

Poultry Fat and Corn Oil May Be Used to Adjust Energy in the Diets of Young Breeder Hens Without Affecting Embryogenesis and Subsequent Broiler Growout Performance¹

E. D. Peebles,*² C. D. Zumwalt,* T. W. Smith,* P. D. Gerard,†
and M. A. Latour‡

**Poultry Science Department, Mississippi State University,
Box 9665, Mississippi State, MS 39762;*

†*Experimental Statistics Unit, Mississippi State University,
Mississippi State, MS 39762; and*

‡*Department of Animal Sciences, Purdue University,
West Lafayette, IN 47907-1151*

Primary Audience: Nutritionists, Broiler Breeder Managers, Hatchery Personnel

SUMMARY

Beginning at 22 wk of age, broiler breeder hens were fed one of six experimental diets. Diets 1 and 2 were fed to provide each bird an ME intake of 467 kcal/day (high) at peak production [467 peak Calories/day (PCD)], whereas Diets 3 and 4 contained low ME levels (430 PCD), and Diets 5 and 6 contained moderate ME levels (449 PCD). Diets 1 and 3 contained 3.0% added poultry fat, Diets 2 and 4 contained no added fat, Diet 5 contained 1.5% added poultry fat, and Diet 6 contained 3.0% added corn oil. Eggs were collected when hens were 29 wk of age. Embryonic mortality, hatchability, and subsequent growout performance were assessed through 42 d of broiler age. Added fat type (poultry fat or corn oil), poultry fat level (1.5 or 3.0%), or ME level from low (430 PCD) to high (467 PCD) in the diets of young (29-wk-old) breeder hens had no effects on subsequent embryogenesis, hatchability, or posthatch growout performance of broiler offspring. It was concluded that 1.5 and 3.0% added poultry fat or 3.0% added corn oil may be effectively used to adjust ME between low and high levels in the diets of young breeder hens without subsequent effects on broiler embryogenesis and growout performance.

Key words: broiler breeder, broiler chick, dietary fat, feed conversion, growth

2002 J. Appl. Poult. Res. 11:146–154

¹ Journal Article Number J-9900 from the Mississippi Agricultural and Forestry Experiment Station. Use of trade names in this publication does not imply endorsement by Mississippi Agricultural and Forestry Experiment Station of these products or criticism of similar ones not mentioned.

² To whom correspondence should be addressed: dpeebles@poultry.msstate.edu.

DESCRIPTION OF PROBLEM

Selection for optimal performance in broilers has led to metabolic and reproductive pressures in broiler breeder hens [1]. To meet these demands, breeder nutrition programs are continuously being modified. Dietary energy appears to be the first limiting nutrient [2, 3, 4] and is critical for proper body maintenance, growth, and production [5] in broiler breeder hens. Dietary ME intake has been shown to affect egg production and egg weight in broiler breeders [3, 6].

The most practical method for increasing the ME density in broiler breeder diets has been by the addition of fats [7]. Research has been conducted concerning the influences of different fats in breeder diets on various parameters in broiler offspring [8, 9, 10, 11, 12, 13, 14, 15]. Some of these influences have been associated with changes in egg and eggshell quality characteristics [9, 16]. Addition of 4 to 6% poultry fat (PF) to broiler breeder diets during lay has been reported to increase egg production, either have no effect on or decrease hatchability, and decrease egg specific gravity and shell percentage [7, 16]. Fats added to hen diets may alter yolk fatty acid composition [17], which can subsequently influence embryogenesis [15]. Cruickshank [18] has noted that ingestion of unsaturated fatty acids by hens considerably modified the degree of saturation and the proportion of the component fatty acids in yolk. Saturated dietary fatty acids had little effect on the proportion of mixed fatty acids in yolk [18].

Changes in the types and levels of various fats added to the diets of 35-, 51-, and 63-wk-old breeder hens have been found to impact posthatch broiler performance and slaughter yield [11, 12] without having any noticeable effects on embryonic growth [13]. The independent influences of altered dietary ME and added fat levels and added fat type in breeder diets on subsequent broiler growout performance through 42 d of age have not been previously examined in breeder hens of any age. Mortality has been reported to be higher in chicks from 29-wk-old breeders in comparison to those from 58-wk-old hens [19]. Therefore, these effects may be particularly important in the chicks from these young birds. This study was conducted to

determine the independent effects of ME, fat source, and fat level in the diets of young, 29-wk-old breeders on embryogenesis, hatchability, and subsequent broiler performance through 42 d.

