ISSN 1682-8356
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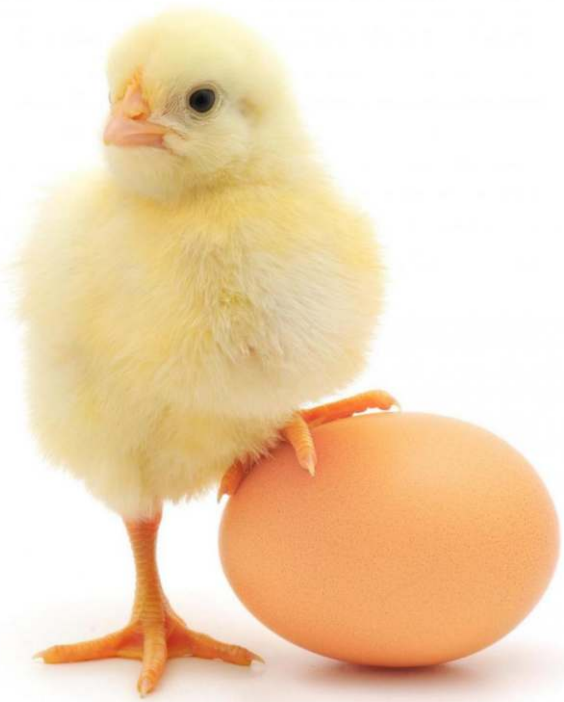

INTERNATIONAL JOURNAL OF POULTRY SCIENCE

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International Journal of Poultry Science 4 (12): 976-981, 2005
ISSN 1682-8356

Effect of Different Energy to Protein Ratio and Tallow Supplementation on Broiler Performance

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Abstract: This experiment was carried out to examine the effect of tallow supplementation and reducing protein level on broiler chickens performance. A total of 480 one-day old broiler chicks of a commercial strain (Arian) from both sex with equal ratio were placed in 32 pens, fifteen in each pen. Treatments were included tallow at 0, 2.5, 5 and 7.5% levels and protein level reduction in NRC energy diets as ME to CP ratio increased 10 unit. Each treatment replicated four times. Metabolizable energy of tallow was determined by Sibbald method. Results showed that AME_n value of tallow was 7150 kcal kg^{-1}. In whole production period (days 7-56) chicks that fed with a diet containing NRC protein level, adding 5 and 7.5 percent tallow significantly ($P<0.05$) increased feed intake but in reduced protein diets, adding tallow could not affect feed intake. Feeding different levels of tallow and diet protein reduction in both low and high energy diets had no significant effect on weight gain in ages 1-21 and 42-56 and 7-56. There was no significant difference in feed conversion ratio in chicks fed with different experimental diets in all ages. Carcass, liver and abdominal fat did not affect by experimental treatments. The results showed that adding 2.5 percent tallow to a diet with a protein level according to NRC recommendation results to better performance.

Key words: Tallow, energy to protein, broiler, performance, organ weight

Introduction

Broiler industry is increasing dramatically throughout the developing countries. There have been a notable increase in growth rate and feed efficiency in commercial broiler chickens in last 20 years. Current commercial hybrids with high performance require high energy diets which would enable the maximum exploitation of those genetic potential. There is a problem to meet such a high energy level with conventional feed ingredients such as maize, wheat, barley and soybean. Use of fat is a great advantage in formulating high energy poultry diet. Another problem with new commercial broilers is the accumulation of large amount of fat in the abdominal cavity, since modern broilers contains about 150-200 g fat per kg body weight and over 85% of it is physiologically inessential. Abdominal fat is removed by evisceration, thus decreasing processing yield (Choct *et al.*, 2000). In developed countries, fat or oils as energy rich feeds are available from animal sources such as tallow and fish oil or from plant sources such as soybean oil, sunflower oil and maize oil. Fats also provide varying quantities of the essential nutrient linoleic acid (Leeson and Summers, 2001). Another important role of fats in diet is its inhibition from de novo lipogenesis in broiler chickens (Yeh and Leveille, 1971) that could increase energy efficiency in diets. Dietary fat also may interact with other nutrients in the diet. Abawi *et al.* (1985) showed that adding 0, 3 and 6 percent tallow in broiler diet increase plasma vitamins E and A. Tallow has traditionally been the principle fat source used in poultry nutrition and its production is noticeable throughout the world and there has been a great use of tallow in blended oils for poultry. Tallow and other saturated animal fats usually have been used in the later phases of feeding, because of limited digestibility in young chicken (Leeson and Summers, 2001). Tallow has include about 42.5% saturated fatty acids and only 1% unsaturated fatty acids that all of them are n-6 fatty acids (Manilla *et al.*, 1999).

