QUALITY OF TURKEY MEAT COOKED FROM THE FROZEN OR DEFROSTED STATE AS AFFECTED BY BRAISING OR PRESSURE COOKING

by

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INTRODUCTION

Total preparation time could be reduced and convenience to the homemaker increased if poultry could be cooked directly from the frozen state and still maintain high quality. Increased utilization of turkey may result if defrosting was found to be non-essential. Methods that will reduce cooking losses and time and still maintain palatability and quality characteristics are of interest to commercial processors as indicated by Bowers et al. (1965).

In the past there has been reluctance on the part of consumers to purchase frozen poultry meat (Brant et al., 1965). McCoy (1965) stated that a slightly larger proportion of homemakers across the United States reported using frozen turkey rather than fresh as compared to a reverse trend in chickens. Although consumers expressed reluctance to purchase frozen chickens nearly 2/3 froze purchased chickens when they got them home (Brant et al., 1965 and Winawer and May, 1964).

The purpose of this study was to compare the quality and acceptability of turkey halves cooked from the frozen or defrosted state by pressure (15 p.s.i.) or braising at oven temperatures of 325 and 350°F to an internal temperature of 80°C in the breast.

REVIEW OF LITERATURE

Initial state of cooking

Comparative studies on muscle from fresh (unfrozen) and freshly frozen chickens showed that freezing caused small, but detectable changes in eating quality (Khan and van den Berg, 1967). Khan and van den Berg (1967) also reported that taste panel comparisons of fresh and frozen chicken meat showed that freezing caused a decrease in tenderness of breast meat after cooking.

According to van den Berg and Lentz (1964) cooking losses of fresh (frozen) birds were unaffected by freezing as compared to fresh (unfrozen) birds.

Marsden et al. (1952) reported that fresh, chilled, not frozen turkey hens and toms required longer cooking times (min/lb) to roast than did frozen, defrosted turkeys studied in an earlier investigation by Alexander et al. (1948). They attributed this difference in rate of cooking to the freezing and defrosting of the turkeys. Goertz et al. (1960) found that for each end point temperature (90°C in the breast or 95°C in the thigh), cooking times were slightly, but not significantly less, for fresh-unfrozen than for fresh-frozen defrosted turkeys.

Kotschevar (1956) was concerned primarily whether differences were detectable between samples of meat cooked from the frozen state and those which were defrosted prior to cooking. Nine cuts of meat which had been frozen were studied: beef pot roast, grilled calves' liver, braised short ribs, grilled pork chops, pork roast, lamb stew, lamb roast, rib steaks, and rib roast of beef. Individual cuts of meat were not distinguishable except in the cases of beef pot roast, grilled pork chops, and pork roast. A check on preference indicated a choice significantly in favor of meat cooked directly from the frozen state without defrosting.

Effect of cooking methods

The time required to cook meat is affected by such factors as the method of cooking, composition of the meat, oven temperature, and initial temperature. The rate of cooking also may be dependent on whether the meat is still frozen when cooking is started (Lowe, 1955).

Simmering or pressure cooking of turkeys was recommended by Hanson et al. (1950) to increase tenderness. They reported that roasting had no advantage over simmering or pressure cooking in producing typical "roast turkey flavor", but it did cause increased rancidity.

In an experiment by Schlosser et al. (1957) fresh turkey halves were steamed at 15 lbs pressure and matching halves were braised in the oven at 325°F. Average yield of edible turkey meat was 44% for those steamed and 45% for those braised. There were no significant differences in tenderness, flavor, or general acceptability of turkeys attributable to method of cooking. They reported steaming at high pressures presented a faster technique in comparison with other common cooking methods.

Goertz and Stacy (1960) found that total cooking losses and cooking time in min per lb were significantly less for defrosted half turkeys cooked at 350°F as compared to cooking at 300 or 325°F. For the defrosted whole turkeys, cooking times in min per lb were similar for those roasted at 325 and 350°F and significantly less than those cooked at 300°F. Palatability scores for tenderness, and juiciness of light and dark meat were similar for turkeys roasted at all 3 oven temperatures. When turkeys were roasted to an end point of 90°C in the breast muscle, oven temperatures of 325 and 350°F were most satisfactory for whole and half turkeys, respectively (Goertz and Stacy, 1960).

In 1964, Goertz et al., reported defrosted broilers cooked to an internal temperature of 203°F with 350°F maintained on the surface of broiling pan were nearer optimal doneness as judged by general appearance than birds at either 375 or 400°F. Tenderness (based on chews) and juiciness scores for light and dark meat were similar for birds cooked at the 3 temperatures. Broilers cooked at 350°F were considered done; those broiled at the higher temperatures were considered slightly overdone.

Hoke et al. (1967) indicated that cooking times for defrosted turkey roasts of light or dark meat increased with decreases in oven temperatures used for roasting or braising. Only mealiness of roasted meat was changed by oven temperatures; that of light meat increased with increases in oven temperatures and that of dark meat was greater when roasted at 250 and 400°F than at 325°F.

EXPERIMENTAL PROCEDURE

Meat used

Thirty bronze turkey hens (12-14 lb dressed weight, U.S. Grade A) were purchased from Kansas State Poultry Farm and processed by Roy-al commercial plant in Hesston, Kansas. Birds were stunned by electric shock, bled, scalded, picked in a Pickwick batch-type picker, eviscerated, and chilled in slush ice overnight. Following processing, the turkeys were packaged in Cryovac[1] bags and blast frozen (-40°F). After each turkey was divided into halves, the sides were labeled right and left as viewed from dorsal to anterior of bird. The coded halves were stored 6 per box in a walk-in freezer (-20°C or -3°F) until used in the experiment. The halves were defrosted at room temperature (approx. 25°C or 77°F) for 15 hrs to an internal temperature of 12° ± 4°C in the mid-portion of the breast.

Treatments

The turkey halves were coded according to the number of the bird, the side of carcass, initial state at beginning of cooking (frozen or defrosted), and method of cooking. The design for 20 evaluation periods was randomized (Appendix p. 43).

The turkey halves were cooked by 3 methods, pressure (15 p.s.i.) and braising at 2 oven temperatures--325°F or 350°F. Two treatments, frozen and

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[1]Trademark of W. R. Grace & Co.

defrosted were also used. Each half was cooked to an internal temperature of 80°C (176°F) in the pectoralis major muscle.

In preparation for braising, a centigrade thermometer was inserted in the pectoralis major muscle of both the frozen and defrosted halves (Fig. 1). A mechanical drill was used to make a hole for the thermometer in the frozen half. For braising, wire racks were used in covered Wear-ever aluminum roasters with inside dimensions of 37 x 25 x 10 cm. Braising was done in a rotary gas oven. For pressure, a cast aluminum All-American pressure cooker No. 925 was used. The end point temperature of each half cooked by pressure was determined by the L & N Potentiometer Indicator (Fig. 2).

Evaluation of turkey halves

Total cooking losses were determined by weights taken immediately after removal from the oven. Defrost losses and total cooking time in min per lb were also calculated.

Muscles used in evaluation and the sampling plan for pectoralis major and biceps femoris are illustrated in Fig. 3, 4, and 5. All evaluations except expressible moisture were made the day of cooking. Those samples kept overnight were refrigerated.

Organoleptic acceptability. Flavor intensity and desirability, juiciness, and tenderness (based on chews) of each breast and each thigh were scored by 2 separate panels of experienced judges on a 1 to 7 point scale (Form 1, Appendix p. 44). The members of each sensory panel had been previously trained. The six judges in each panel selected at random a ½-in. cube from the pectoralis major (light meat) or a piece ½ x ½-in. x muscle thickness from the biceps femoris (dark meat).

Total moisture. The percentage moisture was determined on samples from the pectoralis major muscle and a composite of thigh muscles of semimembranosus

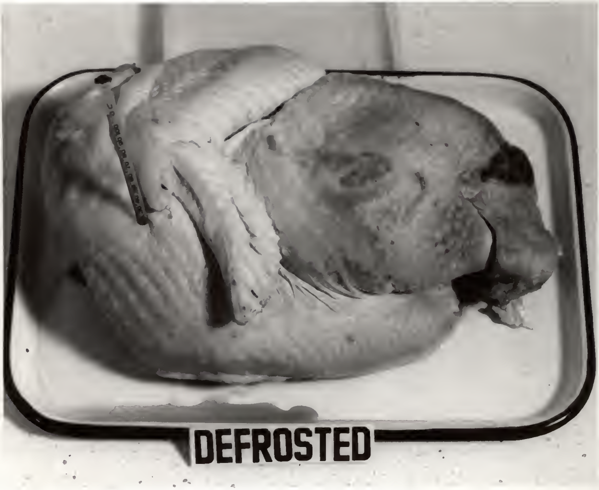

Fig. 1. Placement of thermometer in pectoralis major muscle of turkey half prior to cooking.

