4-1-1957

Chemical Composition of Turkeys as it Affects Palatability and Keeping Quality

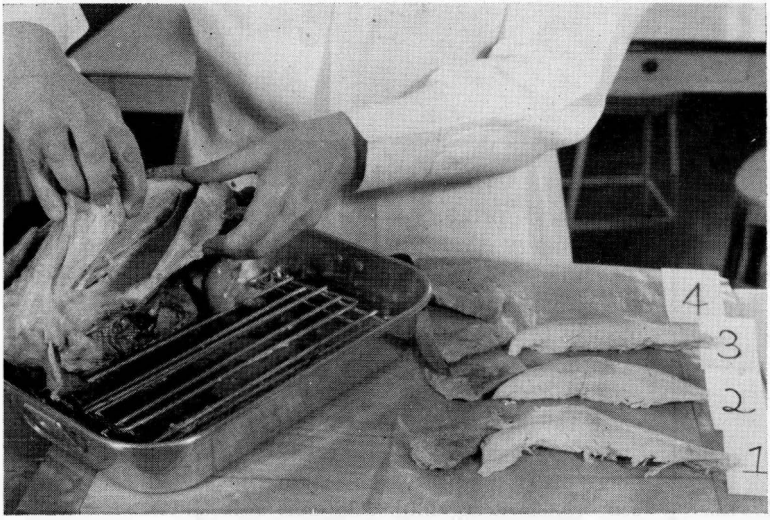
L. M. Burrill

C. W. Carlson

W. Kohlmeyer

E. B. Alsup

BULLETIN 463 APRIL 1957



chemical composition of turkeys

AS IT AFFECTS PALATABILITY AND KEEPING QUALITY

POULTRY, HOME ECONOMICS, AND BIOCHEMISTRY DEPARTMENTS
AGRICULTURAL EXPERIMENT STATION
SOUTH DAKOTA STATE COLLEGE, BROOKINGS

SUMMARY

Turkeys produced on low and high energy diets were slaughtered for chemical analyses and taste panel evaluations before and after 6 months of frozen storage.

Although the carcasses from groups fed the high energy diets were fatter than those fed the low energy diets, there were no differences in palatability scores for flavor, tenderness, and juiciness before or after storage. Likewise there were no consistent over-all preferences before or after storage. Neither were there consistent differences in fat peroxide levels after storage.

The stored half-carcasses of toms showed no decline in palatability scores for flavor and tenderness whereas those of hens showed a decline. The toms showed higher juiciness scores than hens.

COVER PHOTO: Roasted half of turkey showing position from which breast samples were taken for tasting.

CHEMICAL COMPOSITION OF TURKEYS as it affects palatability and keeping quality

C. W. Carlson, Wm. Kohlmeyer, E. Beth Alsup, Lida M. Burrill, and O. E. Olson[1]

Today's turkey feeding methods and practices and economic factors limit the time for growing turkeys to the larger sizes. As a result, much stock does not carry what is thought to be the desirable amount of finish when it is sold. At a recent turkey growers meeting a processor stated that 5 years ago 90 to 95 percent of the birds dressed at his plant graded A; this past season less than 70 percent of the stock dressed at his plant were of the top grade, largely because of insufficient finish.

If such "below grade" stocks are being produced and marketed, two questions among others are then suggested. Are these turkeys as palatable as the turkeys finished to a higher grade? Do they keep as well in storage? A series of experiments being conducted at this station may help answer these questions.

EXPERIMENTAL

Two Types of Diets. Carcasses of differing degrees of finish were obtained by feeding low and high energy diets to Broad Breasted Bronze turkeys. Essentially, the diets varied with respect to the cereal grain being used to supply the energy requirement—corn for high energy, oats for lower energy.

Another variable was introduced in the diets—chlortetracycline supplementation at 5 milligrams per pound in one series of low and high energy diets in each experiment. This variable did not produce a consistent difference in carcass composition. Thus, the data presented in this report are the averages for each experiment of the two groups on high energy (one with and one without chlortetracycline) and of the two groups on low energy (with and without the antibiot-

[1]Poultryman, poultryman, former research assistant, nutritionist, and biochemist, respectively, South Dakota Agricultural Experiment Station.

