The relationship among age, yolk fatty acids content, and incubation results of broiler breeders

B. Yilmaz-Dikmen*[1] and U. Sahan†

*Department of Animal Husbandry and Health, Keles Vocational School, University of Uludag, 16740, Keles; and †Department of Animal Science, Faculty of Agriculture, University of Uludag, 16059, Gorukle, Bursa, Turkey

ABSTRACT This research was carried out to investigate the correlations among age, yolk fatty acids content, and incubation results of broiler breeders. Egg samples were obtained from Ross 308 broiler breeder parent stock at 28, 45, and 65 wk of age. A total of 1,800 eggs were used for incubation results of each age period. The mean values of hatchability of fertile eggs (H/F) were 94.04 ± 0.42, 91.36 ± 1.08, 85.97 ± 0.96%, values for hatchability of total eggs (H) were 92.00 ± 0.47, 83.61 ± 1.23, 62.78 ± 1.57%, and fertility ratios (F) were 97.83 ± 0.30, 91.50 ± 0.54, and 73.00 ± 1.55% at 28, 45, and 65 wk of age, respectively ($P < 0.01$). The mean values of early embryonic mortality and hatched chick weight were 2.73 ± 0.27, 4.01 ± 0.56, 8.93 ± 0.89% and 36.58 ± 0.51, 42.47 ± 0.48, 45.31 ± 0.96 g, at 28, 45, and 65 wk of age, respectively ($P < 0.01$). Myristic acid and linoleic acid contents of yolk significantly decreased with increasing age of broiler breeder ($P < 0.01$). The mean yolk myristic acid contents were 0.34 ± 0.02, 0.29 ± 0.06, and 0.24 ± 0.01 mg/g, and linoleic acid contents were 21.60 ± 1.26, 16.05 ± 3.04, and 13.87 ± 0.49 mg/g at 28, 45, and 65 wk of age, respectively ($P < 0.01$). Correlations between breeder age and myristic acid and linoleic acid (r = −0.317 and −0.435, respectively) were significant when data were pooled from 28 to 65 wk of age. Significant correlations between H/F and myristic acid and linoleic acid were determined. The correlation between F and linoleic acid (r = 0.364; $P < 0.05$) was found to be significant with the change of breeder age. There were negative correlations between late embryonic mortality and myristic acid (r = −0.432; $P < 0.05$), stearic acid (r = −0.437; $P < 0.05$), and linoleic acid (r = −0.469; $P < 0.5$) at 28 to 65 wk of age. The findings from this study will contribute to the hatcheries of the poultry sector and the new studies that are going to be carried out..

Key words: age, breeder, broiler, hatchability, yolk fatty acid

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INTRODUCTION

Lipids are the major nutritive components of the yolk, the oxidation of yolk-derived fatty acids provides the embryo with almost all of its energy needs, and the transport and transformation of yolk lipids represent the predominant metabolic features of the embryo. The chicken embryo derives more than 90% of its energy requirements from the oxidation of yolk fatty acids. All of the nutrients required for embryonic growth are prepackaged in the egg before laying (Romanoff, 1960; Speake et al., 1998).

Egg fatty acids content is affected by some factors such as age (Nielsen, 1998; Burnham et al., 2001), genetics (Horbanczuk et al., 1999), ration (Noble et al., 1990; Leskanich and Noble, 1997), and season (Pandey et al., 1989). The palmitic and stearic acid contents were greater in the yolks of eggs from hens at 51 and 64 wk than in eggs from hens at 36 wk (Latour et al., 1998). Nielsen (1998) found that myristic acid, palmitic acid, palmitoleic acid, stearic acid, and oleic acid contents of yolk decreased but linoleic acid content of yolk increased with increasing age of breeder.

Variations in the fatty acid content of the yolk could contribute to variation in hatchability and growth (Washburn, 1990). Menge et al. (1974) demonstrated that essential fatty acid depletion of dams resulted in reduction of the arachidonic and linoleic acid contents of their progeny, which hatched later and grew more slowly than progeny from hens not depleted.