Fig. 2. Thermocouple and L & N Potentiometer Indicator arrangement used in pressure cooking.

Fig. 3. Turkey muscles used for evaluation:
1. pectoralis major
2. biceps femoris
3. sartorius
4. semimembranosus

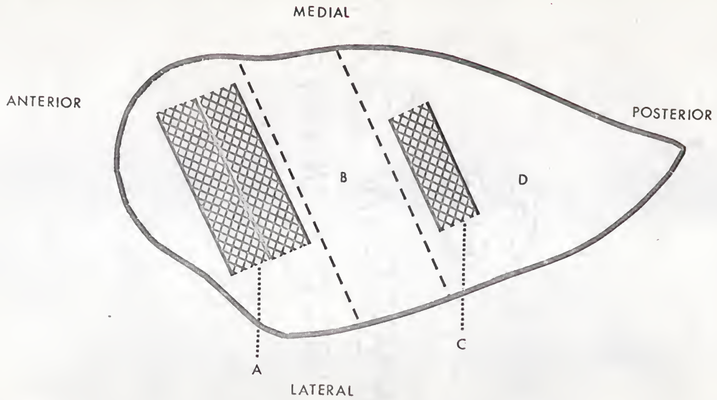

Fig. 4. Sampling plan for pectoralis major:
A = cores (1-in.) for shear value
B = organoleptic evaluation ($\frac{1}{2}$-in. cubes)
C = expressible moisture
D = total moisture (20 g)

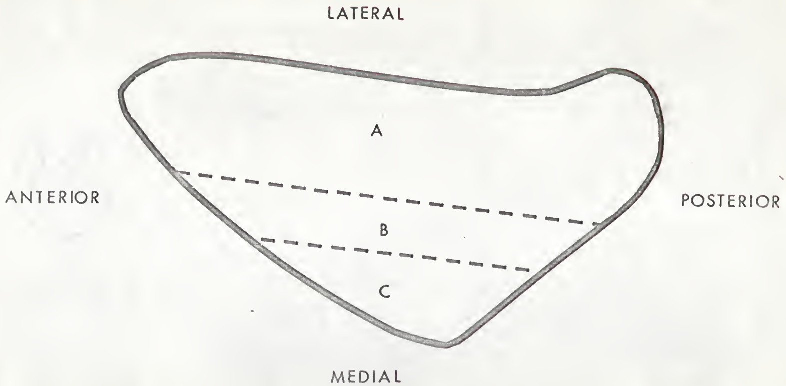

Fig. 5. Sampling plan for biceps femoris:
A = organoleptic evaluation ($\frac{1}{2}$ x $\frac{1}{2}$-in. X muscle thickness)
B = strip (2-in. X $\frac{1}{2}$-in. X muscle thickness)
C = expressible moisture

and sartorius. The cooked samples were ground in a Kenmore #3 food grinder directly into pliofilm bags. Duplicate 10-g samples were weighed into calibrated dishes and subjected to 121°C for 60 min in the C. W. Brabender Semi-Automatic Rapid Moisture Tester.

Shear values. One 1-in. core from the cooked pectoralis major and a 2-in. x ½-in. x muscle thickness strip from the cooked biceps femoris were sheared across fibers on the Warner-Bratzler shearing apparatus with a 25-lb dynamometer. Four readings were taken on each sample.

pH. The pH was determined on samples from the pectoralis major muscle and a composite of thigh muscles of semimembranosus and sartorius by the Beckman Expanded Scale pH Meter (model 76). A slurry was made by adding 10 g cooked ground meat to 100 ml distilled water in the Waring Blender for 2 min. After the mixture reached room temperature (approx. 25°C), 2 readings were determined for each sample. Prior to each use, the instrument was standardized with a buffer solution of pH 6.86.

Expressible moisture. Three 0.3-0.5 g portions of pectoralis major and biceps femoris were weighed to the fourth decimal place, and placed on a 3 2½-in. aluminum foil circles. The foil circle and each meat portion were placed on 3 pieces of dried Whatman No.1 filter paper (6 x 6 in.) and stacked alternately between 4 plexiglass plates (6 x 6 in.). Two sets were subjected to 10,000 lbs pressure for 2 min on a Carver Laboratory Press. Expressible moisture was absorbed by the filter paper. Pressed meat was weighed and the percent expressible moisture calculated.

Analysis of data

Analyses of variance were run for each evaluation except defrost losses to determine the effect of cooking method and the effect of a combination of cooking methods plus the initial states of cooking (frozen and defrosted).

Least significant differences at the 5% level were determined when appropriate.

Correlation coefficients were determined for all measurements except defrost losses within each cooking method and initial state of cooking (frozen or defrosted), each cooking method and a combination of the initial states at beginning of cooking, a combination of cooking methods and initial state of cooking (frozen or defrosted), and a combination of both cooking methods and initial states of cooking.

An average was determined for the defrost losses for each cooking method.

RESULTS AND DISCUSSION

Evaluation of cooked dark and light turkey meat from halves was based on selected objective and subjective measurements. The effects of method of cooking and/or initial state at beginning of cooking (frozen or defrosted) on the measurements is discussed. Analysis of variance, least significant differences, and correlation coefficients were used to determine statistical differences for each measurement. Detailed data are presented in tables in the Appendix pp. 45 - 50.

Objective measurements

Defrost losses. Defrost losses of 2.0%, 2.1%, and 2.6% increased as the frozen weight and weight at time of cooking decreased (Table 1). Brodine (1966) suggested that the time required to defrost meat is influenced by several factors: initial temperature, composition, size and shape of the frozen meat, temperature, and nature of the defrosting media. It is believed that these same factors may affect also the defrost losses.

Cooking time and cooking losses. For each method of cooking, cooking time was longer and total cooking losses greater for the turkey halves cooked from the frozen state (Table 2). Average cooking times for the turkey halves cooked

Table 1. Average frozen weights, defrost losses, and weight at time of cooking of defrosted turkey halves for each cooking method.

Factors	Pressure	Braised 325°F	Braised 350°F
Frozen weight (lbs + oz)	6 lbs 8 oz	6 lbs 6 oz	6 lbs 3 oz
Defrost losses (%)	2.0	2.1	2.6
Weight at cooking (lbs + oz)	6 lbs 6 oz	6 lbs 5 oz	6 lbs

with 15 lb pressure were 7.8 min/lb for the frozen and 6.0 min/lb for the defrosted halves. Cooking times for frozen and defrosted birds braised at 325°F were longest of the 3 methods. Cooking time for braising at 325°F for the frozen halves was 33.0 min/lb and for the defrosted halves 20.7 min/lb. For the halves braised at 350°F the cooking times were 28.0 min/lb and 18.2 min/lb for the frozen and defrosted halves, respectively. Average total cooking losses for the turkey halves cooked by pressure were 27.2% for the frozen and 25.4% for the defrosted halves. Total cooking losses for the frozen and defrosted halves braised at 325°F were lowest of the 3 methods, 17.7% and 15.3%, as compared to 19.5% and 16.2% for the turkey halves braised at 350°F. Cooking time is influenced by weight and shape of the turkey, initial temperature, final internal temperature, and oven temperature used (Brodine, 1966). Cooking method, initial state at beginning of cooking and an interaction of cooking method x initial state resulted in significant ($P = 0.001$) differences in cooking time in min/lb (Table 3). A direct relationship was found between cooking time and total cooking losses for all methods of cooking; however, braising at 325°F was lowest of all methods ($r = 0.342$ for frozen and $r = 0.060$ for the defrosted) (Table 4). Correlation coefficients of cooking time vs total cooking losses were statistically significant for the pressure cooked

Table 2. Average cooking times and losses, shear values, pH, total and expressible moisture of cooked turkey halves.

Factors	Pressure (15 p.s.i.)[a] Frozen[b]	Defrosted[b]	Braised at 325°F[a] Frozen	Defrosted	Braised at 350°F[a] Frozen	Defrosted
Cooking time (min/lb)	7.8	6.0	33.0	20.7	28.0	18.2
Total cooking losses (%)	27.2	25.4	17.7	15.3	19.5	16.2
Light meat						
Shear value (lb/1-in. core)	20.4	19.3	16.0	15.1	17.3	16.3
pH	5.94	5.90	5.91	5.92	5.93	5.97
Total moisture (%)	65.4	65.5	67.3	68.4	68.0	68.4
Expressible moisture (%)	39.7	41.5	43.1	45.9	44.1	43.7
Dark meat						
Shear value (lb/½-in. strip)	7.1	5.7	7.2	6.4	7.1	6.0
pH	6.33	6.33	6.29	6.32	6.30	6.36
Total moisture (%)	62.7	63.5	65.0	65.9	64.7	66.1
Expressible moisture (%)	33.8	35.4	37.4	40.0	38.5	41.1

[a]Cooked to an internal temperature of 80°C (176°F) in pectoralis major muscle.
[b]Initial state at start of cooking period.
Defrosted = 12 ± 4°C in pectoralis major.

