Iran Agricultural Research 8:129-140 (1989).

NOTE

RESPONSE OF LAYING HENS FED ON DIFFERENT DIETARY SULPHUR AMINO ACID SUPPLEMENTED WITH MAIZE OIL

J. POURREZA AND W.K. SMITH[1]

Poultry Science Department, West of Scotland College, Auchincruive, AYR., UK.
(Received February 5, 1989).

ABSTRACT

The response of Ross Brown egg layers to the addition of different levels (20, 50 and 80 g kg^{-1}) of maize oil in feeds containing 4.6 and 6.4 g kg^{-1} of sulphur amino acid (SAA) was studied. Each diet was fed to 12 replicates of eight birds at 37 wk of age for three 28-day periods. Data were collected and analyzed for three 28-day periods. Egg components were determined at the beginning, week eight and wk 12 of the experiment. Samples of egg yolk were analyzed for lipid. Added maize oil increased egg weight and egg output significantly at both levels of dietary SAA. Maximum response was obtained when maize oil was included at level of 50 g kg^{-1}. Supplemental maize oil increased the amount of yolk fat.

[1]Former Graduate Student and Senior Lecturer, respectively. Senior author's present address is Animal Science Department, College of Agriculture, Isfahan University of Technology, Isfahan, Iran.

تحقیقات کشاورزی ایران
۸:۱۲۹-۱۴۰ (۱۳۶۸)

اثر افزایش روغن ذرت به جیره‌های غذایی حاوی مقادیر مختلف اسیدهای آمینه گوگرددار بر عملکرد مرغهای تخمگذار

جواد پوررضا و دبلیو. ک. اسمیت
به ترتیب دانشجوی سابق دوره دکترا (اکنون استادیار پرورش طیور گروه دامپروری دانشگاه صنعتی اصفهان) و مدرس ارشد دانشکده غربی اسکاتلند.

چکیده:

واکنش مرغهای تخمگذار به مقادیر روغن ذرت (۲۰، ۵۰ و ۸۰ گرم درکیلوگرم) به جیره‌های حاوی ۴/۶ و ۶/۴ گرم درکیلوگرم از اسیدهای آمینه گوگرددار مورد مطالعه قرار گرفت. هرجیره غذایی به ۱۲ تکرار هشت مرغی از سن ۳۷ هفتگی برای سه دوره ۲۸ روزه داده شد. ارقام مربوط به این سه دوره جمع‌آوری و مورد تجزیه و تحلیل قرار گرفت. اجزای فیزیکی تخم مرغ در اول، هفته هشتم و هفته دوازدهم آزمایش، تعیین گردید. نمونه‌هایی از زرده تخم مرغ برای تعیین چربی مورد تجزیه قرار گرفت. روغن ذرت اضافه شده درهردوسطح از اسیدهای آمینه گوگرددار وزن تخم مرغ و بازده تخمگذاری را بطور معنی داری افزایش داد. حداکثر واکنش با افزودن ۵۰ گرم درکیلوگرم روغن ذرت بدست آمد. روغن ذرت میزان چربی زرده را افزایش داد.

INTRODUCTION

Investigations have demonstrated that vegetable oils possess a special nutritive value for poultry. Increased egg production and egg weight due to supplemental fat is attributed to the greater concentration of metabolizable energy (ME) (15) or linoleic acid content of the diet (4).

The effect of added fats in increasing egg weight and egg output is partly due to its effect on increasing fat and non-fat dietary nutrient utilization (11) and partly because of fat deposition in the yolk. Recent data (6) indicated that the most part of increased egg weight due to supplemental maize oil was associated with an increase in albumen rather than yolk weight. Response to supplemental fat is different with different fats and level of inclusion, however, there is a question about the maximum fat required for maximum egg weight and egg output. This experiment was carried out to determine the effect of different levels of maize oil on the performance of laying hens fed on diets containing different levels of protein and SAA. The level of fat required for maximum response was also investigated.

MATERIALS AND METHODS

Seven hundred and sixty eight Ross brown layers at 37 wk of age were used in this experiment. Records of daily egg production were kept four wk before starting the experiment. The birds were randomly divided into 96 replicates, 48 replicates per bank of cages, eight birds per replicate. The eight experimental diets were fed to 12 replicates of 8 birds (6 replicates per bank of cages, two replicates per tier) from 37 until 48 wk of age.

The eight experimental rations, were prepared by mixing appropriate portions of the summit and dilution diets and the addition of maize oil. Maize oil was substituted for glucose and cellulose which were used as an inert compound. The composition of the summit and dilution diets have been reported elsewhere (14). The composition of experimental diets are presented in Table 1. Maize oil at levels

Table 1. Composition of experimental diets.

