Nevertheless, important gaps exist due to a paucity of current information. Particularly useful would be studies providing data on yields of meat related to stages of processing, freeze-dried products, and large-scale operations. Productivity of past efforts strongly justifies continued support in the broad area of poultry technology.

H. J. Sloan, administrative adviser

Factors Affecting
Poultry Meat Yields

M. H. Swanson, C. W. Carlson, and J. L. Fry

INFORMATION ON POULTRY MEAT YIELDS and the many factors affecting these yields is becoming increasingly important. Many producers who sell on a yield basis are interested in how improved breeding, nutrition, and management would affect their returns. Processors must be aware of the various plant procedures that influence yields because even small differences are significant in large volume operations. With "further processing," yield data are especially valuable for planning new ventures and evaluating operational efficiency once they are underway. Consumers are also concerned about cooking losses and yields of edible meat, particularly in institutional food services where large quantities are involved.

The purpose of this publication is to bring together and briefly review published research concerning poultry meat yields. This was a frustrating task from several standpoints. First, research reported 10 or more years ago is of questionable value because of the rapid progress made by the poultry industry in breeding, nutrition, management, and processing procedures.

Second, researchers often failed to specify all the conditions under which the work was done or the bases on which data were reported. Third, much research involved small numbers of birds and laboratory conditions which yield different results than large-scale commercial operations. And finally, many gaps in our present information need to be filled by additional research.

Because of these difficulties, this report mainly deals with principles involved in meat yields rather than specific data having universal application. Tables 4-12 serve merely as a guide for those seeking particular yield values.

In compiling this report, the NCM-7 Technical Committee used research results from cooperating institutions within the north-

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The cover photo was supplied by Land O'Lakes Creameries, Inc., Minneapolis.

central region. However, other published data from outside the region were utilized to make the review as complete as possible.

BREEDING AS A FACTOR IN EVISCERATED AND RAW EDIBLE MEAT YIELDS

Results from random sample tests suggest that differences exist in eviscerated yields among entries and that these differences may be attributable to hereditary factors. In its summary report of turkey performance tests for 1961, the National Turkey Improvement Plan utilized Duncan's Multiple Range Test in evaluating results. Variations of 3-4 percent or more in eviscerated yields were not uncommon in the various state tests; statistical significance of differences was indicated. Reports from chicken broiler tests show similar variations in yield among entries. However, in most instances a statistical significance of differences is not available.

Numerous investigators have compared strains, breeds, and crossbred stocks in an effort to demonstrate the role of genetics in meat yields. Interpretation of results is difficult because of the variety of interpretations already made and the complex interrelationships of factors involved. However, the data enable one to draw general conclusions regarding the heritability of meat yield.

Chickens

Purebreds Versus Crossbreds

The three most common breeds of chicken used today in broiler production are White Rock, New Hampshire, and Cornish. From each of these breeds several commercial strains have been developed. Study of recent literature reveals that when pure breeds are compared by themselves, the Cornish is generally superior in meat yield. For example, Hathaway et al. (1953), May (1956), and Orr (1955) reported that Cornish consistently yielded the highest percentage of total raw edible meat based on either live or eviscerated weights. Analysis of their data indicated that differences in total yields were due to breast yield, giblet yield, and bone losses rather than to "other meat" yields.

In general, crossbreds have proved superior to purebreds in eviscerated yield. Gyles et al. (1954) found that crossbreds outyielded purebreds by 1.5 percent on an eviscerated basis. When the weight of breast, drumsticks, and thighs was expressed as a percentage of live weight, crossbreds again outyielded purebreds 38.8 percent to 37.4 percent.

Although the Cornish is considered superior to other purebreds in eviscerated yield, its performance with respect to growth rate, feed efficiency, chick cost, and other economic considerations is generally not equal to other purebreds or purebred combinations. However, by using the Cornish as the male line for crossing with meat type or production strains of the White Rock and New Hampshire, many desirable characteristics of both the Cornish and non-Cornish breeds can be captured.

The work of May (1956) and Stotts and Darrow (1953) demonstrated that Cornish male crossbreds yielded more of both total raw edible meat and breast meat than did non-Cornish crossbreds or pure non-Cornish breeds. For example, Stotts and Darrow obtained average raw edible meat yields based on eviscerated weights of 88.31 percent for Cornish-cross males compared to 87.47 percent for non-Cornish males and 88.63 percent for Cornish-cross females compared to 87.86 percent for non-Cornish type females.

Meat Strains Versus Production Strains

Limited work has been reported on comparison of meat type and production type strains within a breed. It would seem that the meat type strain should produce a higher eviscerated and raw edible meat yield. However, Stotts and Darrow (1953) found little or no differences in their test stocks. Although Essary et al. (1951) did not report specific eviscerated or meat yields from a production and broiler strain of New Hampshire, the production strain did sustain a higher offal and giblet loss but a lower New York dressing loss.

From time to time tests have compared the performance of Leghorn and Leghorn crosses with broiler strains. Yield data generally favored the broiler strains. Renard (1949) reported higher dressing and eviscerated losses for both the White Leghorn and Leghorn crosses but indicated that this might be due to their smaller body size. Likewise, Dawson et al. (1958b) observed that at 6 and 16 weeks of age Leghorns gave lower yields of cooked edible meat and higher bone yields than did commercial broiler strains.

Size And Age

Research data on meat yields usually confirm the general principle that within a particular class of poultry the heavier the bird, the larger the yield on a percentage basis. Some investigators, studying effects of breeding on yield, ignored this fact when analyzing results and drawing conclusions. When birds of different breeds or different strains are all grown to the same age for processing, the fastest growing group generally produces the highest eviscerated and edible meat yield. If there are true genetic factors affecting yield, one way in which they apparently act is through growth rate.

McNally and Spicknall (1949 and 1955) studied all classes of chicken—from broilers to mature hens and cocks. They found that dressed, eviscerated, and raw edible yields became greater as live body weight increased, and that this relationship was linear. This finding enabled them to derive regression formulae for accurately predicting yields. Results of Jaap et al. (1950) were similar in that rapid growth or size was the major factor increasing dressed and eviscerated percentages in 12-week-old chickens from 44 different strains and crosses.

Conformation

The general rule that only insignificant differences in meat yield exist among breeds when live or carcass weight is held constant appears to have one exception. In subjecting their data to a covariance analysis, Stotts and Darrow (1953) found that the increased raw edible meat yield from Cornish crossbreds was not entirely accounted for by differences in eviscerated weight compared with non-Cornish stocks. A similar observation was made by Jaap et al. (1950).

Where birds of the same weight differ in meat yield, such differences could result from variation in conformation. Cornish breeding is noted for its breast width and the characteristic meat quality that this contributes to the processed bird. Several studies indicated that breast yield of Cornish crosses exceeded that of other breeds or breed combinations. According to Hathaway et al. (1953) and May (1956), breast width is the best single measure for predicting both percentage breast meat and total raw edible meat yields in 12-week-old broilers.

Turkeys

Variety And Size

Three varieties or types of turkey dominate today's commercial production: Broad Breasted Bronze, Broad Breasted White, and Beltsville Small White. The large types, mainly due to their faster growth and heavier weights, generally outyield smaller varieties on an eviscerated basis when age is held constant. Data of Alexander (1951a), Orr et al. (1956), and Scott (1956) supported this conclusion. Howèver, within those limits where live weight can be held constant, McCartney (1952) demonstrated that the large Bronze still had a yield advantage over the small Beltsville.