Table 3. Significance of F-values and least significant differences for factors in turkey halves cooked to an internal temperature of 80°C in pectoralis major muscle by 3 methods of cooking and 2 initial states.

Factors	Cooking method[a] Significance	LSD[c]	Initial state[b] Significance	LSD[c]	a x b Significance	LSD[c]
Cooking time (min/lb)	***	1.23	***	-	***	1.74
Total cooking losses (%)	***	2.70	*	-	ns	-
Flavor intensity[d]						
Light	*	0.29	ns	-	ns	-
Dark	ns	-	ns	-	ns	-
Flavor desirability[d]						
Light	ns	-	ns	-	ns	-
Dark	ns	-	ns	-	ns	-
Tenderness[d]						
Light	ns	-	ns	-	ns	-
Dark	ns	-	**	-	ns	-
Warner-Bratzler Shear values (lb)						
Light	**	2.41	ns	-	ns	-
Dark	ns	-	***	-	ns	-
Juiciness[d]						
Light	***	0.44	ns	-	ns	-
Dark	**	0.40	ns	-	ns	-
Total moisture (%)						
Light	***	0.96	ns	-	ns	-
Dark	***	1.05	*	-	ns	-
Expressible moisture (%)						
Light	**	2.57	ns	-	ns	-
Dark	**	2.82	ns	-	ns	-

Table 3. (Contd.)

Factors	Cooking method[a]		Initial state[b]		a x b	
	Significance	LSD[c]	Significance	LSD[c]	Significance	LSD[c]
pH						
Light	ns	-	ns	-	ns	-
Dark	ns	-	ns	-	ns	-

[a]Pressure (15 p.s.i.), braised at 325°F or 350°F.
[b]Cooking started at frozen or defrosted state.
[c]Least significant difference calculated at the 5% level.
[d]Judged on scale of 1-7; highest possible score = 7.
ns - non significant
* - significant at 5%.
** - significant at 1%.
*** - significant at 0.1%.

Table 4. Correlation coefficients (r-values) for selected paired variates of total cooking losses (%) and cooking time (min/lb) for light turkey meat cooked by 3 methods and 2 initial states.

Paired variates	Pressure (15 p.s.i.) Frozen	Pressure (15 p.s.i.) Defrosted	Braised at 325°F Frozen	Braised at 325°F Defrosted	Braised at 350°F Frozen	Braised at 350°F Defrosted
DF = 8						
Cooking time vs total cooking losses	0.971***	0.853**	0.342	0.060	0.674*	0.516
Cooking time vs shear values	0.173	-0.420	-0.288	0.191	0.013	0.190
Cooking time vs total moisture	-0.870**	-0.897***	-0.428	0.018	-0.761*	-0.140
Cooking time vs expressible moisture	-0.563 †	-0.460	-0.256	-0.182	-0.605 †	-0.233
Total cooking losses vs total moisture	-0.937***	-0.876***	-0.573 †	-0.925***	-0.629 †	-0.649*
Total cooking losses vs expressible moisture	-0.507	-0.359	0.132	-0.585 †	-0.910***	-0.474
Total cooking losses vs juiciness	-0.756*	-0.735*	-0.633*	-0.556 †	-0.290	-0.637*

† P = 0.10
* P = 0.05
** P = 0.01
*** P = 0.001

frozen (r = 0.971***) and defrosted halves (r = 0.853**). Cooking time vs total cooking losses of turkey halves braised at 350°F had correlation coefficients of r = 0.674* for the frozen halves and r = 0.516 for the defrosted halves. For each method of cooking, the relationships between cooking time and total cooking losses were lower for the defrosted turkey halves than the frozen. Differences in total cooking losses were significant among methods (P = 0.001) and for the initial state of cooking (P = 0.05) (Table 3). Brodine (1966) states that factors that may affect cooking losses include initial temperature, final internal temperature, surface area, composition of the meat, method of cooking, and temperature of the cooking media. Significant correlation coefficients were noted for total cooking losses and cooking time for pressure (r = 0.894***) and braising at 350°F (r = 0.687***); however, the correlation coefficient was lower for braised at 325°F (r = 0.440†) (Table 5). Correlation coefficient data (Table 6) indicated that cooking time and cooking losses were negatively correlated for the defrosted turkey halves (r = -0.680***) and the frozen turkey halves (r = -0.576***).

When data from all cooking methods for light turkey meat were combined, cooking time was inversely related to shear values for the defrosted (r = -0.450*) and frozen turkey halves (r = -0.418*) (Table 6). An indirect relationship of cooking time and shear values of light meat was found for the combination of all cooking methods x initial state at beginning of cooking (r = -0.333**).

Cooking time was negatively correlated with expressible moisture for each method of cooking, and r values were smaller for the defrosted turkey halves when compared to the frozen (Table 4). Correlation coefficients of cooking time vs expressible moisture of light turkey meat in the frozen and defrosted halves, respectively were r = -0.563† and r = -0.460 for pressure cooked; r = -0.256 and r = -0.182 for braised at 325°F; and r = -0.605† and r = -0.233

Table 5. Correlation coefficients (r-values) for selected paired variates of total cooking losses (%) and cooking time (min/lb) on the basis of combined data for light turkey meat cooked from the frozen or defrosted state by 3 cooking methods.

Paired variates	Pressure (15 p.s.i.)	Braised at 325°F	Braised at 350°F
DF = 13			
Cooking time vs total cooking losses	0.894***	0.440†	0.687***
Cooking time vs shear values	0.031	0.125	0.153
Cooking time vs total moisture	-0.806***	-0.428†	-0.330
Cooking time vs expressible moisture	-0.479*	-0.386†	-0.104
Total cooking losses vs total moisture	-0.907***	-0.771***	-0.607**
Total cooking losses vs expressible moisture	-0.406†	-0.355	-0.567**
Total cooking losses vs juiciness	-0.747***	-0.403†	-0.197

† $p = 0.10$
* $p = 0.05$
** $p = 0.01$
*** $p = 0.001$

Table 6. Correlation coefficients (r-values) for selected paired variates of total cooking losses (%) and cooking time (min/lb) on the basis of a combination of cooking methods for light turkey meat from 2 initial states.

Paired variates	Frozen[a]	Defrosted[a]
DF = 28		
Cooking time vs total cooking losses	-0.576***	-0.680***
Cooking time vs shear values	-0.418*	-0.450*
Cooking time vs total moisture	0.383*	0.648***
Cooking time vs expressible moisture	0.371*	0.285
Total cooking losses vs total moisture	-0.812***	-0.926***
Total cooking losses vs expressible moisture	-0.557**	-0.519**
Total cooking losses vs juiciness	-0.784***	-0.645***

[a] Initial state at beginning of cooking period.
Defrosted = 12 ± 4°C in pectoralis major.

* P = 0.05
** P = 0.01
*** P = 0.001

for braised at 350°F. On the basis of combined data for light turkey meat cooked from the frozen or defrosted state, cooking time vs total moisture was significant for pressure (r = -0.806***) and braised at 325°F (r = -0.428†) and non-significant for braised at 350°F (r = -0.330) (Table 5). Correlation coefficient data (Table 6) indicated that cooking time and total moisture were correlated for the defrosted turkey halves (r = 0.648***) and lower for the frozen turkey halves (r = 0.383*).

