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Effects of Feed Restriction and Dietary Fat Saturation on Performance and Serum Thyroid Hormones of Broiler Chickens

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Abstract: This experiment carried out to study the effects of dietary fat saturation on performance and serum thyroid hormones of broilers under free or skip a day nutrition at 18-28 days of age. We used 720 male Ross 308 broiler chickens in a completely randomized design with a 2*4 factorial arrangement with 3 replicate and 30 chicks for each replicate. Experiment factors were: 1- skip a day or free feeding at days 10-28 of age and, 2- diets with different unsaturated to saturated fatty acid ratios (2, 3.5, 5 and 6.5) formulated using different levels of sunflower oil and tallow. At 28 and 42 days of age, weight gain and feed consumption recorded and blood samples were taken. SAS software used for Variance analysis and means comparing. Skip a day nutrition at days 18-28 of age significantly reduced feed intake and weight gain and increased feed conversion, But free nutrition at days 29-42 of age removed this differences. At day 28, diet with unsaturated to saturated ratio of 6.5 significantly reduced feed intake and weight gain and increased feed conversion. At day 42 of age dietary fat type didn't have any significant effect on feed intake and weight gain but altered feed conversion as a manner same to day 28 of age. Skip a day nutrition significantly decreased T3 and increased T4 levels at day 28 of age but this effects were disappeared after re-feeding at day 42 of age. This survey showed that feed restriction didn't affect bird's ability to utilize fats with different degrees of saturation. Fat type and feed restriction affect broilers performance separately without any interaction. Dietary fat saturation didn't have any significant effect on serum thyroid hormones levels, while feed restriction have a pronounce effect.

Key words: Dietary fat, thyroid hormones, fatty acid

Introduction

Thyroid hormones regulate both the metabolism of chickens and possibly, the flux of calories required to support metabolism. Although thyroxine (T4) is the predominant thyroid hormone in circulation, it has little inherent biological activity (Cristofori *et al*., 1997). The more metabolically active thyroid hormone, triiodothyronine (T3), is produced by the 5'-deiodination of T4 catalyzed by iodothyronine 5'-monodeiodinase within the thyroid gland and in extra thyroidal tissues (Cristofori *et al*., 1997; Darras *et al*., 1992).

Because of limited capacity of digestive tract, plant or animal fats or their mixtures are important components of broilers high energy diets. Fats with high unsaturated fatty acid content have a more absorbability and there is a known synergism between saturated and unsaturated fats (Freeman, 1984; Hulan *et al*., 1984). Age of birds affect fats digestibility too, so that at earlier ages, there is an inadequate production of fat digestive enzymes from liver and especially animal fat digestion significantly improve with age (Yu and Robinson, 1992). Increased hepatic 5'D activity was reported in rats fed a high fat diet (Giachetto *et al*., 2003) and in sheep fed a palm oil (Hulan *et al*., 1984) or a soy lecithin supplemented diet (Kahl *et al*., 1998). Some reports have shown that feeding T4 (Ketels and DeGroote, 1989) or T3 (Klandorf and Harvey, 1985) to growing chickens decreased body weight gain, total lipid content and in vitro lipogenesis. These researches indicate that the hepatic generation of T3 is stimulated by increased dietary fat intake. Bartha (1993) showed that adding fat to isocaloric diets lead to decreased T3 and increased T4 levels in the serum of broiler chickens. Rosenbrough *et al*. (1999) reported no differences in plasma thyroid hormones in broilers chickens fed diets with different dietary fat levels. Kahl *et al*. (1998) had a same observation. These findings indicate that there is a close relationship between thyroid hormone metabolism and fat metabolism and deposition, but the effect of dietary fat type needs more investigation.