Ingredients g kg^{-1}	Diet No. 1	2	3	4	5	6	7	8
Summit	750	750	750	750	800	800	800	800
Dilution	50	50	50	50	-	-	-	-
Glucose	200	151	78	6	200	151	78	6
Cellulose	-	29	72	114	-	29	72	114
Maize oil	-	20	50	80	-	20	50	80
DL-methionine†	-	-	-	-	1.44	1.44	1.44	1.44

†Methionine was added on top of the diets.

of 20, 50 and 80 g kg^{-1} was added to the two control diets (diets 1 and 5) differing in protein and SAA contents. All diets were isoenergetic and calculated to contain 11.6 MJ kg^{-1} of ME. Diets one to four contained 142 g kg^{-1} protein and 4.6 g kg^{-1} SAA. Diets five to eight contained 151 g kg^{-1} protein and 6.4 g kg^{-1} SAA. Diets one to four contained 22.4, 42.4, 72.4 and 102.4 g kg^{-1} fat, respectively. Fat contents of diets five to eight were similar to the corresponding diets one to four, respectively.

At the beginning, wk. eight and wk 12 of the experiment three eggs were randomly collected from each replicate. The eggs were broken and the physical composition was determined as described previously by Pourreza *et al.* (15). Samples of eggs were collected, blended and placed in polyethylene bottles with screw-type polyethylene caps, and yolk fat was determined (5).

Computerized programs, EDEX (8) and Genstat (2) were used for analyses of data. The data for egg components were subjected to regression analysis

RESULTS AND DISCUSSION

The results of this experiment for egg weight, egg output, body weight changes and feed intake are presented in Table 2. Egg output was increased significantly ($P<0.01$) due to increasing dietary SAA and protein. Supplemental maize oil increased egg weight and egg output significantly ($P<0.01$). At both dietary SAA levels, maximum egg weight and egg output were obtained with 50 g kg^{-1} supplemental oil. With the high dietary SAA there were no significant differences in performance after adding maize oil. Egg output was diminished at the level of 80 g kg^{-1} added oil at both levels of dietary SAA compared with 50 g kg^{-1} added oil (diets 3 and 7 vs. diets 4 and 8)

The regression equations (Table 3) for egg output and supplemental maize oil were quadratic

Table 2. Egg weight, egg output, body weight changes, feed intake and yolk fat content of hens fed on diets with different SAA content supplemented with maize oil (45 to 48 weeks).

Diet No.	Added oil $g\ kg^{-1}$	SAA† intake $mg\ hen^{-1}\ d^{-1}$	Egg weight (final) g	Egg output $mg\ hen^{-1}\ d^{-1}$	Body weight change $g\ hen^{-1}\ d^{-1}$	Feed intake $g\ hen^{-1}\ d^{-1}$	Yolk fat %
1	None	440	63.1a*	44.0a	4.2a	105.0a	30.2a
2	20	480	63.0a	47.4ab	3.6a	113.4bc	31.2ab
3	50	460	65.6bc	49.3b	3.2a	110.3abc	31.6ab
4	80	470	64.5ab	46.7ab	4.3a	111.3abc	32.2b
5	None	640	62.5a	48.2b	5.6a	107.7ab	32.4b
6	20	690	65.8bc	58.8c	4.0a	116.0c	35.0c
7	50	670	67.0c	59.1c	4.2a	113.6c	35.5c
8	80	670	66.8c	56.8c	4.5a	113.4bc	36.7c
LSD			2.3	3.7		6.9	1.5

†SAA intakes were calculated on the basis of determined SAA content of the summit diet.

*Values followed by the same letters in each column are not significantly different ($P>0.05$).

irrespective of SAA intake. The interaction between maize oil and daily SAA intake was significant ($P<0.05$). The quadratic equations due to supplemental maize oil indicated the effect of inclusion level on the layers performance which is in agreement with other findings (7, 12). These results indicate that a critical level of added fat is necessary to produce a maximum improvement in protein and SAA utilization and egg output.

Table 3. Relationship between supplemental maize oil (X) and egg output (Y).

Low SAA diet	$Y= 46.8596+0.1498*X-0.0012*X^2$ $\pm1.7729\pm0.1153\ \ \pm0.0014$	S*
High SAA diet	$Y= 48.8401+0.1430*X-0.0007*X^2$ $\pm1.8962\pm0.1229\ \ \pm0.0015$	S
High and low SAA diets	$Y= 47.8681+0.1413*X-0.0008*X^2$ $\pm1.3085\pm0.0848\ \ \pm0.0001$	S

*Significant ($P<0.01$).