Mortenson's (1960) survey of processing plants in the north-central states revealed that, on the average, the Broad Breasted Bronze outyielded the Broad Breasted White by slightly less than 1 percent. Again, the size factor may account for the difference since most Bronze strains are slightly larger than the Broad White.

Within varieties or types, strain differences can be expected; this is evident in random sample test results and is suggested by data of Carlson et al. (1962). Therefore, some improvement in yields could be expected through breeding and selection programs.

Age And Sex

Because turkeys grow in size and weight with age, eviscerated yields would be expected to increase as the birds progress through a market-age range of 12-26 weeks. This generally held true for the large type turkey, according to reports of Orr et al. (1956), McCartney (1952), Scott (1956), Swickard and Harkin (1954), and others. However, the small Beltsville did not always show the same tendency. Data from these same workers indicated that percentage yields of the Beltsville as a fryer-roaster and as a mature bird sometimes differed only slightly or not at all.

It is commonly believed that the male outyields the female on an eviscerated basis because the female supposedly has a larger body cavity and consequently proportionately more viscera. Yet much of the mentioned data suggested that sex differences were small or insignificant, especially as the bird approached maturity. Work of Carlson et al. (1962) showed about a 1-percent advantage for large toms over hens. Orr et al. (1956) found that the female had a significantly higher ready-to-cook yield than the male at the fryer-roaster stage.

Random sample test results were not consistent on the effect of sex on yield. Data for 1961 showed that in two of seven state tests, hen turkeys outperformed toms by 0.1-1.7 percent. In five of the tests, males had the advantage by 2.0-4.6 percent.

Conformation—Body Measurements

Turkey breeders have given considerable attention to the improvement of body conformation. They have increased breast width, keel length, and body depth—changes that have resulted in a more acceptable bird from the appearance standpoint. However, work of several researchers did not support the assumption that these changes also would favorably affect yield.

Berg and Shoffner (1954) and Leighton et al. (1961) concluded that body weight was the best single measurement for estimating eviscerated or raw edible meat yields; information on breast width, keel length, body depth, and shank length added little in prediction value. A similar study by Draper et al. (1961) indicated that all correlations between body measurements and yield were small.

Waterfowl

Geese

Little information is available concerning differences in yields among breeds of geese. Snyder (1959) suggested that breed was a factor in yield but that age and degree of finish also played important roles. In a comparison of Pilgrim, White Chinese, Embden, crossbreds, and mixed breeds, he found that the White Chinese gave the highest eviscerated yield. This breed is most popular for processing at an early age because of its rapid growth and tendency to deposit smaller amounts of abdominal and visceral fat.

Ducks

The Pekin breed dominates commercial duck production. Snyder (1959) and Kahle and Gray (1956) agreed that typical eviscerated yields for ducks approximated 73 percent.

DIET, MANAGEMENT, AND HORMONE TREATMENT AS FACTORS IN EVISCERATED YIELDS

Diet

Because the use of dietary fats was reported by Leong et al. (1955) to increase abdominal fat deposition, such use would be expected to also affect eviscerated yield. But this result has not always been clearly demonstrated experimentally. To the extent that fats were used, they did not produce a great effect.

Orr (1955) reported that the use of 5 percent stabilized animal fat did not significantly influence the eviscerated yield of 10 broiler strains. He also reported no effect upon yield of edible cooked meat. Furthermore, Arscott and Sather (1958) found no consistent effect of barley on eviscerated shrinkage. Groups receiving 3 percent animal fat as a supplement to a corn diet did show significantly less eviscerated shrinkage, but this may have been due to heavier dressed weights before evisceration.

Harms et al. (1957) reported a significant increase in eviscerated yield with White Rock broilers fed higher dietary energy levels—790 versus 880 and 980 Calories of productive energy per pound. The differences, though small, were significant. However, no data were given for actual body weights.

On the other hand, Essary (1961) reported that use of from 0 to 8 percent fat in diets for White Cornish cross broilers showed no significant effect on warm eviscerated yield. But he reported that higher dietary levels of fat and protein increased liver size, amount of gizzard fat, and percentage of skin—changes which could lead to an increased yield.

Goertz et al. (1961b) reported no significant difference in eviscerated yield with the following dietary variables (with 60 percent of the diet as grain): corn, sorghum, wheat with 1 percent corn oil, and oats or barley with 6 percent corn oil. When total cooking, thawing, and dressing losses were combined, broilers fed oats or barley with corn oil had the highest losses; those fed corn or wheat had the lowest. Since other workers indicated that animal fats had little effect on yield, increased losses probably were due to barley or oats per se in the diet.

Previously, Goertz et al. (1961a) showed that turkey hens and toms fed oats as the major dietary energy source had significantly higher dressing losses than those fed sorghum grain or wheat. Also, toms fed corn had higher dressing losses than those fed sorghum grain; hens fed corn had lower losses than those fed oats.

Studies of Carlson et al. (1957 and 1962) found that higher energy pelleted growing diets with corn as the major energy source tended to produce turkeys that gave slightly greater eviscerated yields than did turkeys fed lower energy diets with oats as the major energy source. Since body size influences eviscerated yield and since the higher energy fed birds were also heavier, the effect observed on yield probably was due in part, at least, to the size factor. This effect was evident in data reported by Harkin et al. (1960). Although greater eviscerated yields were obtained from turkeys fed 4 percent and 8 percent lard-containing diets, the turkeys were also heavier prior to evisceration.

Therefore, where live weights are the same, prior dietary differences apparently have little effect on eviscerated yield. Although some reports indicated that higher energy diets increased yield, these diets also generally resulted in greater live body weights. Use of feed-grade fats cannot always be expected to increase yield; however, use of low energy cereals normally reduces yield, probably because of slower growth.

Management

Few reports considered the effect of management on eviscerated yield. Wisman et al. (1961) reported variation of floor space from 0.8 to 1.2 square feet per bird had no effect on eviscerated yield of chicken broilers.

On the other hand, Enos et al. (1961), working with turkeys, obtained data which indicated 5 square feet per bird to be superior to 3 and 4 square feet for increasing percent yield for toms. Two square feet per bird were adequate for hens in this respect. However, the toms at 3 square feet per bird were 1.6 pounds lighter (dressed weight) and also graded 19 percent less as grade A compared to the 5 square foot group. Size and degree of finish undoubtedly were reflected in eviscerated yield. If floor space restriction is not adverse to growth, it probably has little effect upon eviscerated yield.

Enos et al. (1961) also reported that all-pelleted rations were superior to grain plus concentrate and all-mash rations in respect to eviscerated yield and average dressed weight. Here again weight may have influenced results. Similar effects were noted in comparing polehouse-reared toms (heavier, greater yield) with those reared on range.

Hormones

The proper use of hormones, or hormone-like substances, increases eviscerated yield. Administration has been through the feed or water or by subcutaneous pellet implantation in the neck. Presently, government regulations prohibit pellet implantation. Some researchers who reported favorable increases in yield were:

■ Detwiler et al. (1950), using White Rock and Barred Rock broilers treated from the 9th to 12th weeks with 0.15 percent thiouracil in the feed or at 9 weeks with 12 mg. pellets of stilbestrol or the combination of thiouracil and 6 mg. pellets of stilbestrol. Although a 0.20 percent level of thiouracil depressed growth, 0.15 percent did not. Stilbestrol generally increased growth.

■ Stadelman et al. (1951), using meat type chickens implanted at 6 weeks of age with 12 mg. of diethylstilbestrol. Treated birds were significantly heavier at 8 and 10 weeks of age and yielded 71.3 percent cut-up weight compared to 70.4 percent for the control birds—a nonsignificant difference.

