EFFECT OF COOKING METHODS ON PALATABILITY OF DARK TURKEY MEAT AND HYPOXANTHINE AND URIC ACID CONTENT

by

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TABLE OF CONTENTS

INTRODUCTION

The expansion in turkey production and the increasing quantity of turkey meat being processed as boneless or cooked, coupled with the seasonal consumption, makes it necessary to store frozen turkey for longer periods of time (Marion and Forsythe, 1964; Katz et al., 1966). Flavor stability is the main problem that confronts turkey processors in processed and stored meat. Since acceptance of food is primarily determined by flavor, prevention of the desirable loss of flavor and the development of rancidity during storage is of major concern.

Present studies indicate that flesh foods owe their characteristic flavor to complex blends of compounds. Kazeniac (1961) after several years of research on chicken flavor, summarized the possible role of known components on flavor. He associated amino acids, peptides, carbohydrates, inorganic salts, sulfides, carbonyls and non-amino nitrogen compounds with taste; sulfides, ammonia and carbonyls with aroma; protein, lipids and carbonyls with body or texture and amino acids, peptides, phosphates, lactates and inosine monophosphates (IMP) with mouth satisfaction. Post mortem changes are of prime importance also, since enzyme degradation may affect flavor favorably or unfavorably.

Recent investigations indicate that breakdown products of adenosine triphosphates (ATP) are of interest and merit attention. The measurement of degradation products of ATP has been suggested by Rhodes (1965) as a means of estimating the age of meat and fish and hence, the remaining storage life. At the same time,

many investigators have commented on the meaty flavor and flavor intensifying properties of IMP and that its disappearance following slaughter has been correlated in fish with simultaneous loss of desirable sweet, meaty flavor and a progressive increase in bitterness attributable to hypoxanthine which was cleaved from inosine.

Limited information is available concerning the degradation of IMP and accumulation of hypoxanthine and its relationship to the palatability and stability of poultry flavor. It appeared that a useful approach to the problem would be to study the composition of specific muscles that may produce differences in flavor intensity and desirability of cooked turkey.

The present investigation was conducted therefore to:

1. Analyze for hypoxanthine and preformed uric acid contents in biceps femoris (BF) and quadriceps femoris (QF) thigh muscles of cooked turkey.
2. Determine the TBA values of a composite of cooked sartorius and semimembranosus muscles of turkey.
3. Determine the total fat, moisture, pH and Warner Bratzler shear values.
4. Study the relationship of hypoxanthine and uric acid content to subjective and objective measurements in assessing the quality characteristics of braised and roasted turkey quarters.

REVIEW OF LITERATURE

Definition of Flavor

Flavor is not a sole property of meat, but it is of prime importance in the acceptability of meat. Moncrieff (1951 p. 437)

defined flavor as a "complex sensation" consisting of taste, odor or aroma, roughness or smoothness, coldness or hotness and pungency or bitterness. According to Moncrieff, odor or aroma exerts the greatest influence on flavor because if the odor is lacking, the flavor is primarily a function of the basic tastes; sweet, salt, bitter and sour. Cramer (1963) stated that juiciness, texture and tenderness are other factors to be considered in the evaluation of a product because these factors also influence the over-all differences in flavor sensations. May (1965) reported that the major factors that affect consumer acceptability of poultry meat are flavor and tenderness.

Chemical Nature of Meat Flavor

Mackenzie (1963 p. 530) reported that there are two different approaches available for the study of meat flavor. One is to fractionate raw meat and by heating these fractions singly or together, one can determine which substances are necessary to produce meat flavor. Another approach is to isolate flavor substances from cooked meat. The same author believed that by distillation one can separate taste from odor, because taste is non-volatile and the low vapor pressure prevents the molecule from reaching the nose.

Flavor precursors in meat have been found to be water soluble and of low molecular weight. When the extracted water soluble substance was heated, a meaty flavor developed (Batzer and co-workers, 1960, 1962; Hornstein and Crowe, 1963). This has been confirmed by Pippen et al. (1954) and Peterson (1957) in their

chicken flavor studies. Water soluble flavor and odor precursors in lean pork, beef and lamb were studied by Macy et al. (1964a). Amino acids, carbohydrates, non-amino nitrogen compounds and phosphoric acid esters in lyophilized diffusates from cold water extracts of beef, lamb and pork were determined using paper and ion exchange chromatography. The investigators identified 31 compounds and concluded that low molecular weight organic constituents were qualitatively similar in three species. The only differences noted were the presence of glutathione in lamb but not in pork and beef and the presence of cysteic acid and ornithine in pork and lamb but not in beef. In a later paper (1964b) the same workers reported that the amino nitrogen compounds were qualitatively and quantitatively similar in all three species.

Batzer and his co-workers (1960) fractionated water extract from beef muscle tissues using sephadex gel, dialysis and ion exchange chromatography. These researchers isolated a glycoprotein fraction which when heated resulted in meaty flavor. A mixture of glucose, inosine monophosphate and amino acid component of glycoprotein also yielded meaty flavor after being heated. The same investigators (1962) reported that specific amino acids are essential precursors of meat flavor. Craig and Kings (1955) showed that only the water extract fraction, based on fractionation by countercurrent dialysis, having a molecular weight of 200 produced beef flavor when heated. This water soluble, low molecular weight fraction contained 32 amino acids and small peptides in addition to four carbohydrates (glucose, glucoseamine,

fructose and ribose). Similar results were noted by Hornstein and Crowe (1960). According to Hornstein and Crowe (1960), one of the most important aspects in the production of desirable odor and flavor is the interaction of carbohydrates and amino acids during heating to produce browned products. These two fractions, namely amino acids and reducing sugars, were obtained by ion exchange chromatography of the dialyzate.

Wood (1961) analyzed a cold water extract of ox muscle after dialysis. These investigators identified 17 amino acids in addition to several peptides, guanidines, purines and other nitrogen containing compounds. The same workers demonstrated that the major changes caused by heating involved losses in amino acids, phosphoric acid esters, glucose and ribose and the flavor development attributed to Maillard reaction. Tarr (1954) reported that ribose liberated enzymatically from ribonucleic acid was responsible for Maillard reaction in muscle tissues of fish.

Hornstein (1967 p. 236) summarized the results of early studies concerning lean meat flavor precursors: 1. Low molecular weight and water soluble materials are the meat flavor precursors. 2. Protein of high molecular weight do not contribute to the typical meat flavor. 3. Amino acid and carbohydrate composition of lean lamb, pork and beef are identical and this is reflected in the similarities of lean meat odor from these species. 4. A specific glycoprotein and inosinic acid may serve as flavor precursors. 5. Maillard reaction may not be the only mechanism responsible for the development of characteristic flavors.

Origin of Poultry Flavor

Early investigations were primarily concerned with the origin or source of flavor. Comparisons of flavor intensity have been made among dark and light meat, skin, bones, fat and blood of chicken. Crocker (1948) reported chicken flavor to be more complex than that of red meat, varying considerably between parts of the same birds, and from different stages in the life cycle. He also stated that difference in flavor seemed to be more in quantity rather than quality for all red meats had some of the flavor characteristics of fish and vice versa.

Crocker (1948) in a study of meat flavor reported that flavor of raw meat is confined mostly to the juice and that meat flavor on heating was attributed to chemical reaction occuring in the meat fiber rather than in the juice. Kramlich and Pearson (1958) however, in contrast to conclusion of Crocker, found that raw juice developed a cooked meat flavor on heating which suggested that part of cooked meat flavor is present in the juice.

Bouthilet (1951) investigated the source of meat flavor components in chicken. His results indicated that meat flavor in chicken may be attributable to a compound associated with meat fibers and not in the fat. Peterson (1957) reported that leg and breast meat produced a typical chicken flavor and aroma than did skin and bones. Whole blood, plasma and blood cells were not a source of flavor or odor of chicken. He also stated that fat contributed to aroma but was otherwise of minor importance to flavor.

Kazeniac (1961) stated that comparison between light and dark meat was difficult because of certain flavor differences. Light meat was found to have a stronger taste and mouth satisfaction whereas that of dark meat had more body and stronger aroma. Light meat broths tasted sourish and with some degree of astringency and more buttery whereas dark meat broths tended to be quite eggy and more sulfury.

Volatile Components of Poultry Flavor

Sulfur compounds: Crocker's (1948) classic distillation of muscle tissues from chicken, pork, and beef was the beginning of research regarding the chemistry of chicken flavor. Compounds found in the distillates of the three species were hydrogen sulfide, acetaldehyde and ammonia. Crocker concluded that all meats possess identical flavor factors and that differences may be attributed to particular compounds that are characterictically present in low concentration in certain species.

Bouthilet (1951) using high vacuum distillation was able to fractionate chicken broth. Hydrogen sulfide and ammonia appeared again in the distillates. After completion of numerous tests on chicken broth, Bouthilet concluded that glutathione is the major precursor of chicken flavor in chicken muscle tissues.

Pippen and Eyring (1957) did similar studies on the aqueous phase of chicken broth. They found ammonia and hydrogen sulfide in the distillates and demonstrated that removal of ammonia enhanced the chicken flavor. This finding also supported the hypothesis of Bouthilet (1951) that a progressive lowering of

pH raised the chicken flavor level in the distillate. This led Pippen and Eyring to conclude that fundamental chicken flavor is associated with neutral or acidic constituents.

Lineweaver and Pippen (1961) reported that 100% of the volatiles from cooked chicken should be accounted for by nitrogen, sulfur and carbonyls, with the latter two classes of compounds playing an important part in the development of flavor. Mecchi et al. (1964) found that the presence of hydrogen sulfide in heated chicken muscle is caused by protein decomposition and can be related directly to the cysteine and cystine content of the muscle tissues.

Carbonyl compounds: The volatile carbonyl compounds of cooked chicken were first identified by Pippen et al. (1958). Acetoin was found in breast meat, thigh meat and skin by Pippen and coworkers (1960) who believed that a transient oily, buttery aroma characteristic in freshly cooked chicken is imparted by acetoin. They suggested that by mild oxidation, acetoin may be converted to diacetyl.

Pippen and Nonaka (1963) investigated these volatiles by gas chromatography and found that essentially all volatiles were heat produced. The over-all yield of volatiles was greater from the skin and depot fat and that from the leg and breast meat are of more complex nature. Chromatograms of chicken and turkey volatiles revealed that differences existed. It was not determined, however, whether the differences in composition are relative to the distinctive flavor of chicken and turkey.

