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Influence of abnormal body weight on serum biochemical integrant

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Abstract

Two experiments were conducted separately for this study, in each experiment genetically fat and lean chickens were selected and reared under the same environment and management system. The effect of breed on body weight and abdominal fat weight were found to be significant (P < 0.05). Genetically fat and lean chickens were significantly differed in total cholesterol (TCH) and LDL (P < 0.05) in the first experiment and in TCH and HDL (P < 0.01) in the second experiment. Male and female in fat chickens were found significantly different (P < 0.05) in triglycerides and VLDL in the first experiment, and in TCH and LDL (P < 0.01) in both fat and lean chickens in the second experiment. In addition, fat was negatively correlated with TCH, triglycerides, HDL and VLDL, and positively with LDL in fat chickens, whereas in lean abdominal fat was positively correlated with all serum biochemical concentrations, and negatively with triglyceride in the first experiment. In the second experiment all serum biochemical concentrations were positively correlated with fat in fat and lean chickens, whereas triglycerides, high density lipoprotein and very low density lipoprotein were negatively correlated with fat in fat chicken. Finally our result illustrated that fat has a significant impact on lipoprotein metabolism.

Keywords: lipoprotein metabolism, obesity.

INTRODUCTION

The lean and fat chicken lines have been selected for adipose tissue weight (LeClerq et al., 1980; Cahaner and Nitsan, 1985) and for VLDL concentration (Whitehead and Griffin, 1984). It is noted that the difference between fat and lean line in adiposity is not a result of difference in food consumption or metabolic utilization of energy. It was due to differences in the number of adipocytes in the abdominal fat LeClerq et al. (1980). In contrast, Zollitsch et al. (1997) indicated that abdominal fat was significantly influenced by the dietary fatty acid pattern. Comparative studies in lean and fat lines of chickens show that in avian species, triglycerides accumulation in adipocytes depend manly on the availability of plasma substrate VLDL rather than the activity of LPL (Hermier et al., 1989). This was concord with the assumption that the growth of adipose tissue in birds depends directly on the VLDL-triglyceride level (Hermier et al., 1991). The hepatic secretion and plasma concentration of VLDL were always higher in fat line than lean chicken; because VLDL concentration reflected the availability of plasma triglycerides and therefore the susceptibility to fattening (Her-mier, 1997) . The objective of the study was to investigate which lipid component can control fat accumulation in chickens, therefore lean and fat chickens were used in each experiment.

MATERIALS AND METHODS

Experimental animals

The experimental animals include Wenchang and Rugao chickens for the first experiment, Anka and Rugao for the second experiment. In each experiment both breeds were reared to 12 weeks of age under the same environment and management in Jiangsu Poultry Institute, Yangzhou, China. In each breed the numbers of males and females are equally selected. Diets in Table 1 and water were provided ad libitum during the study period (2005 - 2006). At 12 weeks of age birds were subjected to feed withdrawal overnight, 5 ml blood samples were taken from the wing vein of fasting chicken. Serum was harvested by centrifugation and frozen for serum lipid and lipoproteins analysis.

Table 1. Diet formulation of chicken breed.

Ration ID	CP	CF		Ash	Ca	P		Nacl	Meth	Water
510[1]	21.0	5.0		7.0	0.8-1.3	0.60		0.3-0.8	0.37	13.0
510[2]	19.0	5.0	7.0	0.7-1.2	0.55	0.3-0.8	0.32	13.0		

[1]0 - 3week, [2]4 - 12week

Table 2. Breed effect on body and fat weight.

Experiment	First experiment		Second experiment	
Breed	**Fat (Wenchang)**	**Lean (Rugao)**	**Fat (Anka)**	**Lean(Rugao)**
Sample size	30	40	60	60
Body weight	1075±37 [a]	878±20.52 [b]	3400±63 [a]	1113±22 [b]
Fat weight	22±3 [a]	9±1.04 [b]	55.99±1.26 [a]	16.69±0.39 [b]
Fat weight %	2.52±0.26	1.19±0.14	1.75±0.05	1.67±0.03

Parameters with different subscript in column was significant at ($P < 0.05$)

Table 3. Breed effect on total cholesterol, triglyceride and serum lipoprotein concentrations (mg/dl).

