

Fatty acid composition of yolk of nine poultry species kept in their natural environment*

Esad S. Polat**, **Ozcan B. Citil¹**, **Mustafa Garip²**

¹ Selcuk University, Faculty of Veterinary Medicine,
Department of Animal Nutrition and Nutritional Disorders, Konya 42250 Turkey

² Selcuk University, Faculty of Veterinary Medicine,
Department of Animal Science, Konya 42250 Turkey

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Fatty acid (FA) composition of eggs from nine poultry species was determined chromatographically. Twenty six FAs were determined in the lipid composition of eggs. Monounsaturated fatty acids (MUFA) were found in higher amounts than saturated fatty acids (SFA) and polyunsaturated fatty acids (PUFA) in egg yolks. Oleic acid (C18:1 n9) was the major MUFA in egg yolk and, palmitic acid (C16:0) was the major SFA in nine of all different originated eggs. Linoleic acid (C18:2 n6), arachidonic acid (C20:4 n6) and linolenic acid (C18:3 n3), reached the highest levels among the PUFAs. SFA/PUFA ratios were found to be 0.97, 2.51, 2.20, 1.46, 1.67, 1.40, 1.96, 1.27, and 1.34 in chicken, goose, duck, turkey, peacock, guinea fowl, pheasant, quail and partridge, respectively. Eggs of all nine species were found valuable for human consumption as fatty acids source, but the chicken's egg occurred to be the most beneficial to human health according to its highest omega 6 fatty acid (29.8%), highest PUFA / MUFA ratio (0.80) and lowest of SFA / PUFA ratio (0.97).

KEY WORDS: egg / fatty acid composition / poultry

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**Corresponding author: epolat@selcuk.edu.tr

Egg is known as one of most important components of human diet. There are many types of poultry species' eggs consumable as a protein and amino acid supplement. According to recent statistical data [FaoStat 2011], a total world production of chicken eggs amounts to about 1220 bln per year yielded mainly by chickens but also coming from another poultry species as 86 bln eggs per year (7% of whole egg production). The question arises whether there are interspecies differences in poultry eggs quality which may affect the egg nutritive value and quality as human food.

The compositions of fatty acids in egg lipids have been highly concerned to human health such as saturated fatty acids (SFA), monounsaturated fatty acids (MUFA) and polyunsaturated fatty acids (PUFA) – Chow [1992]. For instance, an inadequate intake of n3 PUFA, especially docosahexaenoic acid (DHA, C22:6n-3), negatively influences brain growth and functional parameters in human infants [Hoffman *et al.* 2004, Poławska *et al.* 2013].

The n-3 and n-6 PUFAs are considered essential for growth and development of children as precursors of composite hormones known as eicosanoids, involved in several metabolic processes of great importance for the human organism, mainly related to cardiovascular activity [Mustonen *et al.* 2009]. Long chain n-3 PUFAs cannot be synthesized within the human organism and must be supplied with the diet [Chow 1992]. Poultry egg is one of the best sources of omega 3 in all over the world and must regularly be consumed especially by growing individuals [Sauerwald *et al.* 1997].

The fatty acid composition of poultry egg may be affected, among others, by diet, age of hen and geographic allocation [Milinsk *et al.* 2003]. The composition of eggs of different species' eggs needs to be investigated and compared as well. The objective of this study was to determine both the fatty acid composition and SFA/PUFA ratio variation of egg yolk of chicken, goose, duck, turkey, peacock, guinea fowl, pheasant, quail, and partridge living in natural environment.

Material and methods

Sampling

Species such as chicken, goose, duck, turkey, peacock, guinea fowl, pheasant, quail and partridge living in natural environment in countryside natural conditions have been sampled for eggs. Under such conditions poultry are mainly kept outdoors for feeding and are not supplemented with concentrates, only a very limited amount of grain is fed. In this study eggs were collected randomly from each species as 1 egg per day for 5 days. and analysed to determine the fatty acids composition. The yolks from eggs were separated mechanically and kept in polyethylene packing (in N₂ atmosphere) at -18°C before the methylation.

