Moisture, Total Lipid, Fatty Acids, and Cholesterol in Raw Ground Turkey†

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Ground turkey (GT) samples from several locations in the United States were analyzed for fatty acids (FA), moisture (M), lipid (L), and cholesterol (C). Major FA were *cis*-18:1 (32.4–35.8%), 18:2*n*–6 (20.7–28.2%), and 16:0 (16.9–23.6%). Trans FA were present in all samples (1.6–4.3%). The means per 100 g of raw product for M, L, and C were 72.1 g, 8.5 g, and 81 mg, respectively. Analyses of dark meat, light meat, skin, and visible fat were consistent with the suggestion that differences in L and C among GT samples were related to differences in the ratios of specific turkey parts used in the product. As presently prepared, GT is lower in total fat than extra lean ground beef but has a similar C content.

INTRODUCTION

In the United States, the consumption of poultry has increased due to the current emphasis on reducing the dietary intake of products high in cholesterol and saturated fatty acids (Richardson, 1989). Although ground turkey is marketed as a substitute for ground beef, there is little information on the fatty acid composition and cholesterol content in ground turkey products. We obtained raw ground turkey samples from nine processors in eight different geographical locations in the United States and analyzed these samples for moisture, fat, cholesterol content, and fatty acid composition. These data are reported herein.

MATERIALS AND METHODS

Materials. Frozen samples of raw ground turkey were obtained from nine poultry processors from eight different areas of the United States [Colorado, Michigan, Minnesota, Missouri, North Carolina, Pennsylvania (2), Utah, Virginia]. One of the two processors from Pennsylvania shipped two separate samples for a total of 10 ground turkey samples. Each sample was thawed in a refrigerator and thoroughly mixed to ensure that homogeneous subsamples were taken for analyses of moisture, total lipid, cholesterol, and fatty acids. Processors from four areas (Colorado, Minnesota, Missouri, and Virginia) also supplied raw turkey breast halves and leg quarters, which were thawed, deboned, and separated into four composite fractions: light meat, dark meat, skin, and separable visible fat. Each of the four fractions was ground in a prechilled Waring blender in a 4 °C cold room and thoroughly mixed to ensure homogeneous sampling for the moisture, lipid, cholesterol, and fatty acid analyses.

Methods. Moisture analysis was conducted on 2.0–4.0 g of homogenized samples essentially as recommended in Method 24.003 of the Association of Official Analytical Chemists (AOAC, 1984a). Lipids were extracted from additional aliquots of the homogenized samples essentially as described by Folch *et al.* (1957), except that methylene chloride was substituted for chloroform and butylated hydroxytoluene was added to minimize lipid oxidation. The lipid extracts were brought to known volumes, and aliquots were removed for gravimetric determination of lipid content, fatty acid analysis, and cholesterol determination.

Fatty acid methyl esters (FAME) were generated using anhydrous methanolic HCl and methylene chloride as cosolvent in an air oven at 80 °C overnight (Sampugna *et al.*, 1982). For some samples, FAME were prepared by a modification of the direct method of Lepage and Roy (1986). The FAME were extracted into hexane, purified using thin-layer chromatography (Sampugna *et al.*, 1982), diluted in isooctane, and separated on a 30 m × 0.25 mm i.d. fused silica capillary column, coated with 0.2 μm of SP2380 (Supelco, Inc., Bellefonte, PA). The column was fitted into a Hewlett-Packard (Avondale, PA) 5890 Series II gas chromatograph, equipped with a Hewlett-Packard autoinjector (7673A) and flame ionization detector. The injector and detector were maintained at 250 °C. Helium was used as the carrier gas, and the FAME were eluted at a flow rate of 0.8 mL/min with a split ratio of 94:1 using temperature programming from 165 to 174 °C at 2.2 °C/min, followed by a 2 °C/min rate to a final temperature of 200 °C, which was maintained for 10 min. Standards purchased from NuChek Prep, Inc. (Elysian, MN), were used to help identify components and assist in calculation of response factors for individual FAME. Correction factors used to calculate the proportions of *cis*- and *trans*-18:1 values were obtained essentially as described previously (Sampugna *et al.*, 1982).

Cholesterol was determined using a scaled-down adaptation of AOAC Method 43.283-43.291 (AOAC, 1984b). The method used differs in that some samples were analyzed without prior lipid extraction (Ulberth and Reich, 1992), the internal standard, 5α-cholestane (catalog no. C 8003, Sigma Chemical Co., St. Louis, MO), was added at the point of saponification, and the trimethylsilyl ether derivatives were separated on a 25 m × 0.31 mm i.d. fused silica capillary column coated with cross-linked 5% phenylmethyl silicone (Hewlett-Packard). The capillary column was fitted into a Hewlett-Packard 5880A Series gas chromatograph equipped with a split injector and a flame ionization detector. Oven, injector, and detector were operated isothermally at 280, 280, and 300 °C, respectively. Helium, at a flow rate of 8.3 mL/min and split ratio of 20:1, was used as the carrier gas. Relative retention time and response factor for cholesterol were based on authentic cholesterol standard (catalog no. C 8253; Sigma).