Data in Table 4 indicate that as total cooking losses increased there was a decrease in total moisture for all methods of cooking. On the basis of combined data for light turkey meat cooked from the frozen or defrosted state, total cooking losses vs total moisture was significant for pressure (r = -0.907***), braised at 325°F (r = -0.771***), and braised at 350°F (r = -0.607**) (Table 5). Total cooking losses vs total moisture was correlated for the defrosted halves (r = -0.926***) and the frozen halves (-0.812***); however, total cooking losses vs expressible moisture was correlated at the 1% level for the frozen birds (r = -0.557**) and the defrosted birds (r = -0.519**) (Table 6). Mostert and Stadelman (1964) stated that a higher cooking loss will result in a lower meat yield and lower moisture content as determined by drying 10 g of sample under vacuum of 29 in. of mercury at 105°C for 16 hr. These investigators reported that frozen cooked broiler parts resulted in a lower moisture retention with a higher cooking loss as compared to the nonfrozen. Frozen meat contains water in the form of ice crystals which is partially lost on defrosting as drip because cells are not able to reabsorb all of this water. In the cooking process, cell walls are ruptured with a subsequent exudation of water and soluble constituents as cooking loss. Mostert and Stadelman (1964) believe that since frozen meat contains free water in the form of ice crystals, it is expected to result in a higher cooking loss when cooked from the frozen state compared to meat cooked after defrosting. Combination of all cooking methods x initial states at beginning of cooking resulted in significant differences for total cooking losses and total moisture ($r = -0.869^{***}$), and were significant for total cooking losses vs expressible moisture ($r = -0.548^{***}$). Total cooking losses were highly correlated with juiciness for defrosted turkey halves ($r = -0.645^{***}$) and frozen turkey halves ($r = -0.784^{***}$) (Table 6).

Warner-Bratzler shear values. Average shear values for cooked light turkey meat ranged from 16.0 to 20.4 lbs per 1-in. core for the frozen halves and 15.1 to 19.3 lbs per 1-in. core for the defrosted turkey halves (Table 2). Cooked dark turkey meat had shear values ranging from 7.1 to 7.2 lbs per 2-in. x $\frac{1}{2}$-in. x muscle thickness strip for the frozen birds and 5.7 to 6.4 lbs per 2-in. x $\frac{1}{2}$-in. x muscle thickness strip for the defrosted birds. Cooking method had a highly significant effect ($P = 0.01$) on shear values of light turkey meat, and initial state of cooking had a significant effect ($P = 0.001$) on shear values for dark turkey meat (Table 3). Brodine (1966) stated that tenderization may occur after defrosting. This appears to be true in this investigation.

pH values. Cooking method and initial state at the beginning of cooking did not affect pH of light or dark meat. The pH values for light turkey meat ranged from 5.90 to 5.97 and from 6.29 to 6.36 for dark turkey meat (Table 2).

Total moisture and expressible moisture. Average values for total moisture for light meat ranged from 65.1% to 68.0% for the frozen halves and 65.5% to 68.1% for the defrosted halves (Table 2). Expressible moisture averages for light meat were 39.7% to 44.1% for the frozen turkey halves and 41.5% to 45.9% for the defrosted halves (Table 2). Average values for total moisture for dark meat ranged from 62.7% to 65.0% for the frozen birds and 63.5% to 66.1% for the defrosted halves. Expressible moisture averages for dark meat were 33.8% to

38.5% for the frozen and 35.4% to 41.1% for the defrosted. Percentage expressible and total moisture of both light and dark meat tended to be higher for the defrosted turkey halves in each method of cooking. For total moisture of light meat, a significant difference ($P = 0.001$) was found for cooking method, and initial state of cooking had a significant effect ($P = 0.05$) on total moisture of dark meat (Table 3). Cooking method had a highly significant effect on expressible moisture of both light and dark meat. LSD for percentage expressible moisture values at the 5% level of significance were 2.57 for light meat and 2.82 for dark meat.

Subjective measurements

Dark meat tended to have higher palatability scores than light meat. This may be attributed, in part, to differences in taste panels. One experienced panel evaluated light meat, whereas another experienced panel evaluated dark meat samples.

Flavor intensity and desirability. Crocker (1948) stated that chicken flavor varied considerably between parts of the same bird. The breast meat tasted sourish and somewhat astringent but was mild in all birds tested. The leg meat of fowl was more prominently sulfury. Crocker (1948) also found that meat cooked at low temperature retains all the salts and sugars of the raw meat, and these may be noted in the taste.

Average values for flavor intensity and flavor desirability are shown in Table 7. For light meat, the braised turkey halves tended to be more desirable and more intense in flavor than those cooked by pressure; however, the flavor intensity of the light meat braised at 350°F was similar to the flavor intensity of the defrosted halves that were pressure cooked. Flavor intensity and flavor desirability of light meat were more highly correlated for the frozen turkey halves in each method of cooking than for the defrosted halves (Tables 8 and 10).

Table 7. Average flavor intensity and desirability, tenderness, and juiciness scores[a] of cooked turkey halves.

Factors	Pressure (15 p.s.i.) Frozen[b]	Pressure (15 p.s.i.) Defrosted[b]	Braised at 325°F Frozen	Braised at 325°F Defrosted	Braised at 350°F Frozen	Braised at 350°F Defrosted
Light meat[c]						
Flavor intensity	4.2	4.5	4.7	4.8	4.4	4.5
Flavor desirability	5.0	5.2	5.4	5.4	5.4	5.4
Tenderness	4.7	5.2	5.3	5.7	5.7	5.5
Juiciness	3.5	4.0	4.8	4.4	4.9	4.6
Dark meat[c]						
Flavor intensity	5.4	5.3	5.4	5.4	5.5	5.3
Flavor desirability	5.5	5.7	5.7	5.8	5.9	5.8
Tenderness	5.7	6.2	5.7	6.2	5.8	5.9
Juiciness	4.4	4.6	5.4	5.1	4.9	5.3

[a]Highest possible score, 7 points.
[b]Initial state at start of cooking period for 10 turkey halves.
[c]Light and dark meat samples evaluated by 2 different experienced panels.

Table 8. Correlation coefficients (r-values) for selected paired variates for light turkey meat.

Paired variates	Pressure (15 p.s.i.) Frozen	Defrosted	Braised at 325°F Frozen	Defrosted	Braised at 350°F Frozen	Defrosted
DF = 8						
Total moisture vs expressible moisture	0.299	0.379	0.084	0.415	0.773**	0.260
Juiciness vs total moisture	0.892***	0.767**	0.732*	0.570†	-0.119	0.208
Tenderness vs juiciness	0.218	-0.450	0.248	0.255	0.206	0.540
Tenderness vs shear values	-0.922***	-0.925***	-0.842**	-0.656*	-0.796**	-0.842**
Flavor desirability vs tenderness	0.599†	0.191	0.225	0.273	0.514	0.874***
Flavor desirability vs shear values	-0.614†	-0.313	0.024	-0.572†	-0.199	-0.793**
Flavor desirability vs juiciness	0.615†	0.070	0.346	0.634*	0.282	0.470
Flavor intensity vs flavor desirability	0.545	-0.167	0.706*	0.492	0.615†	0.324
Flavor desirability vs pH	0.308	0.047	0.146	-0.046	0.330	0.415
Tenderness vs pH	0.478	0.035	-0.022	0.227	0.523	0.457

Table 8. (Contd.)

Paired variates	Pressure (15 p.s.i.) Frozen	Defrosted	Braised at 325°F Frozen	Defrosted	Braised at 350°F Frozen	Defrosted
Juiciness vs						
pH	-0.001	-0.257	0.423	0.129	0.089	0.204

† P = 0.10
* P = 0.05
** P = 0.01
*** P = 0.001

Flavor desirability was positively correlated with juiciness for all methods of cooking (Tables 8 and 9). Flavor desirability vs juiciness of light meat for frozen turkey halves was significant at the .1% level of correlation (r = 0.607***) and the correlation coefficient of the defrosted halves was lower (r = 0.426*) (Table 10). Flavor desirability was positively correlated with tenderness for both frozen and defrosted turkey halves with r values of 0.585*** and 0.577*** respectively.

For dark turkey meat, flavor intensity was more highly correlated with flavor desirability in the frozen halves than the defrosted (Tables 11 and 13). Also, correlation coefficients tended to be higher for flavor desirability vs juiciness in the cooked frozen halves as compared to the birds that were defrosted before cooking halves.

Tenderness. Tenderness scores for dark meat were affected by the initial state at beginning of cooking (Table 3). Generally, average tenderness scores were higher for the defrosted halves of both light and dark meat (Table 7). Pengilly (1958) stated that 2 factors operate during cooking to affect changes in tenderness of meat. Heat coagulates the muscle fibers and tends to harden and toughen the meat, whereas the heat plus moisture in the meat brings about a softening of collagenous tissue which tends to tenderize. Tenderness as evaluated organoleptically was inversely related to shear values of light meat for all methods of cooking (Tables 8 and 9). Tenderness and shear values of light meat were highly correlated for frozen turkey halves (r = -0.834**) and defrosted turkey halves (r = -0.806**) (Table 10). Tenderness was negatively correlated with shear values in all methods of cooking for dark meat (Tables 11 and 12). Tenderness vs shear values was significant at the .1% level for all frozen turkey halves (r = -0.590***), but lower for the defrosted turkey halves (r = -0.320†) (Table 13).