Hens fed on low protein and SAA diets with or without supplemental oil had significantly ($P<0.05$) lower body weights than those fed on high protein and SAA diets supplemented with maize oil at weeks 8 and 12 of the experiment. There were no significant differences between body weight changes due to the level of fat inclusion. Body weight changes during the last four weeks of the experiment were not significantly different and all hens gained during this period (Table 2).

It is indicated that fats can be used to reduce a part of dietary SAA and protein. In addition to the extra ME intake as the result of increased energetic efficiency due to added fats, improved dietary nutrient utilization was involved in increasing egg size, because maximum egg size was obtained with lower daily SAA intake at higher rates of oil inclusion. The higher body weight of hens fed on higher dietary oils indicated that all the extra ME intake resulting from an increased energy efficiency was not used for egg production. Also a part of increased egg size due to added oil is related to the increased yolk fat deposition (Table 2). Such effect has also been reported by Balnave (3).

Supplemental oil at a level of 20 g kg^{-1} increased daily feed intake which resulted in increasing daily protein and SAA intake (Table 2). A portion of the increased performance can be attributed to these greater protein and SAA intakes. Added oil at levels of 50 and 80 g kg^{-1} as compared with 20 g kg^{-1} slightly reduced feed intake at both levels of SAA.

Feed efficiency was improved both due to increasing dietary SAA and oil (Table 4). Maximum efficiency was obtained with 50 g kg^{-1} and the SAA sufficient diet. This result is in agreement with other reports (9, 17, 18) There were no differences between feed efficiency due to the different levels of maize oil inclusion (Table 4).

The regression analysis of egg components data indicated that for one g increase in egg weight there was an increase in yolk weight of 0.171 g, in albumen weight of 0.758 g, and in shell weight of 0.071 g.

It is calculated that 0.217 g (1.217*0.17) of the 0.758 g increase in albumen weight was due to increased in yolk weight and the rest (0.541 g), probably was due to the stimulating effect of maize oil on albumen secretion by the oviduct. As suggested by Griffin *et al.* (6), albumen secretion is also dependent on plasma estrogen levels and as reported by Akiba and Jensen (1) dietary corn oil significantly increased plasma estrogen. This suggests that fats not only improve the utilization of amino acids and protein but provide more fat for

Table 4. Efficiency of utilization of protein, sulphur amino acids, energy and feed for egg output.

Diet No.	Added fat $g\ kg^{-1}$	Efficiency†			
		Protein (%)	SAA (%)	Energy (%)	g feed $g\ egg^{-1}$
1	None	32.5	59.1	21.0	2.41a
2	20	31.7	58.6	21.0	2.44a
3	50	33.5(1.0)‡	63.0(4.0)	22.2	2.24b
4	80	31.2	59.6(0.5)	21.0	2.39ab
5	None	32.0	43.7	22.4	2.24b
6	20	37.0(5.0)	50.7(3.0)	25.4(3.0)	1.97c
7	50	37.2(5.2)	52.2(8.5)	26.0(3.6)	1.92c
8	80	36.0(4.0)	50.7(7.0)	26.0(3.6)	2.00c
LSD					0.16

†Protein efficiency was calculated on the basis of determined yolk and albumen output and 16.2% and 10.1% protein contents of yolk and albumen respectively. SAA and energetic efficiency were calculated on the basis of 5.91 mg and 0.0058 MJ SAA and energy contents per gram of shell egg respectively [Stadelman and Cotterill (19)].

‡Figures in parentheses represent percent changes in the protein, SAA and energy efficiencies of corresponding diets without added lipids. Only improved data are indicated.

yolk formation and stimulate the oviduct to synthesize more albumen.

The fat content of the yolk is shown in Table 2. Hens fed on the higher SAA diets supplemented with maize oil produced yolks which contained significantly ($P<0.01$) higher percentage of fat. Yolk fat content was proportional to the supplemental maize oil and maximum yolk fat was obtained when 80 g kg^{-1} oil was added to the high SAA diet. This confirmed the result of previous experiment (13) and the report of Balnave (3), but is not in accordance with the findings of Marion and Edwards (10), who reported no change in the total fat content of the yolk due to supplemental fats.

As indicated in Table 4 efficiencies of protein and SAA utilization were higher when diets were inadequate in SAA. Supplemental oil improved the efficiency of protein and SAA utilization particularly when SAA intake was about 460 mg hen^{-1} day^{-1} and 50 g kg^{-1} oil was included. The efficiency of protein and SAA utilization was improved up to 50 g kg^{-1} added oil and then diminished when 80 g kg^{-1} oil was included. Such improvements in utilization indicated a synergistic effect between fat and SAA and protein. The interaction between added maize oil and SAA intake also confirmed the synergistic effect between fats and other dietary nutrients. Synergism between fats and other dietary nutrients (20) and supplemental fats and dietary fats and fatty acids (21, 22) has been reported. This result confirmed the findings of previous experiments (13) as far as protein and SAA utilization is concerned.