Studies on meeting the energy intake of high-productivity animals with fats show that animal reproduction is affected by the fat used in the ration (Thatcher et al., 1994). Fatty acids have an important role in embryonic life and the subsequent periods. Embryo life and hatchability rate decreased with lack of essential fatty acids (Menge, 1968). Aydin (2000) stated that there was a

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[1]Corresponding author: bilgehan@uludag.edu.tr

relationship between embryonic life and saturated fatty acids. The lack of essential fatty acids in diets results in a decrease in egg weight and production of smaller eggs; in particular, lack of linoleic acid results in a change of the level of yolk fatty acids (Balnave, 1970).

There are many factors affecting incubation results of broiler breeders. There is limited research on the correlations between yolk fatty acids content and hatchability of broiler breeder eggs. This study was carried out to determine the variation in yolk fatty acids content dependent on the age of broiler breeders in one production period and to determine the level of correlations among yolk fatty acids content and age, egg yolk weight, incubation results, and hatched chick weight.

MATERIALS AND METHODS

Eggs were obtained from a same commercial Ross 308 broiler breeder parent stock at 28, 45, and 65 wk of age. The flock from which the eggs were obtained was reared and kept under standard management conditions during lay in a standard commercial broiler breeder house (Aviagen Inc., 2001). The layer diet (16.0% CP and 2,750 kcal of ME/kg) was fed between 22 and 65 wk of age. The diet was formulated to meet or exceed National Research Council (NRC, 1994) specifications. Water was provided ad libitum.

A total of 1,800 eggs was used for incubation results of each age period. Eggs were collected daily and stored at 16 to 18°C and 70 to 75% RH for 3 d at each age period. Eggs were selected between the weights of 51 to 56 g at 28 wk of age, 61 to 65 g at 45 wk of age, and 62 to 71 g at 65 wk of age. Each tray in the setter contained 150 eggs, and 12 trays were used for each age. Each tray was considered a replicate. Egg incubation conditions for each period were identical and were as adopted by normal commercial practice. Eggs were incubated in the same setter (Petersime, Zulte, Belgium) at 37.5°C and 55% RH for 18 d. The eggs were candled and eggs with viable embryos were transferred to a hatcher (Petersime) at 37.0°C and 60% RH. On d 22 of incubation hatched chicks were removed from the hatcher, counted, and weighed. At the transfer and end of the incubation period all unhatched eggs were opened and examined macroscopically for true fertility or early, middle, and late embryonic mortality. Hatchability was calculated for total eggs set (**H**) and for all fertile eggs set (**H/F**). Fertility (**F**) was calculated as the ratio of total eggs at set to fertile eggs.

Laboratory Analyses

For each age period, 1 egg was selected from each tray and used for yolk fatty analysis. A total of 36 eggs from 12 trays for each age period were used for yolk fatty content analysis (1 egg × 12 trays × 3 ages = 36 eggs).The initial individual egg weight was recorded. Egg yolks were separated from albumen and weighed. The yolk samples were kept frozen at −20°C until analysis. Approximately 50 mg of yolk sample was taken in 2 replicates. The fatty acid contents of yolk were determined at Tubitak-Butal Research Centre (Bursa, Turkey) by using the direct methylation method (Wang et al., 2000). Yolk fatty acids were transformed to form methyl esters that were determined quantitatively by gas chromatography with flame-ionization detection, using tricosanic acid methyl ester as external standard preparing.. Gas chromatography was carried out on a Shimadzu (model GC-FID 17A, Shimadzu Inc., Tokyo, Japan) capillary gas chromatograph equipped with a Supelco (model SP-2330, Supelco, Bellefonte, PA) column (30 m × 0.25 mm internal diameter). Conditions were as follows: injector: 240°C; detector: 250°C; oven: 60°C for 2 min increased to 145°C (4°C/min), increased to 225°C (4°C/min), and held for 15 min. The carrier gas was helium using a column flow rate of 1 mL/min. One microliter was injected automatically with a split of 1:10.

The fatty acid content of egg yolk was calculated as concentration (mg/g) = peak area of given fatty acid × concentration of external standard (mg/mL)/peak area of external standard/sample weight (g).