Table 9. Correlation coefficients (r-values) for selected paired variates on the basis of combined data for light turkey meat cooked from the frozen or defrosted state.

Paired variates	Pressure (15 p.s.i.)	Braised at 325°F	Braised at 350°F
DF = 18			
Total moisture vs expressible moisture	0.319	0.339	0.545*
Juiciness vs total moisture	0.805***	0.470*	-0.029
Tenderness vs juiciness	0.051	0.145	0.414†
Tenderness vs shear values	-0.907***	-0.741***	-0.793***
Flavor desirability vs tenderness	0.526*	0.228	0.751***
Flavor desirability vs shear values	-0.513*	-0.227	-0.553*
Flavor desirability vs juiciness	0.456*	0.486*	0.370
Flavor intensity vs flavor desirability	0.406†	0.524*	0.432†
Flavor desirability vs pH	0.086	0.022	0.370
Tenderness vs pH	0.199	0.086	0.439†
Juiciness vs pH	-0.196	0.281	0.072

† P = 0.10
* P = 0.05
*** P = 0.001

Table 10. Correlation coefficients (r-values) for selected paired variates on the basis of a combination of cooking methods for light turkey meat.

Paired variates	Frozen[a]	Defrosted[a]
DF = 28		
Total moisture vs expressible moisture	0.531**	0.480**
Juiciness vs total moisture	0.743***	0.621***
Tenderness vs juiciness	0.420*	0.176
Tenderness vs shear values	-0.834***	-0.806***
Flavor desirability vs tenderness	0.585***	0.577***
Flavor desirability vs shear values	-0.448*	-0.574***
Flavor desirability vs juiciness	0.607***	0.426*
Flavor intensity vs flavor desirability	0.637***	0.305
Flavor desirability vs pH	0.175	0.205
Tenderness vs pH	0.257	0.291
Juiciness vs pH	0.082	0.129

[a]Initial state at beginning of cooking period.
Defrosted = 12 ± 4°C in pectoralis major.

* P = 0.05
** P = 0.01
*** P = 0.001

Table 11. Correlation coefficients (r-values) for selected paired variates for dark turkey meat.

Paired variates	Pressure (15 p.s.i.) Frozen	Pressure (15 p.s.i.) Defrosted	Braised at 325°F Frozen	Braised at 325°F Defrosted	Braised at 350°F Frozen	Braised at 350°F Defrosted
DF = 8						
Total moisture vs expressible moisture	0.640*	0.342	-0.355	-0.094	0.372	0.336
Juiciness vs total moisture	0.692*	0.380	0.117	0.481	-0.333	-0.548
Tenderness vs juiciness	0.039	-0.400	-0.475	0.574 †	0.446	-0.376
Tenderness vs shear values	-0.118	-0.215	-0.772**	-0.249	-0.748*	-0.520
Flavor desirability vs tenderness	0.252	0.086	0.640*	-0.071	0.599 †	0.652*
Flavor desirability vs shear values	-0.050	-0.235	-0.424	0.358	-0.559 †	-0.448
Flavor desirability vs juiciness	0.675*	0.523	0.126	0.200	0.562 †	-0.076
Flavor intensity vs flavor desirability	0.591 †	0.502	0.272	-0.139	0.843**	0.536
Flavor desirability vs pH	0.562 †	-0.026	-0.381	0.194	0.278	-0.053
Tenderness vs pH	0.674*	0.711*	-0.242	0.041	-0.102	-0.452
Juiciness vs pH	0.221	-0.474	-0.014	0.387	0.125	0.818**

† P = 0.10 * P = 0.05 ** P = 0.01

Table 12. Correlation coefficients (r-values) for selected paired variates on the basis of combined data for dark turkey meat cooked from the frozen or defrosted state.

Paired variates	Pressure (15 p.s.i.)	Braised at 325°F	Braised at 350°F
DF = 18			
Total moisture vs expressible moisture	0.555*	-0.098	0.496*
Juiciness vs total moisture	0.568**	0.208	-0.109
Tenderness vs juiciness	-0.134	-0.531*	0.215
Tenderness vs shear values	-0.429†	-0.664**	-0.592**
Flavor desirability vs tenderness	0.232	0.306	0.593**
Flavor desirability vs shear values	-0.219	-0.068	-0.383†
Flavor desirability vs juiciness	0.612**	0.136	0.264
Flavor intensity vs flavor desirability	0.454*	0.069	0.731***
Flavor desirability vs pH	0.205	-0.074	0.031
Tenderness vs pH	0.607**	0.040	-0.194
Juiciness vs pH	-0.211	0.168	0.480*

† P = 0.10
* P = 0.05
** P = 0.01
*** P = 0.001

Table 13. Correlation coefficients (r-values) for selected paired variates on the basis of a combination of cooking methods for dark turkey meat.

Paired variates	Frozen[a]	Defrosted[a]
DF = 28		
Total moisture vs expressible moisture	0.475**	0.456*
Juiciness vs total moisture	0.533**	0.502**
Tenderness vs juiciness	0.149	-0.424*
Tenderness vs shear values	-0.590***	-0.320 †
Flavor desirability vs tenderness	0.472**	0.211
Flavor desirability vs shear values	-0.298	-0.112
Flavor desirability vs juiciness	0.522**	0.280
Flavor intensity vs flavor desirability	0.548**	0.266
Flavor desirability vs pH	-0.002	0.060
Tenderness vs pH	-0.037	0.067
Juiciness vs pH	-0.043	0.092

[a]Initial state at beginning of cooking period. Defrosted = 12 ± 4°C in pectoralis major.

† P = 0.10
* P = 0.05
** P = 0.01
*** P = 0.001

Juiciness. For light turkey meat juiciness scores were higher for the frozen halves than for those cooked by pressure (Table 7). Average juiciness scores of light meat for the frozen halves pressure cooked, braised at 325°F and braised at 350°F were 3.5, 4.8, and 4.9, respectively, whereas scores for the defrosted halves were 4.0, 4.4, and 4.6 respectively. The dark turkey meat of halves cooked by pressure had juiciness scores of 4.4 for the frozen and 4.6 for the defrosted. Average juiciness scores of dark meat for the frozen birds braised at 325°F were 5.4 and 5.1 for the defrosted. Juiciness scores of dark meat braised at 350°F wore 4.9 for the frozen halves and 5.3 for the defrosted halves. Juiciness scores for both light and dark meat were significantly affected by cooking methods (Table 3). On basis of combination of cooking methods for light turkey meat, juiciness vs total moisture was highly correlated for the frozen halves (r = 0.743***) and the defrosted halves (r = 0.621***) (Table 10); for dark meat, juiciness vs total moisture had r values of 0.533** for the frozen halves and 0.502** for the defrosted halves (Table 13).

Interaction of all cooking methods and initial states

On the basis of combination of all cooking methods x initial states at beginning of cooking period, the correlation coefficient of total moisture vs expressible moisture was significant for light turkey meat (r = 0.512***) and dark meat (r = 0.499***) (Table 14). Juiciness vs total moisture was highly correlated in both the light turkey meat (r = 0.672***) and the dark meat (r = 0.519***). Tenderness was negatively correlated with shear values for both light and dark turkey meat with r values of -0.824*** and -0.544***, respectively. A positive correlation was found between flavor intensity and flavor desirability of light meat (r = 0.469***) and dark meat (r = 0.411**).

Table 14. Correlation coefficients (r-values) for selected paired variates on the basis of an interaction of all cooking methods x initial states at beginning of cooking period for light and dark turkey meat.

Paired variates	Light	Dark
DF = 58		
Total moisture vs expressible moisture	0.512***	0.499***
Juiciness vs total moisture	0.672***	0.519***
Tenderness vs juiciness	0.306*	-0.074
Tenderness vs shear values	-0.824***	-0.544***
Flavor desirability vs tenderness	0.583***	0.354**
Flavor desirability vs shear values	-0.514***	-0.206
Flavor desirability vs juiciness	0.503***	0.425***
Flavor intensity vs flavor desirability	0.469***	0.411**
Flavor desirability vs pH	0.192	0.039
Tenderness vs pH	0.273*	0.100
Juiciness vs pH	0.101	0.042

* P = 0.05
** P = 0.01
*** P = 0.001

Appearance. Appearance of all cooked frozen and defrosted turkeys was observed. The skin of turkey halves cooked directly from the frozen state were lighter in color. The surface of the defrosted turkey halves was darker with brownish spots on the wings and legs. Birds cooked by pressure had a greater tendency to fall apart than those that were braised (Figs. 6 and 7). Meat of the frozen halves that were braised was smooth and consistent with no separation of fibers, whereas meat of the defrosted halves exhibited slight separation among fibers of the muscles. There was greater separation of fibers in both the frozen and defrosted pressure cooked turkey halves than in the braised halves. Each half cooked by pressure had a tendency to split between the areas of dark and light meat.