Experiment	First experiment		Second experiment	
Breed	**Fat (Wenchang)**	**Lean (Rugao)**	**Fat (Anka)**	**Lean(Rugao)**
Sample size	30	40	60	60
TCH[1]	121.73±5.00[a]	137.77±3.59[b]	141.39±3.53 [a]	157.80±4.94 [b]
TG[2]	56.92±13.70	48.79±2.99	19.09±0.97	20.35±0.69
HDL[3]	59.62±2.93	61.40±1.55	93.97±2.78 [a]	118.15±3.99 [b]
VLDL[4]	11.38±2.74	9.76±0.61	3.82±0.19	4.07±0.14
LDL[5]	50.32±4.58 [a]	66.61±3.46 [b]	43.44±3.99	35.56±4.68

[1]Total cholesterol; [2]Triglycerides; [3]High density lipoprotein cholesterol; [4]Very low density lipoprotein cholesterol; [5]Low density lipoprotein cholesterol; Parameters with different subscript in column was significant at ($P < 0.05$).

Fat determinations

Chickens were slaughtered, carcasses were eviscerated and dissected manually and then abdominal fat weight was estimated. The percentage of abdominal fat weight was expressed as a ratio of body weight (Musa et al., 2006).

Biochemical serum analysis

Total serum cholesterol and triglycerides were assayed using a commercial enzymatic kit supplied by (Zhejiang Dongou Biological Engineering Co., Ltd.). High density lipoprotein cholesterol was detected enzymatically after precipitation of (LDL and VLDL) by heparin and manganese. Very low density lipoprotein cholesterol is estimated as [Triglycerides/5] (Friedwald et al., 1972). Low density lipoprotein cholesterol is estimated using the Friedewald equation [Low density lipoprotein cholesterol = Total cholesterol – High density lipoprotein cholesterol – Trigylerides/5] (Friedewald et al., 1972).

Statistical analysis

Significant difference between breeds and sexes were determined by student t-test using SAS 9.0 software. Pearson correlation coefficients were computed between cholesterol, triglycerides, lipoprotein concentrations and abdominal fat weight. All statements of significance were assessed at ($P < 0.05$) and all values are presented as the means ± standard error of mean (S.E.M).

RESULTS

Breed effect on fat and biochemical serum levels

The effect of genetically fat and lean chickens on body weight and abdominal fat weight was significant ($P < 0.05$), whereas on the percentage of abdominal fat weight was non significant in both conducted experiments (Table 2). In the first experiment, total cholesterol and LDL were found to be significantly ($P < 0.05$) differed between fat and lean chickens, whereas triglyceride, VLDL and HDL were non significantly different (Table 3). In the second experiment fat and lean chickens were also found to significantly differed ($P < 0.01$) on cholesterol and high density lipoprotein levels, and non significantly differed on

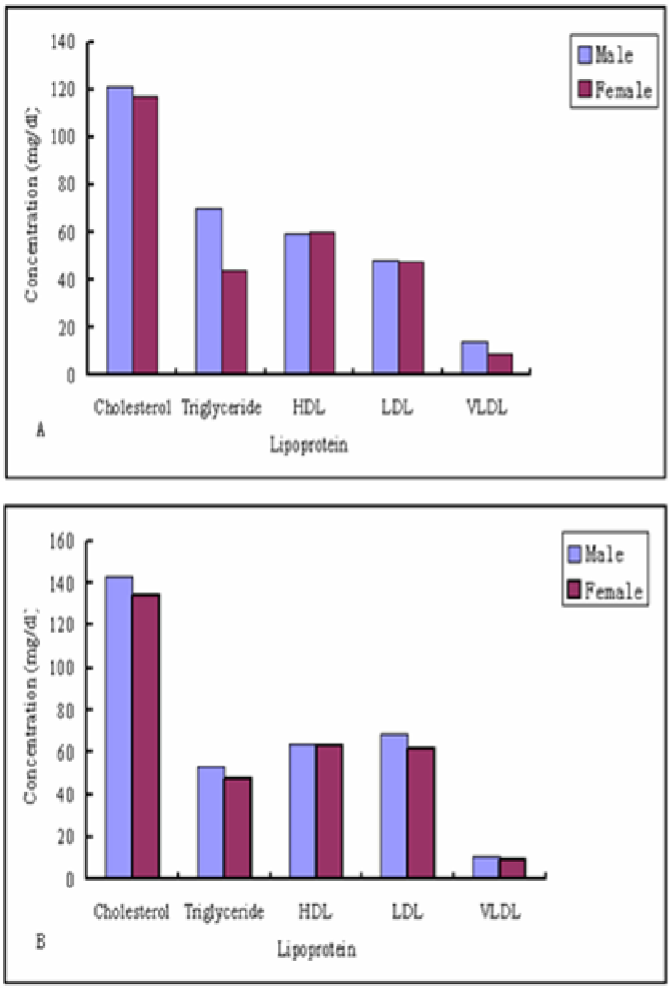

Figure 1. Effect of sex on total cholesterol, triglycerides and lipoprotein concentrations in chickens A, Wenchang, B, Rugao (First experiment).