MATERIALS AND METHODS

General

Male and female Arbor Acres [20] broiler breeder chicks were obtained. Housing and management of birds during the prebreeder and breeder periods were as described by Latour et al. [8]. Twenty hens and four males, at 18 wk of age, were assigned to each of 24 breeder pens (six treatments with four replicates per treatment) in a curtain-sided breeder house. Males were housed 2 d before females to allow males more time to adjust to their feeders. Males were fed a common corn-soybean meal basal diet. Each treatment group of hens was limit-fed one of six different corn-soybean meal basal diets. Dietary treatments began at Week 22 and were accompanied by a photoperiod change from a 10L:14D cycle to a 15.5L:8.5D cycle to initiate lay.

The amount of feed provided daily was adjusted each week to maintain recommended BW gains. Increases in feed, which were made every 5 d, began before lay so that daily feed intake was adjusted from 11.23 kg/100 birds per day at housing on Week 18 to 14.06 kg/100 birds per day at initiation of lay on Week 22. After lay was initiated, daily feed intake was adjusted according to hen-day egg production. These increases were predetermined so that the maximum daily allowance was achieved by 50% hen-day egg production. This increase was accomplished by issuing the remaining allotment of feed in equal increments at each 10% production interval to reach a maximum of 15.88 kg/100 birds per day [21].

Experimental Diets

Six diets were formulated to meet or exceed National Research Council [22] specifications. Determined analyses of the CP, crude fat, ash, and moisture contents (Table 1), and the fatty acid compositions (Table 2), of Diets 1 through 6 were also performed. The experimental diets contained two types and levels of added fat. The

TABLE 1. Ingredient percentages and calculated and determined analyses of breeder diets

Ingredient	Diet ^A					
	1	2	3	4	5	6
	(%)					
Yellow corn	60.81	63.06	45.95	58.28	59.53	52.53
Soybean meal (48% CP)	14.65	15.55	12.65	13.55	14.10	13.55
Wheat middlings	10.45	10.25	27.40	17.15	13.80	19.90
Limestone	6.59	6.62	6.69	6.65	6.66	6.67
Menhaden fishmeal	2.50	2.50	2.50	2.50	2.50	2.50
Defluorinated phosphate	1.45	1.46	1.27	1.33	1.36	1.32
Micronutrient premix ^B	0.25	0.25	0.25	0.25	0.25	0.25
Sodium chloride	0.25	0.29	0.20	0.23	0.24	0.22
DL-Methionine ^C	0.02	0.00	0.03	0.03	0.03	0.03
Lysine HCl, ^D 78%	0.03	0.02	0.06	0.03	0.03	0.03
Poultry fat	3.00	0.00	3.00	0.00	1.50	0.00
Corn oil	0.00	0.00	0.00	0.00	0.00	3.00
Dietary analysis						
CP, calculated	15.56	15.26	16.27	15.96	15.76	15.96
CP, determined	14.50	13.60	14.51	14.43	15.66	14.40
ME, calculated kcal/kg	2,940	2,940	2,709	2,709	2,826	2,826
Lysine, calculated	0.81	0.81	0.81	0.81	0.81	0.81
TSAA, calculated	0.54	0.54	0.55	0.54	0.54	0.55
Tryptophan, calculated	0.18	0.18	0.19	0.19	0.18	0.19
Calcium, calculated	3.19	3.20	3.19	3.19	3.20	3.19
Available phosphorus, calculated	0.44	0.43	0.43	0.43	0.43	0.43
Sodium, calculated	0.25	0.21	0.32	0.28	0.27	0.29
Ash, determined	10.82	11.73	11.90	11.22	10.61	9.87
Moisure, determined	11.48	12.04	10.94	11.76	11.67	11.36
Crude fat, calculated	6.07	3.24	6.08	3.26	4.66	6.12
Crude fat, determined	5.06	2.26	5.28	2.37	3.79	4.87
Linoleic acid, calculated	1.54	1.64	1.48	1.58	1.56	3.07

^ASee Table 3.

