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Effect of Unsaturated to Saturated Fatty Acids Ratio of Supplemental Fat in the Diet with or without L-Carnitine on Performance of Broiler Chicken

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ABSTRACT

The present trial was conducted to study the effect of ratio of unsaturated to saturated fatty acids with or without L-carnitine supplementation on the performance male broiler chicks. A total of 320 day old male broiler chicks were randomly divided into 8 treatments with eight replicate and five birds each. T_1, T_2, T_3 and T_4 diets were formulated to contain ratio of UFA: SFA fatty acids as 60: 40, 65: 35, 70: 30 and 75: 25, respectively. Diets T_5, T_6, T_7 and T_8 were formulated to contain same ratio of fatty acids to that of T_1 to T_4 but with supplementation of L-carnitine at 100 mg/kg diet level. Before the feed formulation, the lipid profile of the tallow and crude soybean oil were analyzed. The unsaturated fatty acids (UFA) : saturated fatty acids (SFA) ratio were found to be 5.37 and 0.77, respectively for crude soybean oil and tallow. The results indicated that 70: 30 ratio without L-carnitine had significantly ($P<0.05$) higher weight gain during starter, finisher and overall period compared to other ratios. However, carnitine supplementation to these ratios did not have significant effect on weight gain during the finisher and the overall period. Significantly ($P<0.05$) lowest feed intake was noticed at 75: 25 ratio with L-carnitine supplementation. The FCR was better ($P<0.05$) at 60: 40 ratio diets without carnitine supplementation compared to others. The interaction effect was significant ($P<0.05$) only during starter phase.

Key words: Broiler chicken, Crude soybean oil, FCR, UFA: SFA ratio, Weight gain

INTRODUCTION

Addition of fats and oils in poultry ration is a usual practice and a must to meet the higher energy requirement of broilers for sustaining the growth potential of superior germ plasm. The fats/oils are referred to as a source of concentrated energy and fatty acids inclusion in the diet increases the amount of energy provided to the bird which causes increased feed efficacy. L-carnitine promotes mitochondrial β-oxidation of long chain fatty acids by facilitating their transfer across the inner mitochondrial membrane thereby facilitating fatty acid oxidation and reducing the long-chain fatty acids availability for storage in adipose tissues. Several studies on pigs, fish, quails, foals and broiler chickens have shown that growth performance was significantly improved by feeding dietary L-carnitine (Rabie *et al.,* 1997). The present experiment was conducted to study the effects of ratio of unsaturated to saturated fatty acids (60:40, 65:35, 70:30 and 75:25) with or without L-carnitine supplementation on the performance of male broiler chicks.

MATERIALS AND METHODS

A total of 320 day old male broiler chicks were divided into 8 treatments with eight replicate and five birds each. The experiment was conducted at the Poultry Experimental Station, Department of Poultry Science, College of Veterinary Science, Rajendranagar, Hyderabad, India. At day one, chicks were wing banded and housed under battery brooder with optimum brooding conditions. Standard management practices were followed up to 42 days of age. Before the feed formulation, the lipid profile of the tallow and crude soybean oil was analyzed using Gas chromatography (Agilent Technologies 6890N).

The birds were fed with maize and soybean meal based diets presented in Table 1. The nutrient content of ingredients was taken as per the NRC (1994). The

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broiler starter diet was formulated to contain 22% protein and 2950 kcal/kg ME so as to get 1: 135 protein: calorie ratio. Similarly, the broiler finisher diet was formulated to contain 18% protein and 3100 kcal/kg ME so as to get 1: 170, protein: calorie ratio. The starter diet was fed up to four weeks of age and the finisher diet was fed during 5th and 6th week. The energy contributed by fat and or oil sources was kept constant for all the treatments. The diets T_1, T_2, T_3 and T_4 were formulated to contain ratio of unsaturated fatty acids (UFA): saturated fatty acids (SFA) as 60: 40, 65: 35, 70: 30 and 75: 25, respectively. Diets T_5, T_6, T_7 and T_8 were formulated to contain same ratio of fatty acids to that of T_1 to T_4 but with supplementation of L-carnitine at 100 mg/kg diet level (Table 1). Body weights of individual birds were recorded and body weight gain was calculated as mean of each replicate. The feed intake was recorded from day old to 42 days at weekly intervals. The feed conversion ratio (FCR) was calculated from 0-6 weeks of age at weekly intervals and presented in 2 phases (starter and finisher). Mortality was recorded throughout the experimental period. The data were analysed using General Linear Model procedure of SPSS 16th version and comparison of means was tested using Duncan's multiple range test and significance was considered at $P<0.05$ level.