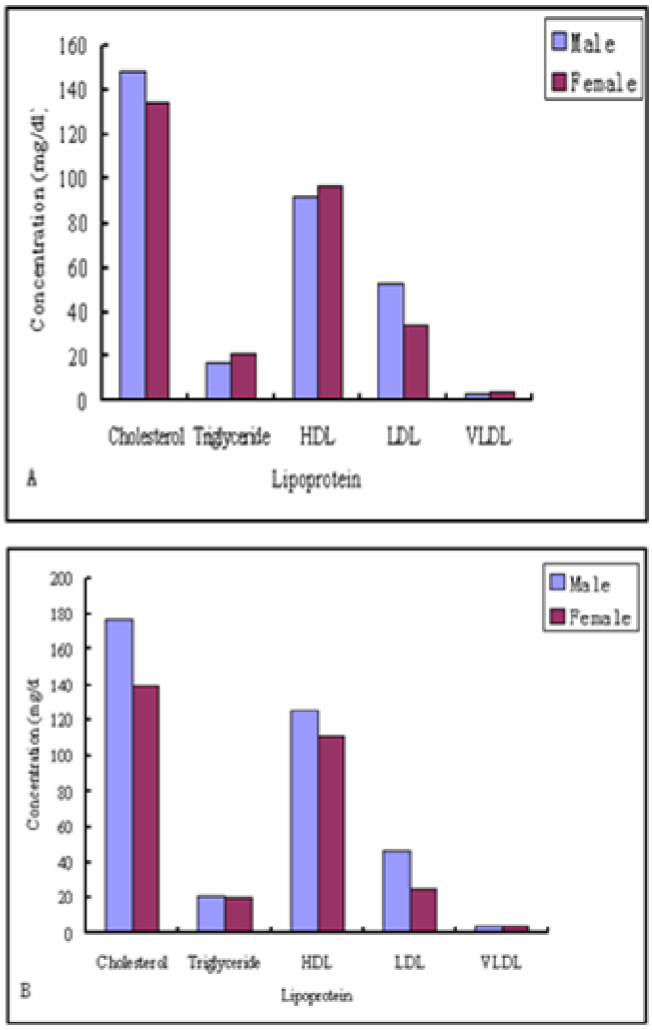

Figure 2. Effect of sex on total cholesterol, triglycerides and lipoprotein concentrations in chickens, A, Anka, B, Rugao (Second experiment).

triglycerides, very low density lipoprotein and low density lipoprotein levels (Table 3).

Sex effect on biochemical serum levels

The effect of sex on biochemical serum levels for the first experiment was shown in (Figure 1). Males and females were non significantly different on total cholesterol level, triglycerides, HDL, VLDL and LDL in lean chickens. In fat chickens, triglycerides and VLDL were significantly different ($P < 0.05$), while total cholesterol, HDL and LDL was non significantly different ($P > 0.05$). Males compared with females in the second experiment showed to have significantly ($P < 0.01$) higher levels of total cholesterol and low density lipoprotein in fat and lean chickens. However, triglycerides, high density lipoprotein and very low density lipoprotein levels were non significantly ($P > 0.05$) different between males and females (Figure 2).

Correlation between abdominal fat and biochemical serum levels

The relationship between biochemical serum concentrations and abdominal fat weight in fat and lean chickens were studied and their results are exhibited in Table 4). In the first experiment, abdominal fat weight was negatively correlated with total cholesterol, triglycerides, high density lipoprotein and very low density lipoprotein, and positively with LDL in fat chickens. In lean chickens abdominal fat weight was found positively correlated with all serum biochemical concentrations, while it was negatively correlated with triglyceride. In the second experiment, all serum biochemical concentrations were positively correlated with fat weight in fat and lean chickens. In addition, triglycerides, high density lipoprotein and very low density lipoprotein were negatively correlated with fat weight in fat chicken.

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Table 4. Correlation between abdominal fat and biochemical serum levels.