■ Moreng et al. (1952), using New Hampshire broilers pelleted at 5 weeks of age with 12 mg. of diethylstilbestrol.

■ Fromm and Margolf (1956), using New Hampshire cockerals pelleted at 8 weeks of age with 12 mg. diethylstilbestrol.

■ Issawi et al. (1956), using various imported stocks and breeds indigenous to Egypt implanted at 20 and 25 weeks of age with 15 mg. of diethylstilbestrol. The effect was more pronounced at the earlier age for the Blue Holland and Rhode Island Red breeds and at the later age for the Light Sussexs and White Leghorns. Moreng and Bryant (1956) found no difference in yield of White Rock, Barred Rock, White Leghorn, and New Hampshire males due to implantation at 8 months with 12 mg. of diethylstilbestrol.

■ Lauffer (1957), using New Hampshire males with implantation of 15 mg. of diethylstilbestrol at 8 and 19 weeks, or fed dienestrol diacetate at 10 weeks of age for 3 weeks at 31.75 mg. per pound of feed and again at 21 weeks of age. These treatments also resulted in greater weight at 24 weeks of age. Whereas surgical capons were only slightly heavier than the controls, there were no differences in dressing yield. Hormone-treated groups gave significantly greater yield with improved finish, feathering, and fleshing scores. However, Sell and Balloun (1960) found that dienestrol diacetate at 32 mg. per pound had no effect on growth, whereas methimazole

(Tapazol) at 20 mg. per pound depressed growth but was counteracted by dienestrol diacetate. Eviscerated yield was not significantly affected by any of these treatments.

Studies of the use of hormone-type compounds on turkeys have not demonstrated any significant effect on eviscerated yield. Apparently, turkeys are either less responsive to hormone treatment than are chickens or require a different method of administration. The following reports supported this conclusion:

- Stadelman (1952), using 11, 17, and 21-week-old Broad Breasted Bronze turkeys and 0.2 percent thiouracil or 12, 24, and 36 mg. implants of diethylstilbestrol or combinations with thiouracil.

- Stadelman et al. (1952), using turkey breeder hens and 24 mg. implants of diethylstilbestrol.

- Carter et al. (1958), using dienestrol diacetate at 22 or 32 mg. per pound of feed for 3-6 weeks prior to slaughter of Small White turkeys at 12 and 16 weeks of age.

- Carlson (1959-61), using dietary supplements of dienestrol diacetate at 11 mg. per pound or Dianabol at 1.1 mg. per pound for turkeys from 16 to 24 weeks of age. No differences in growth or breast skin thickness resulted.

PROCESSING METHODS AS A FACTOR IN YIELDS

Preslaughter Handling

If eviscerated yields are computed on a live weight basis at the time of cooping, then shrinkage occurring in handling and transporting to the processing plant can significantly affect results. One factor involved in this shrinkage is humidity, especially during summer months.

Henry and Raunikar (1958), working with chicken broilers, estimated that weight loss of live birds decreased 0.22 percent for each 10-point rise in relative humidity from a base of 80.5 percent. For each 1-percent decrease in loss of live weight, eviscerated yield was increased by 0.66 percent. They predicted that in the May-October period, processors in the North Carolina area could increase eviscerated yields by more than one-half of 1 percent by adopting "early morning processing"—a 12:00 p.m.-9:00 a.m. schedule. This schedule permits loading and transporting during the most humid portion of the day.

Another important factor is the time lapse between cooping and slaughter. Weight loss was estimated by Henry and Raunikar

(1958) to increase by 0.34 percent for each hour involved. By matching the bird-per-hour output of hauling crews to the input capacity of the processing plant and reducing "lead time" to a minimum, substantial savings can be effected.

Length of the starvation period can also affect eviscerated yield. May and Brunson (1955) found that starving for 24 hours gave significantly lower yields for chicken broilers than starving for only 0, 3, 6, or 12 hours. No significant differences in yield existed among the 0-12 hour groups for either sex.

Killing and Bleeding

The bleeding phase of processing can affect eviscerated yields insofar as methods used influence blood loss. Although it is advantageous from a yield standpoint to limit blood loss, processors must be concerned with the adverse effects of poor bleeding on carcass appearance. Newell and Shaffner (1950) pointed out that, in chickens, blood constitutes approximately 10 percent of body weight but that the blood loss in slaughtering may vary over a range of 35-50 percent of total blood volume.

Immobilization of poultry prior to bleeding is presently limited largely to the use of electric stunning for turkeys. The work of Mountney et al. (1956) suggested that the principal effect of electric shock was a slower rate of bleeding as measured by percent loss in the first 45 seconds. No differences in total blood loss over a more extended bleeding period were noted.

Use of carbon dioxide to immobilize poultry was explored by Swanson and Helbacka (1953), Drewniak et al. (1955), Kotula et al. (1957), and Kotula et al. (1961). Reported results indicated that this treatment increased the rate of blood loss but had a nominal effect, if any, on total loss. Some reduction in bird-to-bird variation was observed.

Several drugs were tested experimentally for their effects on blood loss. Newell and Shaffner (1950) found that the vasoconstriction and increased blood pressure resulting from epinephrine injections were ineffective. Sodium pentobarbital, which acts as a sedative and may have potential as an immobilizer, slowed down the rate of bleeding but did not affect total loss during a 2-minute period, according to Huston and May (1961).

Bleeding by severing the jugular vein outside the throat behind the mandible is favored in commercial practice. Newell and Shaffner (1950) and Davis and Coe (1954) agreed that a higher percentage of blood was lost by the use of this method than by beheading. Bleeding is apparently more closely related to heart action than to blood coagulation. Therefore, cutting off nervous control to the heart by decapitation may account for poorer bleeding in this killing method.

Evisceration Methods

Practices followed on the eviscerating line can affect ready-to-cook yields in several ways. For example, the kind and extent of cut used in opening the abdominal cavity influence, in part, the quantity of moisture picked up in liquid chilling. In a study made by Kotula et al. (1960a), chicken broilers whose abdominal cavities were opened by cutting the skin between the thigh and the rib cage on one or both sides gained significantly more weight than controls in which the thigh areas were not opened.

Essary and Howes (1960) reported on effects of kidney removal on yield. As expected, when kidneys were removed, there was a significant reduction of yield in the warm eviscerated bird, ranging from 0.82 percent in broilers to 0.66 percent in fowl. However, after 4 hours of chilling in ice slush, this yield loss was more than restored by significantly greater weight increase in birds without kidneys.

Controlled studies to demonstrate effects of other evisceration practices on yield are meager or nonexistent. Nevertheless, it is commonly accepted that the care used in such operations as removing head and preen gland, trimming giblets, cutting around the vent, and salvaging abdominal fat can significantly affect final yields.

Chilling Procedures

In processing poultry, carcass cooling probably affects yields to the greatest extent. Some moisture is absorbed on the evisceration line as birds are sprayed and washed to avoid dehydration and maintain sanitary standards. But much larger weight gains can result from liquid chilling.

Possibilities of adding excessive moisture to poultry prompted the U.S. Department of Agriculture to establish maximum limits for weight gains in poultry processed under USDA supervision. These regulations protect both the legitimate processor and the consumer from unscrupulous practices.

Experimental results indicate that numerous factors influence weight changes during chilling. As pointed out by Tarver et al. (1956) and Froning et al. (1960), even losses in weight can result if poultry is cooled in air. However, nearly 100 percent of commercially processed poultry is now subjected to liquid chilling and weight gains can be expected.