Gas chromatography analysis of fatty acid methyl esters

The fatty acid methyl esters (FAME) of the total lipids were prepared according to Folch *et al.* [1957]. Quantitative and qualitative analyses were performed as

described by Eder [1995] with a Shimadzu 15-A Series Gas Chromatograph (Agilent Technologies, Palo Alto, CA) equipped with a flame ionization detector 1.8 m - 3 mm internal diameter packed glass column containing GP 10% SP-2330 on 100/120 Chromosorb WAW(Cat. No. 11851) was used. Nitrogen was used as a carrier gas. The injector and detector temperatures were 270°C and 260°C, respectively. Column temperature was programmed for 190°C for 41 min, rising progressively at 30°C / min up to 220°C where it was maintained for 10 min at 220°C. The injection volume was 1.0 µl. The Shimadzu Class-VP Software was used to calculate the peak areas and retention times. The FAMES were identified by comparing their retention times with those of the authentic standard mixtures. All the chemicals used for the gas chromatography analysis procedure were obtained from ALLTECH.

Statistical

The results were subjected to nonparametric variance analysis (Kruskal Wallis Test), at P<0.05 significance level by the SPSS Statistical software package 16.0 version. The means were compared by Mann-Whitney U test.

Results and discussion

The total lipid contents (Tab. 1) as determined in chicken, goose, duck, turkey, peacock, guinea fowl, pheasant, quail, and partridge eggs did not differ amongst the species within a range of lowest in duck egg (30.6%), and highest in the egg of chicken (33,4%). These results are similar to those reported by Sinanoglou *et al.* [2011], Parlat *et al.* [2010] and Cital *et al.* [2011] who made comparative investigations on poultry species.

In egg's yolks, 26 fatty acids were identified as presented in Table 2.

The major fatty acids in all of the poultry eggs analysed were: oleic (18:1) – 33.9-48.3%, palmitic (16:0) – 21.1-26.3%, linoleic (18:2) – 10.7-28.5%, stearic (18:0) – 4.3%-8.1, palmitoleic (16:1) – 2.6-6.5% and arachidonic (20:4) – 0.7 to 2.2%, respectively.

Similar fatty acid contents were identified by Milinsk *et al.* [2003] and Krawczyk *et al.* [2011] for chicken eggs; Cital *et al.* [2011] for quail egg; by Sinanoglou *et al.* [2011] for ostrich, turkey, quail, duck and goose; Chen *et al.* [2003] for Tsaiya duck and Mustonen *et al.* [2009] for pheasant eggs.

Table 1. The total lipid content of eggs of nine poultry species

Poultry	Lipid content (%)
Chicken	33.42
Goose	31.27
Duck	30.61
Turkey	32.76
Peacock	33.02
Guinea fowl	32.97
Pheasant	31.75
Quail	30.63
Partridge	33.22

Table 2. Fatty acid compositions of egg yolk from nine poultry species as percentage