SUMMARY

Acceptability and quality of meat from turkey halves cooked from the frozen or defrosted state were studied. Methods of pressure cooking (15 p.s.i.) and braising at 2 oven temperatures of 325°F or 350°F were used. Each half was cooked to an internal temperature of 80°C in the pectoralis major muscle. Organoleptic evaluation of the pectoralis major muscle (light meat) and biceps femoris muscle (dark meat) was done by 2 different experienced sensory panels. Expressible moisture and Warner-Bratzler shear measurements were made on the pectoralis major and biceps femoris muscles. Total moisture and pH were determined on the pectoralis major muscle and on a composite of the thigh muscles, semimembranosus and sartorius.

For each method of cooking, cooking time was longer and total cooking losses greater for the turkey halves cooked from frozen state than for the defrosted halves. Percentages of expressible and total moisture of both light and dark meat tended to be higher for the meat from the defrosted turkey halves

Fig. 6. Braised turkey halves cooked from the defrosted or frozen state.

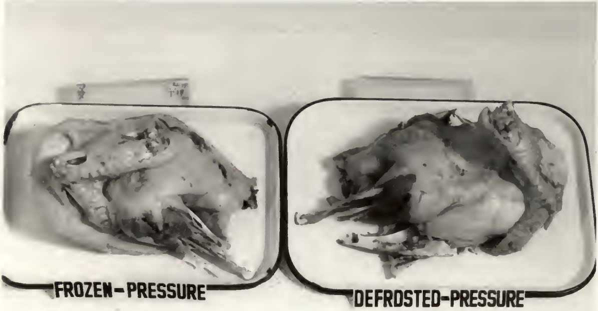

Fig. 7. Pressure cooked turkey halves cooked from the frozen or defrosted state.

in each method of cooking than for meat cooked from the frozen state.

For light turkey meat juiciness scores were higher for meat braised from the frozen state than for braised defrosted halves. No such trend was noted in the dark meat or for the meat cooked by pressure.

Flavor intensity and flavor desirability of light and dark meat were more highly correlated for the frozen turkey halves in each method of cooking than for the defrosted halves. Correlation coefficients tended to be higher for flavor desirability vs juiciness of both light and dark meat of the cooked frozen halves than for the halves that were defrosted before cooking.

For all methods of cooking, average shear values were higher for cooked meat from the frozen halves than for the defrosted turkey halves. Generally, average tenderness scores were higher for the defrosted halves of both light and dark meat than for the frozen halves. Tenderness as evaluated organoleptically was inversely related to Warner-Bratzler shear values.

It was observed that meat of the frozen halves that were braised was smooth and consistent with no separation of fibers whereas meat of the defrosted halves exhibited slight separation among fibers of the muscles. There was greater separation of fibers in both the frozen and defrosted pressure cooked turkey halves than in the braised halves. The data indicated that turkey halves cooked directly from the frozen state was of high quality; objective and sensory measurements between samples cooked from frozen and defrosted states were similar with the exception of tenderness which was slightly less in meat cooked directly from the frozen state.

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REFERENCES

Alexander, L. M., G. E. Schopmeyer, and S. J. Marsden. 1948. Yield of cooked edible portion of young roasted turkey. Poultry Sci. 27, 579.

Bowers, J. R., G. E. Goertz, and J. L. Fry. 1965. Effect of cooking method and skewers on quality of turkey rolls. Poultry Sci. 64, 789.

Brant, A. W., R. H. Forsythe, and M. H. Swanson. 1965. Consumer and retailer attitudes toward "fresh" versus frozen fryers. Food Tech. 19, 661.

Brodine, M. V. 1966. Factors affecting the quality of frozen whole turkeys and precooked turkey rolls. Unpublished M. S. thesis. Iowa State University, Ames, Iowa.

Crocker, E. C. 1948. Flavor of meat. Food Res. 13, 179.

Goertz, G. E., D. Meyer, B. Weathers, and A. Hooper. 1964. Effect of cooking temperatures on broiler acceptability. Comparison of two cooking methods. J. Am. Dietet. Ass. 45, 526.

Goertz, G. E., A. Hooper, and D. L. Harrison. 1960. Comparison of rate of cooking and doneness of fresh-unfrozen and frozen, defrosted turkey hens. Food Tech. 14(9), 458.

Goertz, G. E., and S. Stacy. 1960. Roasting half and whole turkey hens. Effect of varying oven temperatures. J. Am. Dietet. Ass. 37, 458.

Hanson, H. L., H. M. Winegarden, M. B. Horton, and H. Lineweaver. 1950. Preparation and storage of frozen cooked poultry and vegetables. Food Tech. 4, 430.

Hoke, I., B. K. McGeary, and M. K. Kleve. 1967. Effect of internal and oven temperatures on eating quality of light and dark meat turkey roasts. Food Tech. 21(5), 773.

Khan, A. W., and L. van den Berg. 1967. Biochemical and quality changes occurring during freezing of poultry meat. J. Food Sci. 32, 148.

Kotschevar, L. H. 1956. Taste testing frozen meat cooked before and after thawing. J. Am. Dietet. Ass. 32, 444.

Lowe, B. 1955. "Experimental Cookery from the Chemical and Physical Standpoint". 4th edition. p. 238. John Wiley and Sons, Inc., New York.

Marsden, S. J., L. M. Alexander, G. E. Schopmeyer, and J. C. Lamb. 1952. Variety as a factor in fleshing, fatness and edible quality of turkeys. Poultry Sci. 31, 433.

McCoy, J. L. 1965. Homemakers voice opinion on poultry. Preliminary Report SRS-7 (USDA Statistical Reporting Service, Washington, D.C.). Original not seen. Abst. in Poultry Meat 2, c-58.

Mostert, G. C., and W. J. Stadelman. 1964. Effect of method of cookery on shrinkage, moisture, and ether extractable contents of broiler legs and thighs. Poultry Sci. 43, 896.

Pengilly, C. I. 1958. Effect of three end point temperatures on the doneness and palatability of pork loin roasts. Unpublished M.S. thesis. Kansas State University, Manhattan, Kansas.

Schlosser, G. C., R. Seaquist, E. W. Rea, and E. H. Dawson. 1957. Food yields and losses in pressure cooking. J. Am. Dietet. Ass. 33, 1154.

Van den Berg, L., and C. P. Lentz. 1964. The effect of cooling and freezing procedures on drip and cooking losses of chicken broilers. Presented at the 7th National Conference, Canadian Inst. of Technology. Food Processing Abstr. No. 33.

Winawer, H. H., and K. N. May. 1964. Quality of ice-packed and frozen chickens. (1). A consumer preference study. Poultry Sci. 43, 1031.

APPENDIX

Table 15. Design for each evaluation period.

Evaluation Period	Code[a]		
1	3-R-F-P	30-R-D-350	14-R-F-350
2	20-R-D-P	11-L-D-350	6-R-F-325
3	19-L-F-P	8-R-F-325	12-L-D-350
4	20-L-F-P	27-R-D-350	26-L-F-350
5	1-R-F-P	6-L-D-325	21-L-F-325
6	4-L-D-P	25-R-D-325	27-L-F-350
7	2-R-F-P	7-L-D-325	23-R-D-325
8	19-R-D-P	29-L-F-350	25-L-F-325
9	16-R-D-P	29-R-D-350	9-R-F-325
10	5-R-F-P	10-R-F-325	14-L-D-350
11	3-L-D-P	24-L-F-325	26-R-D-350
12	5-L-D-P	30-L-F-350	12-R-F-350
13	17-L-F-P	28-L-F-350	11-R-F-350
14	17-R-D-P	22-R-D-325	7-R-F-325
15	2-L-D-P	21-R-D-325	22-L-F-325
16	18-R-D-P	23-L-F-325	15-L-D-350
17	18-L-F-P	13-R-F-350	10-L-D-325
18	4-R-F-P	15-R-F-350	8-L-D-325
19	1-L-D-P	24-R-D-325	28-R-D-350
20	16-L-F-P	9-L-D-325	13-L-D-350

[a]Code refers to the following: Numerical value = bird number; R--right; L--left; D--defrost; F--frozen; P--pressure (15 p.s.i.); 325°--braise at 325°F; 350°--braising at 350°F. For each evaluation period only one was drawn for pressure cooking because of limited equipment.