One of other most important decisions for broiler nutritionist is level of protein in diet and its ratio to energy. Reduction in feed efficiency and production of leaner bird in diets with excess dietary CP and increasing fat accretion in broilers fed with a diet with low protein content reported by Buyse *et al.* (1992). These workers found that broilers reared on a 15% protein diet increased their feed intake in an attempt to meet their protein and amino acid requirement. Reginatto *et al.* (2000) in tow experiments with different energy to protein ratio showed that protein utilization was improved with higher levels of dietary energy and with lower levels of dietary CP.

The results of Rosebrough *et al.* (1999) experiment with broilers showed that the level of dietary CP must be considered when dietary fat is used to decrease *de novo* lipogenesis. They showed that dietary fat addition to diets containing low CP levels did not decrease lipogenesis to the degree noted when added to a diet containing a higher level of CP. Other researchers noted

Table 1: Composition and specifications of starter chicken diets (7-21 d) and calculated major components (g kg^{-1} as fed)

	Tallow (%)				Tallow (%)			
	0	2.5	5	7.5	0	2.5	5	7.5
CP level	NRC	NRC	NRC	NRC	Lower than NRC	Lower than NRC	Lower than NRC	Lower than NRC
Corn	644.7	594.5	546.2	495.7	677.5	629.1	579.4	531
Soybean	252.3	275.4	300.6	326	219.4	242.6	267.1	390.3
Fish meal	70	70	70	70	70	70	70	70
Tallow	0	25	50	75	0	25	50	75
Oyster shell	12.7	12.7	12.7	12.7	12.7	12.7	12.7	12.7
MCP*	6.2	6.2	6.2	6.2	6.2	6.2	6.2	6.2
Methionine	1.5	1.6	1.7	1.8	1.6	1.7	1.8	1.9
Na Cl	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6
Mineral premix [a]	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
Vitamin premix [b]	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
Calculated Composition								
ME (Kcal/Kg)	2930	3010	3110	3200	2970	3060	3155	3240
CP (%)	21.1	21.62	22.3	23.0	19.95	20.54	21.17	21.75
ME:CP ratio	139	139	139	139	149	149	149	149
SAA (g/Kg)	8.5	8.7	9	9.3	8.5	8.7	9	9.3
Lys (g/Kg)	12.2	12.5	12.8	12.9	12.8	12.3	12.4	12.1
AP (g/Kg)	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5
Ca (g/Kg)	10	10	10	10	10	10	10	10

*Mono Calcium Phosphate. [a]supplemented (mg kg^{-1} of diet): Mn, 1200; Fe, 60; Zn, 120; Cu, 12; I, 1.2; Se, 0.24
[b]supplemented (mg or IU kg^{-1} of diet): Vit. A, 10800 IU; D_3, 2400 IU; E, 21.6 IU; K_3, 2.4 IU; B_1, 2.16; B_2, 7.9; B_3, 12; B_5, 3.6; B_9, 1.2; B_{12}, 0.015; Biotin, 0.12; choline chloride, 600; and adequate anti oxidant.

that fat accretion will increase when the energy to protein ratio of broiler diets increase (Kita *et al.*, 1993, Nieto *et al.*, 1997 and Collin *et al.*, 2003).

The finding on the effect of different levels of CP in high energy diets on broiler metabolism and body composition are different and more researches are necessary to understanding of broiler response to different levels of protein in high energy diets with low and high levels of animal fat as a diet energy source.