Fatty acid (%)	Chicken	Goose	Duck	Turkey	Peacock	Guinea-fowl	Pheasant	Quail	Partridge
C 10:0	0.00±0.00	0.03±0.01	0.00±0.00	0.01±0.01	0.03±0.03	0.02±0.01	0.00±0.00	0.01±0.01	0.00±0.00
C 11:0	0.00±0.00	0.00±0.00	0.01±0.01	0.01±0.02	0.00±0.00	0.01±0.01	0.00±0.00	0.01±0.01	0.00±0.00
C 12:0	0.02±0.00	0.11±0.00	0.04±0.05	0.08±0.17	0.05±0.04	0.05±0.02	0.01±0.00	0.02±0.02	0.00±0.00
C 13:0	0.00±0.00	0.00±0.00	0.00±0.00	0.01±0.02	0.04±0.06	0.01±0.01	0.07±0.07	0.02±0.02	0.00±0.00
C 14:0	0.43±0.05	0.45±0.07	0.35±0.08	0.87±0.44	1.14±0.66	0.77±0.41	0.39±0.15	0.77±0.67	0.29±0.06
C 15:0	0.01±0.01	0.00±0.00	0.01±0.01	0.04±0.09	0.15±0.32	0.10±0.22	0.01±0.01	0.21±0.33	0.03±0.06
C 16:0	21.11±2.50	25.05±0.66	24.37±0.46	22.10±3.15	23.16±2.06	22.77±2.52	26.32±1.75	22.77±1.79	23.80±0.59
C 17:0	0.07±0.08	0.00±0.00	0.31±0.19	0.25±0.09	0.23±0.21	0.20±0.14	0.20±0.24	0.23±0.22	0.09±0.09
C 18:0	7.44±1.24	8.07±1.81	6.21±0.80	4.38±0.52	4.26±1.00	4.16±0.69	7.12±1.34	5.53±2.37	6.67±1.05
C 20:0	0.23±0.28	0.17±0.08	0.31±0.15	0.34±0.28	0.04±0.04	0.14±0.10	0.09±0.08	0.09±0.11	0.03±0.01
C 21:0	0.20±0.03	0.11±0.03	0.11±0.05	0.15±0.11	0.07±0.07	0.11±0.09	0.09±0.06	0.12±0.09	0.07±0.10
C 22:0	0.14±0.02	0.17±0.04	0.14±0.04	0.01±0.02	0.07±0.05	0.09±0.03	0.11±0.10	0.12±0.04	1.89±0.97
Σ SFA	29.66±3.26	34.17±1.80	31.85±0.35	28.26±3.57	29.24±2.56	28.44±2.61	34.43±1.67	29.90±3.54	32.89±1.28
C 14:1	0.09±0.07	0.09±0.02	0.08±0.06	0.33±0.30	0.29±0.25	0.16±0.11	0.04±0.03	0.18±0.10	0.10±0.10
C 16:1	5.02±0.78	4.60±0.19	3.95±0.55	6.54±2.82	6.44±3.36	6.45±1.79	3.37±0.74	4.65±2.53	2.62±0.19
C 18:1	33.91±1.78	47.19±1.54	48.30±5.15	40.41±5.07	44.10±4.05	40.30±7.56	43.25±2.37	39.91±3.16	38.82±1.00
C 20:1	0.03±0.07	0.04±0.01	0.06±0.14	0.22±0.14	0.39±0.23	0.05±0.07	0.05±0.03	0.25±0.17	0.96±0.86
C 22:1	0.01±0.02	0.07±0.02	0.10±0.03	0.00±0.00	0.01±0.01	0.01±0.02	0.45±0.49	0.03±0.07	0.00±0.00
Σ MUFA	39.07±1.40	52.01±1.53	52.49±5.64	47.50±7.81	51.22±6.10	46.98±9.25	47.15±2.78	45.02±5.16	42.50±1.26
C 18:2	28.45±3.67	10.71±1.41	12.46±5.08	21.51±11.28	16.82±7.68	21.98±10.59	15.15±3.75	22.17±6.43	22.42±0.94
C 18:3	0.95±0.96	0.16±0.03	0.50±0.30	0.31±0.09	0.34±0.31	0.71±0.31	0.48±0.22	0.44±0.34	0.59±0.27
C 20:4	1.30±0.10	1.79±0.23	1.43±0.34	1.87±0.41	2.17±0.67	1.55±0.51	1.65±0.26	1.93±0.35	0.68±0.40
C 20:5	0.09±0.07	0.01±0.00	0.20±0.21	0.00±0.00	0.01±0.01	0.04±0.03	0.20±0.24	0.08±0.08	0.15±0.06
C 22:2	0.00±0.00	0.00±0.00	0.08±0.10	0.01±0.02	0.00±0.00	0.00±0.00	0.02±0.03	0.00±0.00	0.02±0.05
C 22:3	0.03±0.06	0.00±0.00	0.68±0.14	0.00±0.00	0.02±0.01	0.04±0.05	0.04±0.08	0.07±0.13	0.17±0.09
C 22:4	0.06±0.06	0.29±0.18	0.15±0.15	0.10±0.22	0.03±0.07	0.03±0.03	0.17±0.22	0.01±0.02	0.02±0.05
C 22:5	0.10±0.22	0.29±0.08	0.06±0.03	0.25±0.07	0.02±0.01	0.11±0.10	0.32±0.18	0.16±0.23	0.33±0.19
C 22:6	0.31±0.28	0.58±0.12	0.12±0.12	0.19±0.08	0.14±0.18	0.13±0.13	0.40±0.28	0.22±0.20	0.22±0.22
Σ PUFA	31.28±3.83	13.84±1.74	15.66±5.57	24.25±11.24	19.55±7.81	24.59±11.65	18.42±4.15	25.09±6.58	24.61±0.76