Comparisons of volatiles from fresh and rancid chicken was

made, also (Pippen and Nonaka, 1963). Results showed that volatile fractions from rancid chicken were larger in quantity and there was greater odor potency than that of fresh chicken. It was noted that rancid flavor is caused primarily by an increase in the amount of volatile constituents present in fresh chicken rather than appearance of new volatiles. Therefore, below a certain level, volatiles may contribute to the desirable flavor whereas above this level, it may be recognized as rancid or off flavor.

Nonaka and Pippen (1966) isolated, by gas chromatography, volatiles from fried chicken undergoing flavor deterioration. Results revealed that the quantity of volatile material in fried chicken meat was increased proportionally to the storage time and, hence, intensity of oxidative off-flavor. The increase in quantity of n-hexanal therefore, suggested the extent of oxidative process and this may serve as an indicator of flavor deterioration in fried chicken. It was noted that quantity of n-hexanal, as indicated by the well defined peak, was also evident in meat at zero storage time when no off flavor was detected. Thus it was postulated that it is the increase in n-hexanal, above its initial value when no off-flavor is present, that follows the development of oxidative flavor deterioration.

To determine the significance of volatile components, Minor et al. (1965a) using chemical analysis and organoleptic evaluation attempted to relate the volatile components released upon cooking to chicken aroma. Their study indicated that sulfur compounds are responsible for the "meaty" aroma and that "chickeny" aroma is

attributed to the presence of carbonyls. Results confirmed the earlier work of Crocker (1948) that chicken flavor is composed of two main flavor components: a meaty flavor and a flavor characteristic of poultry.

Minor et al. (1965b) compared the carcasses of old and young female chicken to determine if any differences exist between the respective volatile fractions. Results revealed that constituents separated from the old and young birds were found to be chemically similar but the concentration of total volatiles from the old hens was greater than from the young pullets. It was not indicated, however, whether the particular volatile fractions that were present in greater concentration would indicate a better flavor rather than simply more volatiles.

Role of Fat in Poultry Flavor

The role of fat in the development of desirable and undesirable flavor in meat is not fully understood. From the above studies reported, it has been demonstrated that primary flavor of meat has been shown to be water soluble. Pippen et al. (1954) reported that depot fat by itself contributed very little to taste, aroma and mouth satisfaction. Research in the same laboratory, however, demonstrated that depot fat may play a secondary role in the development of desirable flavor. Chicken broth with fat yielded a more desirable flavor than broth with fat removed. From this finding, Kazeniac (1961) postulated that fat may serve as a trapping agent for volatiles. Thus, when fat was incorporated into the broth, the volatiles would be retained slightly

longer and possibly prolong the sensation in the mouth.

Fat affects flavor in two ways: oxidation, primarily of unsaturated fatty acids, results in carbonyl formation. These carbonyl compounds as n-hexanal, n,2,4, deca-dienal may at a definite level of concentration contribute to a desirable meaty flavor (Patton, et al., 1959; Pippen et al., 1960; Minor et al. 1965a). At a higher level of concentration, undesirable, rancid, off flavor may result (Pippen and Nonaka, 1963). Fat may also serve as a reservoir for fat soluble odorus materials that may strongly affect flavor (Craig et al., 1962; Hornstein and Crowe, 1964).

According to Katz et al. (1966) one of the major changes that occur in stored meat is oxidative rancidity. Lipids in both fatty and lean muscle tissues are found to play an important role in affecting flavor stability and thus product quality. A better understanding of this chemical reaction is therefore of great importance.

Chang and Watts (1952) found that poultry fat is much more unsaturated than beef, pork and even lamb. Keskinel et al. (1964) studied oxidative changes in turkey, beef, lamb and pork. These workers observed that after one week of refrigerated storage, turkey had undergone greater oxidative deterioration than the other meats. The rapid autoxidation of turkey fat is attributed to the fatty acid composition. Scott (1958) reported that composition of turkey fat was found to be: 30% saturated fatty acid and 70% unsaturated fatty acid.

Turkey fat is chemically identical to chicken fat but the

former is more susceptible to oxidative changes (Mecchi et al. 1956a). The same workers (1956b) studied the stability of depot fat from chicken and turkey fed identical rations. It was demonstrated that turkey fat is less stable than chicken fat because chicken deposits tocopherol, a natural antioxidant, more efficiently.

The 2-thiobarbituric Acid Test

Rancidity in meat is caused by oxidative deterioration of lipids. The 2-TBA test has been used as an objective measurement of oxidation of unsaturated fatty acids in foods. In this chemical analysis, the 2-TBA reacts with 1 malonaldehyde or substances resembling it, giving a red pigment that can be qualitatively measured by a spectrophotometer. Sinnhuber et al. (1958) reported that the red colored compound formed is a condensation product between the oxidized lipids and 2-TBA. Factors that affect the TBA test values are: pH of the material, time necessary to collect the distillate, the amount of distillate and the length and type of storage (Tarladgis et al., 1960).

The TBA determination has been used for numerous food products and correlated with sensory tests. Bloemer (1964) reported the effect of precooking and length of storage on TBA number of light and dark meat from turkey rolls. Taste panel members seemed to detect off-flavor in turkey meat that had TBA values greater than 10. The TBA values were significantly higher for rolls precooked before storage than for fresh frozen turkey rolls (Bloemer, 1964).

Similar results were reported by Brodine (1966). Off-flavor as determined by TBA was slightly greater for precooked turkey rolls stored at 0°F for seven months than for those stored 2 weeks at the same temperature. Furthermore, off-flavor for light meat was slightly greater than those for dark meat from all precooked turkey rolls.

Thawing temperature was found by Hartung et al. (1966) to be related to oxidative rancidity. He stated that a higher thawing temperature resulted in an increased rancidity in both raw and cooked turkey. It was noted that low thawing temperature was significantly effective in reducing TBA number for both raw and foil roasted product.

Jewel (1963) investigated the effect of weight of bird, length of storage and area of production in the retail market. She found no significant correlations between taste panel scores for odor and flavor and TBA values. However, total fat content of white meat and skin showed a high negative correlation with TBA. Thus, it was concluded that the total fat content of chicken may influence the TBA number.

Marion and Forsythe (1964) following the same hypothesis, studied the autoxidation of turkey lipids by 2-TBA test. Results based on the variation in total lipids in sample of white and red meat (1.59 and 3.64%) respectively, showed a positive correlation between amount of total lipids and oxidation rate. They postulated that heme catalysis is more active in red muscles which contain a large amount of myoglobin than white muscle.

Nucleotides and Flavor

It has become increasingly apparent that products of adenosine triphosphate (ATP) degradation also merit attention and interest. In the study of psoas muscle of well rested and well fed rabbits, Bendall and Davy (1957) reported that the pattern in pre-rigor muscle consists of small amounts of diphosphopyridine nucleotide (DPN) triphosphopyridine nucleotide (TPN) and adenosine diphosphate (ADP) and a large amount of ATP, whereas during and after rigor, it changes to one of DPN, TPN, inosine tri, di and monophosphate of which the latter is vastly predominant. Inosine monophosphate (IMP) breakdown products such as inosine and hypoxanthine are also present.

Tarr (1966) stated that except in unusual circumstances ATP is rapidly degraded postmortem by a series of enzyme reactions. Hydrolysis to the stage of IMP is quite rapid and the rate of conversion to inosine is slower. Therefore, IMP tends to accumulate in the muscle. Inosine is the first breakdown product of IMP and it is formed by the action of enzyme nucleoside hydrolase.

Kassemsarn et al. (1963) illustrated diagrammatically ATP degradation:

ATP	ATPase	ADP + Pi
2 ADP	Myokinase	AMP + ATP
AMP	Deaminase	IMP + NH_3
IMP	5'nucleotide Hydrolase	Inosine + Pi
Inosine	Nucleoside Hydrolase	Hypoxanthine + ribose

Doty et al. (1961) implicated IMP as one of the major components in meat. Wood (1961) commented on the meaty flavor of ox muscle extracts. Kazeniac (1961) indicated that IMP made a major contribution to mouth satisfaction and intensified the flavor effects of other substances. He also stated that in comparison to chicken flavor, hypoxanthine is bitter and inosine is tasteless. Jones (1961) reported similar results in fish, that inosine which arises from dephosphorylation of IMP is said to be flavorless, and hypoxanthine formed by hydrolytic and phosphorylytic splitting of inosine is reported to be bitter when held for considerable time after storage. Hashimoto (1965) in contrast to the above findings, stated that hypoxanthine is tasteless. Jones (1965) showed that taste panel scores for flavor in cod and several other fish showed a positive correlation with hypoxanthine concentration. Spinelli (1965) in a study of effect of hypoxanthine on flavor of irradiated fish found that hypoxanthine concentration of 8.8 uM per g of fish did not produce a detectable change in flavor.

Literature reports concerning nucleotide degradation in fish muscle are available. Information pertaining to these factors in the muscles of meat animals is limited. Solov'ev (1952) determined several chemical changes in meat and found a relationship between ripening as judged by taste test and the formation of hypoxanthine from nucleotide when maintained over a wide range of storage temperatures. He suggested that degradation products of nucleotide contributed to the taste and aroma of ripened meat. Howard et al. (1960) supported Solov'ev claim of

correlation between tenderness and hypoxanthine concentration of meat. It was suggested that increase in hypoxanthine from about 0.25 to 1.25 - 2.0 uM per g meat is associated with a rise in tenderness rating of 3.5 - 5.5 but that with hypoxanthine content above 2.0 uM per g of meat, little further increase in tenderness was observed. The relationship between change in hypoxanthine concentration and tenderness appears to be independent of the type of muscle, the temperature during aging and whether the carcass is frozen after aging or not. Furthermore, it was noted that actual levels of hypoxanthine and degree of tenderness are dependent on these factors.

Lee and Webster (1963) investigated the conditions that might affect the rate of hypoxanthine production in beef muscles. Their work indicated that the process of ripening was at the optimum when the hypoxanthine has risen to 1.5 - 2.0 uM per g of muscle. The rate of hypoxanthine production increased with rising temperature and increasing pH. Recently, Dannert and Pearson (1967) studied the concentration of IMP in meat. Their findings suggest that IMP content of meat varies extremely depending upon the initial level and the length and conditions of storage. It was observed also that IMP concentration differs between muscles obtained from different species with beef sampled at 0 hour containing the highest amounts (4.71 uM per g) and the pork heart muscle containing the least amount (0.13 uM per g).