Grateful appreciation is expressed to Cathrine Hendrick Whitehead and Biruta Zarins for their assistance in the chemical analyses and to R. A. Wilcox, A. W. Adams, Alice M. Rosenberger, Zora Colburn, Evelyn Hollen, and G. F. Gastler for their assistance in this experiment. The work was supported, in part, by Regional NCM-7 funds.

ic). The results on such factors as growth rate and feed efficiency have been presented in detail in a previous publication.[2] In brief, the high energy diets supported faster growth rates and produced a greater degree of finish more economically.

Sampling Carcasses. Six toms and six hens were slaughtered from each treatment in each experiment; thus 12 toms and 12 hens on high energy diets and a like number on low energy diets were used in each study. The hens were slaughtered at 24 weeks of age and the toms at 26 weeks. Samples were taken of the fresh carcasses after cooling as follows:

Skin: A piece of skin approximately 2 inches square was taken from a uniform place on each right breast feather tract.

Muscle: a) Both of the coccygeus muscles (under the tail) were removed as completely as possible. A previous study (unpublished) had indicated that fat analysis of the coccygeus muscle gave a better indication of the degree of fat infiltration into muscle tissue than fat analysis of the breast muscle, pectoralis minor.

b) For the latter experiment, samples of the thigh muscle about 1½ inches square were taken uniformly from near the upper portion of each right biceps femorus.

These samples were placed in a labeled polyethylene giblet bag, immediately frozen, and held for chemical analysis. Analyses were made for ether extract (fat) and moisture and protein (expressed as N x 6.25) according to modifications of the official AOAC methods.

Freezing Method. The carcasses were then bagged in polyethylene and frozen at 0° F. After freezing, each one was divided through the keel and backbone with a band saw. The right half was used for initial taste panel studies, and the left half was rebagged and placed in 0° F. storage for 6 months.

The carcasses did not have the desirable bloom and appearance that might have been obtained with a sharper freeze. However, there seemed to be no serious detrimental effect from the slower freeze other than the less attractive appearance. Drip loss in defrosting was greater than it might have been if a faster freeze had been used. The halves were kept frozen until 72 hours before they were to be roasted. They were then defrosted in a refrigerator at 35-40° F. over the 72-hour period.

Roasting. One half turkey from each treatment was roasted each day, thus four halves, two high energy and two low energy representatives, were roasted at a time. Hen halves were roasted first and the tom halves on later days.

The turkeys were roasted in a large rotating oven to a doneness measured by an internal temperature of 92° C. registered on a thermometer placed about an inch into

[2]"Effects of Energy and Protein Levels and Antibiotics on Growing Turkeys," Tech. Bul. 17, S. Dak. Agricultural Experiment Station, April 1956.

the thigh muscle. This amounted to an average of about 28 minutes per pound at an oven temperature of 300° F., although there was considerable variation in cooking time requirements from bird to bird. Later work has indicated that a temperature of 90° C. at the center of the thigh muscle may provide a better gauge of doneness.

After sufficient cooling to handle the roasted halves, the pectoralis major muscle was removed from the breast and the semi-tendinosis muscle removed from the thigh. Cross-sections were cut from these muscles and served to the taste panel. Each taster received his sample from about the same place on each muscle each day. The samples were not kept warm. Five judges were on the taste panel in the 1954 study and seven were used in the 1955 study.

Evaluation by Tasters. Each sample was evaluated by the taste panel using palatability scores for flavor, tenderness, and juiciness. After evaluation the panel was asked to make an over-all evaluation of preference for both breast and thigh samples. A sample palatability score card appears in the appendix, listing the possible scores and corresponding description of terms.

The taste panel evaluations were repeated on the left half of each bird after 6 months of storage. In addition, fat samples were obtained for chemical tests for rancidity, in this instance for peroxide[3] content. In the first experiment, leaf fat from the abdominal region taken before cooking was used. In the second experiment, clear drip fat obtained after cooking was used.

