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Composition of Commercial Samples of Poultry Oil[1]

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Primary Audience: Nutritionists, Researchers, Purchasing Agents

Summary

Analytical values for a number of samples of poultry oil were obtained and subjected to statistical analysis. Compared to classical literature values, present-day poultry oil is higher in stearic ($C_{18:0}$) and oleic ($C_{18:1}$) and lower in linoleic ($C_{18:2}$) acid. Ratios of unsaturated to saturated fatty acids were similar, indicating that metabolizable energy content would be very similar to previously published values. However, meeting minimum dietary levels of linoleic acid requires that values should be modified. Recent assays of fatty acid content of broiler adipose tissue suggest a marked reduction in linoleic acid content compared to earlier reports. This study attempted to evaluate the composition of commercial poultry oil for standard composition.

Key words: Fat supplements, linoleic acid, metabolizable energy, poultry oil
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Description of Problem

Poultry oil obtained from the rendering of poultry offal is widely used as an energy source in poultry feeds. Much of this by-product is produced and used in-house; some is sold. Although producers of poultry oil may analyze poultry oil as a quality control measure, few published data exist regarding the typical composition of poultry oil. Edwards [1] reported on the fatty acid composition of three poultry oil samples from two different geographic regions in the United States; this remains the primary source of published information on the fatty acid composition of poultry oil. Lessire *et al.* [2] determined the fatty acid composition of two poultry oils from France and found values similar to those published by Edwards [1], especially in regard to linoleic acid content.

In the course of recent research in our laboratory, poultry oil obtained from several commercial sources was included either as the primary fat supplement or as a reference standard for comparison with other fat supplements [3, 4]. These samples, submitted to a commercial laboratory specializing in analysis of feed fat samples, differed markedly in fatty acid composition from those reported by Edwards [1], especially in content of linoleic acid. The objective of the present study was to evaluate the composition of commercial poultry oil to determine if the values observed in samples used in our laboratory were typical of those observed in samples used in the poultry industry.

Materials and Methods

A number of producers of poultry oil were contacted and asked to provide analytical data for recent samples of poultry oil. These producers represented a wide geographical area that included the primary broiler producing areas of the United States. Analytical values came from fifty-one samples of poultry oil, including analysis of fatty acids, iodine value, free fatty acids, moisture, and insoluble impurities (not all assays were performed on all fifty-one samples). Data were combined and mean, minimum, and maximum values were determined. Standard deviation and coefficient of variation were calculated as a means of expressing degree of variability.

Results and Discussion

Table 1 presents a summary of the analytical values of commercial samples of poultry oil provided by different producers. Many of the fatty acids were detected in very small amounts or not detected at all; these possessed a large degree of variability. In agreement with the report of Edwards [1], the primary fatty acids in the poultry oil samples included palmitic ($C_{16:0}$), palmitoleic ($C_{16:1}$), stearic ($C_{18:0}$), oleic ($C_{18:1}$), and linoleic ($C_{18:2}$); these typically had a much lower degree of variabil-

TABLE 1. Composition of commercial samples of poultry oil

PARAMETER	n[A]	MINIMUM	MAXIMUM	MEAN	STANDARD DEVIATION	COEFFICIENT OF VARIATION
FATTY ACID, % OF METHYL ESTERS[B]						
$C_{8:0}$	3	0.01	0.02	0.02	0.006	34.64
$C_{10:0}$	21	0.01	0.05	0.03	0.009	29.87
$C_{12:0}$	28	trace	0.19	0.10	0.048	49.55
$C_{12:1}$	4	0.01	0.02	0.02	0.006	38.49
$C_{13:0}$	5	0.01	0.01	0.01	0.00	0.00
$C_{14:0}$	49	0.46	1.80	1.05	0.315	29.98
$C_{14:1}$	48	0.09	0.76	0.32	0.129	40.40
$C_{15:0}$	27	0.02	0.63	0.21	0.128	61.90
$C_{15:1}$	2	0.05	0.09	0.07	0.028	40.41
$C_{16:0}$	51	12.36	24.23	20.79	2.033	9.78
$C_{16:1}$	51	4.08	8.44	5.85	1.027	17.56
$C_{16:2}$	14	0.02	0.34	0.13	0.107	85.52
$C_{17:0}$	48	0.01	2.04	0.40	0.37	92.79
$C_{17:1}$	2	0.10	0.38	0.24	0.198	82.50
$C_{18:0}$	51	4.79	11.55	8.47	1.753	20.71
$C_{18:1}$	51	37.45	49.14	41.75	2.144	5.14
$C_{18:2}$	51	15.72	22.57	19.10	1.465	7.67
$C_{18:3}$	51	0.29	1.73	0.82	0.367	44.93
$C_{20:0}$	42	0.01	1.15	0.26	0.254	96.04
$C_{20:1}$	41	0.17	0.80	0.54	0.155	28.49
$C_{20:2}$	2	0.06	0.14	0.10	0.057	56.57
$C_{20:4}$	2	0.10	0.29	0.20	0.134	68.90
$C_{22:0}$	43	0.01	0.68	0.10	0.113	116.07
$C_{22:1}$	44	0.01	0.52	0.15	0.118	86.80
$C_{24:0}$	46	0.01	0.51	0.20	0.139	68.61
$C_{24:1}$	22	trace	0.50	0.31	0.152	49.24
Iodine value	42	72.45	85.13	78.30	2.64	3.37
Free fatty acids, %	22	2.26	15.31	7.07	2.99	42.32
Moisture, %	22	0.02	0.85	0.46	0.25	54.25
Insoluble impurities, %	22	0.02	1.52	0.22	0.41	184.27