The purpose of present study was to further examine the interaction of diet animal fat supplementation and reduction of crude protein levels in high and low energy diets on productivity, fat deposition and organs weight in broiler chickens.

Materials and Methods

A total of 480 one-day old broiler chicks of a commercial strain (Arian) from both sex with equal ratio were placed in 32 pens, fifteen in each pen. Feed and water were provided *ad libitum*. The chicks were allocated randomly to 8 experimental diets. The experiment arrangement consisted of a 4*2 factorial design (4 fat level and 2 crude protein level) with four replicate per each treatment. Tallow was used at 0, 2.5, 5 and 7.5% in diets and crude protein levels were NRC (1994) recommendation and lower than NRC recommendation as ME to CP ratio increased 10 unit. Metabolisable energy of tallow determined by Sibbald (1986) method by using 8 leghorn roosters. Gross energy was determined using an adiabatic bomb calorimeter (Parr Instrument, Moline. Il, USA) using a benzoic acid standard. Metabolizable energy of tallow was 7150 kcal kg^{-1} that used for diet formulation. The diets (Table 1, 2 and 3) were formulated to meet nutrient requirements according to NRC (1994). Diets were containing the same levels of methionine, lysine, vitamins and minerals. The chickens were weighed at the start of the experiment, and during the experiment, live weight and total feed consumption per pen were recorded and feed conversion ratio was calculated at 21.42 and 56^{th} days of the experiment. Mortality was also recorded for each treatment. Tow birds (male and female) from each replicate were slaughtered after bleeding at days 56 and carcass, abdominal fat and liver were weighed and presented as a percentage of live weight.

The results obtained from the experiment were analyzed by an analysis of variance using the general linear model (GLM) procedure of SAS and means were compared by Duncan's Multiple Range Test (SAS Institute, 1995). There was no significant difference between both sexes in organs weight and blood parameters, so the data pooled and analyzed together.

Table 2: Composition and specifications of grower diets (21-42 d) and calculated major components (g kg^{-1} as fed)

	Tallow (%)				Tallow (%)			
	0	2.5	5	7.5	0	2.5	5	7.5
CP level	NRC	NRC	NRC	NRC	Lower than NRC	Lower than NRC	Lower than NRC	Lower than NRC
Corn	706.3	661.2	616.2	571.2	734	690	643.8	598
Soybean	208	222.8	242.8	268	180	198.8	220	240
Fish meal	55	55	55	55	55	55	55	55
Tallow	0	25	50	75	0	25	50	75
Oyster shell	12	12	12	12	12	12	12	12
MCP*	6	6	6	6	6	6	6	6
D-L Methionine	0.3	0.4	0.4	0.4	0.6	0.6	0.6	0.6
NaCl								
Mineral premix [a]	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
Vitamin premix [b]	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
Calculated Composition								
ME (Kcal/Kg)	2995	3083	3162	3260	3025	3114	3200	3288
CP (g/Kg)	18.80	19.28	19.76	20.23	17.83	18.26	18.77	1924
ME to CP ratio	160	160	160	160	170	170	170	170
SAA (g/Kg)	6.8	7.0	7.1	7.2	6.8	7.0	7.1	7.2
Lys (g/Kg)	10.4	10.4	10.3	10.3	10.5	10.5	10.5	10.5
AP (g/Kg)	3.9	3.9	4.1	4.2	4.0	4.0	4.0	4.0
Ca (g/Kg)	9.0	9.2	9.1	9.1	9.0	9.0	9.0	9.0

*Mono Calcium Phosphate

[a] supplemented (mg kg^{-1} of diet): Mn, 1200; Fe, 60; Zn, 120; Cu, 12; I, 1.2; Se, 0.24

[b] supplemented (mg or IU kg^{-1} of diet): Vit. A, 10800 IU; D_3, 2400 IU; E, 21.6 IU; K_3, 2.4 IU;B_1, 2.16; B_2, 7.9; B_3, 12; B_5, 3.6; B_9, 1.2; B_{12}, 0.015; Biotin, 0.12; choline chloride, 600; and adequate anti oxidant.