Experiment	First experiment		Second experiment	
Breed	**Fat (Wenchang)**	**Lean (Rugao)**	**Fat (Anka)**	**Lean(Rugao)**
Sample size	30	40	60	60
TCH[1]	-0.167	0.198	0.089	0.440*
TG[2]	-0.174	-0.181	-0.145	0.209
HDL[3]	-0.162	0.279	-0.248	0.236
VLDL[4]	-0.174	0.181	-0.144	0.209
LDL[5]	0.083	0.132	0.259	0.257

[1]Total cholesterol; [2]Triglycerides; [3]High density lipoprotein cholesterol; [4]Very low density lipoprotein cholesterol; [5]Low density lipoprotein cholesterol.
*Correlation is significant at the 0.05 level (-tailed).

DISCUSSION

The abdominal fat pad represents one of the main regions of fat deposition in chickens, and it seems to be directly related to total carcass fat. In the present study the effect of breed on body weight and abdominal fat weight was significant ($P < 0.05$). Gaya et al. (2005) indicated that as abdominal fat content seems to respond to selection, it can be used as a selection criterion for decreasing or increasing fat content in chickens. Because abdominal fat is highly correlated (0.6 to 0.9) with total carcass lipids (Chambers, 1990).The increase of fat in adipose tissue is mainly due to hepatic lipogenesis, an increase in adipose tissue mass is due to an increase in the number of adipocytes (LeClercq, 1984). In young broiler chickens approaching market weight, about 80 - 85% of the fatty acids that accumulate in the adipose tissue are derived from plasma lipids (Griffin et al., 1992). Total cholesterol and LDL were significantly different ($P < 0.05$) between fat and lean chickens in the first experi-ment. However in the second experiment the significant difference ($P < 0.01$) were found on cholesterol and high density lipoprotein levels. Generally the difference between lean and fat lines of chicken is due to the accumulation of triglycerides in adipocytes which depend on the availability of plasma VLDL (Hermier et al., 1989). Triglycerides are the most significant source of fatty acids, because this is the form in which dietary lipids are assembled by the gut and liver. No significant difference ($P > 0.05$) was observed between male and female on biochemical serum in lean chicken in the first experiment. However, triglycerides and VLDL was significantly difference ($P < 0.05$) in fat chickens, because the growth of fat was depends on VLDL and triglyceride levels.

In the second experiment males compared with fe-males shows significantly ($P < 0.01$) higher levels of cholesterol and low density lipoprotein in fat and lean chickens. Similarly Tassaduqe et al. (2003) found that male had significantly higher level of total cholesterol than female and higher LDL cholesterol. Simon and Le Clercq (1982) reported that 90% of the difference was within each sex but not between sexes, because female display larger adipocytes and higher ratios of abdominal fat to live weight. In the first experiment total cholesterol, triglycerides, high density lipoprotein and very low density lipoprotein were negatively correlated with fat weight in fat breed and positively with LDL. In lean abdominal fat weight was found positively correlated with all serum biochemical concentrations, while it was negatively corre-lated with triglyceride. In the second experiment all serum biochemical concentrations were positively correlated with fat weight in fat and lean chickens, while triglycerides, high density lipoprotein and very low density lipoprotein were negatively correlated with fat weight in fat chicken. Griffin et al. (1991) indicated that body fat content was highly correlated with rate of secretion of plasma trigly-ceride rich lipoprotein. Selection of broilers for rapid growth rate leads to excessive fat accumulation. The ba-lance between synthesis and secretion of VLDL is therefore the key point that regulates hepatic and extra hepatic fattening in poultry. LDL and very low density lipoprotein (VLDL) particles in meat type cockerel chickens occur in much smaller proportion compared to HDL (Peebles et al., 2004).

However, in the mature egg- laying hens, VLDL particles are the most predominant lipoprotein, followed by HDL, and then LDL (Walzem et al., 1994). Birds of the leaner, low VLDL lines are more efficient than those of the fatter, high-VLDL line at converting dietary protein into body protein and this sug-gests that selection has had a major impact on protein and lower amino acid metabolism, as well as on fat deposition (Griffin et al., 1989).

Finally the results of two experiments conclude that total cholesterol in lean chickens was found to be significantly ($P < 0.05$) higher that fat chickens. Similarly, lean chickens showed signify-cantly ($P < 0.05$) higher LDL in the first experiment and HDL in the second experiment compared with fat. Males observed signify-cantly ($P < 0.05$) higher triglyceride and VLDL than females in fat chicken the first experiment. However, in the second experiment male showed significantly ($P < 0.05$) higher total cholesterol and LDL in both fat and lean chickens.

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