Statistical Analysis

The egg weight, yolk weight, yolk fatty acids content, H/F, H, F, embryonic mortality, and hatched chick weight data were analyzed as 1-way ANOVA using the GLM procedure of the Minitab software (Minitab, 1998). The analyses for percentage data of incubation results were conducted after arcsine transformation. Significant differences among treatment means were determined by Duncan's multiple range test. The correlations between yolk fatty acid contents and age, egg and yolk weights, H/F, H, F, embryonic mortality, and hatched chick weight were determined using Pearson correlation coefficients.

RESULTS AND DISCUSSION

Mean values of H/F, H, F, early, middle, late, and pip embryonic mortality, and hatched chick weight at 28, 45 and 65 wk of age are presented in Table 1. Mean values of H/F, H, and F were 94.04 ± 0.42, 91.36 ± 1.08, 85.97 ± 0.96% (H/F), 92.00 ± 0.47, 83.61 ± 1.23, 62.78 ± 1.57% (H), and 97.83 ± 0.30, 91.50 ± 0.54, 73.00 ± 1.55% (F) at 28, 45, and 65 wk of age, respectively ($P < 0.01$). Mean values of early embryonic mortality and hatched chick weight were 2.73 ± 0.27, 4.01 ± 0.56, and 8.93 ± 0.89% and 36.58 ± 0.51, 42.47 ± 0.48, and 45.31 ± 0.96 g at 28, 45, and 65 wk of age, respectively ($P < 0.01$). The values of H/F, H, and F decreased with increasing age ($P < 0.01$), but H/F decreased at 65 wk of age, which was similar for 28 and 45 wk of age. Early embryonic mortality and hatched chick weight increased with increasing age ($P < 0.01$). Middle embryonic, late embryonic, and pip embryonic mortality did not change by age ($P > 0.05$)..

Table 1. The mean values of incubation results at different broiler breeder ages (mean ± standard error of the mean)[1]

	Breeder age			
Item	28 wk	45 wk	65 wk	Significance
Hatchability of fertile eggs, %	94.04 ± 0.42[a]	91.36 ± 1.08[a]	85.97 ± 0.96[b]	**
Hatchability of total eggs, %	92.00 ± 0.47[a]	83.61 ± 1.23[b]	62.78 ± 1.57[c]	**
Fertility ratio, %	97.83 ± 0.30[a]	91.50 ± 0.54[b]	73.00 ± 1.55[c]	**
Early embryonic mortality (0–7 d), %	2.73 ± 0.27[c]	4.01 ± 0.56[b]	8.93 ± 0.89[a]	**
Middle embryonic mortality (8–18 d), %	1.16 ± 0.24	1.48 ± 0.32	1.65 ± 0.36	NS
Late embryonic mortality (19–21 d), %	2.06 ± 0.22	2.49 ± 0.30	3.27 ± 0.39	NS
Pip, %	1.36 ± 0.24	2.20 ± 0.93	1.14 ± 0.32	NS
Hatched chick weight, g	36.58 ± 0.51[c]	42.47 ± 0.48[b]	45.31 ± 0.96[a]	**

[a–c]Means in the same row with no common superscript are significantly different at $P < 0.01$.

[1]Each setter tray contained 150 eggs and 12 tray used for each age (total of 1,800 eggs).

$^{**}P < 0.01$.