^BSupplied the following per kilogram of finished feed: vitamin A acetate, 11,000 IU; cholecalciferol, 2,750 IU; α -tocopherol acetate, 22 IU; riboflavin, 7.7 mg; niacin, 38.64 mg; d-pantothenic acid, 13.2 mg; folic acid, 1.1 mg; vitamin B₁₂, 13 μ g; biotin, 110 μ g; choline chloride, 441 mg; thiamine, 1.8 mg; pyridoxine, 4.7 mg; menadione sodium bisulfite, 4.96 mg; ethoxyquin, 55 mg; manganese, 55 mg; zinc, 50 mg; iron, 30 mg; copper, 5 mg; iodine, 0.50 mg; and selenium, 0.1 mg.

^CManufactured by Hoffman-LaRoche, Inc., Nutley, NJ.

^DManufactured by Degussa Corp., Ridgeland, Park, NJ.

^EManufactured by Heartland Lysine, Inc., Chicago, IL.

two different fat sources varied in fatty acid profile. Linoleic acid content in corn oil (CO) is 33.7% higher than that in PF, whereas the levels of stearic, palmitic, and oleic acids are 1.7, 5.3, and 17.6%, respectively, higher in PF than CO. At the expense of saturated fatty acids, there is approximately a 15% higher level of unsaturated fatty acids in CO as compared to PF. Also, there is approximately 750 kcal more ME per kilogram in CO than in PF [22]. Analyses of the fatty acid compositions of Diets 1 through 6 show that relative proportions of saturated and unsaturated fatty acids reflect the source of dietary fat added (Table 2). Deter-

mined analyses of diets were performed according to the methods of the Association of Official Analytical Chemists [23]. The level of ethoxyquin added to the diets was 150 ppm and conformed to the current level as mandated by the US Food and Drug Administration and as recommended by manufacturers of the fats used.

Diets 1 and 2 were fed to provide each bird an ME intake of 467 kcal/day (high) at peak production [467 peak Calories/day (PCD)], whereas Diets 3 and 4 contained low ME levels (430 PCD), and Diets 5 and 6 contained moderate ME levels (449 PCD). Diets 1 and 3 contained 3.0% added PF, Diets 2 and 4 contained

TABLE 2. Determined fatty acid compositions of broiler breeder diets

Fatty acid type	Diet ^A					
	1	2	3	4	5	6
	(% of total fatty acids)					
Myristic	1.2	0.8	0.7	1.1	0.9	0.4
Palmitic	23.6	17.9	20.7	16.9	18.4	14.0
Palmitoleic	4.7	2.4	4.2	1.9	3.2	0.8
Stearic	7.3	4.6	4.8	3.5	4.1	2.7
Oleic	35.4	35.0	34.1	30.0	33.0	28.2
Linoleic	26.1	36.7	33.4	43.4	37.6	51.8
Linolenic	1.7	2.6	2.1	3.2	2.8	2.1
Saturated fatty acids	32.1	23.3	26.2	21.5	23.4	17.1
Unsaturated fatty acids	67.9	76.7	73.8	78.5	76.6	82.9

^ASee Table 3.

no added fat (NAF), Diet 5 contained 1.5% added PF, and Diet 6 contained 3.0% added CO (Table 3). Diets 5 and 6 were included so as to allow for the evaluation of a different fat type (CO), a moderate ME level (449 PCD), and a 1.5% level of added fat.

Embryonic Mortality and Hatchability

At 29 wk of age, eggs were collected daily over a 7-d period, stored at 15 C, and randomized within each replicate by day of collection. Eggs were randomly distributed within individual replicate groups in a Petersime Model 5 incubator [24]. Eggs were incubated at 37.5°C dry bulb and 28.3°C wet bulb temperatures. For hatchability and embryonic mortality determinations, eggs were candled on Day 12 of incubation to identify infertile eggs or early dead embryos. Eggs in either class that exhibited visual bacterial contamination were also identified and discarded. On Day 19, eggs were transferred to Jamesway Model 252 A incubators [25] for hatching. Hatching incubators were set at 37.5°C

dry bulb and 28.9°C wet bulb temperatures. Eggs were compartmentalized within hatching trays so that exact numbers of embryonic deaths and hatched chicks could be identified for each dietary treatment replication. Infertile eggs and early, late, and pipped embryonic mortalities were recorded as part of a hatchery residue analysis at 21.5 d of incubation. These data were used to evaluate treatment differences in 21.5-d percentage hatchability and percentage embryo mortality at various periods in incubation. All hatchability and mortality data were expressed as percentages of fertile eggs set.