To achieve desired rates of cooling, ice in one form or another is invariably used. Results reported by Mickelberry et al. (1962a) indicated that the percentage of ice used can affect moisture absorption. Chicken broilers and roasters cooled in unagitated chill tanks showed the greatest increase in weight after 8 hours when the cooling medium consisted of 33 percent crushed ice. However, after a 16-hour drain period, roasters chilled in 50 percent ice had the greatest eviscerated yield.

Coolant temperature has reportedly affected moisture pickup and retention. Although rapid cooling in liquid media at or near 32° F. is normally recommended, prechilling with uniced well water is often practiced for economic reasons. Thomson et al. (1961) found that fryers prechilled for 15-30 minutes at 70° F. and then finished in ice slush gained significantly more than those cooled at 32° F. for the entire period. Prechilling at 50° F. gave intermediate results.

Numerous investigations confirmed that moisture absorption was affected by length of time carcasses were exposed to the chilling medium. Studies of Froning et al. (1960), Swanson et al. (1962), Bigbee and Dawson (1961), Thomson et al. (1961), and Fromm and Monroe (1958) all supported the conclusion that weight gains were directly proportional to length of chilling period.

In normal processing of ice packed poultry, chilling time is kept at a minimum to expedite product flow through the plant. But where poultry is to be frozen, chill periods up to 20-24 hours are commonly used to permit maximum tenderization. However, Swanson et al. (1962) did not obtain excessive moisture pickup in turkey fryer-roasters held in unagitated ice slush for 24 hours.

The rather recent development of continuous on-the-line cooling systems employing mechanical agitation prompted several investigators to reevaluate chilling effects on yield. These new devices not only accelerate cooling rates but also increase water absorption. For example, Klose et al. (1960) reported that at least twice as much moisture pickup can be obtained with mechanical agitation as without.

Kotula et al. (1960b) compared conventional tank cooling with continuous on-the-line methods. He found that the parallel-flow tumble and counterflow tumble systems gave by far the largest increases in weight gains. The continuous drag and 2- and 4-hour tank systems produced the smallest pickup. Intermediate increases were obtained with the oscilating vat and 24-hour tank chills.

Eviscerated yields calculated immediately after chilling may be quite different from those computed later in the marketing chain. Fromm and Monroe (1958) demonstrated that in ice-packed fryers the greater the amount of moisture picked up in conventional batch-type chilling, the higher the weight loss during the following 48-hour period. According to Kotula et al. (1960b), moisture picked up in most continuous chilling systems was quite loosely bound; most of it was lost during normal commercial handling. At the end of the marketing chain, yields from the standard tank method and the continuous systems were quite comparable.

Although Bigbee and Dawson (1961) confirmed the finding that weight losses of ice packed poultry in storage generally were proportional to weight increases in chilling, they also found that holding room temperature played a role. Ice-packed fryers actually gained slightly in weight when held at 60° F. for 48 hours, whereas iced fryers at 35° F. lost weight.

Polyphosphates as an additive to the chilling medium recently were tested in several studies for their effect on moisture absorption and retention by poultry. Results reported by Mountney and Arganosa (1963), Schermerhorn et al. (1963), Schermerhorn and Stadelman (1964), Klose et al. (1963), May et al. (1963), Spencer et al. (1963), and Thomson et al. (1963) did not completely agree. However, there is evidence that polyphosphates do somewhat reduce moisture uptake, especially when used at levels above 4 percent. The advantage this treatment may have is that of reducing weight loss sustained by ice-packed poultry while in market channels.

Freeze-Drying

According to Bird (1963), poultry eventually will be the largest meat item to be freeze-dried. Presently the major use is freeze-dried chicken in the manufacture of dehydrated soups.

The final moisture content of freeze-dried chicken is usually less than 2 percent in order to prevent carbonyl-amine browning. Dawson (1963) found that the hydration range based on dry weight varied with the age of the bird, method of cooking, and conditions of dehydration. For broilers the increase in weight on rehydration was usually about 145 percent, whereas old hens rehydrated by only about 120 percent.

On this basis, 100 grams of fresh chicken would yield about 37 grams of freeze-dried product. On rehydration, about 90 grams and 81 grams of reconstituted meat would be obtained from broilers and old hens, respectively. Wells et al. (1962) also found that meat from younger birds rehydrated more completely than did meat from older birds.

FACTORS AFFECTING COOKED YIELDS OF WHOLE BIRDS

Eviscerated yields of poultry, based on live weights, are of primary concern to producers and processors. But cooked yields are generally computed on a ready-to-cook basis and are of special interest to housewives, institutional food services, hotel and restaurant trade, and those engaged in "further processing." A knowledge of factors affecting cooked yields should be helpful in estimating requirements, selecting and purchasing the product, and interpreting results.

Characteristics of the Bird

A survey of studies reporting data on cooked yields can be confusing because of the many interactions among factors. For example, it is difficult to differentiate specific individual effects of size, age, sex, conformation, and finish. In many cases, experimental design and analysis of results do not permit meaningful conclusions.

It is generally believed that larger birds have higher cooked yields than those of lighter weight. Data presented in the Turkey Handbook (undated) demonstrated this clearly. Yet, results of Dawson et al. (1960) and Swickard and Harkin (1954) emphasized that these yield differences due to size were not always large or significant.

When increased size is largely the result of added fat, cooked yields on a percentage basis may even decrease. Swanson and Canfield (1957) and Snyder and Orr (1953), when working with geese, found lower edible yields in the older larger birds due to increased dripping losses during roasting.

Conformation, particularly with respect to the breast, influences cooked edible yields. Alexander et al. (1951a) observed that turkeys with the wider breast yielded a higher percent of cooked muscle. Dawson et al. (1957), working with miniature Cornish-cross broilers, noted the same relationship.

The female is normally smaller than the male of the species at maturity. This fact has led to the false generalization that the male bird yields a higher percent of edible meat than does the female. This assumption holds true only under certain conditions.

For example, data from the Turkey Handbook (undated) indicated that tom turkeys over 22 pounds definitely outyielded lighter hen turkeys. However, when tom turkeys under 22 pounds were compared in edible yield with hens, the difference was in favor of the hen turkey. May (1956) also found that, when weight was held constant for both sexes, female chicken broilers and light roasters gave significantly higher edible meat yields.

The effect of U. S. grade on cooking losses and edible yield was investigated by Goertz et al. (1962a). The workers divided grade A, B, and C Broad Breasted White turkey hens into groups on the basis of finish and fleshing, bruising, cuts and tears, missing parts, and deformities. Grade A turkeys in the finish and fleshing group had higher ether extract for light meat and more edible cooked meat and smaller total cooking losses than did grade B. For other groups, cooking losses and servings per pound were similar for grades A, B, and C.

Processing Effects

Ordinarily, processing procedures are not thought to particularly affect cooked yields based on eviscerated weight. Nevertheless, there are one or two possible exceptions.

When ice-packed poultry arrives at its market destination, it has reached a point of equilibrium where differences in moisture content will be negligible regardless of the chilling methods followed. On the other hand, in frozen poultry the moisture picked up in the chilling operation is largely retained by the bird during packaging and freezing. Therefore, cooked yields based on purchased weights can be affected by moisture content. Froning et al. (1960) and Swanson et al. (1962) found that thawing and cooking losses were directly proportional to the extent of moisture absorbed in chilling.