Rhodes (1965) observed similar results. According to him, inosinic acid was completely degraded after 30-40 days in some beef cuts whereas decomposition was slower in other cuts of beef

and lamb and this may be a possible reflection of the physiological age of the animals.

Terasaki et al. (1965) studied the pathway of formation and degradation of inosinic acid related substances in the muscles of chicken and pork. It was demonstrated that the total amounts of IMP and inosine plus hypoxanthine were similar. After 5-6 days of storage and thereafter, the longer the storage time, the greater the amount of inosine formation and eventually the amount of hypoxanthine was increased. It was suggested also that the slaughter methods affect the time to reach maximum content of IMP. It is well established that the changes in pH and the formation of lactic acid proceed more rapidly in the struggled muscle. It is believed that these changes may influence the activity of creatine phosphokinase, ATPase, myokinase and 5' AMP deaminase and that these phenomena may related closely to the formation of IMP. It was demonstrated also that IMP content of light meat was greater than that of dark meat, but the degradation of IMP in dark meat was slightly faster than in light meat, Terasaki et al. (1965).

Effect of Cooking Methods on Flavor

Clark et al. (1955) studied the effect of braising and pressure pan cookery on cooking losses, palatability and nutritive losses of beef round steak. The results indicated that the internal temperature to which the meat was cooked was more important in determining both cooking losses and palatability of steak than the method of cooking. Meats cooked to

176°F (80°C) lost less weight during cooking and were more desirable in flavor, aroma, and juiciness than steaks cooked to 234°F (110.2°C) but were less tender.

Simmering or pressure cooking was recommended by Hanson et al. (1950) to increase tenderness of older, less tender chicken. They reported that roasting had no advantage over simmering or pressure cooking in producing typical "roast turkey" flavor, but it did have the disadvantage of accelerating the rancidity development.

Kahlenburg and Funk (1961) made a comparison of the effects of various cooking methods on old fowls with and without salts added to water to determine the degree of tenderness in the breast meat, the cooking losses and the amount of fat in the thigh meat. Cooking in salt solutions had no advantage over cooking in water. Significantly lower adjusted non-fat cooking losses were obtained by simmering than by boiling. Pressure cooking resulted in increased tenderness of breast meat but the tenderness thigh meat fat was reduced by pressure cooking. A statistical treatment of palatability scores showed that cooked dark meat were significantly more flavorful, juicier and more tender than cooked light meat from the same bird.

Kotchevar (1956) studied the cooking differences of different cuts before and after thawing. Roasts of beef, pork and lamb were cooked with both dry and moist methods. Results showed that the taste panel was unable to distinguish between the two treatments, before and after thawing, but were able to establish a consistent preference for the dry cooking method.

Bowers et al. (1965) studied the effect of braising and roasting of turkey rolls. Results revealed that total cooking losses at 165°F (70.4°C) were significantly lower for braised (23%) than for roasted rolls (28%); however, drip losses were significantly higher for braised (16%) than for roasted rolls (6%). The cooking method did not affect the flavor, texture, tenderness of the turkey rolls or juiciness of dark meat. Moisture content of the rolls and juiciness scores for light meat were significantly higher for braised than for roasted rolls.

EXPERIMENTAL PROCEDURE

Meat Used in the Experiment

Twenty-four Broad Breasted Bronze turkey hens (U.S. Grade A) from the same flock and processed under similar conditions, were purchased from Kansas State University Poultry Farm and processed by Roy-Al commercial processing plant in Hesston, Kansas. The dressed weight of turkey hens ranged from 12-14 lbs.

The birds were stunned by electrical shock, scalded at 60°C for 30 seconds in a batch type scalding machine, picked for 45 sec in a Pickwick batch type picker, eviscerated and chilled in ice water overnight. The following day, the whole turkeys were separated using a band saw at the KSU Animal Industry Meat Laboratory into quarters separating the light meat from the dark meat. The right and the left sides were labeled as the turkeys were viewed from dorsal to anterior of the bird. The coded quarters were wrapped in .0015 in. thick aluminum foil, frozen and stored at -13°C (-25°F) in a household type freezer.

Statistical Design and Analyses

The turkey quarters were coded according to the number of the bird, the side of the carcass and the method of cooking. A balanced randomized incomplete block design (Table 1) was used to determine the order of cooking. The design consisted of 24 blocks, with left and right sides from 1 turkey composing a block. There were 24 replications for each cooking method with each side either braised or roasted.

Analyses of variance were run for subjective and objective measurements.

Correlation coefficients were determined for each cooking method. For braised and roasted turkey quarters correlation coefficients were determined from the data of the following measurements: cooking time, cooking losses, aroma, flavor intensity, flavor desirability, tenderness, shear values, juiciness, total moisture, pH, hypoxanthine, total nucleotide, uric acid, TBA and total fat. Each factor was correlated with every factor.

Cooking Methods

Cooking was done in a conventional rotary hearth gas oven, preheated and maintained at 325°F. The turkey quarters composed of thigh-leg, were cooked from the frozen state. The thigh temperature of 85°C (185°F) was used as the end point of cooking as determined by meat roasting thermometers. In preparation for cooking, a centigrade thermometer was inserted with the aid of a mechanical drill, in the center of the bicep femoris (BF) thigh muscle not too close to the bone (Fig. 1).

For roasting, the quartered birds were placed in V-shaped

Table 1. Incomplete block design for determining the cooking method of turkey quarters.[a]

Block[b]				Block[b]			
Day of cooking	Method of[c] cooking	Side[d]	Bird No.	Day of cooking	Method of[c] cooking	Side[d]	Bird No.
1	Ro	L	21	13	Ro	R	9
	B	R	16		B	R	20
2	Ro	L	20	14	Ro	L	1
	B	R	6		B	R	8
3	Ro	L	13	15	Ro	R	12
	B	R	10		B	L	9
4	Ro	R	5	16	Ro	R	3
	B	L	5		B	L	7
5	Ro	L	22	17	Ro	L	19
	B	R	21		B	L	2
6	Ro	L	23	18	Ro	L	15
	B	R	22		B	R	18
7	Ro	R	4	19	Ro	L	8
	B	R	23		B	L	17
8	Ro	L	24	20	Ro	L	10
	B	R	13		B	R	15
9	Ro	L	16	21	Ro	L	6
	B	R	1		B	L	4
10	Ro	L	18	22	Ro	R	7
	B	L	3		B	L	12
11	Ro	L	14	23	Ro	L	11
	B	R	11		B	R	19
12	Ro	R	2	24	Ro	R	17
	B	L	24		B	R	14

[a] Cochran and Cox (1950).

[b] Left and right pairs from 1 turkey equal 1 block.

[c] Ro = roasting.
B = braising.

[d] R = right half viewed from dorsal to anterior of bird.
L = left half viewed from dorsal to anterior of bird.

Fig. 1. Position of thermometer in frozen turkey quarter.

racks (cut side down) and cooked uncovered in Wearever aluminum roasters (37 x 25 x 10 cm). For braising, V-shaped racks were used also and the cooking was done in covered aluminum roaster.

Percentage total cooking losses, including drip and volatile losses were calculated.

Subjective Evaluation

Samples consisting of $\frac{1}{2}$ x $\frac{1}{2}$ in. x muscle thickness from the bicep femoris (BF) and quadricep femoris (QF) were presented randomly to a panel of six judges. Judging was done in a room especially designed for organoleptic tests. Aroma, flavor intensity, flavor desirability and tenderness based on the number of chews, and juiciness was scored on a 7 point scale (7 = the highest possible score) Form 1, Appendix p. 63.

Objective Measurements

Percentage total moisture, TBA and total fat measurements were made on composite of thigh muscles of semimembranosus (SM) and sartorious (S) muscles (Fig. 2). The samples for these three tests were ground in a Kenmore No. 3 food grinder directly into pliofilm bags.

In addition to the above measurements, shear values, pH, percentage total nucleotide, hypoxanthine and uric acid contents were determined on (BF) and (QF) thigh muscles (Fig. 2). Sampling plan for (BF) and (QF) are illustrated in Figs. 3 and 4.

All objective evaluations with the exception of shear values, pH and total moisture were done on the day after cooking. Total

Fig. 2. Muscles used for subjective and objective measurements.

1. Biceps femoris (BF)
2. Quadriceps femoris (QF)
3. Sartorious (S)
4. Semimembranosus (SM)

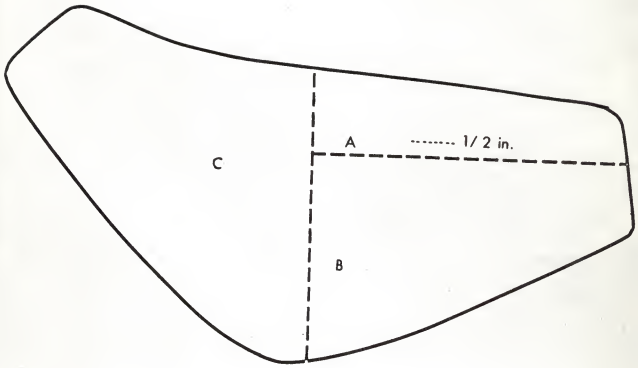

Fig. 3. Sampling the Bicep Femoris Muscle.

A. Warner Bratzler shear values and pH.

B. Palatability samples cut from $\frac{1}{2}$ x $\frac{1}{2}$ in. x muscle thickness.

C. Percentage nucleotide, hypoxanthine, and uric acid determinations.

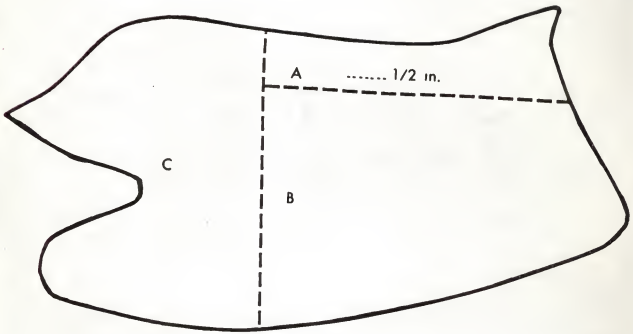

Fig. 4. Sampling the Quadricep Femoris Muscle

A. Warner Bratzler shear values and pH.

B. Palatability samples cut from $\frac{1}{2}$ x $\frac{1}{2}$ in. x muscle thickness.

C. Percentage total nucleotide, hypoxanthine and uric acid determinations.

fat analyses however, were done at the end of 24 cooking periods. Samples for chemical analyses were kept frozen until analyzed.