Lipid metabolism in the broiler breeder is affected by age as well as the fat provided by the feed (Latour et al., 1998). Gardner (1997) reported that in broiler breeder flocks even 2 wk of age difference was an important factor affecting stearic acid content, which was greater in older breeder flocks than in younger ones. Mean values of egg yolk weight and yolk fatty acid contents at 28, 45, and 65 wk of age are presented in Table 2. There was an increase in egg weight and yolk weight continuously with increasing age ($P < 0.01$), which could explain the increase in chick weight with the age of broiler breeder ($P < 0.01$). The mean values of myristic acid and linoleic acid were 0.34 ± 0.02, 0.29 ± 0.06, and 0.24 ± 0.01 mg/g and 21.60 ± 1.26, 16.05 ± 3.04, and 13.87 ± 0.49 mg/g at 28, 45, and 65 wk of age, respectively ($P < 0.01$). The levels of myristic and linoleic acids decreased with increasing age of breeder ($P < 0.01$). In the present study, the concentrations of oleic and palmitic acids were found to be greater than the other fatty acids and did not change with age. The level of myristic acid was lower than that of the other fatty acids (Table 2). A similar result was found by Köksal (1994), who reported that the levels of oleic, palmitic, and linoleic acids (4.88, 3.32, and 1.58%, respectively) were greater than that of myristic acid.. Noble et al. (1990) found that the level of oleic acid was greater than other fatty acids in chicken eggs. In the study of Noble (2004), it was stated that the fatty acid contents of chicken eggs were 46.2% oleic acid, 24.5% palmitic acid, 14.7% linoleic acid, 6.6% palmitoleic acid, and 6.4% stearic acid. Differences in yolk fatty acid contents may also depend on the use of different units; Nielsen (1998) expressed fatty acid contents as a percentage of total yolk fatty acids, whereas Wang et al. (2000) expressed results in milligrams per gram.

The correlations between yolk fatty acid contents and breeder age, egg yolk weight, incubation results, and hatched chick weight are presented in Table 3. In the present study, the greatest levels of palmitic, palmitoleic, stearic, linoleic, and myristic acids were found at 28 wk of age, and the oleic acid level was greatest at 45 wk of age (Table 2). These results show that there was a negative correlation between breeder age and yolk fatty acid contents and a negative correlation as determined between breeder age and myristic acid (r = −0.317; $P < 0.05$) and linoleic acid (r = −0.435; $P < 0.01$) at 28 to 65 wk of age (Table 3). Among the investigated fatty acids, only myristic and linoleic acids were decreased with increasing age of breeder ($P < 0.01$). Levels of other fatty acids were numerically low at 65 wk of age compared with levels at 28 wk of age (Table 2; $P > 0.05$). This result is similar to the findings of Nielsen

Table 2. The mean values of egg weight, yolk weight, and yolk fatty acids content at different broiler breeder ages (mean ± standard error of the mean)[1]

	Breeder age			
Item	28 wk	45 wk	65 wk	Significance
Egg weight, g	55.40 ± 2.01[c]	65.00 ± 1.35[b]	68.92 ± 2.08[a]	**
Yolk weight, g	13.96 ± 0.40[c]	18.69 ± 0.44[b]	20.51 ± 0.55[a]	**
Yolk fatty acids, mg/g				
Myristic acid ($C_{14:0}$)	0.34 ± 0.02[a]	0.29 ± 0.06[b]	0.24 ± 0.01[b]	**
Palmitic acid ($C_{16:0}$)	30.60 ± 1.76	28.37 ± 5.38	27.29 ± 1.06	NS
Palmitoleic acid ($C_{16:1}$)	3.01 ± 0.26	2.44 ± 0.51	2.62 ± 0.22	NS
Stearic acid ($C_{18:0}$)	13.03 ± 0.78	12.39 ± 2.11	12.97 ± 0.47	NS
Oleic acid ($C_{18:n\text{-}1}$)	30.91 ± 1.84	37.26 ± 7.14	34.93 ± 1.33	NS
Linoleic acid ($C_{18:n\text{-}2}$)	21.60 ± 1.26[a]	16.05 ± 3.04[b]	13.87 ± 0.49[c]	**

[a–c]Means in the same row with no common superscript are significantly different at $P < 0.01$.

[1]n = 12 eggs.

$^{**}P < 0.01$.

(1998) who found that myristic, palmitic, palmitoleic, stearic, and linoleic acids contents of yolk fatty acids decreased with increasing age of layer hen. The levels of linoleic acid, palmitic acid, and stearic acid content in young broiler breeder eggs reported by Burnham et al. (2001) were greater than those in the current study. On the contrary, Pandey et al. (1989) found that palmitoleic and linoleic acid contents of eggs increased with increasing age of layer. Nielsen (1998) reported that oleic acid insignificantly increased with increasing age of hen. Latour et al. (1998) found that palmitic and stearic acids contents were high between 51 and 64 wk of broiler breeder age.