RESULTS AND DISCUSSION

The results showing average weights, breast widths, dressing percentages, and ether extract (fat), protein, and moisture contents are summarized in table 1. The differences in weights of birds on the different types of diets were the only differences that were shown to be significant. The high energy diets had promoted the most rapid growth with the least amount of feed, averaging 2 pounds less in the 1954 experiment and 1.2 pounds less feed per pound of gain in the 1955 experiment.

Differences from Diets. There were no real differences in dressing percentages or in breast widths, although there did appear to be a slight tendency for producing wider breasts with the higher energy diets in the 1955 trial. It did appear that turkeys grown on high energy diets had skin with a higher fat content, considering each sex separately.

Because of the consistency of these figures and because similar trends had been obtained before and have been obtained since, (unpublished data), it appears that the higher energy diets produced fatter turkeys. These differences were not great enough to be easily detectable with the naked eye. However, they did provide, to some degree at least, the type of carcasses desired for the palatability tests,

[3]Method of Wheeler, Oil and Soap 9:89, 1932.

Table 1. Some Effects of Low and High Energy Diets on Weight, Dressing Percentage and Body Composition of Broad Breasted Bronze Turkeys

Experiment Variables	Wt., lb.	24-Wk. Breast Width, mm.*	Dressing Percent†	Percent Fat			Percent Protein			Percent Moisture		
				Skin	Coccygeus Muscle	Thigh Muscle	Skin	Coccygeus Muscle	Thigh Muscle	Skin	Coccygeus Muscle	Thigh Muscle
1954 (all-mash diets) (28 wks.)			(dry cooled)									
High Energy—870 cal.‡												
Toms	26.7§	70	75	57.0	5.5	—	10.3	20.9	—	31.5	72.6	—
Hens	16.6**	71	74	54.0	9.2	—	11.3	21.6	—	34.2	68.1	—
Low Energy—656 cal.‡												
Toms	24.3§	68	75	54.9	6.4	—	10.9	20.5	—	33.3	72.1	—
Hens	16.0**	71	74	51.2	5.8	—	11.8	21.5	—	36.4	72.6	—
1955 (pelleted diets) (26 wks.)			(water cooled)									
High Energy—851 cal.‡												
Toms	25.6††	79	82	64.4	3.7	5.4	7.1	21.6	22.1	28.0	73.0	72.0
Hens	16.1‡‡	74	80	59.5	3.3	5.6	6.9	21.4	21.1	31.1	74.5	72.7
Low Energy—662 cal.‡												
Toms	24.8††	78	80	59.7	4.7	5.2	8.1	21.0	22.0	31.4	73.5	73.5
Hens	15.6‡‡	73	80	56.2	3.4	4.8	7.9	21.0	21.6	34.9	74.2	72.6

*Live measurement.
†12 hens at 24 weeks and 12 toms at 26 weeks of age were slaughtered from each group for chemical analyses and taste panel evaluations.
‡Calculated calories of productive energy per pound of diet.
§L.S.D.=0.8 lb.
**L.S.D.=0.4 lb.
††L.S.D.=0.7 lb.
‡‡L.S.D.=0.5 lb.

i.e., turkeys which differed as to degree of finish they carried. The fat content of the skins varied inversely with the protein content. This was true for moisture also. These data are further evidence that skin fat content differences were real.

A further consideration of the data in table 1 provides some interesting comparisons between experiments. Although the high energy fed birds of the 1954 experiment were heavier than those of the later experiment largely because they were older, they did not carry as great a degree of fat deposition in skin or muscle tissue. The low energy fed toms of the 1954 experiment were not as heavy as in the later experiment, and the hens were heavier. But like the high energy fed turkeys, neither carried as much finish as the hens and toms in the later experiment.

The more rapid growth in the 1955 experiment, which enabled ending the experiment when the turkeys were younger, has been explained on the basis of having used pelleted feed instead of all-mash diets. A more nearly adequate starter diet was also used early in the life of the turkeys. These may also be the chief reasons why turkeys in the 1955 trial were fatter, since they were farther along towards maturity. The slightly higher values for moisture content of the coccygeus muscles in the 1955 experiment may have been due in part to the water cooling. However, it is interesting to note that the skin did not appear to take up water in the cooling process.