Moisture, pH and Shear Values

To determine the percentage total moisture, 10 g samples were dried for 60 minutes at 121°C in a C. W. Brabender semi-automatic moisture tester. For pH, 5 g finely minced meat and 20 ml boiled distilled water (25°C) were mixed thoroughly with stirring rod. The pH was determined using a Beckman expanded scale, model 76. Prior to each use, the instrument was standardized against a buffer solution of pH 7.00. The Warner Bratzler shearing apparatus was used to determine the shear values of strips of ½-in. wide and 3 in. long from the outer portion of (BF) and (QF). Each strip was sheared three times across the grain.

Total Fat Analyses

Total fat analyses was done by the KSU Chemical Services at the end of all cooking periods. A.O.A.C. No. 23.005 (1965) was followed in this determination with slight modifications.

Three to 4 g duplicate samples were weighed onto the interior surface of defatted cotton pads of known weight. The meat samples on the cotton pads were dried in vacuum oven at 110°C for 5-6 hours to constant weight. The dried samples were extracted with anhydrous ether for 20 hours on low heat in a Goldfisch fat extractor. The ether was reclaimed after extraction and the

beakers were placed in the vacuum oven at 110°C for one hour, then cooled in a dissector for 30 minutes and weighed. Weight of the fat in the samples was obtained by differences in beaker weights before and after extraction. The percentage fat was calculated on the wet basis.

Malonaldehyde Determination

The 2-thiobarbituric acid method as modified by Tarladgis et al. (1960) was used to determine the oxidative changes in the braised and roasted dark meat of turkey. TBA analyses were done on the frozen samples the day following cooking and subjective evaluation.

The weighed frozen 10 g sample was homogenized in a Waring Blender at low speed for 2 minutes with 50 ml of boiled distilled water (25°C). The meat slurry was transferred to a 500 ml Kjeldahl flask. The blender was rinsed with 47.5 ml distilled water. The maximum release for malonaldehyde is pH 1.3 - 1.8 (Keskinel, et al., 1964). In order to obtain the pH range, the pH of the slurry was adjusted to 1.5 by the addition of 2.5 ml of a 4N solution of hydrochloric acid. To prevent foaming of meat slurries during distillation, a small amount of Dow Antifoam A aerosol was added to the mixture. A few Zinc metal chips were added to prevent bumping. The mixture was heated for ten minutes in Kjeldahl distillation apparatus to collect approximately 50 ml of distillates in the volumetric flasks.

Five ml portions of each distillate and equal amounts of 0.02 M TBA reagent (2-thiobarbituric acid in 90% glacial acetic

acid) were mixed in 10 ml volumetric flasks provided with glass stoppers. The flasks were shaken to mix the contents. The flasks were heated in a boiling water bath for 35 minutes. Then, the flasks were removed and placed in an ice bath for 5 minutes. The mixture was transferred to test tubes and 10 ml of distilled water was added. The tubes were covered with Parafilm and shaken to mix the contents. A distilled water blank was treated in a like manner. The mixture was transferred to a cuvette and read in the Beckman DU spectrophotometer to measure the light absorbancy. Maximum absorbancy of the TBA pigment is 538 mu (Tarladgis et al., 1960).

The absorbancy reading was converted to mg malonaldehyde per 1000 g sample, which is referred to as TBA number. This conversion was made by multiplying the absorbancy with a constant 7.8. This constancy was originally calculated by Tarladgis et al. (1960) using a standard solution of 1×10^{-3} M 1,1,3,3, tetra-ethoxy propane (TEP) in distilled water. A standard curve was prepared by appropriate dilutions of TEP standard solution to give amounts ranging from 1×10^{-8} to 7×10^{-8} moles of malonaldehyde in 5 ml. Jewell (1963) derived a constant of 7.7 in her laboratory.

Total Nucleotide and Hypoxanthine Measurement

Percentage of dephosphorylation at 248 mu absorbance and hypoxanthine assay described by Jones et al. (1964) as modified by Meyer (1965) was used to determine nucleotide degradation in two thigh muscles BF and QF, cooked by two methods of cooking,

braising and roasting.

Tissue extraction: Twenty g of cooked frozen muscle tissue was homogenized with 40 ml of 0.6 N chilled (6°C) perchloric acid for 2 minutes in a macro virtis homogenizer at full speed. The flasks were embedded in crushed ice to eliminate or minimize nucleotide changes during the analysis.

The homogenates were filtered through Whatman No. 40 paper under light vacuum. The filtrate was measured for each sample. The quantities of hypoxanthine per se and uric acid were determined. Fifteen ml of the filtrate was neutralized with 2 N KOH to pH of 6.50. Duplicated aliquots were removed from each tissue homogenate. Volumes were adjusted in a calibrated pyrex centrifuge tube (44 mm x 122 mm, capacity of 70 ml) to 40 ml using boiled distilled water (7°C). Neutralized filtrates were allowed to set for 1 hour at -5°C (23°F) and centrifuged at the same temperature for 20 minutes at 4,000 rpm in Sorvall automatic refrigerated centrifuge model RC2-B, to remove the potassium perchlorate.

Dephosphrylation: The neutralized potassium perchlorate free extract was diluted 25 times with boiled distilled water (25°C) (1 ml extract and 24 ml distilled water). Ten ml of the distilled extract was shaken for 5 minutes with 1 ml of an anion-exchange resin suspension (60 mg/ml) of Dowex 1-8x (formate 200 - 400 mesh) to remove the nucleotide and phosphorylated sugars. The percentage of 248 mu absorbing material remaining after resin treatment is believed to be a measure of nucleotide dephosphorylation, according to Jones and Murray (1964). The

difference in optical density before and after resin treatment was assumed to represent the phosphorylated compounds that absorb at 248 mu and was reported as percentage total mucleotide.

The percentage of material not held by the resin (nucleoside and nucleobases) was calculated in the following manner:

$$\% \text{ not held} = \frac{\text{optical density after resin treatment minus correction for resin (.008)}}{\text{optical density before resin treatment}} \times 100$$

% held or phosphorylated compounds that absorb at 248 mu. = 100 - % not held

Hypoxanthine assay: Neutralized potassium perchlorate free extract (0.5 ml) obtained in tissue extraction was added to 2 ml phosphate buffer (0.25M pH 7.6). Five tenth ml (0.5 ml) of freshly diluted xanthine oxidase containing 0.32 International Units (a purchased preparation from Nutritional Biochemical Corporation) was added. The material was incubated at 37°C for 30 minutes. After the incubation period, the samples were placed in crushed ice for 10 minutes and removed to a temperature of 22°C (72°F) for approximately 30 minutes prior to reading. The principal of this measurement is to convert hypoxanthine, which shows no ultraviolet spectral absorption at 290 mu, to uric acid, which is characterized by strong ultraviolet absportion at 290 mu. Conversion to uric acid by xanthine oxidase was evaluated at 290 mu against a hypoxanthine standard (0-100 ug) treated similarly. Blanks containing the enzyme in the absence of tissue extract (extract replaced with distilled water) and blanks containing tissue extract but in the absence of enzyme (enzyme replaced with distilled water) were deducted from the

samples and hypoxanthine per se or without the inherent muscle uric acid was calculated. Uric acid was calculated from the blanks containing the tissue extract in the absence of the enzyme, therefore, inherent muscle uric acid. Hypoxanthine and uric acid were reported as uMoles/g tissue based on molecular weight of hypoxanthine (136.11)

RESULTS AND DISCUSSION

Analyses of variance and correlation coefficients were used to determine whether differences for the measurements were attributable to method of cooking and/or muscle type.

Palatability characteristics as aroma, flavor intensity, flavor desirability, tenderness and juiciness of dark cooked turkey muscles were evaluated organoleptically by an experienced panel and objective measurements as cooking time in min/lb, percentage total cooking losses, shear values and percentage total moisture were taken. Chemical analyses included pH, percentage total nucleotide, hypoxanthine, uric acid, percentage total fat and malonaldehyde determinations. All data are presented in Tables 9-15, Appendix p. 64-70.

Cooking Time and Total Cooking Losses

The two methods of cooking, roasting and braising, resulted in highly significant differences in cooking time in min/lb $P \leq .01$). Average cooking time for braising was shorter, 45.5 min/lb as compared to roasting, 50.9 min/lb (Table 2). Hoke et al. (1967) reported similar results in cooking turkey roasts

Table 2. Effect of method of cooking on cooking time (min/lb) and cooking losses (%).

Factors	Roast	Braise	F-value
	Mean	Mean	
Cooking time (min/lb)	50.9	45.5	12.04 **
Total cooking losses (%)	25.41	26.55	1.34 ns

** $P \leq .01$.
ns not significant.

and suggested that there is a faster rate of heat penetration by braising. Harrison (1943) found that beef roast cooked in water reached internal temperature of 70°C more rapidly than those roasts cooked in fat, steam or air. Increased cooking time and reduced cooking losses were noted by Bowers et al. (1965) for braising of dark and light turkey rolls as compared to roasting. Cooking time was inversely related to shear values of QF muscle in both braising (r = -.419) and roasting (r = -.417) at 5% level of significance. Since these factors were not as highly correlated for the BF muscle, time and temperature variations between the two muscles, BF and QF may in part explain these findings. Hase (1966) found internal end point temperature variations of the same thigh muscle located at different positions within turkey roasts. The internal temperature decreased from the upper thigh through the lower thigh of the roast.