SCORE CARD FOR TURKEY MEAT

Form I

Judge ____________________

Date ____________________

Type of Meat

Dark ☐

Light ☐

Sample No.	Flavor		Tenderness Based on Chews		Juiciness	Comments
	Intensity	Desirability	No.	Score		
1						
2						
3						

Flavor

Intensity

7. Very pronounced
6. Prounounced
5. Moderately pronounced
4. Slightly pronounced
3. Perceptible
2. Slightly perceptible
1. Inperceptible

Desirability

7. Very desirable
6. Desirable
5. Moderately desirable
4. Slightly desirable
3. Slightly undesirable
2. Moderately undesirable
1. Undesirable

Tenderness

7. Very tender
6. Tender
5. Moderately tender
4. Acceptable
3. Slightly tough
2. Moderately tough
1. Very tough

Juiciness

7. Very juicy
6. Juicy
5. Moderately juicy
4. Acceptable
3. Slightly dry
2. Moderately dry
1. Very dry

Table 16. Defrost and total cooking losses and cooking time for turkey halves and shear, moisture, pH, and organoleptic values for light meat.

Cooking periods	Defrost losses	Cooking time	Total cooking losses	Flavor intensity	Flavor desirability	Tenderness	Shear values	Juiciness	Total moisture	Expressible moisture	pH
	%	min/lb	%	1-7	1-7	1-7		1-7	%	%	
Frozen - Pressure 15 p.s.i.											
1		6.6	23.2	4.6	5.8	5.8	15.2	4.2	66.4	44.1	5.99
2		5.6	20.4	4.0	4.6	4.6	17.8	4.2	68.3	39.2	6.00
3		6.2	22.5	4.2	5.7	6.2	15.4	4.5	66.9	40.6	5.95
4		7.4	22.9	5.0	5.0	4.3	21.5	3.8	66.6	36.7	5.99
5		6.9	25.4	3.8	4.7	5.7	19.2	2.8	65.1	45.4	5.96
6		4.2	19.0	4.5	4.8	2.8	27.4	4.3	67.4	41.1	5.81
7		10.9	36.4	3.0	4.3	3.5	25.8	2.0	62.0	39.2	5.90
8		11.1	35.4	4.4	4.8	5.6	17.6	3.4	63.9	36.6	5.88
9		7.8	30.2	4.2	5.0	4.6	19.5	2.8	64.1	37.9	6.02
10		11.5	37.0	4.7	5.0	4.3	24.1	3.2	63.7	35.8	5.92
Defrosted - Pressure 15 p.s.i.											
1	1.8	6.4	24.1	4.2	5.3	5.8	16.8	3.8	66.2	39.8	6.00
2	2.0	6.5	25.5	4.5	5.5	4.5	24.4	5.0	65.8	28.2	6.00
3	2.6	4.5	19.8	4.8	5.0	4.8	21.1	4.8	66.1	43.2	5.84
4	1.7	4.4	24.9	4.4	4.6	5.6	20.2	4.0	66.2	41.8	5.93
5	1.2	7.7	31.7	4.3	5.8	6.2	14.3	4.0	64.3	44.0	5.90
6	2.5	3.9	14.5	5.2	5.2	4.0	24.0	4.8	68.3	48.6	5.85
7	1.2	8.2	31.9	4.0	5.2	5.5	16.1	2.8	62.9	39.2	5.90
8	2.2	5.3	22.9	4.4	5.4	5.4	18.3	4.4	66.3	47.5	5.81
9	2.1	5.7	29.4	4.7	5.3	5.8	15.5	3.5	65.9	44.2	5.87
10	2.3	7.7	29.8	4.8	5.2	4.8	22.4	2.8	63.4	38.5	5.98

Table 16. (Contd.)

Cooking periods	Defrost losses	Cooking time	Total cooking losses	Flavor intensity	Flavor desirability	Tender-ness	Shear values	Juici-ness	Total moisture	Expressible moisture	pH
	%	min/lb	%	1-7	1-7	1-7		1-7	%	%	
					Frozen - Braised 350°F						
1		27.9	15.2	4.0	5.4	4.8	23.0	5.4	68.2	46.8	5.93
2		30.0	18.8	4.5	6.0	6.5	11.5	5.0	67.1	45.8	6.00
3		28.9	23.0	4.0	5.5	6.3	17.7	5.0	66.5	38.5	5.88
4		28.3	19.6	4.0	4.8	4.0	21.7	5.0	68.8	44.7	5.80
5		24.6	15.0	4.8	5.8	6.2	17.2	5.2	69.7	49.9	5.94
6		29.5	21.2	4.8	5.7	5.5	17.6	4.8	66.0	41.4	5.91
7		24.7	17.6	4.3	5.0	6.3	12.9	5.5	69.8	45.9	5.90
8		27.4	20.9	4.5	4.8	5.8	13.3	4.5	67.0	41.2	6.08
9		31.7	23.1	5.4	6.0	6.0	16.5	5.4	66.9	41.3	6.05
10		27.3	20.2	4.2	5.2	5.2	21.9	3.6	69.9	45.5	5.88
					Defrosted - Braised 350°F						
1	3.4	18.3	18.5	4.4	5.8	6.2	14.3	4.4	67.2	38.3	6.02
2	3.2	15.7	14.9	4.8	5.7	5.8	16.6	4.5	68.3	43.2	6.15
3	2.9	18.4	12.2	4.6	5.4	6.6	12.6	5.2	69.3	47.1	6.02
4	3.8	18.2	13.9	3.8	5.7	5.7	16.9	5.3	69.4	42.4	5.92
5	1.9	18.3	16.3	3.6	3.8	2.2	27.4	3.6	70.1	41.5	5.87
6	2.9	19.6	16.7	4.5	5.5	5.3	14.8	5.3	68.8	46.7	6.04
7	2.2	16.8	15.4	4.0	5.8	5.7	10.7	4.7	68.2	49.5	6.00
8	1.6	19.6	16.7	5.0	5.8	5.5	14.9	4.5	67.3	42.0	5.83
9	2.2	15.8	16.5	5.4	5.0	5.6	15.6	4.6	67.7	44.5	5.90
10	1.6	21.3	21.2	4.8	5.7	6.0	19.1	3.8	67.2	42.1	6.01

Table 16. (Concl.)

Cooking periods	Defrost losses	Cooking time	Total cooking losses	Flavor intensity	Flavor desirability	Tender-ness	Shear values	Juici-ness	Total moisture	Expressible moisture	pH
	%	min/lb	%	1-7	1-7	1-7		1-7	%	%	
					Frozen - Braised 325°F						
1		29.0	14.6	5.5	5.8	5.0	21.7	6.0	69.0	42.6	6.11
2		32.5	16.3	5.2	5.6	6.2	11.8	5.6	68.3	46.8	5.80
3		34.5	14.9	4.3	5.3	5.3	15.2	4.2	67.5	42.8	6.00
4		34.1	20.6	4.6	5.4	4.8	16.3	4.4	66.5	37.1	5.80
5		33.8	16.1	4.4	5.4	5.4	14.7	4.8	65.9	37.5	5.99
6		33.3	16.1	4.5	5.0	4.8	16.0	5.3	68.9	39.7	5.90
7		33.5	16.3	4.7	5.5	6.3	11.8	5.2	69.1	45.7	5.99
8		31.8	19.1	4.5	5.2	5.8	13.2	4.0	66.6	48.5	5.85
9		33.9	20.1	4.8	5.8	5.0	16.1	4.2	64.3	45.0	5.82
10		33.7	22.7	4.7	5.2	4.3	23.4	4.3	67.0	45.1	5.91
					Defrosted - Braised 325°F						
1	3.7	21.3	19.2	4.2	5.0	4.3	17.2	3.7	67.2	42.6	5.92
2	2.3	20.6	14.9	5.0	6.5	5.5	15.0	5.8	68.5	40.4	5.82
3	1.7	20.6	16.5	5.0	5.0	5.2	16.0	4.7	68.5	39.4	5.93
4	2.9	19.2	14.5	5.0	4.7	5.0	18.2	3.8	68.6	45.3	5.89
5	1.3	17.6	15.9	4.7	5.0	6.2	14.4	4.3	67.7	49.1	5.88
6	2.1	20.5	15.2	4.0	4.8	6.4	15.1	4.4	69.4	47.4	5.94
7	1.9	21.6	9.4	5.2	6.0	6.2	13.6	5.0	70.9	51.6	6.08
8	1.7	20.9	18.8	5.4	5.8	6.0	12.9	3.6	66.4	46.7	5.82
9	1.9	19.8	12.4	4.6	5.8	6.0	11.9	4.6	69.3	51.5	5.94
10	1.6	24.7	16.1	4.7	5.5	6.0	16.7	4.3	68.0	45.2	5.98

Table 17. Shear, moisture, pH, and organoleptic measurements of cooked turkey halves for dark meat.