In addition, the fat content in muscle tissue was not correlated with the degree of skin fatness. Although there appeared to be such a trend in the thigh muscle, the differences were not very great, and that trend was not evident in a subsequent study (unpublished data). There were also no consistent differences in protein content of the raw muscle tissues.

Taste Panel Ratings. The results of the roasting and taste panel evaluations are given in table 2 for before storage and in table 3 for after storage. Note in table 2 the remarkable uniformity in palatabilty scores within and between years and also between sexes. An exception was in the somewhat poorer scores for juiciness in the initial tests in the 1954 experiment, which coincided with relatively greater cooking losses. Also, there seemed to be slightly lower juiciness values for toms as compared with hens in this experiment, again coincident with greater cooking losses.

This observation of sex differences was not consistent with the results of the later experiment, however. Although there was a trend for over-all preference for the toms of the low energy fed group in the 1954 experiment, the same trend was not evident in the 1955 experiment.

The most noticeable differences between the initial evaluations and the evaluations made after storage were the consistently lower palatability scores for the hens as compared with that for the toms. Cooking losses were greater for hens and

Table 2. Initial Roasting Tests on Turkeys

	Average of Breast and Thigh Palatability Scores*				
	Flavor	Tenderness	Juiciness	Over-all Preference†	Total Cooking Losses, %
1954					
High Energy				(30)	
Toms	6.5	6.5	5.2	11	17
Hens	6.5	6.7	5.4	14	14
Low Energy					
Toms	6.5	6.6	5.2	19	18
Hens	6.4	6.5	5.4	16	14
1955					
High Energy				(42)	
Toms	6.8	6.8	6.2	23	12
Hens	6.9	6.8	6.4	17	14
Low Energy					
Toms	6.8	6.4	6.5	19	11
Hens	6.8	6.3	6.1	25	12

*Samples were scored from 10 to 1 according to the score card shown in this publication. Within the range here reported, a higher value is generally considered to be a better value.
†Average of all over-all preferences from among the representative breast and thigh samples presented to the panel. Numbers in parentheses represent the highest possible score.

Table 3. Roasting Tests on Turkeys After 6 Months of Storage at 0° F.

	Average of Breast and Thigh Palatability Scores*					
	Flavor	Tenderness	Juiciness	Over-all† Preference	Total Cooking Losses, %	Fat Peroxides, M Mol./Kg.
1954						
High Energy				(30)		
Toms	6.7	6.8	6.8	18	13	77
Hens	6.3	6.2	5.8	15	19	64
Low Energy						
Toms	6.6	6.6	6.5	12	15	60
Hens	6.2	6.3	5.6	15	19	95
1955						
High Energy				(42)		
Toms	6.7	6.8	6.2	19	16	40
Hens	6.1	6.0	5.2	21	22	41
Low Energy						
Toms	6.7	6.5	6.6	23	16	38
Hens	6.1	5.8	5.0	21	22	45

*Samples were scored from 10 to 1 according to the score card shown in this publication. Within the range here reported, a higher value is generally considered to be a better value.
†Average of all over-all preferences from among the representative breast and thigh samples presented to the panel. Numbers in parentheses represent the highest possible score.

the corresponding juiciness scores were lower by an average of about 1.1 points. The differences for flavor and tenderness were less, but in the same order. The significance of these differences is indicated by the data shown in table 4. For this tabulation the scores for each half of the same bird were compared.

The relatively greater cooking losses and lower juiciness scores observed with the fresh-frozen carcasses in the 1954 experiment as compared with smaller cooking losses and higher juiciness scores of the paired halves after storage makes the data for the two experiments appear at first to be unlike. However, the trends were in the same direction for both experiments. The relative juiciness values for hens were lower than for toms in every comparable instance. Toms appeared to show slight improvements in flavor with storage in the 1954 experiment. However, a slight decrease appeared in the later experiment.