RESULTS AND DISCUSSION

The UFA and SFA present in crude soyabean oil were 84.27 and 15.69%, respectively (Table 2) and the levels were almost similar to the findings of Waldroup and Waldroup (2005). The proportion of linoleic acid (18: 2), linolenic acid (18: 3) and UFA: SFA ratio in CSO was higher compared to normal values. Jeong-Dong Lee *et al.* (2007) indicated that soybean grown under high average temperatures reduced 18: 2, 18: 3 and increased 18: 1 content, however, contents of saturated fatty

Table 1. Ingredient composition (%) of experimental diets

Treatment	Maize	Soya	Tallow	Crude soy oil	Constants*	L-Carnitine (mg/kg diet)
Starter diet (0-28 d)						
T_1	53.47	39.70	1.84	1.26	3.73	-
T_2	53.42	39.80	1.44	1.61	3.73	-
T_3	53.27	40.00	1.05	1.95	3.73	-
T_4	53.22	40.10	0.67	2.28	3.73	-
T_5	53.47	39.70	1.84	1.26	3.73	100
T_6	53.42	39.80	1.44	1.61	3.73	100
T_7	53.27	40.00	1.05	1.95	3.73	100
T_8	53.22	40.10	0.67	2.28	3.73	100
Finisher diet (28-42 d)						
T_1	62.40	30.00	2.29	1.57	3.74	-
T_2	62.35	30.10	1.80	2.01	3.74	-
T_3	62.31	30.20	1.31	2.44	3.74	-
T_4	62.24	30.32	0.84	2.86	3.74	-
T_5	62.40	30.00	2.29	1.57	3.74	100
T_6	62.35	30.10	1.80	2.01	3.74	100
T_7	62.31	30.20	1.31	2.44	3.74	100
T_8	62.24	30.32	0.84	2.86	3.74	100

*Dicalcium phosphate, Calcite powder, Common salt, DL-methionine, Choline chloride, vitamins AB_2D_3K, B-E mix, vitamin B_{12}, Trace mineral mixture, L-lysine HCl, Cygro, Auryomycine

acids were changed little by the environment. The UFA: SFA ratio for tallow in the present experiment was 0.77. It could be noticed that tallow contained higher levels of stearic acids when compared to the normal values. The difference in fatty acid profile of animal fat can be attributed to the diet, age and environmental conditions and mostly tissue involved in the rendering process.

The body weight gain of broilers was influenced (P<0.05) by UFA: SFA ratio during starter, finisher and overall period but there was no significant trend in weight gain (Table 3). However, body weight gain was higher at 70: 30 and and lower with 75: 25 ratios of UFA: SFA during all the phases. Navidshad *et al.* (2006) also reported that feeding diets with UFA: SFA ratio 6.5 adversely affected weight gain when compared to other ratios of UFA: SFA (2, 3.5 and 5). Similarly, Wongsuthavas *et al.* (2007) found that the average daily weight gain of broilers was not influenced by feeding with three levels (3, 6 and 9%) of soybean- tallow blends, composing of different ratio of SFA: UFA ratio (1: 1, 1: 2, 1: 3, 1: 4 and 1: 5). The present data suggested that the best synergism between unsaturated and saturated fatty acid at 70:30 ratio (2221g) and further increase in the ratio did not show any advantage. Supplementation of 100 mg/kg L-carnitine reduced (P<0.05) body weight gain during starter, finisher and overall period of the experiment. Whereas, Lien and Horng (2001) reported no significant reduction in weight gain in broilers fed 160 mg/kg L-carnitine. At higher environmental temperature, supplementing L-carnitine or L-carnitine and ascorbic acid increased body weight gain (Celik and Ozturkcan, 2003) whereas a reverse trend was observed under ambient temperature condition. The interaction effect of UFA: SFA with L-carnitine on body weight gain of broilers during all the periods was also significant. The growth rate was higher (P<0.05) for