In birds with retarded growth because of feed restriction, re-feeding can lead to a compensatory growth (Plavnik and Hurwitz, 1985). This birds can even show a better final live weight in compare to controls (Plavnik and Hurwitz, 1990). Changes in weight gain composition, higher efficiency of energy utilization, and reduction in maintenance requirements are important factors for compensatory growth occurrence (Yu and Robinson, 1992). It has been shown that hyperphagia and high carbohydrate diets increase extrathyroidal 5'D activity in mammals (Freeman, 1984; Furlan *et al*., 2001). May (1978) and Klandorf and Harvey (1985) reported that in

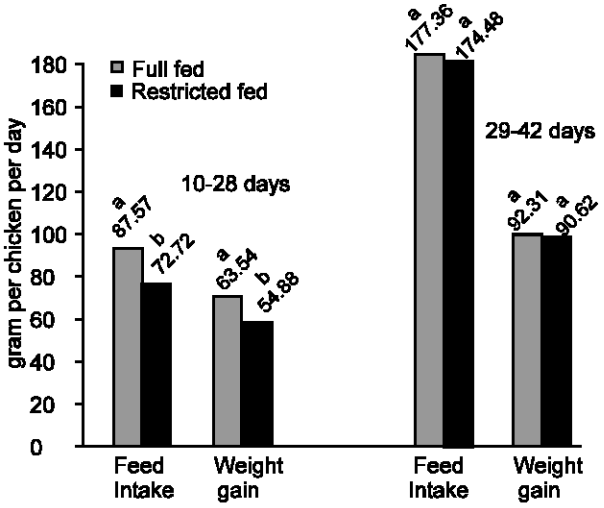

Fig. 1: Effects of feed restriction on weight gain and feed intake

[a,b]Means in a column with no common superscripts differ significantly (P<0.05)

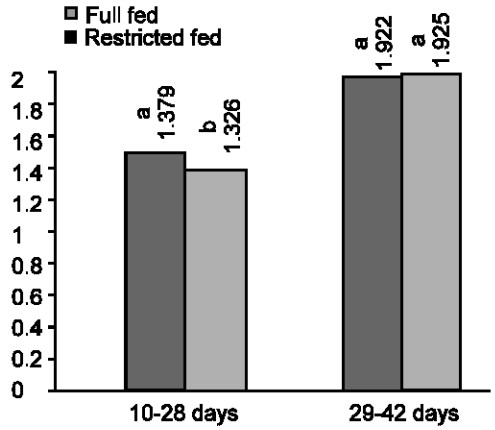

Fig. 2: Effects of feed restriction on feed conversion ratio

[a,b]Means in a column with no common superscripts differ significantly (P<0.05)

chicken like other studied vertebrae, feed restriction reduce plasma T3, and unlike more vertebrae enhance plasma T4 level (Freeman, 1984). There are controversial findings in this respect, for instance Giachetto *et al.* (2003) showed that feeding program type and dietary energy level didn't affect serum T3 and T4 levels in chicken.

The purpose of the present study was to investigate the probable interaction between feed restriction and dietary fat saturation on broilers performance and serum T3 and T4 levels.

Materials and Methods

Seven hundred and twenty, 10 days old male chicks (Ross 308) were used in the study. The birds were randomly assigned according to their initial body weights to a completely randomized design with a 2*4 factorial arrangement with 3 replicate and 30 chicks for each replicate. Experiment factors were: 1- skip a day or free feeding at days 18-28 of age and, 2- diets with different unsaturated to saturated fatty acid ratios (2, 3.5, 5 and 6.5) formulated using different levels of sunflower oil and tallow. Fatty acids content of beef tallow and sunflower oil determined by gas chromatography and other information for diet formulation extracted from NRC (1994).

The birds were fed a grower diet until 28 d of age followed by a finishing diet at 29 to 42 days of age. The basal diets were formulated using Ross Co. (2002) guideline. Fatty acid composition of ingredients and the composition of experimental diets are shown in Table 1 and 2, respectively.

At the end of grower (28d) and finisher (42d) periods, feed intake and body weights were determined and feed conversion ratio calculated. At same times, blood samples were collected from jugular vein from 5 birds randomly chosen from each treatment, and serum was prepared and stored at -20°C for determination of T3 and T4 levels via radioimmunoassay method. The data were analyzed using the GLM procedure of SAS software (1990). Significant differences among treatment means were determined using Duncan's new multiple range test.

Results

Effects of dietary fat saturation degree: Table 3 illustrates the effects of different dietary ratios of unsaturated to saturated fatty acids on feed intake, weight gain and feed conversion at 28 and 42 days of age.