Table 4. Palatability Changes During Storage of All Toms and Hens Analyzed by the "t" Test* for Individually Paired Comparisons

	Palatability Scores		
	Flavor	Tenderness	Juiciness
1954			
Toms			
d†	0.14	–0.02	1.44
t	1.17	0.14	3.21‡
Hens			
d	–0.18	–0.26	0.41
t	1.23	1.90	2.68§
1955			
Toms			
d	–0.11	–0.07	0.16
t	1.24	0.58	1.05
Hens			
d	–0.78	–0.67	–1.17
t	8.2‡	5.7‡	10.4‡

*Test for significance according to Snedecor, Geo. W., 1946, *Statistical Methods,* Iowa State College Press, Ames, Iowa.
†d—Average difference.
‡Highly significant.
§Significant.

These variations in results indicated that storage had no great effect on flavor of the toms. On the other hand, flavor scores for hens after storage were lower for both experiments, significant at the 1 percent level of probability in the latter study. Similar effects were noted for tenderness. It has been reported that when juiciness values are lower and cooking losses are greater as a result of a longer cooking time, the scores for both flavor and tenderness go up. In the 1955 experiment, however, lower juiciness scores were accompanied by lower flavor and tenderness scores, which indicates that the increase in cooking loss, in itself, was not the factor causing a decrease in the flavor and tenderness scores.

Keeping Quality. The variation in peroxide values obtained with the fat samples in the 1954 experiment as compared with the rather uniform values in the 1955 experiment and their lack of correlation with palatibility scores makes it unlikely that the lower scores for flavor of the hens were due to fat rancidity. In some tests, a value of above 40 millimoles of peroxide per kilogram of fat is considered indicative of the development of fat rancidity; however, the taste panel

did not consider these stored turkeys to be objectionable.

Just why the hens did not keep as well as toms in storage cannot be determined from the results of this work. Perhaps a greater amount of physical breakdown of tissue may have occurred in the hens than in the toms. Although the carcasses were bagged in polyethylene, the smaller sized halves with a relatively greater surface may have been more susceptible to storage degeneration. These differences with half carcasses may not necessarily indicate what would happen with whole carcasses.

The possibility that the degree of fat covering could have affected keeping quality may be ruled out. This is based on the fact that the halves from the high energy fed groups did not show consistently higher palatability scores nor were they preferred over the low energy fed groups. The toms did show a higher fat content in the breast skin than the hens. However, since the fat differences obtained as a result of dietary differences did not affect keeping quality, it is not likely that skin fat differences was the reason for this difference in keeping quality of the sexes. More evidence to support this conclusion is found in the differences in skin fatness between the experiments. The toms of the 1954 experiment were not as fat as those of the later experiment, yet they appeared to keep as well.

At least within the range of skin fat contents here considered, it does not appear that finish has much to do with palatability or keeping quality. Further work will be necessary to determine whether greater differences in degree of finish will affect these factors.

The only real objection to a poorly finished turkey may well be the blue appearance of the fresh carcass. It may taste as good and keep as well as a fatter one. This is only a speculation, and needs to be substantiated by further work. Nevertheless, turkeys that are to be used for home cooking will probably need good fat covering or at least appear to have such to appeal to today's discriminating purchasers.

FORM USED BY TASTE PANEL IN RATING COOKED TURKEY

GRADING CHART FOR COOKED TURKEY

Kind of Meat.....

Name..... Date.....

	Sample Number			
	1	2	3	4
FACTOR				
FLAVOR—LEAN				
TENDERNESS				
JUICINESS				

KEYS:

	Flavor	Tenderness	Juiciness
10	Extremely good	Extremely tender	Extremely juicy
9	Very good	Very tender	Very juicy
8	Good	Tender	Juicy
7	Medium plus	Medium plus	Medium plus
6	Medium	Medium	Medium
5	Medium minus	Medium minus	Medium minus
4	Fair	Fair	Fair
3	Poor	Tough	Dry
2	Very poor	Very tough	Very dry
1	Extremely poor	Extremely tough	Extremely dry

Remarks:

Preference .....

(Among samples judged at one time)

COOPERATIVE RESEARCH

This publication is the result of cooperative research by three departments of the South Dakota State College Agricultural Experiment Station. The research is also a phase of a cooperative project with the other North-Central States and the U. S. Department of Agriculture.

Cooperative research—among departments or states—combines the efforts of many scientists and means greater returns on the research dollar.