Chick Growout

At hatch, chicks within the four replicates from the same treatment group were re-randomized into three replicates for placement into floor pens. Floor pens contained fresh pine shavings. Replicate groups were randomly assigned to 1 of 18 pens. Each pen in a curtain-sided growout house measured 1.5 × 2.9 m (4.38 m²) and housed 50 unsexed chicks. Pens were supplied

TABLE 3. Dietary treatments for broiler breeder hens

Diet	Added fat type	Added fat (%)	ME at peak production (kcal/hen/day)
1	Poultry	3.0	467
2	None	0.0	467
3	Poultry	3.0	430
4	None	0.0	430
5	Poultry	1.5	449
6	Corn oil	3.0	449

TABLE 4. Ingredient percentages and calculated analysis of broiler starter, grower, and finisher diets

Ingredient	Starter	Grower	Finisher
	1–3 wk	4–5 wk	6 wk
	(%)		
Corn	49.36	59.79	62.30
Soybean meal (48% CP)	38.57	30.72	30.72
Dicalcium phosphate	1.79	1.66	1.66
Limestone	1.30	1.16	1.16
Poultry fat	7.28	5.10	3.47
DL-Methionine	0.18	0.05	0.00
Micronutrient premix ^A	0.25	0.25	0.25
NaCl	0.44	0.44	0.44
Coban	0.83	0.83	0.00
Calculated analysis			
Crude protein	23.00	20.00	18.00
ME, kcal/kg	3,194	3,194	3,194
Total fat	9.46	7.65	6.28
Calcium	1.00	0.90	0.80
Available phosphorus	0.45	0.42	0.35
TSAA	0.93	0.72	0.61
Lysine	1.35	1.13	0.97

^ASupplied the following to each kilogram of finished feed: vitamin A, 12,300 IU; cholecalciferol, 2,750 IU; vitamin E, 33 IU; riboflavin, 9.2 mg; niacin, 57.9 mg; d-pantothenic acid, 20.70 mg; folic acid, 442 mg; vitamin B₁₂, 13.2 µg; biotin, 146 µg; choline chloride, 1,552 mg; thiamine, 4.5 mg; pyridoxine, 4.7 mg; menadione sodium bisulfite, 0.72 mg; manganese, 1.62 mg; zinc, 183 mg; iron, 574 mg; copper, 45 mg; and selenium, 0.5 mg. Supplied by Hoffman-LaRoche, Inc., Nutley, NJ.

with hanging bell waterers and tube feeders to provide access to water and feed ad libitum. Water founts and feeder pans were provided for the first week of the growout. Birds were provided with continuous light. Pen temperatures were 32°C on Day 1 and then gradually lowered approximately 3°C every 4 d through Day 12. Thereafter, a minimum temperature of 24°C was maintained.

Birds were provided standard broiler starter, grower, and finisher diets (Table 4). Mortalities were recorded daily. Total bird numbers, BW, and feed consumption per pen were recorded on 0, 21, and 42 d of the growout period. Mean chick BW was determined for each pen. Percentage mortality, mean BW gain, and feed conversion (kg of feed intake/kg of BW gain) of broilers between 0 and 21, 22 and 42, and 0 and 42 d of growout were also calculated for each pen. The effects of breeder diet were evaluated for all parameters ([26]; Table 5).

RESULTS AND DISCUSSION

The breeder flock and diets used in this study were the same as those used for Trial 1 in Peebles et al. [21]. Age-related performance parameters

of the flock have been described in that article. Briefly, birds grew normally between 22 and 29 wk of age. Body weight was approximately 2.30 kg across all diets at 22 wk and increased to approximately 3.17 kg at 29 wk. Weekly mortality was highest (1.1%) at Week 28, whereas egg weight increased between all age periods and peaked at 67.3 g on Week 47. Peak egg production (78.4%) was reached on Week 32. Hatchability, mortality, egg weight, and egg production were not affected by dietary treatment.