No significant differences in total cooking losses attributed to method of cooking were observed (Table 2). Turkey quarters had losses from 19.1 to 33.6% when roasted and 21.7% to 33.4%

when braised. However, correlation coefficient data (Table 3) indicated that total cooking losses and cooking time were highly correlated for braising (r = +.539 **) and for roasting the correlation coefficient was lower (r = +.340). According to Lowe (1955) covering the pan lessens evaporation; therefore with less evaporation a higher temperature is reached in the covered pan since evaporation requires heat. In addition, steam is retained in a covered pan to a greater extent and this moist atmosphere is a better conductor of heat than dry air. Goertz and Watson (1964) in the study of right and left sides of turkeys roasted to selected end point temperatures of 85 and 90°C in the breast muscle and 90 and 95°C in the thigh muscle, reported that generally as the cooking time in min/lb increased, cooking losses also tended to increase. The results of this study on turkey quarters agree with the findings of Hood (1955) and Paul *et al.* (1956) in that shorter cooking time and increased cooking losses were noted for braised than for roasted beef cuts. The data in Table 3 indicate that as total cooking losses increased there was a decrease in total moisture for braised turkey. A similar trend was noted for roasted turkey but the correlation coefficient was statistically non significant. Mostert and Stadelman (1964) reported that a higher cooking loss will result in a lower meat yield and lower moisture content. Since roasting is a dry cookery method, it was expected to result in higher cooking losses with lower moisture content than was found. It is suggested that in roasting, heat transfer to meat was slower and this may be attributed to the lower heat

Table 3. Correlation coefficients (r values) for selected paired variates of dark turkey meat cooked by two methods.

Paired variates	Roast	Braise
D/F = 22	r value	r value
Cooking time vs		
cooking losses	0.340 ns	0.539 **
tenderness (BF)	0.187 ns	0.519 **
tenderness (QF)	0.306 ns	-0.020 ns
Warner Bratzler shear values (BF)	0.325 ns	-0.253 ns
Warner Bratzler shear values (QF)	-0.417 *	-0.419 *
Total cooking losses vs total moisture	-0.218 ns	-0.444 *
Flavor desirability (BF) vs		
aroma	0.698 **	0.527 **
flavor intensity	0.387 ns	0.324 ns
tenderness	-0.256 ns	-0.067 ns
juiciness	0.239 ns	0.356 ns
Flavor desirability (QF) vs		
aroma	0.157 ns	0.120 ns
flavor intensity	0.199 ns	0.388 ns
tenderness	0.127 ns	0.619 **
juiciness	0.438 *	0.488 *
Tenderness vs juiciness (BF)	-0.091 ns	0.084 ns
Tenderness vs juiciness (QF)	0.124 ns	0.407 *
Juiciness vs total moisture (BF)	-0.001 ns	0.299 ns
Juiciness vs total moisture (QF)	0.083 ns	0.302 ns

* $P \leq .05$.
** $P \leq .01$.
ns not significant.
BF = biceps femoris.
QF = quadriceps femoris.

conductivity of dry air as compared to moist heat in braising.

Palatability Characteristics

Aroma: For the sensory quality of aroma, highly significant differences were found for both method of cooking and muscle type (Table 4). Turkey quarters that were roasted had an average aroma score of 5.4 whereas those that were braised had an average score of 5.1 (Table 4). It appears that the browning reaction may have had a definite effect on aroma scores even though the skin was discarded and not evaluated organoleptically. The outside appearance of the roasted turkey quarters ranged from pale to dark brown as the internal end point temperature was approached. Turkey quarters cooked by braising had little browning because lids remained on the utensil throughout the cooking period (Fig. 5).

Muscles differed significantly ($P \leq .001$) in aroma scores (Table 4). The BF muscle was considered to be more desirable in aroma as compared to QF. The position of the muscle and its accessability to direct heat may have affected the quality of aroma since the BF is on the external side whereas QF is further imbedded in the carcass of the bird during the cooking process.

Flavor intensity and desirability: It appears, from the data presented in Table 4, that method of cooking resulted in significant differences in flavor intensity and flavor desirability. Organoleptic scores indicated that roasted turkey quarters were more desirable and more intense in flavor than the

Table 4. Mean values and F values attributable to method of cooking and selected thigh muscle for subjective measurements.

Factors	Method of cooking			Muscle type			Cooking x muscle interaction
	Roast	Braise	F value	BF	QF	F value	
	Mean	Mean		Mean	Mean		
Palatability scores[a]							
Aroma	5.4	5.1	16.468 ***	5.4	5.1	14.160 ***	8.856 **
Flavor intensity	5.3	4.8	27.573 ***	5.0	5.1	2.269 ns	0.417 ns
Flavor desirability	5.6	5.2	21.685 ***	5.6	5.2	25.169 ***	5.974 *
Tenderness	6.2	5.9	15.168 ***	6.3	5.9	24.618 ***	1.138 ns
Juiciness	5.4	4.9	19.099 ***	5.0	5.2	3.131 *	0.076 ns

[a]Highest possible score, 7 points.

* $P \leq .05$.
** $P \leq .01$.
*** $P \leq .001$.
ns not significant.

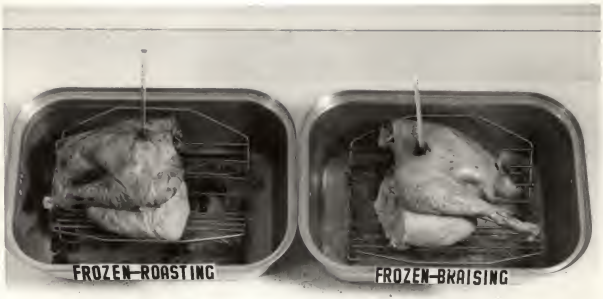

Fig. 5. Frozen turkey quarters cooked by roasting (dry heat) and braising (moist heat).

braised turkey quarters (Table 4). Paul et al. (1956) in their beef study, reported that dry heat cooked steaks were superior to braised steaks in flavor. Crocker (1948) stated that meaty flavor increased with longer cooking to about 3 hours, and decreased with still longer cooking. It was indicated also in the meat flavor studies of Crocker (1948) that sulfur flavor was intensified with longer heating. This could, in part, be a reason for roasted turkey quarters to have more desirable and intensified flavor than the braised turkeys. Average time for roasting was 5.4 min/lb longer than for braising (Table 2).

The type of muscle used for organoleptic evaluation for each cooking method did not affect the flavor intensity but gave highly significant differences for flavor desirability of BF muscle ($P \leq .001$) (Table 4). This reaction may be associated with changes in muscle fiber during cooking, though there is little evidence at present on this point except that methods of cooking x muscle interaction was found to be significant at 5% level for flavor desirability. Webb et al. (1960) in the study of beef roast suggested that cooked meat flavor is a function of various tissue components that are combined and concentrated as time and temperature increased. Baird (1960) found that anterior cuts of beef had higher flavor scores than those from the middle section, which in turn had higher scores than the posterior cuts. Therefore, Webb et al. (1960) and Baird (1960) believed that differences in flavor desirability may be attributable to sections of meat. It is suggested that further research be done to understand the reasons for such differences.

Correlation coefficients of flavor desirability to each quality characteristics are presented in Table 3. Flavor desirability of BF muscle was positively correlated with aroma for both braising and roasting with r values of +.527 and +.698, respectively. Flavor desirability of the same muscle was closely related also to flavor intensity and juiciness in both cooking methods, but the coefficients were not statistically significant.

Unlike the BF muscle, the trend shown by the average scores of QF muscle was toward increasing flavor desirability with increasing juiciness for both cooking methods, braising and roasting. With increasing flavor desirability, increasing tenderness for QF of braised turkey was found (Table 3). Flavor desirability vs juiciness for both cooking methods were significant at 5% level of correlation.

Tenderness: Tenderness scores were affected by method of cooking and type of muscle used for evaluation (Table 4). Braised turkeys had lower scores than those of roasted turkey. Dawson et al. (1959) summarized the results of a number of beef studies comparing dry and moist heat methods of cooking on the same muscle and at the same temperature. It was reported that in general, the dry heat method gave higher scores for tenderness which agrees with the results of this study on turkey quarters. The rate of heat penetration during cooking may affect the tendering of the muscles.

Statistical analysis showed that muscle type had a highly significant effect on tenderness ($P \leq .001$), Table 4. Several studies (Cover et al., 1962a, 1962b, and 1962c) have reported

that structural differences in the organization of collagen in the muscles as the basis for difference. Machlik and Draudt (1963) and Bramblett et al. (1959) have reported that the length of time the meat was held at an internal temperature of 57 to 60°C appeared to be a decisive factor and closely related to an increase in tenderness. Bramblett et al. (1959) found a negative correlation of $r = -.73$ for the length of time the meat was within this temperature and shear values. It appears that at this temperature, changes take place in both muscle fiber and connective tissue which may result in more tender meat. It is quite evident that time and temperature variation in two muscles BF and QF had an effect on tenderness of meat probably causing physical as well as chemical changes both in the connective tissue and muscle fiber. Thus, results obtained with one muscle would be less than satisfactory for indicating the tenderness of another muscle in the same carcass. In these analyses of variance between muscles, data indicate that something affecting tenderness is present in BF that is either not present in QF or not present in the same amount.

Correlation coefficient for tenderness vs juiciness (Table 3) was significant at 5% level for braised QF muscle only.

Juiciness: Roasted turkey quarters had higher juiciness scores for BF muscle in comparison with braised turkey quarters (Table 4). This finding disagrees with the results of Bowers et al. (1965) that meat of braised turkey rolls was more juicy than that of roasted turkey rolls.

The juiciness scores of braised turkey quarters were signi-

ficantly affected by the type of muscle used for organoleptic evaluation. BF was considered to be more juicy by the sensory panel than the QF muscle (Table 4).

Treatment interaction: The responses of the two muscles, BF and QF, to two different methods of cooking was measured also, statistically, by calculating muscle x method of cooking interaction. Data presented in Table 4 indicated that muscle x method of cooking interaction was significant for aroma and flavor desirability at 1% and 5% level respectively. No significant differences were observed for flavor intensity, juiciness and tenderness attributable to muscle cooking interaction (Table 4). This may mean that different muscles reacted to heat differently.

Relationship of Objective Measurements to Palatability Scores

Warner Bratzler Shear Values

Warner Bratzler shear values for BF muscle differed significantly ($P \leq .001$) from QF muscles. Also, method of cooking had a highly significant effect on shear values (Table 5). This indicates that QF muscle reacted to heat in a manner different from BF muscle. Similar changes were noted by Hase (1966) in turkey roast study and Machlik and Draudt (1963) in their beef study. These investigators suggested that time and internal temperature variations are important factors that may affect shear values or tenderness of the meat. Machlik and Draudt (1963) studied the effect of time and temperature on shear patterns of small cylinders from beef semitendinosus muscle, heated in test tubes in water bath between 50-90°C. These investigators found that

Table 5. Analyses of variance for objective measurements for biceps femoris and quadraceps femoris muscles of turkey quarters cooked by two methods.