In this study, the total amount of SFA was found lower than that of MUFA. The ratio of total SFAs ranged between 28.26 in turkeys to 34.43% in pheasants. Palmitic acid (16:0) was the main SFA as 21.11-26.32% and stearic acid (C18:0) was the following in 4.16 to 8.07%.

The MUFAs ranged from 39.1 in chickens to 52.5% in duck eggs. The highest level of oleic acid in duck egg (48.30%) elevated the MUFAs content as highest.

Total PUFA content was lowest (13.8) in goose and highest (31.3) in chicken eggs. Linoleic acid was identified as the major PUFA in the eggs of chicken (28.5).

The SFA/PUFA ratio ranged from 0.97 in chicken to 2.51 in goose. Dyerberg [1986] noted that an increase in the ratio of omega 6/omega 3 PUFA also increases the availability of omega 3 PUFAs, which are beneficial for human health. According

to Hidalgo *et al.* [2008], n-3/n-6 fatty acids ratio was 1.65 in organic, 1.56 in free range, 1.53 in barn and 1.33 in cage eggs, which means that the omega 6 rates were higher than omega 3 values which is similar to this study. High level of n-6 fatty acids lowered the n-3/n-6 ratio in yolk of cage eggs. This study revealed that all poultry eggs were rich in PUFA and possessed a high nutritional value for human organism due to its high n-6/n-3 ratios especially of peacock egg (50.6), quail egg (31.8), turkey egg (31.8) and chicken egg (23.6).

The total PUFA to MUFA ratios were lowest in goose (0.27) and highest in chicken (0.80). Total omega 3 was 0.53 in peacock and 1.55 in duck. Total omega 6 was 12.8 in goose and 29.8 in chicken. Total omega 6/3 ratios were found 9.5 in duck as lowest and 50.6 in peacock as highest. Total SFA to PUFA ratios were 0.97 in chicken and 2.51 in goose egg.

Variations in the fatty acid compositions might be related to the differences between species [Mustonen *et al.* 2009], different feeding habits [Krimpen *et al.* 2011] and level of dietary oils [Bean and Leeson 2003]. High levels of linoleic acid and arachidonic acid were reported by Krawczyk *et al.* 2011 and Cachaldora *et al.* 2008. In this study the birds were fed in village conditions mainly as free choice feed consumption; we assume that the differentiation appeared as species effect.

We must conclude that the lower the SFA to the PUFA ratio indicates the higher proportions of omega 6 FAs. So, the highest PUFA/MUFA ratio indicates the hen egg's higher beneficiary nutritional affect to human health. The poultry egg yolks assayed in this trial were found to contain a beneficial n-3/n-6 fatty acid ratio, contributing to cardiovascular risk reduction.

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