At 10-28 days of age, feeding diet with U/S ratio of 6.5 decreased chickens feed intake ($p<0.05$) and body weight gain ($p<0.05$), but these parameters become similar during the period of 29 to 42 days and no significant difference observed at this time. Feeding diets with U/S ratios of 6.5 and 2, adversely affected feed conversion ratio. This difference was more pronounced at 28 d. Serum thyroid hormones didn't affect by dietary fat type during whole the experiment time.

Effects of feed restriction: Fig. 1 and 2 show the effects of feed restriction on weight gain, feed intake and feed conversion ratio. Skip a day feeding at 18-28 days of age, significantly reduced weight gain and fed intake and enhanced feed conversion ($p<0.05$). re-feeding at 29-42 days of age, compensated these reduction.

Fig. 3 shows the effect of skip a day feeding at 18-28 days of age on the serum thyroid hormones. At 28 days of age, Feed restriction significantly reduced T3 and enhanced T4 level in chicken's serum ($p<0.05$), but after returning to every day feeding at 29 to 42 days of age, there weren't any marked differences in this parameters.

Table 1: Fatty acid composition of ingredients

Ingredients	Crude Fat (%)	Fatty Acid type (%)					
		16:0	16:1	18:0	18:1	18:2	18:3
Corn	3.8	0.62	–	0.1	1.17	1.82	0.09
Soybean meal	1	0.24	0.01	0.05	0.16	0.47	0.07
Sunflower oil	100	6.7	0.1	4.3	27.4	57.1	3.7
Beef tallow	100	25	4.2	22.7	37	2.5	0.3

Table 2: Composition and calculated nutrient content of broiler grower (fed 10 to 28 days) and finisher (fed 29 to 42 days) diets with different unsaturated to saturated fatty acids ratios unsaturated to saturated fatty acids ratio

Ingredients	Unsaturated to saturated fatty acids ratio							
	2		3.5		5		6.5	
	Grower	Finisher	Grower	Finisher	Grower	Finisher	Grower	Finisher
Corn (%)	42.83	49.29	46.02	52.42	47.29	53.66	47.97	54.33
Soybean meal (%)	42.38	36.35	41.75	35.72	41.5	35.48	41.36	35.34
Sunflower meal (%)	1.49	1.32	4.36	4.14	5.5	5.26	6.12	5.86
Beef Tallow (%)	9.07	8.85	3.64	3.52	1.48	1.4	0.33	0.27
$CaCO_3$	0.99	1	1	1.01	1	1.01	1	1.01
DCP (%)	1.84	1.88	1.83	1.87	1.83	1.87	1.83	1.87
Common salt (%)	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38
Vitamin premix (%)	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Mineral premix (%)	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
DL- Methionine (%)	0.34	0.31	0.34	0.3	0.34	0.3	0.33	0.3
HCl-Lysin (%)	0.18	0.13	0.18	0.14	0.19	0.15	0.19	0.15
ME (Kcal/Kg)	3150	3200	3150	3200	3150	3200	3150	3200
Crud Protein (%)	21	19	21	19	21	19	21	19
Calcium (%)	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
Av. Phosphorus (%)	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45
Sodium (%)	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16
Lysin (%)	1.2	1.05	1.2	1.05	1.2	1.05	1.2	1.05
Methionine (%)	0.54	0.49	0.54	0.49	0.54	0.49	0.54	0.49
Met + Cys (%)	0.85	0.78	0.85	0.78	0.85	0.78	0.85	0.78

No significant interaction observed between feeding procedure and dietary fat type and these factors apparently acts independently on measured traits.

Discussion

In this study, skip a day feeding cause a pronounce reduction in feed intake and growth. Chickens under feed restriction, had a lower feed intake and weight gain even after returning to continuous feeding program, but at the end of experiment (day 42) these variations were insignificant.

These results are in agreement with Furlan *et al.* (2001), Kelaricolaii *et al.* (2003) and Lippens *et al.* (2003) findings, while in some cases improvements in final body weight after catch up growth have reported too (KyuHo *et al.*, 2002; Oyedeji and Atteh, 2003).