RESULTS AND DISCUSSION

The fatty acid compositions of ground turkey samples, as weight percent of the total FAME, are summarized in Table I. The major fatty acids were the *cis*-octadecenoates, c18:1i (32.4–35.8%); linoleate, 18:2*n*–6 (20.7–28.2%); and palmitate, 16:0 (16.9–23.6%). Other fatty acids present in significant amounts were stearate, 18:0 (6.9–9.1%); *cis*-hexadecenoates, c16:1i (3.2–5.6%), and *trans*-octade-

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Table I. Fatty Acid Compositions of Retail Ground Turkey Samples

fatty acid[a]	ground turkey sample and location[b] 1, CO	2, VA	3, NC	4, UT	5, MI	6, MN	7, PA	8, PA	9, MO	10, PA	mean ± SD[c]
10:0	tr	tr	tr	tr	nd	tr	tr	tr	tr	tr	tr
12:0	0.2	0.1	0.1	tr	0.1	tr	0.1	0.1	0.2	0.2	0.1 ± 0.05
14:0	1.1	1.2	1.1	1.1	1.1	1.1	1.0	1.0	1.2	1.1	1.1 ± 0.07
16:0	22.0	20.7	21.1	23.6	21.5	21.5	16.9	17.6	22.1	22.6	21.0 ± 2.12
17:0	tr	0.1	tr	0.2	0.2	0.2	0.1	0.1	0.3	0.1	0.2 ± 0.07
18:0	7.6	9.1	7.9	8.4	8.3	8.6	6.9	7.2	8.6	8.2	8.1 ± 0.68
20:0	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.1	0.1	0.1 ± 0.03
22:0	tr	tr	tr	tr	tr	tr	tr	tr	tr	tr	tr
24:0	tr	tr	tr	tr	tr	tr	tr	tr	tr	tr	tr
total saturates	30.9	31.3	30.3	33.3	31.3	31.5	25.1	26.2	32.4	32.2	30.4 ± 2.68
14:1	0.2	0.2	0.2	0.2	0.1	0.2	0.2	0.2	0.2	0.2	0.2 ± 0.03
Σt16:1i	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1 ± 0.00
Σc16:1i	5.2	3.2	4.3	5.6	4.2	4.1	3.4	3.4	4.6	4.9	4.3 ● 0.80
Σt18:1i	2.1	4.2	2.6	2.9	3.8	1.6	4.1	4.3	1.9	1.7	2.9 ● 1.09
Σc18:1i	32.8	33.7	34.1	32.4	34.3	33.2	33.7	34.7	35.8	35.1	34.0 ± 1.05
20:1	0.2	0.4	0.2	0.2	0.3	0.3	0.3	0.3	0.3	0.2	0.3 ± 0.07
22:1	tr	nd	tr	tr	tr	tr	tr	tr	tr	tr	tr
24:1	tr	tr	tr	tr	tr	tr	tr	tr	tr	tr	tr
total monos	40.6	41.7	41.4	41.4	42.9	39.5	41.7	43.0	42.9	42.1	41.7 ± 1.10
18:2*n*-6	24.6	22.1	24.0	20.7	21.9	25.3	28.2	26.6	21.7	22.4	23.8 ± 2.44
Σt18:2i	0.4	0.8	0.5	0.7	0.7	0.3	0.7	0.7	0.3	0.4	0.6 ± 0.19
18:3*n*-3	1.2	1.0	1.1	1.0	1.0	1.7	1.8	1.6	0.9	1.0	1.2 ± 0.34
18:3*n*-6	tr	tr	tr	tr	tr	tr	tr	tr	0.1	tr	tr
20:2*n*-6	0.2	0.2	0.2	0.1	0.2	0.2	0.2	0.2	0.2	0.1	0.2 ± 0.04
20:3*n*-6	0.1	0.1	0.1	0.1	0.1	0.1	tr	tr	0.1	0.1	0.1 ± 0.00
20:4*n*-6	1.2	1.5	1.4	1.6	1.3	1.1	1.1	1.0	1.1	1.1	1.2 ± 0.20
20:5*n*-3	tr	tr	tr	tr	tr	tr	tr	tr	tr	tr	tr
22:4*n*-6	0.3	0.2	0.2	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.2 ± 0.04
22:5*n*-3	0.1	0.2	0.2	0.1	0.1	0.1	0.1	0.1	0.1	tr	0.1 ± 0.04
22:5*n*-6	tr	tr	tr	0.1	tr	tr	tr	tr	tr	tr	tr
22:6*n*-3	tr	0.4	0.4	tr	0.1	tr	0.3	0.3	0.1	0.1	0.3 ± 0.14
total PUFA	28.0	26.5	28.0	24.6	25.5	29.0	32.5	30.6	24.7	25.3	27.5 ± 2.65