Noble et al. (1986) and Applegate and Lilburn (1996) found that eggs from older breeders contained a greater amount of yolk than the eggs of young; therefore, embryos in the eggs from older breeders had an advantage from having more lipid compared with the eggs of young breeders. But in the current study, significant correlations between egg weight and investigated yolk fatty acids were determined at 45 wk of age. There were positive correlations between yolk weight and palmitic acid (r = 0.588; $P < 0.05$), stearic acid (r = 0.629; $P < 0.05$), oleic acid (r = 0.579; $P < 0.05$), and linoleic acid (r = 0.570; $P < 0.05$) at 45 wk of age (Table 3).

In this study, there were positive correlations between myristic acid (r = 0.383 and r = 0.337; $P < 0.05$), linoleic acid (r = 0.380 and r = 0.395; $P < 0.05$) and H/F and H ($P < 0.05$), respectively, at 28 to 65 wk of age (Table 3). This finding is similar to those of Navarro et al. (2003) who stated that hatchability level was greater in eggs of the Lesser Rhea, which contain high levels of polyunsaturated fatty acids. Similarly, Noble et al. (1996) support this finding in ostrich eggs and Noble et al. (1993) in alligator eggs. The decrease in these fatty acids might be a result of age, which also affects metabolism. As long as these fatty acids affect the hatchability, addition of special types of fat to the feed might help to increase (Latour et al., 1998) these fatty acids.

In this study, there was a significant correlation between F and linoleic acid (r = 0.364; $P < 0.05$; Table 3): F increased with increased linoleic acid content of yolk. Menge et al. (1974) stated that a decrease in the essential fatty acid level of breeder rations caused a decrease in linoleic acid content, which resulted in a decrease in hatchability and chick development performance.

In this study, there were negative correlations between late embryonic mortality and investigated yolk fatty acids except for palmitoleic acid at 28 wk of age. Significant correlations were found between late embryonic mortality and myristic acid (r = −0.432; $P < 0.05$), stearic acid (r = −0.437; $P < 0.05$), and linoleic acid (r = −0.469; $P < 0.05$) at 28 to 65 wk of age (Table 3). There was a continuous decrease of myristic and linoleic acid content ($P < 0.01$) with the change in age, which were also moderately correlated ($P < 0.05$) with H/F and H, but linoleic acid content was also correlated with F ($P < 0.05$). Both of these fatty acids were negatively correlated with late embryonic mortality ($P < 0.05$). This significant correlation of myristic and linoleic acids show that the lack of these fatty acids was closely related to hatchability results and late embryonic mortality. The reason for this correlation might be a result of the necessity of fatty acids in embryonic development (Noble and Cocchi, 1990) and age of breeders (Latour et al., 1998). Because all broiler breeders were fed with the same feed during the experiment, the decrease of these fatty acids might be a result of metabolic changes in breeders, and this change might result in a lack of providing these fatty acids for the egg. With the increasing age of broiler breeders the levels of these fatty acids were decreased, and a possible solution to this problem might be providing additional special types of fat to the feed (Latour et al., 1998), which could help to increase the levels of these fatty acids. Linoleic acid deficiency resulted in high mortality. Lipid transfer from yolk to embryo was reduced in the first few eggs produced by young pullets; this appears to the reason for increased embryonic mortality (Wilson, 2004). Because yolk fat has a crucial role in avian embryo development, provides essential nutrients, and is important as an energy source, significant alterations in the fatty acid composition of egg yolk can have adverse effects on embryo survival (Donaldson and Fites, 1990). Marginal nutrient deficiencies may affect the embryos of only the most susceptible hens and also result in predominantly late incubation death or other late-occurring effects (Wilson, 1997). Leeson et al. (1979) have suggested that mortality from 8 to 14 d of incubation was a sensitive indicator of layer breeder diet deficiencies because mortality is normally very low during this period. In this study, significant correlations between early embryonic mortality and investigated fatty acids ($P < 0.05$) except for myristic acid and palmitoleic acid at 28 wk of age were determined. There was a significant correlation between chick weight and investigated fatty acids at 45 wk of age ($P < 0.01$; Table 3). Latour et al. (1998) found that chick hatching weight was greater for 51-wk-old broiler breeders than for 36- or 64-wk-old breeders.