Cooking periods	Flavor intensity	Flavor desirability	Tenderness	Shear values	Juiciness	Total moisture	Expressible moisture	pH
	Frozen - Pressure 15 p.s.i							
	1-7	1-7	1-7		1-7	%	%	
1	5.2	6.0	6.8	05.8	5.2	63.6	35.6	6.40
2	5.4	5.6	5.8	08.6	4.8	67.1	37.0	6.30
3	5.6	5.8	5.6	06.6	4.8	62.6	39.3	6.32
4	5.7	5.7	5.5	07.1	4.7	63.4	28.0	6.33
5	5.4	5.2	5.6	07.6	5.0	62.0	36.4	6.30
6	5.2	5.6	5.4	07.5	5.6	65.9	40.3	6.32
7	4.8	5.2	5.8	05.4	3.6	60.8	37.7	6.30
8	5.0	4.0	5.5	07.3	2.5	59.9	25.5	6.30
9	6.0	5.8	6.4	07.6	4.2	63.9	33.4	6.40
10	6.0	6.0	5.4	07.4	3.8	57.9	24.3	6.34
	Defrosted - Pressure 15 p.s.i.							
1	5.2	6.2	6.4	06.2	4.0	62.5	36.2	6.40
2	5.5	5.5	6.3	04.5	5.3	62.4	30.8	6.41
3	4.6	5.4	4.8	06.0	5.0	67.0	34.4	6.20
4	6.0	6.2	6.2	05.3	5.8	64.8	32.7	6.31
5	4.6	5.6	6.6	03.7	3.8	61.7	30.9	6.45
6	4.6	5.6	6.4	06.6	4.8	66.3	42.5	6.30
7	5.4	5.8	6.0	05.0	4.8	61.0	36.7	6.32
8	6.3	6.0	6.3	06.2	5.0	63.4	40.8	6.28
9	5.4	5.6	6.4	05.8	4.6	63.5	37.1	6.28
10	5.2	5.0	6.6	07.2	2.8	62.7	32.0	6.38

Table 17. (Contd.)

Cooking periods	Flavor intensity	Flavor desirability	Tenderness	Shear values	Juiciness	Total moisture	Expressible moisture	pH
	1-7	1-7	1-7		1-7	%	%	
			Frozen - Braised 350°F					
1	4.6	5.4	5.0	08.9	4.6	66.1	42.0	6.25
2	5.4	6.0	5.2	08.4	4.8	66.2	33.5	6.32
3	5.3	5.3	4.8	07.7	4.3	63.6	32.6	6.30
4	5.0	5.4	5.8	06.6	5.2	62.6	35.3	6.20
5	5.6	6.0	6.2	08.1	5.4	64.8	42.5	6.24
6	6.0	6.6	6.6	05.4	5.8	63.3	39.3	6.31
7	5.6	6.2	6.4	05.9	4.6	64.0	39.6	6.26
8	5.6	6.2	5.6	07.3	4.4	66.3	44.3	6.33
9	6.3	6.3	6.3	06.2	6.0	64.9	40.3	6.41
10	5.2	5.6	6.6	06.9	4.2	65.2	35.8	6.31
			Defrosted - Braised 350°F					
1	5.0	6.0	6.4	04.5	5.4	65.4	41.9	6.38
2	5.4	6.0	5.8	05.5	5.4	66.5	44.2	6.41
3	5.2	5.6	5.8	04.9	5.2	66.3	41.4	6.39
4	5.6	5.8	5.4	08.0	5.0	65.3	37.2	6.32
5	5.2	5.6	6.0	04.8	5.4	66.1	41.8	6.29
6	5.2	5.2	5.0	07.4	6.0	65.8	37.7	6.50
7	5.6	5.8	6.2	07.8	5.5	66.1	43.6	6.35
8	5.0	5.2	6.0	06.9	4.6	67.7	40.8	6.28
9	5.8	6.2	6.4	06.3	4.8	66.5	41.1	6.27
10	5.4	6.4	6.4	04.2	5.4	65.5	40.9	6.42

Table 17. (Concl.)

Cooking period	Flavor intensity	Flavor desirability	Tenderness	Shear values	Juiciness	Total moisture	Expressible moisture	pH
	1-7	1-7	1-7		1-7	%	%	
			Frozen - Braised 325°F					
1	4.8	4.8	5.2	08.3	5.6	67.1	36.0	6.31
2	4.8	5.6	5.6	07.6	5.2	63.0	37.9	6.25
3	6.0	5.3	5.7	06.5	5.2	65.6	30.3	6.50
4	5.2	6.0	5.8	07.9	5.0	64.8	29.4	6.28
5	5.4	6.2	5.4	07.5	6.0	65.3	38.8	6.28
6	5.2	5.2	5.4	07.6	5.2	65.9	40.1	6.30
7	5.6	5.8	5.8	07.3	5.4	63.6	45.1	6.30
8	5.4	6.4	6.2	05.8	5.4	65.1	39.1	6.28
9	5.8	5.8	5.8	08.0	5.5	63.7	40.3	6.25
10	5.4	5.8	6.2	05.9	5.0	65.6	36.9	6.21
			Defrosted - Braised 325°F					
1	5.2	6.0	6.5	05.5	5.0	65.7	36.4	6.40
2	6.0	6.3	6.0	06.2	5.8	66.5	30.3	6.39
3	5.2	6.2	6.2	08.4	5.6	65.1	36.4	6.35
4	5.6	5.2	5.8	06.6	5.4	66.3	35.9	6.20
5	5.0	5.8	6.2	07.1	4.4	64.8	42.4	6.29
6	5.5	5.0	6.3	05.1	5.5	68.3	42.2	6.40
7	4.8	5.8	6.0	06.2	5.3	67.4	43.3	6.42
8	5.8	6.0	6.4	06.3	5.0	64.2	41.6	6.21
9	5.6	5.2	6.6	06.2	4.4	65.7	47.5	6.28
10	5.0	6.2	6.2	06.0	5.0	64.7	44.2	6.30

QUALITY OF TURKEY MEAT COOKED FROM THE FROZEN OR DEFROSTED STATE AS AFFECTED BY BRAISING OR PRESSURE COOKING

by

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Acceptability and quality of meat from turkey halves cooked from the frozen or defrosted state were studied. Methods of pressure cooking (15 p.s.i.) and braising at 2 oven temperatures of 325°F or 350°F were used. Each half was cooked to an internal temperature of 80°C in the pectoralis major muscle. Organoleptic evaluation of the pectoralis major muscle (light meat) and biceps femoris muscle (dark meat) was done by 2 different experienced sensory panels. Expressible moisture and Warner-Bratzler shear measurements were made on the pectoralis major and biceps femoris muscles. Total moisture and pH were determined on the pectoralis major muscle and on a composite of the thigh muscles, semimembranosus and sartorius.

For each method of cooking, cooking time was longer and total cooking losses greater for the turkey halves cooked from the frozen state than for the defrosted halves. Percentages of expressible and total moisture of both light and dark meat tended to be higher for the meat from the defrosted turkey halves in each method of cooking than for meat cooked from the frozen state.

For light turkey meat juiciness scores were higher for meat braised from the frozen state than for braised defrosted halves. No such trend was noted in the dark meat or for the meat cooked by pressure.

Flavor intensity and flavor desirability of light and dark meat were more highly correlated for the frozen turkey halves in each method of cooking than for the defrosted halves. Correlation coefficients tended to be higher for flavor desirability vs juiciness of both light and dark meat of the cooked frozen halves than for the halves that were defrosted before cooking.

For all methods of cooking, average shear values were higher for cooked meat from the frozen halves than for the defrosted turkey halves. Generally, average tenderness scores were higher for the defrosted halves of both light and dark meat than for the frozen halves. Tenderness as evaluated

organoleptically was inversely related to Warner-Bratzler shear values.

It was observed that meat of the frozen halves that were braised was smooth and consistent with no separation of fibers whereas meat of the defrosted halves exhibited slight separation among fibers of the muscles. There was greater separation of fibers in both the frozen and defrosted pressure cooked halves than in the braised halves. The data indicated that meat from turkey halves cooked directly from the frozen state was of high quality; objective and sensory measurements between samples cooked from frozen and defrosted states were similar with the exception of tenderness which was slightly less in meat cooked directly from the frozen state.