Source	D/F	Warner Bratzler shear values		pH		Total nucleotide (%)		Hypoxanthine		Uric acid	
		M.S.	F test	M.S.	F test	M.S.	F test	M.S.	F test	M.S.	F test
Total	95										
Cooking method	1	57.196	36.009 ***	0.032	1.127 ns	93.270	0.585 ns	0.049	0.374 ns	10.600	0.012 ns
Muscle	1	120.826	76.068 ***	0.602	21.533 ***	1297.720	8.133 **	4.660	31.718 ***	2481.700	2.718 ns
Method of cooking x muscle	1	0.158	0.098 ns	0.004	0.140 ns	118.130	0.740 ns	0.019	0.146 ns	87.800	0.096 ns
Error	92	1.588		0.028		159.572		0.131		912.895	

**, $P \leq .01$.
***, $P \leq .001$.
ns not significant.

minimum shear values were obtained after heating for 30-60 min in the range of 60-64°C internal temperature, at this temperature range, collagen shrinkage was complete with little evidence of hardening. At a 70° - 75°C range, hardening occurred rapidly; in the range of 80 - 90°C collagen shrinkage and hardening are completed in a few minutes and shear values declined with increased cooking time. It is possible that a similar relationship may occur in QF muscles of turkey although no internal temperatures of QF muscles were taken.

Correlation coefficient values presented in Table (6) show that Warner Bratzler shear values increased as juiciness scores decreased for braised QF muscle only. However, in roasting, no significant correlation was observed for the QF. Warner Bratzler shear values vs juiciness scores for QF muscle that had been braised and roasted had similar r values and were closely related but the r values were not statistically significant. A similar trend was noted when Warner Bratzler shear values were correlated with tenderness scores of QF muscle. BF muscles from roasted turkey quarters showed a decrease in tenderness scores as Warner Bratzler shear values increase. Hase (1966) reported differences in Warner Bratzler shear values for roasted thighs with different internal temperatures. It was found that shear values were highest at an internal temperature of 74°C and lowest at the highest internal temperature obtainable at atmospheric conditions, with intermediate shear values at 65 and 85°C.

pH; The pH of the cooked meat was not affected significantly by the method of cooking. However, pH was significantly different

Table 6. Correlation coefficients (r values) of certain objective measurements with palatability scores of cooked turkey quarters.

Values correlated	BF muscle		QF muscle	
	Roast	Braise	Roast	Braise
	r value		r value	
Warner Bratzler shear values vs				
juiciness	0.067 ns	-0.435*	-0.255 ns	-0.242 ns
tenderness	-0.438 *	-0.276 ns	-0.025 ns	-0.288 ns
pH versus aroma	0.068 ns	0.312 ns	0.114 ns	0.028 ns
flavor intensity	0.071 ns	0.033 ns	-0.201 ns	0.024 ns
flavor desirability	-0.082 ns	-0.099 ns	-0.243 ns	0.185 ns
tenderness	0.115 ns	0.200 ns	0.580 **	0.351 ns
juiciness	0.056 ns	0.286 ns	0.091 ns	0.351 ns
Hypoxanthine vs aroma	-0.152 ns	0.150 ns	0.162 ns	-0.155 ns
flavor intensity	-0.052 ns	-0.094 ns	-0.240	-0.107 ns
flavor desirability	-0.155 ns	0.344 ns	0.052 ns	0.004 ns
tenderness	-0.122 ns	-0.069 ns	0.044 ns	0.105 ns
juiciness	0.206 ns	1.133 ns	-0.055 ns	0.186 ns
TBA vs aroma	0.248 ns	1.135 ns	-0.090 ns	-0.086 ns
flavor intensity	-0.028 ns	-0.137 ns	0.251 ns	0.290 ns
flavor desirability	0.407 *	0.252 ns	-0.055 ns	-0.275 ns
tenderness	0.268 ns	0.373 ns	0.091	-0.080 ns
juiciness	-0.139 ns	-0.002 ns	0.301 ns	-0.179 ns

* $P \leq .05$.
** $P \leq .01$.
BF = biceps femoris.
QF = quadriceps femoris.

($P \leq .001$) between the two muscles (Table 5). The average pH of the BF muscle was 6.33 whereas the average pH of QF was 6.49 (Table 7).

Table 7. Mean values for pH, total nucleotide (%), hypoxanthine, uric acid of BF and QF muscle.

Factors	BF	QF	F values
pH	6.33	6.49	21.533 ***
Total nucleotide (%)[a]	45.71	38.36	8.133 **
Hypoxanthine[b]	1.190	1.601	31.718 ***
Uric acid[c]	0.970	1.047	2.718 ns

[a]% held, phosphorylated compounds that absorb at 248 mu.
[b]Expressed in uM/g muscle tissue.
[c]Expressed in uM/g muscle tissue.
** $P \leq .01$.
*** $P \leq .001$.
ns not significant.

Moreover, correlation coefficients for pH vs aroma, flavor intensity, flavor desirability or juiciness were not significant (Table 6). Tenderness and pH of QF roasted muscle was positively correlated ($r = +.580$). Although r values for BF muscles for pH vs tenderness in both cooking methods and QF muscle for braising were not statistically significant, the values were closely related.

Percentage Total Nucleotide, Hypoxanthine, and Uric Acid

Percentage total nucleotide: Total nucleotides (%) that absorb at 248 mu were significantly different between the two muscles at 1% level (Table 5). Mean percentage for total

nucleotides for BF was 45.71% and for QF, 38.36% (Table 7). This supports the hypothesis that the imbedded muscle (QF) cools more slowly than the superficial BF muscle following slaughter and during this longer period of time, optimum conditions for enzymatic breakdown of 248 mu absorbing nucleotides remain longer.

Hypoxanthine: The average hypoxanthine contents of BF and QF muscle were 1.19 and 1.60 uMoles/g of muscle tissues for both cooking methods (Table 7). The means are statistically different at .001 level (Table 5). The findings in this study are in close agreement with Terasaki et al. (1965) and Millo (1964) who reported that the rate of IMP decomposition varied among muscles. Since QF is under the BF muscle, which is the surface muscle, it follows the hypothesis postulated by Howard et al. (1960) in their study of beef quality. Howard et al. (1960) found that hypoxanthine content is higher in deep lying muscle of the butt in comparison with longissimus dorsi, a superficial muscle. This finding was attributed to temperature effect, suggesting that deep lying muscle may be expected to have a delay in cooling from body temperature to 0°C. When the same investigators compared fresh vs frozen meat, they found a higher hypoxanthine for fresh than for frozen meat because during the process of thawing, the deep lying muscle would be subjected to delays in temperature rise and hence, develop less additional hypoxanthine.

The data in Table 5 show that pH of the two muscles BF and QF differed. Thus, the data suggest that QF muscle had higher pH and higher content of hypoxanthine than that of BF muscle, which indicates that QF muscle may have had a faster rate of

hypoxanthine production than BF muscle. Lee and Webster (1963) studied the effect of pH on the rate of hypoxanthine production in beef muscle. It was noted that the rate of hypoxanthine production was higher with increasing pH and suggested that the rate of aging would be faster at higher pH values.

Uric acid: Uric acid values were not statistically significant as shown in Table 5. However, there appeared to be a trend for the QF muscle to have a higher level of uric acid in comparison with BF muscle (Table 7). Slower cooling for the QF than the BF following slaughter may be important in total uric acid content, also.

Hypoxanthine and Palatability Scores of Cooked Turkey

It was evident from correlation coefficients presented in Table 7 that hypoxanthine content of either BF or QF was not significantly related statistically to any palatability characteristics. This suggests that the taste panel members were unable to detect flavor intensity and desirability differences attributed to the level of hypoxanthine found in BF and QF muscles of the turkey quarters. However, the sensory panel was able to recognize the differences in flavor desirability of the two types of thigh muscle. They considered the BF muscles to be more desirable than QF muscle.

The non significant correlation between hypoxanthine and palatability characteristics of cooked turkey disagrees with the findings of Jones (1965) who reported that flavor scores in cod and several other fish correlated well with hypoxanthine concentration of approximately 0.450 uMoles/g. Lee and Webster

(1963) also found that as beef ripens and flavor increases, the hypoxanthine production increases. On the contrary, Hashimoto (1965) stated that Japanese investigators suggest that hypoxanthine is comparatively tasteless. Rhodes (1965) concluded that IMP had no role in flavor of meat either as flavor precursor or enhancer and that measure of disappearance can not be expected to correlate with changes in quality. This suggests that further work is necessary to assess the usefulness of IMP degradation products for measuring the quality of poultry meat. The turkey quarters in this study were considered to be of high quality.

Percentage Total Moisture, Total Fat and TBA

Mean and F values for percentage total moisture and total fat and TBA are shown in Table 8. No significant differences

Table 8. Mean and F values for total fat, percentage moisture and TBA.

Factors	Braise	Roast	F values
D/F = 46	Mean	Mean	
Total fat[a]	5.52	5.28	0.493 ns
Total moisture (%)	64.51	64.25	0.467 ns
TBA[b]	0.63	0.77	2.183 ns

[a]Expressed as percent fat, calculated on wet basis.
[b]Expressed as mg malonaldehyde/100 g meat sample.
ns not significant.

were observed for these measurements between the methods of cooking. However, for fat and moisture there was a trend for

higher percentage of total fat and total moisture for braised turkey quarters than for roasted turkey quarters. Also, higher TBA values for roasted turkey in comparison with braised turkey. Koch (1962) stated that water content of food can be a protection against lipid oxidation partly, by inhibiting the absorption of oxygen.

Correlation coefficients for aroma vs TBA were closely related for BF muscle in both method of cooking, although coefficients were statistically non significant. A positive correlation was observed between TBA and flavor desirability of BF muscle from roasted turkey (Table 6). It is recognized that TBA analyses were done on a composite of thigh muscles: semimembranosus and sartorious; therefore, the relationship between TBA analyses and organoleptic scores may be indirect. The samples for total fat were taken from the semimembranosus and sartorious composite also, and the entire turkey quarter was cooked under the same conditions.

Treatment interaction: Muscle x methods of cooking interaction were not significant in any objective measurements as shown in Table 5.