Results and Discussion

Feed Intake: The effect of tallow inclusion and different protein levels on feed intake has shown in Table 4. Inclusion of tallow in diet had no significant effect on feed intake in 7-21d old chicks in both protein levels. But in 5 percent tallow diet, feeding lower protein level resulted to more feed intake than NRC. In 22-42 day old chicks feed intake in low fat and protein level was lowest than others and its different was significant (P<0.05). The higher feed intake in high fat and protein diet could be attributed to better amino acid content and balance. Also, in 42-49 days old broiler chicks feeding low protein diets resulted to lower feed intake. In chicks fed with high tallow level feed intake decreased numerically that it could be attributed to poor fat digestion in young broiler chickens (Leeson and Summers, 2001) or higher energy in these diets. In whole production period (days 7-56) chicks that fed with a diet containing NRC protein level, adding 5 and 7.5 percent tallow significantly (P<0.05) increased feed intake that it may be a result of better palatability of fat supplemented diet. In reduced protein diets, adding tallow couldnot affect feed intake and it could be attributed to amino acid imbalance in low protein diets. D'Mello *et al.* (1994) showed that amino acid imbalance adversely affect feed intake.

Weight gain: Effects of tallow supplementation and feeding different energy to protein ratio on weight gain are shown in Table 5. Feeding different levels of tallow and diet protein reduction in both low and high energy diets had no significant effect on weight gain in ages 1-21 and 42-56 and 7-56. In 22-42 day old chicks feeding a diet with highest energy and protein content resulted to highest weight gain and feeding a diet with lowest energy and protein level resulted to lowest weight gain and those different was significant (P<0.05). This result shows that a diet with higher energy to protein ratio could met all requirements for better growth rate. Reducing diet protein had no adverse effect on body weight gain in broiler chickens that fed with high energy, but in control group with lower energy content, reducing protein resulted to lowest weight gain.

Feed conversion ratio: There was no significant difference in feed conversion ratio in chicks fed with different experimental diets in ages 7-21, 21-42, 42-56 and 7-56 day. (Table 6). In 7-21 d old chicks feeding diets with higher energy level numerically decreased feed conversion ratio and lowest feed conversion had belonged to chicks fed with 5% tallow and higher protein level that it is well coincidence with lower feed intake and higher weight gain in this group.

Table 3: Composition and specifications of finisher diets (42-49 d) and calculated major components (g kg^{-1} as fed)

	Tallow (%)				Tallow (%)			
	0	2.5	5	7.5	0	2.5	5	7.5
CP level	NRC	NRC	NRC	NRC	Lower than NRC	Lower than NRC	Lower than NRC	Lower than NRC
Corn	740	691.5	646.5	601.5	760	716.3	670	625
Soybean	206.5	230	250	270	186.3	205	226.3	246.3
Fish meal	20	20	20	20	55	55	55	55
Tallow	0	25	50	75	0	25	50	75
Oyster shell	13	13	13	13	13	13	13	13
MCP*	8	8	8	8	8	8	8	8
NaCl	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
Mineral premix [a]	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
Vitamin premix [b]	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
Calculated Composition								
ME (Kcal/Kg)	2995	3080	3169	3258	3018	3114	3200	3288
CP (g/Kg)	16.80	17.41	17.89	17.38	16.08	16.53	17.06	17.54
ME to CP ratio	177	177	177	177	187	187	187	187
SAA (g/Kg)	5.8	5.9	6.0	6.1	5.6	5.7	5.8	5.8
Lys (g/Kg)	7	7	7	7	7	7	7	7
AP (g/Kg)	3.8	3.8	3.9	4	3.9	3.9	3.9	3.9
Ca (g/Kg)	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0

*Mono calcium phosphate

[a] supplemented (mg kg^{-1} of diet): Mn, 1200; Fe, 60; Zn, 120; Cu, 12; I, 1.2; Se, 0.24

[b] supplemented (mg or IU kg^{-1} of diet): Vit. A, 10800 IU; D_3, 2400 IU; E, 21.6 IU; K_3, 2.4 IU; B_1, 2.16; B_2, 7.9; B_3, 12; B_5, 3.6; B_9, 1.2; B_{12}, 0.015; Biotin, 0.12; choline chloride, 600; and adequate anti oxidant.