Where fresh and frozen poultry are processed under the same conditions, both forms should yield similarly. Goertz et al. (1960) found no differences in total cooking losses of fresh-unfrozen and frozen-defrosted turkeys. The fresh-unfrozen turkey was generally higher in volatile losses but lower in dripping losses.

Barrie et al. (1964) compared blast with liquid frozen hens and toms. He noted that freezing method had no effect on yield; cooking losses were similar for turkeys frozen by the two methods.

Reports of Mountney and Arganosa (1963), Schermerhorn and Stadelman (1964), Schermerhorn et al. (1963), and Klose et al. (1963) indicated that the addition of polyphosphates to the chilling media favorably affected cooked yields, probably due to greater moisture retention by the treated birds.

Cooking Methods

Available data concerning effects of cooking methods on cooked yields are limited. Dawson et al. (1958a and 1960), Schlosser et al. (1957), and Pecot and Watt (1956) reported results with different preparation methods including broiling, frying, roasting, stewing, simmering, braising, and pressure cooking. Comparative yields somewhat depend on kind and class of poultry involved and on other variables. Reference to tables 4-12 verifies the difficulty of making generalizations regarding effects of cooking methods on yield.

Proper choice of end-point in cooking can be an important factor. Overcooking, especially in roasting, can reduce yields. As pointed out by Alexander et al. (1951b), this is a special problem in large birds since the time required to bring the thickest portions of the bird to the proper end-point may result in overcooking the thinner parts.

In roasting, the kind of oven or heat used can influence final yields. According to Schano (1958), chicken cooked in a regular electric oven yielded about 2.3 percent more than that cooked by the electronic type oven or rotisserie method.

The amount of shrink obtained in frozen cooked poultry during thawing and final cooking depends upon the length of the precooking period. Carlin et al. (1959) demonstrated this fact with chicken broilers. Samples precooked for only 3 minutes had an average loss of 23 percent in weight after reheating, compared to a 14-percent loss for those precooked 10 minutes. Mickelberry and Stadelman (1962b) found that cooking chicken meat before freezing resulted in a smaller freeze drip but greater total losses than did cooking subsequent to freezing the raw meat and slow thawing.

YIELDS OF PARTS AND BONELESS MEAT FROM READY-TO-COOK POULTRY

Expansion of merchandizing parts and "further processing" of poultry is increasing the need for yield information on individual parts as a percentage of the ready-to-cook carcass. Results of such studies were published for several poultry species and classes. However, comparisons are often difficult to make because of variations in procedure. The amount of research conducted in this area is relatively limited. In general, the factors most responsible for variations in yields are size, sex, and body conformation if methods of cutting and calculation remain the same.

Specific data may be of limited value, but they are included in tables 4-12 in order to indicate the relative relationship of different parts of the whole carcass. This tabular format also illustrates the variation existing in published reports and that this variation is due to procedural differences.

Since breast and thighs not only have higher yields than other parts but are also the most valuable, they are given emphasis in discussion of each species and each study reported.

Chickens

Yields for chicken parts (table 5), as determined by different investigators, were fairly consistent with the exception of breast and neck yields reported by Tadle et al. (1955). Apparently, this discrepancy can be accounted for by their inclusion of neck skin with the breast, whereas other workers included neck skin with the neck. The higher leg yields and lower back yields noted by Jull et al. (1943) were due to inclusion of the "oyster" with the leg.

Breast yield percentages of females were equal to or higher than those for males according to Dodge and Stadelman (1959), Newell (1954), and Jull et al. (1943). Both Newell (1954) and Jull et al. (1943) reported an increase in breast percentage with increasing size of bird.

In a more recent study, Walters et al. (1963) observed that weights, volumes, and dimensions of broiler parts were directly related to carcass weights. So these values for broiler parts can be predicted with reasonable accuracy if carcass weights are known. The percentage relationship of weights of parts to carcass weight was found to be approximately the same for all of the weight groups.

Dodge and Stadelman (1959), although finding little strain difference when ready-to-cook birds were cut up as reported in table 5, noted differences when birds were cut up in other ways. This was due to variation in body conformation of the two strains.

Turkeys

Table 7 presents yields of parts for turkeys and illustrates the difficulty encountered in comparing published studies due to procedural differences. Earlier investigators on turkey parts based results on live and New York dressed weights. Therefore, a review of this work is not included.

Little or no information was presented by Sweet et al. (1954) and Brosmer et al. (1956) concerning factors that might affect yields of parts. Headley (1958) found that neither the bird's variety nor sex significantly influenced the percentage of parts, although size and individual bird variation were important. The most recent work on turkey parts was conducted by Fry et al. (1962). They summarized their work as follows:

> Turkeys of twelve different strains (two varieties) were used to study the effects of variety, sex, and strain on the yields of parts as a percentage of the eviscerated ready-to-cook weight minus giblets. Boneless breast averaged 32.5 percent of the eviscerated weight for males and 30.3 percent for females. Thighs accounted for 14.6 percent in males and 15.2 percent in females.
>
> The influence of sex was highly significant on percentage yield of both breast and thighs with males having a higher percentage of breasts and females a higher thigh percentage. Variety did not significantly affect the percentage yield of either breast or thighs.
>
> The differences between strains were significant at the .05 level for percentage of breast, but not for thighs.
>
> Breast width was positively and significantly correlated with yield of breast in both sexes. In males percentage of breast was also positively correlated with eviscerated weight, body depth, and keel length, but the latter correlation was nonsignificant. Negative correlations were observed for percentage of breast of females and eviscerated weight, body depth, and keel length.

The relationship of sex to yield of breast and thighs in turkeys is opposite to that of chickens. Yield of breast is highest in turkey males, whereas yield of thighs is highest in turkey females.

Limited reports are available on yield of boned breast and thighs. This information is of particular interest to processors producing turkey rolls and turkey steaks. Unpublished data of Fry and Taylor (1962) showed yields from toms of 12 commercial strains of 25.2-30.0 percent for raw boneless skinless breast and of 12.6-13.9 percent for boneless skinless thighs.

In preparing combination dark and light meat turkey rolls, Bowers (1963) noted that 9-11 pound rolls were obtained from 22-24 pound grade A Bronze toms. Breast accounted for about 60 percent, thighs 27 percent, and skin 13 percent of the uncooked roll weight. When these rolls were cooked at 325° F. to an end-point of 185° F., cooking losses for the braised rolls were 28 percent—significantly less than the 32 percent loss for roasted rolls.

Marquess et al. (1963) reported yield values of 26.5 percent raw breast muscle and 11.4 percent raw thigh and back muscle from 20-22 pound oven-ready toms. Upon roasting boneless roasts made from these same muscles, yields of cooked light-meat rolls decreased as oven temperatures increased from 250° to 350° F. For the temperatures used, there were no significant differences in yields or losses of dark meat rolls. Range of yields for light meat rolls was 68.9-78.3 percent; for dark meat rolls, 61.1-66.1 percent.

Turkeys rolls were oven braised and cooked in a meat mold pan in water by Fry and Goertz (1964). Braised rolls were cooked at 325° F. to an end-point of 185° F. Panned rolls were cooked at a constant water temperature of 190° F. to an end-point of 176° F. and at a variable water temperature of 150° F. for 1 hour, 170° F. for 1 hour, and 190° F. to an end-point of 176° F. Cooking losses were highest for oven braised and lowest for panned cooked at constant water temperature. Rolls lost an additional 2.5-3.0 percent when cooled to room temperature following cooking.