SUMMARY

Forty-eight frozen turkey quarters were cooked by braising or roasting at 325°F to 85°C internal temperature in the BF of the thigh. An incomplete balanced randomized block design was followed.

Cooking time was shorter for braising than for roasting.

Shorter cooking time and increased total cooking losses were found for braised turkey quarters as compared to those roasted.

There was a marked organoleptic preference for roasted turkey quarters as compared to braised. Roasted turkey quarters had the higher scores for aroma, flavor intensity, flavor desirability, tenderness and juiciness.

Muscles differed also in organoleptic scores. BF, the superficial muscle, was considered to be more desirable in all palatability characteristics in comparison with QF, a deeper lying muscle. It was suggested that time-temperature variations between the two muscles may have an affect on tenderness and Warner Bratzler shear values. Responses of the two muscles for two different methods of cooking was measured statistically by calculating for muscle x method of cooking interaction and were found to be significant at 1% and 5% level for aroma and flavor desirability respectively. This result suggests that muscles respond to heat differently.

Chemical analyses were done using BF and QF muscles for percentage total nucleotide, hypoxanthine and uric acid determinations. Xanthine oxidase assay was used to determine hypoxanthine. The principal of this method is to convert hypoxanthine which shows no ultraviolet spectral absorption at 290 mu to uric acid which is characterized by strong ultraviolet absorption at 290 mu.

Percentage total nucleotide and pH of QF muscle was significantly higher than those of BF muscle. Hypoxanthine concentration was also higher in QF muscle as compared to BF muscle.

This may be attributed to a temperature transfer effect of a delay in cooling of the deep-lying muscle (QF) than superficial muscle (BF) following slaughter.

Hypoxanthine content of both BF and QF was not significantly related to any palatability characteristics. The sensory panel was unable to detect flavor differences that may be attributed to hypoxanthine concentration.

Percentage total fat and total moisture and TBA values were not different statistically between methods of cooking. However, there was a trend for higher percentage of total fat and total moisture for braised turkey quarters and higher TBA values for roasted turkeys.

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APPENDIX

Explanation of Abbreviations and Symbols in the Appendix

Muscle Type

BF - Biceps femoris

QF - Quadriceps femoris

Significance of statistical data

* significant at the 5% level of probability

** significant at the 1% level of probability

*** significant at the .01% level of probability

All objective determination values presented are averages of duplicate measurements.

Form 1

SCORE CARD FOR DARK TURKEY MEAT

Judge _____

Date _____

Sample No.	Aroma	Flavor		Tenderness based on chews		Juiciness	Comments
		Intensity	Desirability	No.	Score		
1							
2							
3							
4							

Aroma

7. very desirable
6. desirable
5. moderately desirable
4. acceptable
3. sl. undesirable
2. mod. undesirable
1. undesirable

Flavor

Intensity

7. very pronounced
6. pronounced
5. mod. pronounced
4. sl. pronounced
3. perceptible
2. sl. perceptible
1. imperceptible

Desirability

7. very desirable
6. desirable
5. mod. desirable
4. acceptable
3. sl. undesirable
2. mod. undesirable
1. undesirable

Tenderness

7. very tender
6. tender
5. mod. tender
4. acceptable
3. sl. tough
2. mod. tough
1. very tough

Juiciness

7. very juicy
6. juicy
5. mod. juicy
4. acceptable
3. sl. dry
2. mod. dry
1. very dry

Table 9. Palatability scores: aroma, flavor intensity, flavor desirability, tenderness and juiciness of roasted turkey quarters.

Cooking Periods	Aroma		Flavor intensity		Flavor desirability		Tenderness		Juiciness	
	B	Q	B	Q	B	Q	B	Q	B	Q
1	5.0	5.0	4.4	4.8	5.4	4.8	6.4	6.4	5.4	5.2
2	6.0	5.8	4.6	5.0	5.8	5.4	6.8	6.4	5.4	5.6
3	5.1	4.6	5.1	5.1	4.8	5.0	6.5	6.0	4.8	4.8
4	5.8	5.6	5.5	5.6	6.1	5.6	6.5	5.7	5.1	5.5
5	5.6	4.5	5.1	5.5	6.1	5.1	6.1	5.8	4.8	5.3
6	5.8	5.0	5.8	5.4	6.4	5.8	6.6	6.0	5.4	5.8
7	5.6	5.0	5.6	5.6	6.1	5.5	6.0	6.3	5.8	5.6
8	5.3	4.8	6.8	5.3	6.0	5.6	6.5	6.1	5.3	5.8
9	6.0	5.2	5.4	6.2	6.4	5.8	6.8	6.4	5.8	5.4
10	6.0	5.2	5.0	5.7	6.0	4.5	6.7	6.5	5.0	5.6
11	5.8	4.8	5.0	6.0	5.6	4.2	6.8	6.4	4.2	5.2
12	6.0	5.0	5.7	5.7	5.7	5.5	6.2	6.2	6.2	5.7
13	5.8	4.5	4.8	5.4	5.8	5.8	5.8	5.8	4.8	5.4
14	5.6	5.4	4.8	5.6	5.6	4.6	6.4	6.0	5.2	5.2
15	5.8	5.3	5.3	5.5	6.0	5.3	6.6	6.1	5.6	5.8
16	5.6	5.0	5.5	5.1	5.8	5.1	6.5	6.3	4.6	5.6
17	6.2	5.6	5.4	5.8	6.6	5.8	6.6	6.2	5.4	5.8
18	5.4	5.2	5.2	5.2	5.8	5.2	6.0	6.4	5.4	4.8
19	5.6	4.8	4.1	5.0	5.5	5.1	6.6	6.1	5.1	5.1
20	5.8	5.5	5.3	5.1	6.3	5.0	6.8	4.5	5.8	5.3
21	6.2	5.6	5.2	5.4	6.2	5.8	6.2	6.8	5.6	5.8
22	5.6	4.8	5.3	4.6	5.8	5.1	6.6	5.6	5.3	5.8
23	5.1	5.6	4.8	5.1	5.0	5.1	6.0	5.6	5.8	5.6
24	5.8	5.0	4.6	5.6	5.6	5.2	5.6	5.8	5.2	4.8
Mean	5.7	5.1	5.2	5.4	5.9	5.2	6.4	6.1	5.3	5.4

Table 10. Palatability scores: aroma, flavor intensity, flavor desirability, tenderness and juiciness of braised turkey quarters.

Cooking Periods	Aroma		Flavor intensity		Flavor desirability		Tenderness		Juiciness	
	B	Q	B	Q	B	Q	B	Q	B	Q
1	5.1	5.0	4.3	4.1	5.0	4.6	6.0	5.3	4.3	3.8
2	4.5	4.5	4.1	3.8	5.0	5.5	6.6	6.0	4.5	5.1
3	5.2	4.8	5.4	4.6	5.4	5.2	6.2	5.4	5.8	5.8
4	5.0	4.4	5.0	4.8	5.0	5.0	6.6	6.2	5.2	5.4
5	5.3	4.8	5.3	5.0	5.6	5.3	6.0	6.1	4.5	5.1
6	6.0	5.0	4.8	5.3	5.8	5.5	6.0	6.0	5.5	5.6
7	4.6	5.0	5.1	5.3	5.0	5.3	6.0	5.6	4.6	4.6
8	4.6	5.6	4.2	5.0	5.0	5.6	6.0	6.2	5.2	5.4
9	4.2	4.2	5.2	5.0	5.2	5.0	6.2	5.5	5.7	5.5
10	4.8	5.2	4.4	4.6	5.2	4.8	5.8	5.2	4.4	4.8
11	5.4	5.2	4.6	4.8	5.2	4.8	5.8	5.8	5.0	5.2
12	5.1	5.0	4.6	5.6	5.8	4.8	6.6	6.0	5.1	4.8
13	6.0	5.8	3.8	5.0	4.6	5.0	6.6	5.8	4.4	5.2
14	5.8	5.4	5.0	5.6	6.0	5.4	6.8	5.8	5.2	5.2
15	5.5	5.2	4.5	4.0	5.5	4.7	6.5	5.7	5.5	5.0
16	5.4	5.8	5.4	5.4	5.6	5.6	6.2	6.0	4.8	5.0
17	4.6	5.1	4.0	4.3	5.0	4.8	6.5	5.1	3.1	4.5
18	4.5	4.5	4.6	4.5	5.0	4.8	5.8	5.5	3.8	4.1
19	4.8	4.8	4.4	4.6	5.2	5.2	5.8	6.0	4.6	4.8
20	5.2	5.2	4.6	5.0	5.4	5.0	6.0	5.8	4.8	4.8
21	5.3	5.3	4.8	4.6	5.6	4.8	5.1	5.1	5.0	4.8
22	5.8	4.3	5.0	5.5	6.1	5.1	6.3	5.8	5.0	6.0
23	4.5	5.1	5.5	4.8	4.8	4.8	6.5	5.3	5.3	5.0
24	5.0	5.4	5.0	4.4	4.6	5.0	6.4	5.8	4.8	5.2
Mean	5.1	5.0	4.7	4.8	5.3	5.1	6.2	5.7	4.8	5.0

Table 11. Cooking time in minutes per pound, percentage cooking losses and Bratzler shear values of roasted turkey quarters.

Cooking Periods	Cooking time (min/lb)	Total cooking losses (%)	Shear values B	Q
1	44.0	24.11	4.9	5.5
2	50.8	27.33	3.2	5.2
3	47.9	24.86	3.4	7.1
4	52.9	26.41	5.7	7.2
5	39.8	22.09	4.6	6.6
6	48.6	30.20	3.3	5.5
7	56.1	19.14	3.1	4.0
8	53.7	23.68	3.2	3.8
9	50.9	27.03	3.1	5.4
10	56.9	23.69	2.9	5.3
11	61.0	26.41	2.4	3.5
12	51.8	27.28	3.0	7.4
13	40.2	19.13	3.8	4.9
14	54.4	27.72	2.9	5.5
15	55.2	26.35	2.4	3.4
16	44.5	22.46	4.0	5.7
17	57.1	27.20	3.1	4.0
18	59.4	27.06	5.1	6.2
19	51.8	21.63	2.0	7.9
20	51.8	33.57	2.4	5.2
21	51.6	26.65	4.9	7.1
22	39.9	24.07	3.8	7.9
23	49.4	25.14	3.8	5.9
24	52.6	26.68	3.8	6.5
Mean	50.9	25.41	3.5	5.7

Table 12. Cooking time in minutes per pound, percentage cooking losses and Bratzler shear values of braised turkey quarters.