Peebles et al. [21] found that CO and PF added at the 1.5% and 3.0% levels, lard added at the 3.0% level, and changes in dietary ME between 430 and 467 PCD had no influence on hatchability in breeder hens at various periods between 27 and 63 wk of age. Furthermore, by using the same diets as in this study, Peebles et al. [13] showed that 1.5 and 3.0% added PF, 3.0% added CO, and changes in dietary ME between 430 and 467 PCD did not influence the body, yolk sac, or liver weights of broiler embryos from 27- and 36-wk-old breeder hens. Similarly, in the present experiment, there were no differences among treatments for hatchability or for early, late, or pipped embryonic mortalit-

TABLE 5. Type of effect tested and dietary treatment combination means compared for each contrast

Contrast type ^A	Treatment ^B means compared
High (467 PCD) vs. low (430 PCD) ME	1 and 2 vs. 3 and 4
High (467 PCD) vs. moderate (449 PCD) ME	1 and 2 vs. 5 and 6
Low (430 PCD) vs. moderate (449 PCD) ME	3 and 4 vs. 5 and 6
PF vs. CO across level	1, 3, and 5 vs. 6
PF vs. CO at the 3.0% level	1 and 3 vs. 6
1.5 vs. 3.0% level of PF	5 vs. 1 and 3

^APCD = peak Calories per day; PF = poultry fat; CO = corn oil.

^BSee Table 3.

ies. Across treatments, mean percentage early dead, late dead, and pipped mortalities were $13.2\% \pm 1.78$, $2.40\% \pm 0.831$, and $0.81\% \pm 0.494$, respectively, and percentage hatchability was $83.6\% \pm 2.02$. Also, using the same diets as in this investigation, Latour et al. [8] demonstrated in Experiment 1 of their study that the diets had no subsequent effects on serum cholesterol, high density lipoprotein cholesterol, low density lipoprotein cholesterol, triglycerides, glucose, or relative yolk sac weight of 18-d embryos or chicks at hatch from 26-wk-old breeder hens. Clearly, the changes in dietary ME and types and levels of added dietary fat described in the current study have no immediate effects on breeder performance or on subsequent embryogenesis.

Breeder age has been shown to affect hen performance [21], embryo development [13], broiler growth [11], and carcass yield [12]. Breeder age becomes of particular importance when viewing the effects of added fat in breeder diets on broiler growout and market age carcass parameters. In relation to PF, CO added to the diets of breeders aged 35, 51, and 63 wk has previously been shown to increase 0- to 21-d BW gain and feed conversion between 22 and 42 d in their broiler offspring [11]. In other related work [12], subsequent slaughter analysis showed that added CO in the diets of those same hens (35, 51, and 63 wk of age) increased subsequent 43-d live broiler BW and chilled carcass yields when compared to lard. Added CO increased relative front-half yields when compared to PF, and a 3.0% level of added fat, in relation to a 1.5% level, regardless of type, also increased 43-d live BW [12]. Additionally, in a more recent study, in which the same diets as in this study were used, contrast analysis indicated that 41-d live BW was higher in broilers from 29-

and 36-wk-old hens fed 430 compared with 449 PCD ME levels and 3.0% compared to 1.5% added PF diets [14]. However, the effects observed on 43-d live BW and on various liver parameters in that study were across both breeder ages examined (29 and 36 wk). There were no reported effects due to diet at Week 29 alone.

In the current study, in which the offspring of only 29-wk-old hens were examined, percentage broiler mortality between Days 0 and 21, 22 and 42, and 0 and 42 and mean broiler BW on Days 0 (hatch), 21, and 42 were not affected by hen dietary treatment. Mean percentages of broiler mortality across treatment between Days 0 and 21, 22 and 42, and 0 and 42 were $3.00\% \pm 0.67$, $1.04\% \pm 0.35$, and $4.00\% \pm 0.84$, respectively. Mean broiler BW across treatments at Days 0, 21, and 42 of growout were $0.04 \text{ kg} \pm 0.0002$, $0.56 \text{ kg} \pm 0.007$, and $1.85 \text{ kg} \pm 0.017$, respectively. Furthermore, mean BW gain (Table 6) and feed conversion (Table 7) between Days 0 and 21, 22 and 42, and 0 and 42 were not influenced by dietary treatment of hen. Comparison of contrast means for ME level, added fat type across levels, added fat type at the 3.0% level, and level of PF also revealed no significant differences for BW gain or feed conversion of progeny within the three age intervals (Table 8). These data suggest that changes in breeder dietary ME and type and level of fat, as formulated in this study, have no effects on broiler growth and carcass quality or on embryogenesis and hen performance in young breeders (29 wk of age). These diets appeared to begin to exert effects on broiler performance as the hens aged, and as has been noted earlier, may exhibit effects by the time hens are 35 wk of age.