Breasts and thighs roasted by Goertz et al. (1962b) at 350° F. to an end-point temperature of 203° F. had cooking losses of approximately 26.4 percent and 29.3 percent, respectively. They yielded 3.7 and 3.3 servings of 71 grams of cooked edible meat per ready-to-cook pound, respectively.

Total edible yield of roasted Broad-Breasted White turkey hens (10-12 pounds) was reported by Goertz et al. (1962a) to range between 34.4 and 39.1 percent of the ready-to-cook weight without neck and giblets. Light meat was approximately 60 percent and dark meat 40 percent of the edible yield. The number of 2½ ounce servings of cooked meat per pound of ready-to-cook turkey was unrelated to grade and ranged from 1.8 to 2.1 servings. Only slices of breast and thigh that made attractive servings were used for these calculations, although small pieces of meat remained that could have been used for other purposes.

Geese

A significant effect of age on yield of parts was shown by Deskins and Winter (1956) for 8-10, 10-12, and 24-week-old geese (table 6). Percentage breast increased almost 10 percent from 8-10 weeks of age to 24 weeks of age; leg and thigh percentages decreased approximately 5 percent during the same time.

In a comparison of weeder geese (6-8 months) and nonweeders (4 months), Bean and Hanson (1962) obtained a slightly higher yield of raw carcass meat from the larger nonweeder geese (32.2 percent versus 30.1 percent, based on live weight).

Ducks

Data presented by Clements and Winter (1956) for 7½-week-old ducks (table 6) showed that the breast, including bone, amounted to approximately 30 percent of the ready-to-cook carcass. Percentages of all parts were similar for both sexes, perhaps because only 0.8-pound weight differences existed between the live male and female ducks studied.

METHODOLOGY FOR REPORTING EVISCERATED, CUT-UP PARTS, AND COOKING YIELDS

Previous sections emphasized the many factors that may affect eviscerated, cut-up parts, and cooking yields of poultry. Moreover, differences in experimental procedure resulted in such variations that a valid comparison of results was difficult. In some cases, insufficient detail was included in the published report for readers to determine accurately the procedure used. Suggestions as to methodology are herein presented in hope of making future research on yields more easily interpreted and of greater value.

Modification of technique in studies of dressing and cooking yields is often the most important part of the research itself. Therefore, it is difficult to set down a method by which dressing and cooking research should be accomplished. It seems more appropriate to prepare a list of conditions of experimental procedure that should be included in any research report on yields. Table 1 contains such a list for dressing yields; a similar list for cooking yields is in table 2; and values or data to be reported in cooking studies are in table 3.

In addition, when planning a project involving evaluation of the product by a taste panel, allowance should be made for extra birds to be used for preliminary cooking tests. This should be done in order to establish optimum thawing time, cooking time, and other procedures that may be influenced by the kind, class, and weight of birds tested.

Following is a description of cut-up parts that can be used as a basis for accomplishing research on yields of parts. Modifications in cutting other than here indicated should be reported. Cutting of

Table 1. Conditions to be reported in eviscerated yield* studies

Kind or market class	Method of chilling
Breed and/or strain	Additives to water (if any)
Live and ready-to-cook weights	Temperature of chill water
Age of birds	Ice-water ratio
Sex of birds	Length of chilling
Type of ration	Method and length of draining time
Length of starve (feed)	Carcass temperature at time of taking ready-to-cook weight
Length of starve (H_2O)	Inclusion or absence of neck and giblets
Scald water temperature and time	
Type of picker	
Method of evisceration	

* Eviscerated yield to be calculated as the percentage the ready-to-cook weight is of live weight.

Table 2. Conditions to be reported in cooked yield* studies

Kind, market class, breed and/or strain, sex, and weight of birds
History of birds (as in table 1)
Thawing time and temperature (if frozen)
Temperature of carcass prior to beginning of cooking
Whole or half bird or parts
Type and number of ovens used
Breast side up or down
Protection against drying (foil, cheesecloth, oil, etc.)
Oven temperature (method of measurement)
Rate of heat penetration (temperature rise per unit of time)
Cooking end-point temperature (method of determination)
Cooking time
Criterion for doneness if other than end-point temperature
Product temperature at weighing and time lapse since cooking
Method of deboning

* Cooked yield to be reported as the percentage the cooked bird is of the ready-to-cook weight. Cooked edible meat percentages to be reported on ready-to-cook basis and cooked basis.

Table 3. Data to be reported in cooked yield* studies

Cooked yield
Total cooking loss:
Volatile loss
Fat, moisture, and sediment loss
Cooked edible muscle
Skin
Bones
Handling loss

* Cooked yield to be reported as the percentage the cooked bird is of the ready-to-cook weight. Cooked edible meat percentages to be reported on ready-to-cook basis and cooked basis.

chickens may differ somewhat from cutting of turkeys. Percentages should be reported on the basis of eviscerated ready-to-cook weights. Whether the kidneys, giblets, and neck are included in the ready-to-cook weight should also be stated.

Breasts (including keel bone): Breasts are separated from the back by a cut starting at the shoulder joint and going through the junction of the vertebral and sternal ribs. Neck skin is not included.

Breasts (boneless): All breast muscle is removed by cutting from the junction of the vertebral and sternal ribs to the point of the keel. Muscle may be removed in one or two pieces but should be reported as one. Neck skin is not normally included.

Wings: Wings include the entire wing with all muscle and skin intact. If wing tips are removed, this should be stated.

Drumsticks: Drumsticks are separated from the thigh by a cut through the knee joint (femorotibial and patellar joint).

Thighs: Thighs are disjointed at the knee and hip joints. They include neither the pelvic bones nor the oyster.

Neck: Necks are separated from the carcass at the shoulder joint and include neck skin, unless stated otherwise.

Backs: Entire backs include the scapula, vertebrae, vertebral ribs, and pelvic bones, with all muscle and skin intact. Backs may be separated into front and rear portions by a transverse cut between thoracic and lumbosacral vertebral regions. (Vertebral ribs and the scapula are part of the front portion of the back.) Back cutlets may be further removed by disjointing the scapula at the shoulder joint; they include the scapula and attached muscle and skin.

Giblets: Giblets include the liver from which the bile sac is removed, the gizzard from which the lining and contents are removed, and the heart. Each organ is properly trimmed and washed. The weight or percentage of each organ may be reported separately, if desired.

Bones: Bones include the sternum with sternal ribs if the boneless breast is removed, and the thoracic region of the vertebral column with vertebral ribs if "back cutlets" are removed. The muscle-free, skin-free bone of any other part completely deboned is also included.

Loss: The cutting and moisture loss is determined by the difference between initial weight and total weights of all individual parts.

Halves: Halves are obtained by cutting the ready-to-cook bird in half by sawing lengthwise through approximately the center of the vertebral column and sternum or cutting directly alongside each to produce two approximately equal halves.

Quarters: The ready-to-cook bird is halved as described above. Front and rear (light and dark) quarters are separated by a cut from a point directly to the rear of the sternum to and through the vertebral column at the junction of thoracic and lumbosacral regions.

ESTIMATED AND EXPERIMENTAL YIELDS

The foregoing sections of this report reviewed the many factors affecting yields of poultry meat. Principles involved rather than specific yield values were emphasized.

Tables 4-12 are only guides for those searching for yield data. It is impossible to tabulate in table form all conditions under which each set of values was obtained. Therefore, the original reference should be consulted whenever more detail is desired.