Table 2. Fatty acid (%) profile of experimental fat source

Fatty Acid	Crude soy oil	Tallow
Lauric	n.d	0.07
Myristic	n.d	2.26
Pentadecylic	n.d	0.67
Palmitic	11.95	25.05
Palmitoleic	0.11	2.32
Margaric	n.d	1.84
Stearic	3.03	26.35
Oleic	25.33	39.05
Linoleic	52.26	1.67
Linolenic	6.57	0.31
Arachidic	0.30	0.36
Behenic	0.41	n.d
Σ saturated fatty acids	15.69	56.60
Σ unsaturated fatty acids	84.27	43.35
UFA/SFA	5.37	0.77
monounsaturated fatty acids(ΣMUFA)	25.44	41.37
polyunsaturated fatty acids (ΣPUFA)	58.83	1.98
omega -3 fatty acids (n3)	6.57	0.31
omega-6 fatty acids (n6)	52.26	1.67
n3/n6	0.13	0.19

broilers fed on diets containing different UFA: SFA ratios without L-carnitine than with 100 mg/kg L-carnitine supplementation. In contrary, Jalali *et al.* (2015) reported that soybean oil with L-carnitine significantly improved body weight gain in the grower and total period of rearing.

Feed intake was significantly (P<0.05) higher at 70: 30 ratio during starter and finisher period. Cumulative feed intake at 6 weeks of age increased with increase in ratios from 60: 40 to 70: 30 and thereafter sudden drop in feed intake was observed (Table 4). These results are in agreement with those of Navidsha, *et al.* (2006) who reported sudden fall in feed intake at 6.5 ratio of UFA: SFA than 2.5, 3.5 and 5 during grower and finisher phases. Conversely, Wongsuthavas *et al.* (2007) reported absence of significant influence of SFA: UFA ratio on feed intake. Effect of carnitine on feed intake was reduced (P<0.05) in broilers fed diets supplemented with carnitine during starter phase whereas during finisher and overall period, feed intake was not affected with carnitine supplementation. The interaction between carnitine supplementation and UFA: SFA ratio of supplemental fats was significant (P<0.05) for feed intake during starter, finisher and overall period. During starter phase L-carnitine supplementation to UFA: SFA ratio significantly reduced feed intake at all the ratios except at 70:30 where the carnitine supplementation increased feed intake. Similarly, the feed intake increased during overall period with L-carnitine supplementation at 60:

Table 3. Effect of ratio of UFA: SFA with or without L-carnitine on body weight gain

Treatment	L-carnitine	Body weight gain (g/bird)		
		0-28 d	28-42 d	0-42 d
T_1 (60: 40)	0	1237^{ab}	912^{b}	2149^{b}
T_2 (65: 35)	0	1258^{a}	924^{b}	2182^{b}
T_3 (70: 30)	0	1246^{ab}	975^{a}	2221^{a}
T_4 (75: 25)	0	1232^{b}	921^{b}	2153^{b}
T_1 (60: 40)	100	1229^{b}	955^{a}	2185^{b}
T_2 (65: 35)	100	1191^{c}	885^{c}	2077^{c}
T_3 (70: 30)	100	1223^{b}	924^{b}	2147^{b}
T_4 (75: 25)	100	1184^{c}	876^{c}	2060^{c}
Effect of UFA: SFA ratio				
60: 40		1233^{a}	934^{a}	2167^{a}
65: 35		1225^{a}	905^{b}	2129^{b}
70: 30		1235^{a}	949^{a}	2184^{a}
75: 25		1208^{b}	899^{b}	2107^{b}
Effect of L-carnitine (mg/kg)				
0		1243^{a}	933^{a}	2176^{a}
100		1207^{b}	910^{b}	2117^{b}
SEM		**3.895**	**4.879**	**7.573**
P value				
UFA: SFA ratio* L-carntine		0.001	0.001	0.001
UFA: SFA ratio		0.003	0.001	0.001
L-Car		0.001	0.001	0.001

^{a,b} Means with different superscripts in a column differ significantly (P<0.05)

40 ratio of UFA: SFA diet. Variation in the composition of diet and period of feeding finisher diet might be responsible for the difference observed between the present study and the above report. The effect of UFA: SFA ratio was better (P<0.05) for 60: 40 ratio during finisher and overall period of the experiment and during starter period 75: 25 ratio had significantly better FCR when compared to the other ratios (Table 5). Similarly, Navidshad *et al.* (2006) reported lowest FCR in birds fed with 3.5 UFA: SFA ratio when compared with 5 and 6.5 ratio of UFA: SFA. Thus the present data suggested that as the unsaturation of supplemental fat increased feed efficiency decreased. These findings are contradictory to Wongsuthavas *et al.* (2007a) who reported lowest FCR at higher inclusion of unsaturated fats at the expense of saturated fats. Supplementing L-carnitine reduced (P<0.05) the performance during starter and finisher periods. Khadem *et al.* (2006) also reported that supplementing L-carnitine at 50 mg/kg had no significant effect on FCR. Similarly, other authors (Xu *et al.* 2003; Murali *et al.* 2015) also indicated that the dosage of carnitine did not have significant effect on FCR. In contrary, Abedpour *et al.* (2017) found that supplementation of L-carnitine could improve growth performance of quails.