In conclusion, competition in the poultry sector results in the need for new information to achieve the maximum level of productivity. Egg yolk is a complex source of nutrients that contains all of the fat-soluble nutrients in the egg and is the main nutrient source for the developing embryo. Normal embryonic growth and development depends on a complete supply of all required nutrients within the egg (Wilson, 1997). There are many factors related to hatchability of broiler breeder eggs. One of these factors might be yolk fatty acid content of the egg (Peebles et al., 1999). The significant negative correlations between myristic acid ($P < 0.05$) and linoleic acid ($P < 0.01$) contents of egg yolk and age of broiler breeders indicated that there was a decrease of these fatty acids with increasing age. The changes in these fatty acids were correlated to late embryonic mortality, H/F, and H of broiler breeders (P

Table 3. The correlations between yolk fatty acid contents and breeder age, egg yolk weight, incubation results,[1] and hatched chick weight in different age periods, n = 12

Yolk fatty acids	Age	Egg weight	Yolk weight	H/F	H	F	Embryonic mortality			Pip	Hatched chick weight
							Early	Middle	Late		
28 wk of age											
Myristic acid	—	−0.354^{NS}	−0.093^{NS}	0.097^{NS}	−0.076^{NS}	−0.267^{NS}	0.509^{NS}	0.272^{NS}	−0.855*	−0.341^{NS}	−0.365^{NS}
Palmitic acid	—	−0.372^{NS}	−0.076^{NS}	0.029^{NS}	−0.170^{NS}	−0.323^{NS}	0.565*	0.276^{NS}	−0.785*	−0.241^{NS}	−0.387^{NS}
Palmitoleic acid	—	−0.502^{NS}	−0.151^{NS}	0.091^{NS}	0.014^{NS}	−0.110^{NS}	0.446^{NS}	0.428^{NS}	−0.544^{NS}	−0.340^{NS}	−0.314^{NS}
Stearic acid	—	−0.113^{NS}	0.068^{NS}	0.096^{NS}	−0.092^{NS}	−0.292^{NS}	0.607*	0.191^{NS}	−0.925**	−0.232^{NS}	−0.266^{NS}
Oleic acid	—	−0.248^{NS}	0.027^{NS}	0.089^{NS}	−0.082^{NS}	−0.265^{NS}	0.573*	0.291^{NS}	−0.830*	−0.284^{NS}	−0.271^{NS}
Linoleic acid	—	−0.453^{NS}	−0.317^{NS}	0.000^{NS}	−0.324^{NS}	−0.535^{NS}	0.649*	0.249^{NS}	−0.793*	−0.206^{NS}	−0.544^{NS}
45 wk of age											
Myristic acid	—	0.745*	0.525^{NS}	0.411^{NS}	0.330^{NS}	0.009^{NS}	−0.218^{NS}	−0.347^{NS}	−0.441^{NS}	−0.263^{NS}	0.843**
Palmitic acid	—	0.760**	0.588*	0.336^{NS}	0.277^{NS}	0.026^{NS}	−0.160^{NS}	−0.302^{NS}	−0.547^{NS}	−0.196^{NS}	0.817**
Palmitoleic acid	—	0.754*	0.503^{NS}	0.414^{NS}	0.327^{NS}	−0.004^{NS}	−0.262^{NS}	−0.326^{NS}	−0.483^{NS}	−0.258^{NS}	0.812**