In using these tables, processors and those engaged in institutional food service should realize that many of the data were obtained in small laboratory experiments. Large volume operations could give different results. At the same time it is hoped that researchers will recognize the many gaps in our information on poultry yields and the need for conducting research in this field under conditions that will make results most meaningful to the industry.

Table 4. Percentage yields of chilled whole eviscerated poultry, including neck and giblets

Class of poultry	Percent yield*			Reference†
	Minimum	Maximum	Average	
Chickens:				
Broilers, fryers	70	75	73	1, 2
Roasters	72	76	74	
Fowl	70	76	73	
Turkeys:				
Fryer-roasters	75	81	79	1, 2, 3, 4
Light breeds	76	83	79	
Heavy hens	78	84	81	
Heavy toms	78	84	82	
Ducks:				
Ducklings (7-9 weeks)	70	75	73	1, 2, 5
Geese:				
White Chinese (6-8 weeks)			68	1, 2, 4, 5, 6
White Chinese (10-16 weeks)	72	75	73	
White Chinese (6-8 months)			73	
Heavy breeds (5-8 weeks)	65	71	68	
Heavy breeds (10-16 weeks)	68	75	73	
Heavy breeds (over 16 weeks)	70	75	73	

* Based on live weight.

† Reference:
1. Kahle and Gray (1956).
2. Pecot and Watt (1956).
3. Mortenson (1960).
4. Turkey Performance Tests (1961).
5. Snyder (1959).
6. Swanson and Canfield (1957).

Table 5. Percentage yield of cut-up parts of chicken based on chilled ready-to-cook weight with giblets

Class	Sex	Breast	Legs	Thighs	Wings	Back	Neck	Heart	Gizzard	Liver	Reference*
		Percentage yield									
Fryers:	Both	22.4	15.0	15.9	12.6	17.3	8.2	0.9	3.7	3.6	1
	Both	22.4	14.6	15.5	12.4	17.7	8.2	0.9	3.8	3.6	1
	Both	25.1	31.5		13.1	18.2	4.9	0.6	3.8	2.8	2
	Male	22.1	15.2	15.8	14.2	18.1	7.5	6.8 (all giblets)			3
	Female	23.4	14.5	15.6	14.0	18.3	7.5	7.0 (all giblets)			3
	Male	24.3	33.5		13.1	14.2	7.6	0.6	3.8	2.5	4
	Female	24.8	31.8		12.4	14.9	7.9	0.6	4.1	2.5	4
Stewing:											
Light hens		24.5	27.7		10.3	21.7	3.2	5.1 (all giblets)			5
Heavy hens		23.2	28.4		9.4	22.1	3.0	4.4 (all giblets)			5

* Reference:
1. Dodge and Stadelman (1959).
2. Tadle et al. (1955).
3. Newell (1954).
4. Jull et al. (1943).
5. Shonebarger (1957).

Table 6. Percentage yield of cut-up parts of ducks and geese based on chilled ready-to-cook weight with giblets

Kind and class	Breast	Legs and thighs	Wings	Back	Neck	Heart	Gizzard	Liver	Reference*
	Percentage yield								
Ducks:									
7½ week Pekin males	29.7	23.4	10.6	23.0	5.4	0.9	4.3	2.7	1
7½ week Pekin females	30.1	23.5	10.8	23.6	4.7	0.9	3.9	2.5	1
Average:	29.9	23.5	10.7	23.3	5.1	0.9	4.1	2.6	1
Geese:									
8-10 weeks	17.8	25.7	15.8	20.5	6.9	0.7	8.3	4.2	2
10-12 weeks	23.7	21.9	16.0	21.3	6.3	0.9	6.3	3.5	2
24 weeks	27.3	20.5	15.4	21.3	6.0	0.9	6.2	2.2	2

* Reference:
1. Clements and Winter (1956).
2. Deskins and Winter (1956).

Table 7. Percentage yield of cut-up parts of turkey based on chilled ready-to-cook weight

Sex	Percentage yield: Breast					Back						Reference*
	Whole	Boneless	Thighs	Legs	Wings	Posterior	Anterior	Cutlets	Neck	Giblets	Bones	
M†	....	32.5	14.6	14.0	11.0	10.8	....	4.0	4.2	....	8.5	1
F†	....	30.8	15.2	14.0	11.9	11.9	....	4.0	4.2	....	7.9	1
M‡	44.3	....	25.8		10.2	19.7		....	....	....	....	2
F‡	38.2	....	27.4		12.2	22.2		....	....	....	....	2
M§	31.8	....	32.6		14.1	21.5		....	....	....	....	2
F§	32.2	....	31.8		13.8	22.2		....	....	....	....	2
M¶	....	30.2	13.4	12.1	10.5	11.5	10.2	....	3.9	4.6	3.4	3
F¶	....	29.3	13.7	11.9	12.0	11.4	10.5	....	3.4	4.9	2.8	3
M♯	....	27.1	12.6	13.5	13.2	12.9	8.9	....	3.5	5.9	3.4	3
F♯	....	27.2	11.9	13.0	12.8	13.1	10.0	....	3.3	6.5	2.8	3

* Reference:
1. Fry et al. (1962).
2. Brosmer et al. (1956).
3. Sweet et al. (1954).

† 26-week Bronze and heavy White males; 22-week females; ready-to-cook weight with neck but without giblets; neck skin with breast.
‡ 28-week Bronze; ready-to-cook weight without both neck and giblets; breast includes sternum but not sternal ribs.
§ 16-week Beltsville X Wahkeen cross; ready-to-cook weight without neck and giblets; breast includes sternum but not sternal ribs.
¶ Bronze toms (20.3 pounds) and Bronze hens (11.6 pounds).
♯ Beltsville toms (6.8 pounds) and Beltsville hens (5.4 pounds).

Table 8. Percentage yields from boning operations, raw and cooked chicken*

Class	Description: Before	Description: After	Yield after preparation: Raw	Yield after preparation: Cooked
			percent	
Chicken fryer:	Ready-to-cook; with neck, giblets	Meat, skin, giblets	66	......
	Ready-to-cook; without neck, giblets	Meat, skin	69	......
Chicken roasters and stewers:	Ready-to-cook; with neck, giblets	Meat, skin, giblets	73	......
	Ready-to-cook; without neck, giblets	Meat, skin	72	......
All chicken:	Whole:			
	Fricassee; with neck; without giblets	Meat, skin	......	66
	Roasted; without neck, giblets	Meat, without skin	......	62
	Roasted; without neck, giblets	Meat, skin	......	74
	Roasted; with giblets	Meat, skin, giblets	......	75
	Stewed, braised; without neck, giblets	Meat, without skin	......	53
	Stewed, braised; without neck, giblets	Meat, skin	......	69
	Stewed, braised; with neck, giblets	Meat, giblets, without skin	......	63
	Stewed, braised; with neck, giblets	Meat, giblets, skin	......	76
	Parts—fricassee:			
	Breast	Meat, skin	......	79
	Drumstick	Meat, skin	......	71
	Thigh	Meat, skin	......	79
	Wing	Meat, skin	......	50
	Back	Meat, skin	......	41
	Ribs	Meat, skin	......	54
	Neck	Meat, skin	......	48
	Parts—fried:			
	Legs (drumstick, thigh)	Meat, skin	......	74
	Parts—roasted:			
	Breast	Meat, skin	......	66
	Leg (drumstick, thigh)	Meat, skin	......	73
	Wing	Meat, skin	......	55
	Back	Meat, skin	......	31
	Parts—stewed or braised:			
	Breast	Meat, skin	......	86
	Drumstick	Meat, skin	......	68
	Thigh	Meat, skin	......	79
	Wing	Meat, skin	......	56
	Back	Meat, skin	......	58
	Ribs	Meat, skin	......	47
	Neck	Meat, skin	......	59

* Reference: Pecot and Watt (1956).