The interaction effect between carnitine and UFA: SFA ratio on feed per gain was significant (P<0.05) during starter phase. The interaction data suggested that supplementing 100 mg/kg L-carnitine to diet containing 75: 25 UFA: SFA ratio had significantly better feed per

Table 4. Effect of ratio of UFA: SFA with or without L-carnitine on feed consumption

Treatment	L-carnitine (mg/kg)	Feed consumption (g/bird)		
		0-28 d	28-42 d	0-42 d
T_1 (60: 40)	0	1861^{bc}	2185^{c}	4046^{cd}
T_2 (65: 35)	0	1884^{b}	2341^{ab}	4225^{a}
T_3 (70: 30)	0	1864^{bc}	2374^{a}	4238^{a}
T_4 (75: 25)	0	1830^{c}	2295^{ab}	4125^{bc}
T_1 (60: 40)	100	1853^{bc}	2329^{ab}	4182^{ab}
T_2 (65: 35)	100	1787^{d}	2260^{bc}	4047^{cd}
T_3 (70: 30)	100	1939^{a}	2300^{ab}	4239^{a}
T_4 (75: 25)	100	1732e	2273^{b}	4005^{d}
Effect of UFA: SFA ratio				
60:40		1857^{b}	2257^{b}	4114^{bc}
65:35		1836^{b}	2301^{ab}	4136^{b}
70:30		1902^{a}	2337^{a}	4239^{a}
75: 25		1781^{c}	2284^{ab}	4070^{c}
Effect of L-carnitine (mg/kg)				
0		1860^{a}	2299	4159
100		1828^{b}	2291	4118
SEM		**8.556**	**11.244**	**15.687**
P value				
UFA: SFA ratio* L-carnitine		0.001	0.001	0.001
UFA: SFA ratio		0.001	0.032	0.001
L-Car		0.001	0.671	0.086

^{a,b} Means with different superscripts within a column differ significantly (P<0.05)

Table 5. Effect of ratio of UFA: SFA with or without L-carnitine on feed conversion ratio

Treatment	L-carnitine (mg/kg)	FCR (kg feed/gain)		
		0-28 d	28-42 d	0-42 d
T_1 (60: 40)	0	1.51[b]	2.40	1.88
T_2 (65: 35)	0	1.50[b]	2.53	1.94
T_3 (70: 30)	0	1.50[b]	2.44	1.91
T_4 (75: 25)	0	1.49[b]	2.49	1.92
T_1 (60: 40)	100	1.51[b]	2.44	1.91
T_2 (65: 35)	100	1.50[b]	2.55	1.94
T_3 (70: 30)	100	1.58[a]	2.49	1.97
T_4 (75: 25)	100	1.46[c]	2.60	1.94
Effect of UFA: SFA ratio				
60: 40		1.51[b]	2.42[c]	1.90[b]
65: 35		1.50[b]	2.54[a]	1.94[a]
70: 30		1.54[a]	2.46[b]	1.94[a]
75: 25		1.47[c]	2.54[a]	1.93[a]
Effect of L-carnitine (mg/kg)				
0		1.50[b]	2.46[b]	1.91[b]
100		1.51[a]	2.52[a]	1.95[a]
SEM		**0.037**	**0.084**	**0.036**
P value				
UFA: SFA ratio* L-carnitine		0.001	0.254	0.062
UFA: SFA ratio		0.001	0.001	0.001
L-carnitine		0.001	0.001	0.001

[a,b] Means with different superscripts within a column differ significantly (P<0.05)

gain whereas at 70: 30 ratio, it resulted in poor FCR and at other ratios it remained unaffected. The interaction effect on feed per gain was not significant during finisher (28-42 d) and overall period (0-42 d).

CONCLUSION

It was concluded that a ratio of UFA: SFA (70:30) without L-carnitine supplementation showed highest body weight gain compared to other treatments but when FCR were considered, 60: 40 ratio without L-carnitine gave better performance than 70:30 ratio.

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