Taken together, the current and previous results indicate that 1.5 and 3.0% added levels of

TABLE 6. Mean BW gain (kg) between 0 and 21 d, 22 and 42 d, and 0 and 42 d of broilers from hens 29 wk of age that were fed Diet 1, 2, 3, 4, 5, or 6^A

Diet ^B	0–21 d	22–42 d	0–42 d
1	0.53 ± 0.012	1.23 ± 0.046	1.77 ± 0.054
2	0.50 ± 0.026	1.28 ± 0.030	1.78 ± 0.034
3	0.52 ± 0.012	1.35 ± 0.043	1.87 ± 0.055
4	0.54 ± 0.016	1.29 ± 0.020	1.83 ± 0.034
5	0.49 ± 0.015	1.27 ± 0.016	1.76 ± 0.023
6	0.55 ± 0.013	1.29 ± 0.030	1.83 ± 0.042

^ANo significant ($P > 0.05$) differences between hen dietary treatments were noted within each designated interval of days.

^BSee Table 3.

TABLE 7. Feed conversion (kg feed intake/kg BW gain) between 0 and 21 d, 22 and 42 d, and 0 and 42 d of broilers from hens 29 wk of age that were fed Diet 1, 2, 3, 4, 5, or 6^A

Diet ^B	0–21 d	22–42 d	0–42 d
1	1.59 ± 0.047	2.10 ± 0.089	1.94 ± 0.049
2	1.66 ± 0.058	2.11 ± 0.024	1.98 ± 0.010
3	1.66 ± 0.023	2.07 ± 0.011	1.95 ± 0.014
4	1.63 ± 0.044	2.16 ± 0.019	2.00 ± 0.030
5	1.68 ± 0.011	2.06 ± 0.044	1.95 ± 0.028
6	1.60 ± 0.028	2.16 ± 0.018	1.99 ± 0.007

^ANo significant ($P > 0.05$) differences between hen dietary treatments were noted within each designated interval of days.

^BSee Table 3.

PF and CO in the diets of more mature breeders (≥ 35 wk of age) can alter posthatch broiler performance without impacting embryonic growth. However, an absence of effects during embryogenesis due to these types and levels of

added fat in the diets of young breeder hens (29 wk of age) may coincide with a subsequent absence during broiler growout. Furthermore, these current data showed that changes in breeder dietary ME between 430 and 467 PCD

TABLE 8. Contrast means for mean BW gain and feed conversion (kg feed intake/kg BW gain) between Days 0 and 21, 22 and 42, and 0 and 42 of broilers from 29-wk-old hens fed low [430 peak calories per day (PCD)], moderate (449 PCD), or high (467 PCD) energy; poultry fat (PF) across levels (1.5 and 3.0%); corn oil (CO) (3.0%); or PF at the 1.5 and 3.0% levels^A

Parameter	Low ME	Moderate ME	High ME	PF	CO	1.5% PF	3.0% PF
0–21 d							
BW gain	0.53 ± 0.010	0.52 ± 0.015	0.52 ± 0.015	0.52 ± 0.009	0.55 ± 0.013	0.49 ± 0.015	0.53 ± 0.008
22–42 d							
BW gain	1.32 ± 0.026	1.28 ± 0.016	1.26 ± 0.027	1.28 ± 0.026	1.29 ± 0.030	1.27 ± 0.016	1.29 ± 0.039
0–42 d							
BW gain	1.85 ± 0.031	1.80 ± 0.027	1.77 ± 0.029	1.80 ± 0.029	1.83 ± 0.042	1.76 ± 0.023	1.82 ± 0.042
0–21 d							
feed conversion	1.64 ± 0.023	1.64 ± 0.022	1.63 ± 0.037	1.64 ± 0.020	1.60 ± 0.028	1.68 ± 0.011	1.63 ± 0.027
22–42 d							
feed conversion	2.12 ± 0.022	2.11 ± 0.032	2.10 ± 0.042	2.07 ± 0.030	2.16 ± 0.018	2.06 ± 0.044	2.08 ± 0.041
0–42 d							
feed conversion	1.98 ± 0.018	1.97 ± 0.016	1.96 ± 0.024	1.95 ± 0.017	1.99 ± 0.007	1.95 ± 0.028	1.95 ± 0.023