[a] c = cis; t = trans; i = isomers; Σ = sum of the individual isomers; monos = monounsaturated fatty acids; PUFA = polyunsaturated fatty acids. [b] Samples are identified by the abbreviation of the state in which the processor is located. Values are mean weight % FAME of duplicates. tr = trace, <0.1%; nd = not detected. [c] Means are grand averages for each FAME ± standard deviation.

Table II. Moisture, Total Lipid, and Cholesterol Contents of Retail Raw Ground Turkey Samples[a]

sample and location[b]	moisture, g/100 g	total lipid, g/100 g	cholesterol, mg/100 g
1, CO	71.6	7.4	76
2, VA	73.1	7.2	80
3, NC	73.0	9.4	78
4, UT	73.5	5.9	71
5, MI	72.6	10.6	90
6, MN	69.2	8.7	83
7, PA	71.2	10.8	89
8, PA	71.5	8.7	91
9, MO	73.0	8.3	83
10, PA	72.4	8.2	73
mean ± SD[c]	72.1 ± 1.27	8.5 ± 1.50	81 ± 7.1

[a] Values are the means per 100 g of homogenized ground turkey. [b] The abbreviation of the state in which the processor is located. [c] Means are grand averages for moisture, lipid, and cholesterol content ± standard deviation.

cenoates, t18:1i (1.6–4.3%). The percentages of 16:0, c18:1i, t-18:1i, and t-18:2i observed in the ground turkey samples were similar to the amounts reported in ground beef (Slover and Lanza, 1979); however, the ground turkey samples contained greater amounts of 18:2*n*-6 than has been reported for ground beef (Slover and Lanza, 1979; U.S. Department of Agriculture, 1990).

The percentages of total polyunsaturated fatty acids (PUFA) in ground turkey ranged from 24.6 to 32.5%, which was largely (20.7–28.2%) 18:2*n*-6. Although arachidonic acid, 20:4*n*-6, was low (1.0–1.6%), it was present at higher levels than any of the 20- or 22-carbon *n*-3 PUFA. The amounts of *n*-3 fatty acids varied from <0.1 to 0.4% for 22:6*n*-3, from <0.1 to 0.2% for 22:5*n*-3, and from 0.9 to 1.8% for 18:3*n*-3. Only trace amounts (<0.1%) of 20:5*n*-3 were found in any sample.

Fatty acid compositions of most ground turkey samples (Table I, samples 1–6, 9, 10) were quite similar. However, samples 7 and 8, which came from the same processor, differed from the other samples. They were lowest in saturated fatty acids (especially 16:0), highest in PUFA, which were primarily 18:2*n*-6 and 18:3*n*-3, and relatively high in trans fatty acids.

All of the turkey samples contained trans fatty acids. Although the specific dietary source is unknown, the trans fatty acids must have come from the diet since these fatty acids are not end products of fatty acid synthases in animal systems. Al-Athari and Watkins (1988) have analyzed poultry diets for trans fatty acids. They reported that as much as 11.7% of t-18:1 and 0.7% of tt-18:2 of the total FAME were present in feed-grade fats used in poultry diets.

Values for total lipid, cholesterol, and moisture content in the ground turkey samples are presented in Table II. Cholesterol was the only sterol detected. Compared to the fatty acid profiles (see Table I) and moisture data (69.2–73.5 g/100 g of raw product), there was considerable variability in cholesterol (71–91 mg/100 g of raw product) and total lipid (5.9–10.8 g/100 g of raw product) values among the different ground turkey samples. Ground turkey is commonly a mixture of dark and light meat, including adhering skin and visible fat. Differences in the amounts of these components used by individual processors to prepare the ground turkey would affect the levels of lipids observed in the final product.