Table 9. Percentage yields from boning operations, raw and cooked turkey*

Class	Description: Before	Description: After	Yield after preparation: Raw	Yield after preparation: Cooked
			percent	
All weights:	Ready-to-cook; with giblets; without neck	Meat, giblets	73	......
	Ready-to-cook; without giblets, neck	Flesh, without skin	63	......
	Parts, raw:			
	Breast	Meat, skin	89	......
	Drumstick	Meat, skin	78	......
	Thigh	Meat, skin	83	......
	Wing	Meat, skin	65	......
	Foreback	Meat, skin	60	......
	Rearback	Meat, skin	65	......
	Roasted; without neck, giblets	Meat, skin	......	71
	Roasted; without neck, giblets	Meat, without skin	......	59
	Roasted—parts:			
	Breast	Meat, skin	......	89
	Drumstick	Meat, skin	......	69
	Thigh	Meat, skin	......	81
	Wing	Meat, skin	......	63
	Foreback	Meat, skin	......	59
	Rearback	Meat, skin	......	64
	Steamed; without neck, giblets	Meat, without skin	......	57
	Boiled or steamed; with neck, giblets	Meat, giblets, without skin	......	65
	Boiled or steamed; without neck, giblets	Meat, without skin	......	62
	Pressure cooked; with neck; without giblets	Meat, without skin	......	55

* Reference: Pecot and Watt (1956).

Table 10. Percentage yields of cooked turkey based on ready-to-cook weights

Product form	Cooking method	Cooked yield: With bone	Cooked yield: Edible meat	Reference*
		percent		
Whole—fryer	Roasted	73	55	1
	Roasted	79	......	2
	Pressure	76	54	3
	Braised	73	55	1
Whole—large	Roasted	72	......	2
	Pressure	68	57	3
Whole—all weights	Roasted	74	......	2
	Boiled	71	......	2
	Steamed	69	......	2
	Pressure	72	......	2
Breast	Pressure	73	68	4
Legs and thighs	Pressure	66	54	4
Wings	Pressure	69	49	4
Back and ribs	Pressure	63	45	4
Neck	Pressure	65	43	4
Gizzard	Pressure	......	43	4
Liver	Pressure	......	62	4
Heart	Pressure	......	60	4

* Reference:
1. Dawson et al. (1960).
2. Pecot and Watt (1956).
3. Winter and Clements (1957).
4. Brosmer et al. (1956).

Table 11. Percentage yields and losses of cooked chicken based on ready-to-cook weights

Cooking method:	Broiled	Fried	Fricassee	Roasted	Stewed	Pressure		
Reference:*	1	1	1	1	1	2	3	3
	percentage yields and losses based on ready-to-cook weights							
Halves or whole:								
With bone	74	79	82	72	68	75	63	62
Cooking loss	26	21	18	28	32	25	37	38
Edible meat	......	......	54	53	47	51	49	49
Bone	......	......	28	19	21	24	14	13
Breast:								
With bone	......	......	81	......	72	76	66	62
Cooking loss	......	......	19	......	28	24	34	38
Edible meat	......	......	64	......	62	63	59	56
Bone	......	......	17	......	10	13	7	6
Legs and thigh:								
With bone	......	64	......	......	......	76	63	62
Cooking loss	......	36	......	......	......	24	37	38
Edible meat	......	47	......	......	......	53	49	49
Bone	......	17	......	......	......	23	14	13
Drumstick								
With bone	......	......	73	......	74	......	......	......
Cooking loss	......	......	27	......	26	......	......	......
Edible meat	......	......	52	......	50	......	......	......
Bone	......	......	21	......	24	......	......	......
Thighs:								
With bone	......	......	72	......	67	......	......	......
Cooking loss	......	......	28	......	33	......	......	......
Edible meat	......	......	57	......	53	......	......	......
Bone	......	......	15	......	14	......	......	......
Wings:								
With bone	......	......	92	......	87	84	72	74
Cooking loss	......	......	8	......	13	16	28	26
Edible meat	......	......	46	......	49	50	49	48
Bone	......	......	46	......	38	34	23	26
Back and ribs:								
With bone	......	......	......	......	......	76	59	61
Cooking loss	......	......	......	......	......	24	41	39
Edible meat	......	......	......	......	......	42	44	44
Bone	......	......	......	......	......	34	15	17
Backs:								
With bone	......	......	76	......	64	......	......	......
Cooking loss	......	......	24	......	36	......	......	......
Edible meat	......	......	31	......	37	......	......	......
Bone	......	......	45	......	27	......	......	......
Ribs:								
With bone	......	......	84	......	72	......	......	......
Cooking loss	......	......	16	......	28	......	......	......
Edible meat	......	......	45	......	34	......	......	......
Bone	......	......	39	......	38	......	......	......
Neck:								
With bone	......	......	89	......	87	71	72	76
Cooking loss	......	......	11	......	13	29	28	24
Edible meat	......	......	43	......	51	......	50	49
Bone	......	......	46	......	36	......	22	27

Table 11. (Continued)

Cooking method:	Broiled	Fried	Fricassee	Roasted	Stewed	Pressure		
Reference:*	1	1	1	1	1	2	3	3
	percentage yields and losses based on ready-to-cook weights							
Gizzard:								
Edible meat	......	......	......	......	......	59	......	......
Cooking loss	......	......	......	......	......	41	......	......
Liver:								
Edible meat	......	......	......	......	......	67	......	......
Cooking loss	......	......	......	......	......	33	......	......
Heart:								
Edible meat	......	......	......	......	......	67	......	......
Cooking loss	......	......	......	......	......	33	......	......

* Reference:
1. Pecot and Watt (1956).
2. Tadle et al. (1955).
3. Shonebarger (1957).

Table 12. Percentage yields and losses of cooked ducks and geese based on ready-to-cook weights

Kind:	Ducks		Geese				
Age (weeks):	7.5	......	......	16	24-32*	10	12-15
Ready-to-cook weight (pounds):	4.9	4.5	7.4	6.9	6.2	6.8	7.6
Reference:†	1	2	3	4	4	5	2
	percentage yields and losses based on ready-to-cook weights						
Whole, with bone:	65	62	65	66	67	69	63
Carcass meat	......	30	......	33	32	......	36
Skin	......	10	......	11	11	......	7
Giblets	......	5	......	3	3	......	5
Neck meat	......	......	......	2	2	......	......
Total edible	38	45	41	49	49	55	47
Bones	......	14	......	16	19	......	12
Drippings	21	24	6	13	9	11	18
Parts:							
Legs and thighs:							
Cooking loss	45	......	34	......	......	......	......
Edible meat	44	......	47	......	......	......	......
Breast:							
Cooking loss	49	......	39	......	......	......	......
Edible meat	43	......	48	......	......	......	......
Wings:							
Cooking loss	25	......	26	......	......	......	......
Edible meat	38	......	36	......	......	......	......
Back and ribs:							
Cooking loss	47	......	38	......	......	......	......
Edible meat	27	......	33	......	......	......	......

* Weeder geese.

† Reference:
1. Clements and Winter (1956).
2. Snyder (1959).
3. Deskins and Winter (1956).
4. Bean and Hanson (1962).
5. Swanson and Canfield (1957).

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