^ANo significant ($P > 0.05$) differences between contrast means for ME level, PF (across levels), CO (3.0% level), or PF at the 1.5 and 3.0% levels were noted for any of the designated parameters.

alone had no impact on broiler performance through 42 d. In fact, a lack of effect of ME in the breeder diet on embryogenesis [13] may coincide with its lack of effect during growout. Nevertheless, these data independently suggest that PF added at the 1.5 or 3.0% levels or CO

added at the 3.0% level may be successfully used to adjust ME levels between 430 and 467 PCD in the diets of young, 29-wk-old breeder hens without influencing embryogenesis and the growout performance of their progeny through 42 d.

CONCLUSIONS AND APPLICATIONS

1. Changes in ME level from low (430 PCD) to high (467 PCD) in the diets of 29-wk-old breeder hens had no effect on subsequent embryogenesis or posthatch growout performance of broiler offspring.
 2. Furthermore, added CO at 3.0% and PF at 1.5% effectively increased dietary ME from low (430 PCD) to moderate (449 PCD) levels, and 3.0% added PF effectively increased ME from low (430 PCD) to high (467 PCD) levels without affecting subsequent embryogenesis or posthatch growout performance of broiler offspring.
 3. As there were no significant influences of fat type (CO or PF) or PF level (1.5 or 3.0%) on the parameters examined as revealed through contrast analysis, it was concluded that changes in ME between low (430 PCD) and high (467 PCD) levels in the diets of young (29-wk-old) breeder hens may be effectively accomplished through the use of 1.5 or 3.0% added PF or 3.0% added CO without affecting subsequent broiler performance.
-