Composites of dark meat, light meat, skin, and visible fat from raw turkey were also examined for fatty acid

Table III. Fatty Acid Profiles of Raw Turkey Composites[a]

fatty acid[b]	raw turkey composite[c] dark meat	light meat	skin	visible fat
10:0	tr	nd	tr	tr
12:0	tr	tr	tr	tr
14:0	1.0	0.7	1.0	1.0
15:0	0.2	0.1	0.2	0.2
16:0	21.6	21.8	21.8	21.7
17:0	0.4	0.2	0.3	0.3
18:0	9.3	10.5	6.7	7.0
20:0	0.2	0.2	0.1	0.1
22:0	0.1	0.1	nd	nd
24:0	0.1	tr	nd	nd
total saturates	32.9	33.6	30.2	30.4
14:1	0.2	0.2	0.2	0.2
Σt16:1i	tr	tr	tr	tr
Σc16:1i	4.2	4.0	5.6	5.1
17:1	0.3	0.2	0.2	0.2
Σt18:1i	2.9	2.1	2.9	3.2
Σc18:1i	30.3	28.2	35.6	35.8
20:1	0.3	0.3	0.4	0.4
22:1	nd	nd	nd	nd
24:1	0.1	0.1	nd	nd
total monos	38.3	35.1	44.9	44.9
18:2*n*–6	22.6	21.2	22.3	21.9
Σt18:2i	0.3	0.2	0.5	0.5
18:3*n*–3	1.2	0.9	1.3	1.2
18:3*n*–6	tr	tr	tr	tr
20:2*n*–6	0.3	0.4	0.2	0.1
20:3*n*–6	0.3	0.4	0.1	0.1
20:4*n*–6	3.0	5.2	0.4	0.4
20:5*n*–3	tr	0.2	nd	0.2
22:4*n*–6	0.6	1.1	0.1	nd
22:5*n*–3	0.2	0.6	nd	nd
22:5*n*–6	0.2	0.2	nd	nd
22:6*n*–3	0.2	0.8	nd	nd
total PUFA	28.9	31.2	24.9	24.4

[a] Samples sent by processors from CO, MN, MO, VA (2). [b] c = cis; t = trans; i = isomers; Σ = sum of the individual isomers; monos = monounsaturated fatty acids; PUFA = polyunsaturated fatty acids. [c] Values are mean weight % FAME of duplicates. tr = trace, <0.1%; nd = not detected.

Table IV. Moisture, Total Lipid, and Cholesterol Contents of Raw Turkey Composites[a]

sample	moisture, g/100 g	total lipid, g/100 g	cholesterol, mg/100 g
dark meat	75.5 (0.07)	5.1 (0.04)	84 (3.5)
light meat	74.4 (0.07)	2.0 (0.08)	54 (0.5)
skin	47.8 (0.51)	39.8 (0.94)	87 (0.5)
visible fat	25.4 (0.02)	68.1 (1.11)	57 (2.2)

[a] Values are the means per 100 g of homogenized raw turkey composite with absolute deviation for duplicates given in parentheses.

composition (Table III) and moisture, total lipid, and cholesterol content (Table IV). As can be seen in Table III, the fatty acid composition across the tissues examined was relatively consistent. The major differences in fatty acid composition were the higher 18:0 and 20:4*n*–6 and lower monounsaturated fatty acid values in the meat composites, compared to skin and visible fat. The highest 20:4*n*–6 was observed in light meat.

Large differences in moisture, total lipid, and cholesterol content (Table IV) were observed among dark meat, light meat, skin, and visible fat composites. As expected, the visible fat fraction was highest in total lipid, followed by skin and dark meat. Light meat had the lowest lipid content. Skin and dark meat had similar and higher cholesterol contents than visible fat and light meat. Also, the cholesterol values observed for visible fat and light meat were similar. The total lipid, moisture, and cholesterol values presented in Table IV are in general agreement with those values for the corresponding items in *Agriculture Handbook 8*, Section 5 (U.S. Department of Agriculture, 1979).

Retail ground turkey composition is dictated by market demand, availability, and price of the meat types (Baker and Bruce, 1989). Since breast meat is in high demand and commands a premium price, most ground turkey is made from surplus thighs and drumsticks. This is in agreement with the data obtained in this study. Compared to values for light meat (5.2% 20:4*n*–6, 2.0 g of total lipid/100 g of raw product and 54 mg of cholesterol/100 g of raw product), the relatively low average value for 20:4*n*–6 (1.2%) and relatively high average values for total lipid (8.5 g/100 g) and cholesterol (81 mg/100 g) in ground turkey samples are consistent with a limited use of light meat in the ground turkey samples analyzed in this study. To the extent that light meat was used in these products, sample 4 probably contained more than any of the others, since it was highest in 20:4*n*–6 and lowest in both cholesterol and total lipid content.

It is of interest that published values for cholesterol content in ground beef are 69–87 mg/100 g of raw product (U.S. Department of Agriculture, 1990). These values are similar to the values reported herein, 71–91 mg/100 g of raw product, for ground turkey. The average fat content of ground turkey, 8.5 g/100 g, is considerably lower than that reported (U.S. Department of Agriculture, 1990) for extra lean ground beef, 17.06 g/100 g. Thus, it seems clear that ground turkey (as presently prepared) is a low-fat alternative to ground beef but not a low-cholesterol alternative. A lower cholesterol level, as well as a lower fat level, in ground turkey could be achieved by the restricted use of dark meat and skin in the product.

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