[A]Number of samples in which parameter was detected or reported

[B]Number of carbon atoms:number of double bonds ity among samples. Edwards [1] noted that only very small amounts of the C_{20} or C_{22} series of fatty acids were present in poultry oil; the present survey data agree. The free fatty acid content of the samples (n = 22) ranged from 2.26 to 15.31%; this factor was not reported in the study by Edwards [1]. No information was available regarding the potential inclusion of dissolved air flotation (DAF) fractions in the various samples, possibly contributing significantly to the variability in free fatty acid content.

Striking differences between the distribution of fatty acids in poultry oil in the present survey and in that reported by Edwards [1] occurred (Table 2). Poultry oil from the present survey contained higher levels of stearic (+2.57%) and oleic (+2.25%) and lower levels of linoleic (-4.40%) acids than reported previously [1]. Relatively minor variations also occurred for other fatty acids. Overall, poultry oil samples reported by Edwards [1] were 1.44% lower in saturated fatty acids and 3.28% higher in unsaturated fatty acids than those from the present survey. As a result, the samples from Edwards [1] had a higher unsaturated/saturated fatty acid ratio than samples from the present survey. Data from the present survey were in agreement with the analytical values of poultry oil used in recent studies in our laboratory [3, 4].

It is interesting to speculate about possible reasons for the differences between the findings of Edwards [1] and the present study as well as the possible implications that such changes may have on the metabolizable energy value of commercially available samples of poultry oil. Fat supplements used during the early 1960's consisted primarily of greases and tallows; more recently, vegetable soapstocks and restaurant greases have become a major part of the fat supplies used in poultry diets. However, these are typically high in linoleic acid and should contribute towards maintaining a high level of linoleic acid in adipose tissue and subsequent poultry oil rendered from these tissues. The bird itself has changed markedly in rate of growth and tendency to develop a fatter carcass; these changes may have impacted upon the fatty acid makeup of the bird. Marion and Woodroof [5] found that the linoleic acid content of breast meat, thigh meat, and skin of broilers fed diets with no fat supplement ranged from 22.3 to 26%. In studies by Valencia *et al.* [3], the linoleic acid content of adipose tissue of birds fed up to 8% supplemental poultry oil did not exceed 16.56%. In more recent studies in our laboratory (unpublished data), the linoleic acid content of broilers fed corn-soybean meal diets with no supplemental fats was only 11.6%.

Although current poultry oils are lower in linoleic acid than those reported earlier by Edwards [1] and Lessire *et al.* [2], there may be little difference in the overall metabolizable energy value. The unsaturated:saturated ratio of fats in the present survey was only slightly reduced. This ratio is one of the predominant factors that contributes to the ability of the chick to digest and utilize fatty acids [6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16]. Thus, one should not have to adjust metabolizable energy values assigned to poultry fats based on these analyses. However, if one is concerned about meeting minimum requirements of linoleic acid in poultry diets, adjustments in the nutrient matrix for poultry fat should be made accordingly.

CONCLUSIONS AND APPLICATIONS

1. The fatty acid composition of commercial poultry oils differs markedly from that reported earlier, especially in content of linoleic acid.
2. Ratios of unsaturated:saturated fats in commercial poultry oils differ only slightly from those reported earlier, indicating that one should not have to adjust metabolizable energy values based on present analyses.
3. The fatty acid composition of adipose tissues of present-day commercial broilers appears to be markedly different from that reported previously, especially in content of linoleic acid.
4. Persons formulating to minimum linoleic acid requirements should adjust values for poultry oil accordingly.

TABLE 2. Comparison of 1961 and 1994 analytical values for poultry oil

FATTY ACID[A]	1961[B]	1994[C]	DIFFERENCE
	% of Methyl Ester		
$C_{10:0}$	0.10	0.03	-0.07
$C_{12:0}$	0.20	0.10	-0.10
$C_{14:0}$	1.40	1.05	-0.35
$C_{16:0}$	21.40	20.79	-0.61
$C_{16:1}$	6.80	5.85	-0.98
$C_{18:0}$	5.90	8.47	+2.57
$C_{18:1}$	39.50	41.75	+2.25
$C_{18:2}$	23.50	19.10	-4.40
$C_{18:3}$	1.00	0.82	-0.18
Total saturated	29.0	30.44	+1.44
Total unsaturated	70.8	67.52	-3.28
Unsaturated/saturated	2.44	2.22	

[A]Number of carbon atoms:number of double bonds

[B]Values from Edwards (1961)

[C]Values from present survey

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