In severe feed restrictions, birds maybe unable to reach an acceptable body weight at the end of raring period. Such finding achieved by Cristofori and *et al.* (1997). Increased feed conversion ratio before returning to ad libitum feeding, has reported by Santoso (2002) too, but more researches have reported feed conversion improvement following catch up growth (Urdanaeta-Ricon and Leeson, 2002). Furlan *et al.* (2001) reported major decline in intestine weight and dimensions due to feed restriction that can affect adversely feed utilization. The expected improvement in feed conversion subsequent re-feeding is likely due to a drop in maintenance requirements or basic metabolism because of a smaller body size (Urdanaeta-Ricon and Leeson, 2002). Feed intake and weight gain reduction and feed conversion enhancement at 21 day of age by diet with U/S ratio of 6.5, is a little in opposite to the better digestibility of unsaturated fats (Ketels and DeGroote, 1989). Ketels and DeGroote (1989) reported that the best digestibility of fats achieve at U/S ratio of 4, but increasing this ratio in their research, unlike current study, didn't reduce digestibility. Lewis (1989) suggested that the highest synergism between saturated and unsaturated fats occur when dietary fat level is not more than 3%, which is extremely lower than fat content of this research rations. T3 reduction and T4 enhancement in chicken's serum during feed restriction is in agreement with previous reports (Klandorf and

Table 3: Performance of broilers fed diets with different U/S ratio

	10-28 days			29-42 days		
U/S ratio	FI (g/d)	LWG (g/d)	FCR	FI (g/d)	LWG (g/d)	FCR
2	80.96[a]	59.61[a]	1.356[ab]	180.57[a]	92.29[a]	1.957[c]
3.5	81.49[a]	60.66[a]	1.342[a]	173.46[a]	91.88[a]	1.888[a]
5	80.56[a]	60.43[a]	1.331[a]	176.05[a]	92.47[a]	1.904[ab]
6.5	77.58[b]	56.13[b]	1.380[b]	173.60[a]	89.22[a]	1.945[bc]
S.E.M	6.1	4.9	0.04	9.2	7.1	0.05

[a,b]Means in a column with no common superscripts differ significantly (P<0.05)
FI: Feed intake, LWG: Live weight gain, FCR: Feed conversion ratio, U/S: Unsaturated to saturated fatty acids ratio

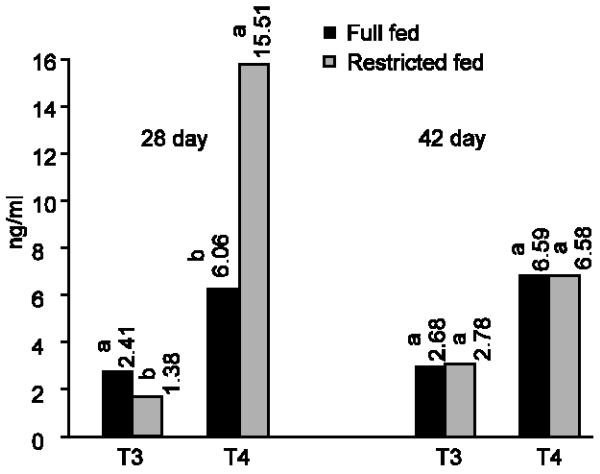

Fig. 3: Effect of feed restriction on serum thyroid hormones.
[a,b]Means in a column with no common superscripts differ significantly (P<0.05)

Harvey, 1985; May, 1978). The decrease in plasma T3 levels in food deprived animals is likely to be the result of a shift in the balance between deiodination of thyroxine by the outer ring deiodinase type I and T3 degradation by the inner ring deiodinase type III (Darras *et al*., 1992, 1995). This change explains the reverse fluctuation of T3 and T4 during feed restriction. Veerle *et al*. (2000) reported that feed restriction in growing broilers increase hepatic inner ring deiodinase type III enzyme, and re-feeding reset this enzyme and T3 level. The results of this research showed that feed restriction apparently doesn't affect bird's ability for utilization fats with different unsaturation degree. Feeding program can affect circulation thyroid hormones levels, but dietary fat type didn't show a same effect.

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