REFERENCES AND NOTES

1. Siegel, P., and E. Dunnington. 1985. Reproductive complications associated with selection for broiler growth. Pages 59–71 in *Poultry Genetics and Breeding*. W. G. Hill, J. M. Manson, and E. Hewitt, ed. Br. Poult. Sci., Ltd., Edinburgh, Scotland.
2. Pearson, R. A., and K. M. Herron. 1981. Effects of energy and protein allowances during lay on the reproductive performance of broiler breeder hens. *Br. Poult. Sci.* 22:227–239.
3. Bornstein, S., and Y. Lev. 1982. The energy requirements of broiler breeders during the pullet-layer transition period. *Poult. Sci.* 61:755–765.
4. Spratt, R. S., and S. Leeson. 1987. Broiler breeder performance in response to diet protein and energy. *Poult. Sci.* 66:683–693.
5. Dansky, L. M. 1981. Changing patterns in the feeding of broiler breeders. Vol. 24(2). Arbor Acres Farm, Inc., Glastonbury, CT.
6. Chaney, L. W., and H. L. Fuller. 1975. The relation of obesity to egg production in broiler breeders. *Poult. Sci.* 54:200–208.
7. Brake, J. T. 1990. Effect of four levels of fat on broiler breeder performance. *Poult. Sci.* 69:1659–1663.
8. Latour, M. A., E. D. Peebles, C. R. Boyle, S. M. Doyle, T. Pansky, and J. D. Brake. 1996. Effects of breeder hen age and dietary fat on embryonic and neonatal broiler serum lipids and glucose. *Poult. Sci.* 75:695–701.
9. Latour, M. A., E. D. Peebles, S. M. Doyle, T. Pansky, T. W. Smith, and C. R. Boyle. 1998. Broiler breeder age and dietary fat influence the yolk fatty acid profiles of fresh eggs and newly hatched chicks. *Poult. Sci.* 77:47–53.
10. Peebles, E. D., T. Pansky, S. M. Doyle, T. W. Smith, C. R. Boyle, M. A. Latour, and P. D. Gerard. 1998. Effects of breeder dietary fat and eggshell cuticle removal on subsequent broiler grow-out performance. *J. Appl. Poult. Res.* 7:377–383.
11. Peebles, E. D., S. M. Doyle, T. Pansky, P. D. Gerard, M. A. Latour, C. R. Boyle, and T. W. Smith. 1999. Effects of breeder age and dietary fat on subsequent broiler performance. 1. Growth, mortality, and feed conversion. *Poult. Sci.* 78:505–511.
12. Peebles, E. D., S. M. Doyle, T. Pansky, P. D. Gerard, M. A. Latour, C. R. Boyle, and T. W. Smith. 1999. Effects of breeder age and dietary fat on subsequent broiler performance. 2. Slaughter yield. *Poult. Sci.* 78:512–515.
13. Peebles, E. D., S. M. Doyle, C. D. Zumwalt, P. D. Gerard, M. A. Latour, C. R. Boyle, and T. W. Smith. 2001. Breeder age influences embryogenesis in broiler hatching eggs. *Poult. Sci.* 80:272–277.
14. Peebles, E. D., C. D. Zumwalt, P. D. Gerard, M. A. Latour, and T. W. Smith. 2002. Market age live weight, carcass yield, and liver characteristics of broiler offspring from breeder hens fed diets differing in fat and energy content. *Poult. Sci.* 81:23–29.
15. Tullett, S. G. 1990. Science and the art of incubation. *Poult. Sci.* 69:1–15.
16. Brake, J., J. D. Garlich, and G. R. Baughman. 1989. Effects of lighting program during the growing period and dietary fat during the laying period on broiler breeder performance. *Poult. Sci.* 68:1185–1192.
17. Hargis, P., and M. Van Elswyk. 1993. Manipulating the fatty acid composition of poultry meat and eggs for the health conscious consumer. *World's Poult. Sci. J.* 49:251–264.
18. Cruickshank, E. M. 1934. Studies in fat metabolism in the fowl. 1. The composition of the egg fat and depot fat of the fowl as affected by the ingestion of large amounts of different fats. *Biochem. J.* 28:965–977.
19. McNaughton, J. L., J. W. Deaton, F. N. Reece, and R. L. Haynes. 1978. Effect of age of parents and hatching egg weight on broiler chick mortality. *Poult. Sci.* 57:38–44.
20. Arbor Acres Farm, Inc. Glastonbury, CT.

21. Peebles, E. D., C. D. Zumwalt, S. M. Doyle, P. D. Gerard, M. A. Latour, C. R. Boyle, and T. W. Smith. 2000. Effects of dietary fat type and level on broiler breeder performance. *Poult. Sci.* 79:629–639.

22. National Research Council. 1994. *Nutrient Requirements of Poultry*. 9th rev. ed. Natl. Acad. Press, Washington, DC.

23. Association of Official Analytical Chemists. 1980. *Official Methods of Analysis*. 14th ed. Assoc. Off. Anal. Chem., Washington, DC.

24. Petersime Incubator Co., Gettysburg, OH.

25. Butler Manufacturing Co., Fort Atkinson, WI.

26. The experimental design was completely randomized. Six breeder hen dietary treatments with four replicates per treatment were utilized in all data analyses. Replicate means were analyzed using a one-way analysis to test for the effects of dietary treatment

on early, late, and pipped embryonic mortalities; hatchability; BW; BW gain; and broiler mortality. Angular transformations (arc sine of the square root of the proportion affected) were performed on all percentage data prior to analysis [27]. Means were compared by Fisher's protected least significant difference test [27]. Data were further tested by contrast analysis. The effects of ME level (430, 449, or 467 PCD), added fat type across level and only at the 3.0% level (PF or CO), and level of PF (1.5 or 3.0%) were tested (Table 5). All data were analyzed using the GLM procedure of the SAS software [28]. Statements of significance were based on $P \leq 0.05$, unless otherwise indicated.

27. Steel, R. G. D., and J. H. Torrie. 1980. *Principles and Procedures of Statistics. A Biometrical Approach*. 2nd ed. McGraw Hill Book Company, Inc., New York, NY.

28. SAS Institute, Inc. 1996. *SAS/STAT Software: Changes and Enhancements Through Release 6.11*. SAS Institute, Inc., Cary, NC.