The energy efficiency was improved when maize oil was included, especially with diets sufficient in protein and SAA. Part of the increased ME intake as the result of improved energetic efficiency was used for increase in the rate of egg production.

Generally, the results suggest that unsaturated fats improve the efficiency of protein, SAA and energy utilization and the manipulation of feed lipid content offers a means of controlling egg weight, egg yolk lipid content or reducing dietary SAA and protein contents depending on the production circumstances. Egg weight, egg output and feed efficiency were maximum with 50 g kg^{-1} supplemental maize oil.

LITERATURE CITED

1 Akiba, Y. and L.S. Jensen. 1983. Temporal effect of change in diet composition on plasma estradiol and thyroxin concentrations and hepatic lipogenesis in laying hens. J. Nutr. 113:2078-2084.

2. Alvey, N., N. Galwey and P. Lane. 1982. An Introduction to Genstat. Academic Press. London.

3. Balnave, D. 1969. Changes in egg composition in response to dietary supplementation with maize oil and Cod liver oil. Record of Agricultural Research, Ministry of Agriculture for Northern Ireland. 18:71-73.

4. Balnave, D. 1970. Essential fatty acids in poultry nutrition. World Poult. Sci. J. 26:442 -460.

5. Folch, J., M. Lees and J.N. Sloane-Stanly. 1957. A simple method for the isolation and purification of total lipids from animal tissues. J. Biol. Chem. 226:497-509.

6. Griffin H.D., A. Bowman and C.C. Whitehead. 1987. Fats in layer diets -Effects on performance. The Scottish Poultry Conference, North Scotland College of Agriculture, Poultry Division, Craibston, Bucksburn, Aberdeen, Scotland.

7. Horani, F. and J.L. Sell. 1977. Effect of feed grade fat on laying hen performance and on metabolizable energy of ration. Poult. Sci. 56:1972-1980

8. Hunter, E.A., H.D. Patterson and M. Talbot. 1979. EDEX. University of Edinburgh, Scientific and Social Science Programme Library, Report No. 12.

9. Jensen, L.S., G.W. Schunaier and J.D. Latshaw. 1970. Extra caloric effect of dietary fat for developing turkeys as influenced by calorie-protein ratio. Poult. Sci. 49:1697-1704.

10. Marion, J.E. and H.M. Edwards, Jr. 1964. The response of laying hens to dietary oils and purified fatty acids. Poult. Sci. 43:911-918.

11. Mateos, G.G. and J.L. Sell. 1980. Influence of graded levels of fat on utilization of pure carbohydrates by the laying hen. J. Nutr. 110: 1894-1903.

12. Muztar, A.J., S.J. Leeson and S.J. Slinger. 1981. Effect of blending and level of inclusion on the metabolizable energy of tallow and tower rapeseed soapstocks. Poult. Sci. 60: 365-372.

13. Pourreza, J. 1988. Lipid supplementation of laying hens diets deficient of protein and sulphur amino acids. Iran Agric. Res. 7:1-22.

14. Pourreza, J. 1989. Response of laying hens fed on inadequate protein and sulphur amino acid diet supplemented with different fatty acids. Iran Agric. Res. 8:12-32.

15. Pourreza, J., M.J. Zamiri and A. Farid-Naeini. 1983. Egg components of the native Fars chickens in cage and on deep-litter. Iran Agric. Res. 2:115-123.

16. Rand, N.T., H.M. Scott and F.A. Kummerow. 1958. Dietary fat in the nutrition of the growing chick. Poult. Sci. 37:1075-1085.

17. Sell, J.L. and W.J. Owings. 1981. Supplemental fat and metabolizable energy to nutrient

ratios for growing turkeys. Poult. Sci. 60: 2293-2305.

18. Sell. J. L. and W.J. Owings. 1984. Influence of feeding supplemental fat by age sequence on the performance of growing turkeys. Poult. Sci. 63:1184-1189.

19. Stadelman, W.J. and O.J. Cotterill. 1986. Egg Science and Technology. 3rd. ed. MacMillan Publishing Co. U.K.

20. Sues, M. 1979. Digestibility and metabolizable energy content of beef tallow for laying hens. XV World Poultry Congress. 367-369.

21. Wiseman, J. and M. Lessire. 1987a. Interactions between fats of differing chemical content: Apparent metabolizable energy values and apparent fat availability. Brit. Poult. Sci. 28:663-676.

22. Wiseman, J. and M. Lessire. 1987b. Interactions between fats of differing chemical content: Apparent availability of fatty acids. Brit. Poult. Sci. 28:677-691.