Stearic acid	—	0.732*	0.629*	0.337^{NS}	0.288^{NS}	0.049^{NS}	−0.111^{NS}	−0.328^{NS}	−0.583^{NS}	−0.193^{NS}	0.800**
Oleic acid	—	0.724*	0.579*	0.349^{NS}	0.300^{NS}	0.058^{NS}	−0.148^{NS}	−0.329^{NS}	−0.495^{NS}	−0.211^{NS}	0.814**
Linoleic acid	—	0.809**	0.570*	0.249^{NS}	0.204^{NS}	0.018^{NS}	−0.085^{NS}	−0.217^{NS}	−0.587^{NS}	−0.154^{NS}	0.809**
65 wk of age											
Myristic acid	—	−0.107^{NS}	0.085^{NS}	−0.254^{NS}	−0.080^{NS}	0.044^{NS}	0.035^{NS}	0.486^{NS}	−0.242^{NS}	0.134^{NS}	−0.118^{NS}
Palmitic acid	—	0.099^{NS}	0.168^{NS}	−0.239^{NS}	−0.257^{NS}	−0.181^{NS}	0.002^{NS}	0.521^{NS}	−0.165^{NS}	0.110^{NS}	0.074^{NS}
Palmitoleic acid	—	−0.060^{NS}	0.006^{NS}	−0.179^{NS}	−0.260^{NS}	−0.207^{NS}	0.007^{NS}	0.380^{NS}	0.057^{NS}	−0.006^{NS}	−0.044^{NS}
Stearic acid	—	0.201^{NS}	0.091^{NS}	−0.571^{NS}	−0.442^{NS}	−0.229^{NS}	0.209^{NS}	0.604^{NS}	−0.436^{NS}	0.490^{NS}	0.184^{NS}
Oleic acid	—	−0.284^{NS}	−0.147^{NS}	−0.354^{NS}	0.042^{NS}	0.233^{NS}	0.030^{NS}	0.766^{NS}	−0.471^{NS}	0.155^{NS}	−0.272^{NS}
Linoleic acid	—	0.239^{NS}	0.147^{NS}	−0.493^{NS}	−0.312^{NS}	−0.121^{NS}	0.343^{NS}	0.467^{NS}	−0.306^{NS}	0.142^{NS}	0.046^{NS}
28 to 65 wk of age											
Myristic acid	−0.317*	−0.086^{NS}	−0.155^{NS}	0.383*	0.337*	0.288^{NS}	−0.222^{NS}	−0.267^{NS}	−0.432*	−0.304^{NS}	−0.152^{NS}
Palmitic acid	−0.120^{NS}	0.091^{NS}	0.041^{NS}	0.217^{NS}	0.139^{NS}	0.094^{NS}	−0.077^{NS}	−0.192^{NS}	−0.374^{NS}	−0.204^{NS}	0.038^{NS}
Palmitoleic acid	−0.125^{NS}	−0.027^{NS}	−0.049^{NS}	0.217^{NS}	0.117^{NS}	0.061^{NS}	−0.049^{NS}	−0.167^{NS}	−0.294^{NS}	−0.279^{NS}	−0.027^{NS}
Stearic acid	−0.03^{NS}	0.196^{NS}	0.146^{NS}	0.098^{NS}	0.016^{NS}	−0.025^{NS}	0.056^{NS}	−0.165^{NS}	−0.437*	−0.148^{NS}	0.139^{NS}
Oleic acid	0.106^{NS}	0.256^{NS}	0.292^{NS}	0.069^{NS}	−0.020^{NS}	−0.054^{NS}	0.033^{NS}	−0.081^{NS}	−0.289^{NS}	−0.127^{NS}	0.247^{NS}
Linoleic acid	−0.435**	−0.160^{NS}	−0.293^{NS}	0.380*	0.395*	0.364*	−0.230^{NS}	−0.262^{NS}	−0.469*	−0.256^{NS}	−0.281^{NS}

[1]H/F = hatchability of fertile eggs; H = hatchability of total eggs; F = fertility ratio.

*$P < 0.05$; **$P < 0.01$.

< 0.05). The only way to increase these fatty acids in older broiler breeders might be to provide additional special types of fats by feed (Latour et al., 1998). The findings from this study will contribute to the hatcheries of the poultry sector and the new studies that are going to be carried out.

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