Table 4: Effect of different levels of tallow and protein on feed intake

Fat level	Protein level	Feed Intake (g)			
		7-21	22-42	42-56	7-56
0	NRC	60.5^{ab}	151.7^{b}	203.9^{ab}	139.5^{b}
2.5	NRC	61.5^{ab}	145.3^{b}	194.8^{ab}	129.2^{c}
5	NRC	58.1^{b}	152.9^{b}	206.9^{ab}	139.0^{b}
7.5	NRC	60.2^{ab}	173.5^{a}	209.0^{a}	148.6^{a}
0	Lower than NRC	63.3^{a}	120.6^{c}	207.0^{ab}	137.3^{bc}
2.5	Lower than NRC	60.8^{ab}	113.8^{c}	187.5^{bc}	135.2^{bc}
5	Lower than NRC	62.1^{a}	152.4^{b}	188.9^{bc}	136.2^{bc}
7.5	Lower than NRC	62.1^{a}	152.9^{b}	194.2^{ab}	136.2^{bc}

Table 5: Effect of different levels of tallow and protein on weight gain

Fat level	Protein level	Weight Gain (g)			
		7-21	22-42	42-56	7-56
0	NRC	83.0	57.4^{ab}	55.1	48.3
2.5	NRC	29.3	59.1^{ab}	65.6	52.4
5	NRC	29.6	58.1^{ab}	57.2	49.7
7.5	NRC	29.6	63.0^{a}	60.8	52.8
0	Lower than NRC	28.4	56.0^{b}	61.1	49.5
2.5	Lower than NRC	28.5	58.4^{ab}	58.6	49.9
5	Lower than NRC	28.7	59.6^{ab}	59.2	50.7
7.5	Lower than NRC	28.7	60.8^{ab}	53.8	49.6

Table 6: Effect of different levels of tallow and protein on feed conversion ratio

Fat level	Protein level	Feed Conversion Ratio (g/g)			
		7-21	22-42	42-56	7-56
0	NRC	2.18	2.32	2.40	2.48
2.5	NRC	2.11	2.17	2.40	2.34
5	NRC	1.96	2.33	2.31	2.40
7.5	NRC	2.04	2.46	2.17	2.42
0	Lower than NRC	2.23	2.26	2.11	2.46
2.5	Lower than NRC	2.14	2.38	2.03	2.32
5	Lower than NRC	2.16	2.26	2.42	2.39
7.5	Lower than NRC	2.17	2.22	2.40	2.36

Table 7: Effect of different levels of fat and protein on carcass and organs weight in 56 days old broiler chicks (As percentage of carcass weight)

Fat Level	Protein level	Carcass	Abdominal Fat	Liver
0	NRC	86.0	3.1	2.7
2.5	NRC	86.3	3.1	2.3
5	NRC	85.1	3.1	2.2
7.5	NRC	85.0	3.6	2.6
0	Lower than NRC	87.0	3.1	2.6
2.5	Lower than NRC	85.0	3.3	2.2
5	Lower than NRC	85.0	3.4	2.4
7.5	Lower than NRC	84.5	3.4	2.3

Organs weight: Feeding different levels of tallow and protein had no effect of carcass, abdominal fat and liver weight (Table7). This is in agreement with results of Tabiedian *et al*. (2005) who showed that feeding different levels of soybean oil and protein had no effect on carcass, pancrease, intestine and preventriculus weight. Abdominal fat in chicks fed with lower protein diets was higher numerically and could be a result of unsuitable amino acid pattern in these diets and stimulating of gluconeogenesis pathway in these chicks, so extra calories could be deposit as fat. Also adding animal fat resulted to more fat deposition. Some reports indicate that unsaturated dietary fat may be used for metabolic purposes; consequently, this could affect deposition of body fat (Awad, 1981). Also, it has been shown that diets containing large energy: protein ratios promote *de novo* lipogenesis and result in obese broiler chicken (Donaldson, 1985).

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