Cooking Periods	Cooking time (min/lb)	Total cooking losses (%)	Shear values B	Q
1	45.6	30.10	3.7	8.0
2	46.1	30.31	4.2	7.0
3	47.4	23.77	6.0	8.1
4	46.6	21.20	2.1	5.3
5	38.2	20.88	5.6	8.0
6	40.0	27.44	4.6	9.4
7	47.2	25.60	6.0	10.4
8	44.4	27.68	4.9	5.9
9	42.1	26.96	4.2	6.8
10	35.9	20.94	6.0	9.5
11	49.1	25.07	5.2	5.2
12	53.2	27.20	4.0	5.2
13	46.3	28.32	6.4	8.6
14	57.1	33.30	4.0	5.2
15	51.7	25.75	6.7	5.5
16	40.0	29.25	6.2	6.1
17	54.0	33.45	6.3	7.0
18	46.4	28.25	6.2	7.8
19	44.3	22.61	6.7	9.6
20	45.0	25.71	4.5	8.4
21	41.8	23.65	4.5	7.5
22	40.8	21.66	5.0	6.1
23	43.7	28.46	7.2	5.3
24	43.9	29.80	6.7	4.8
Mean	45.5	26.55	5.0	7.3

Table 13. pH, percentage total nucleotide, hypoxanthine and uric acid of roasted turkey quarters.

Cooking Periods	pH		Total nucleotide		Hypoxanthine		Uric acid	
	B	Q	B	Q	B	Q	B	Q
			%		uM/g		ug/g	
1	6.29	6.30	44.46	28.15	0.991	1.293	102.4	113.0
2	6.47	6.67	45.50	33.47	1.418	1.872	160.0	144.0
3	6.30	6.61	38.26	19.66	1.034	1.135	123.7	138.6
4	6.17	6.49	40.98	28.80	1.293	1.869	113.0	144.7
5	6.19	6.37	45.37	56.02	1.193	1.534	190.7	147.0
6	6.30	6.32	31.58	40.43	1.332	1.371	160.0	198.7
7	6.21	6.34	34.62	24.02	1.235	2.151	136.4	193.7
8	6.35	6.52	32.75	26.61	0.820	1.204	134.4	136.6
9	6.27	6.35	41.86	34.29	0.783	0.973	133.3	148.0
10	6.45	6.47	40.44	23.29	1.175	1.401	136.4	120.0
11	6.31	6.56	13.02	51.12	0.979	1.479	125.8	166.0
12	6.31	6.35	53.34	43.11	0.820	1.316	138.6	154.6
13	6.29	6.37	54.22	66.98	0.748	2.044	86.4	150.0
14	6.35	6.32	44.06	39.10	1.313	1.661	132.5	113.0
15	6.80	6.90	60.78	53.78	0.752	1.073	125.8	105.3
16	6.27	6.32	51.00	44.05	1.919	2.086	133.3	156.8
17	6.21	6.35	33.85	30.70	1.057	1.296	119.4	119.9
18	6.42	6.40	59.67	54.20	1.483	2.154	113.0	140.8
19	6.27	6.50	45.48	25.22	0.854	1.259	125.8	191.9
20	6.25	7.10	43.05	21.20	0.939	1.380	86.06	101.2
21	6.22	6.17	36.57	55.83	0.987	1.938	236.8	167.1
22	6.35	6.57	56.03	48.77	1.802	1.839	112.1	96.3
23	6.23	6.36	55.00	36.54	1.370	2.123	119.4	117.3
24	6.44	6.50	45.89	38.21	1.456	1.980	118.4	135.2
Mean	6.32	6.40	43.61	38.48	1.156	1.601	131.8	143.90

Table 14. pH, percentage total nucleotide, hypoxanthine and uric acid of braised turkey quarters.

Cooking Periods	pH		Total nucleotide		Hypoxanthine		Uric acid	
	B	Q	B	Q	B	Q	B	Q
			%		uM/g		ug/g	
1	6.32	6.47	54.86	45.37	1.675	2.011	119.6	119.8
2	6.40	6.62	56.32	26.67	1.020	1.506	102.6	144.6
3	6.40	6.63	52.65	43.75	1.176	1.939	109.8	156.9
4	6.82	6.77	24.89	35.97	1.567	1.819	183.5	202.4
5	6.17	6.35	59.03	62.40	1.206	1.681	185.0	186.9
6	6.75	7.05	54.83	15.34	1.591	2.158	119.6	121.9
7	6.22	6.31	40.11	22.94	0.666	1.130	123.7	139.7
8	6.25	6.50	53.01	49.51	1.577	1.741	110.2	129.3
9	6.25	6.32	53.13	31.66	1.046	1.175	140.8	154.6
10	6.29	6.40	66.32	70.25	1.155	1.695	126.8	117.5
11	6.52	6.52	43.00	40.40	0.926	1.563	83.8	101.3
12	6.29	6.54	34.59	36.57	1.408	1.426	137.1	117.3
13	6.47	6.55	60.17	39.76	0.823	0.822	112.1	122.6
14	6.25	6.52	25.00	23.00	1.260	1.217	158.4	118.6
15	6.42	6.57	32.77	27.23	1.602	1.457	147.1	100.1
16	6.40	6.41	34.75	43.38	0.705	1.773	241.4	158.0
17	6.20	6.50	38.83	13.83	1.569	1.450	102.4	124.7
18	6.35	6.40	57.45	45.46	1.056	1.463	132.4	183.4
19	6.27	6.38	44.62	51.00	1.018	1.567	130.1	122.6
20	6.27	6.62	37.44	33.18	0.657	0.991	125.6	133.9
21	6.19	6.35	52.37	59.07	1.897	2.122	116.2	162.7
22	6.19	6.45	69.22	31.49	1.748	2.207	145.8	165.6
23	6.29	6.49	40.96	26.94	1.389	2.043	127.4	153.9
24	6.30	6.67	61.02	42.46	0.782	1.883	101.3	103.5
Mean	6.34	6.51	47.80	38.23	1.229	1.618	133.0	141.3

Table 15. Percentage total fat and total moisture and TBA values of braised and roasted turkey quarters.

Cooking Periods	Total fat		Total moisture		TBA	
	Braised	Roasted	Braised	Roasted	Braised	Roasted
1	4.14	4.21	63.6	63.5	0.553	0.535
2	4.70	5.36	64.2	63.9	0.460	0.478
3	4.92	5.18	65.5	65.3	0.504	0.636
4	5.35	6.13	67.4	62.0	1.107	0.582
5	3.99	5.31	64.8	65.4	0.640	0.699
6	5.13	4.32	64.8	65.5	0.608	1.411
7	6.84	4.34	62.9	65.0	0.523	1.185
8	5.97	4.28	64.5	65.5	0.361	1.037
9	6.16	6.35	65.6	63.9	0.410	0.668
10	4.90	6.44	66.2	65.0	0.640	1.950
11	3.65	4.24	64.9	63.9	0.484	0.897
12	4.55	4.63	65.4	64.3	1.029	0.533
13	8.72	6.93	64.0	65.5	0.460	0.694
14	4.91	6.39	63.0	62.9	1.240	0.577
15	5.78	3.69	64.5	66.5	1.216	0.702
16	5.87	4.37	64.9	61.3	0.242	0.655
17	4.53	4.88	64.2	66.5	0.881	1.443
18	5.19	8.20	63.0	62.7	0.624	0.499
19	5.47	3.50	64.9	67.5	0.858	0.702
20	5.11	5.10	64.1	63.5	0.538	0.679
21	4.50	5.11	64.1	63.6	0.556	0.304
22	8.14	5.77	63.2	62.6	0.398	0.601
23	6.83	5.71	63.5	62.4	0.554	0.476
24	7.08	6.17	65.1	63.8	0.445	0.616
Mean	5.57	5.28	64.5	64.2	0.634	1.773

EFFECT OF COOKING METHODS ON PALATABILITY OF DARK TURKEY MEAT AND HYPOXANTHINE AND URIC ACID CONTENT

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An experiment was conducted to determine the level of hypoxanthine and uric acid from selected thigh muscles of turkey, biceps femoris and quadriceps femoris, and to assess the relationship between the level of these compounds and palatability characteristics as evaluated by a sensory panel.

Broad Breasted Bronze turkey hens raised and processed under similar condition were used. Twenty-four frozen turkey quarters were cooked by braising (moist heat) and another 24 by roasting (dry heat) to the end point temperature of 85°C in the BF muscle of the thigh. A rotary hearth oven at 325°F was used. Palatability characteristics of two thigh muscles; BF and QF were evaluated by a sensory panel of 6 judges. Chemical analyses were made on the same selected thigh muscles for pH, percentage total nucleotide, hypoxanthine, and uric acid. Hypoxanthine was determined by ultraviolet spectrophotometry upon conversion to uric acid by xanthine oxidase. TBA, percentage total fat and total moisture were done on a composite of sartorious and semimembranosus muscles. Other measurements were shear values, cooking time and cooking losses.

Cooking time was shorter and total cooking losses higher for braising than for roasting.

A marked organoleptic preference for roasted turkey quarters was observed. Roasted turkey quarters had higher scores for aroma, flavor intensity, flavor desirability, tenderness and juiciness in comparison with braised turkeys.

Significant differences were noted also between turkey muscles. The BF muscle was considered to be more desirable in

all palatability characteristics than QF muscle. Time and internal temperature variations between the two muscles may account for the differences in tenderness scores and Warner Bratzler shear values of the two muscles.

Percentage total nucleotide and pH of QF were higher than those of BF muscle. Also, hypoxanthine concentration was higher in the QF muscle. It was suggested that a temperature effect may influence the hypoxanthine concentration. This means that there is a further delay in the cooling of deep lying muscle (QF) than the superficial muscle (BF) following slaughter. Uric acid values were similar for both muscles.

Hypoxanthine concentration was not significantly related to any palatability characteristics. This indicates that the sensory panel was unable to detect flavor differences attributed to hypoxanthine concentrations in both muscles at the level found in these turkey quarters.

Percentage total fat and total moisture and TBA values did not differ significantly between methods of cooking. However, there was a trend for higher percentage of total fat and total moisture for braised turkey quarters and higher TBA values for roasted turkeys.