DEVELOPMENTS OF SOME PARAMETERS OF LIPID METABOLISM DURING MATURATION OF QUAILS

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The level of lipidemy from assessed cholesterol, triglycerides, lipoprotein, total lipids and very low density lipoprotein (VLDL) contents in blood serum in maturing Japanese quail at the ages of 36, 56 and 63 days was studied. Levels of cholesterol, triglycerides, total lipids, VLDL and NEFA in 35 days old males and females were the same. They doubled in females at the period of sexual maturing. The level of lipoproteins was stable and independent from sex and age. Weight of males and females at the age of 35 days was uniform. In older birds, body weight and liver of females were higher than of males. Correlations between the triglycerides, lipoproteins, total lipids and VLDL in quails at the age of 56 and 63 days exceeded $r = +0.5$.

Japanese quail; sexual maturing; lipid metabolism; VLDL; cholesterol

INTRODUCTION

Breeding of hens for intensive growth led in the past three decades to marked overfat condition of broilers. Fat of broilers is undesirable as for a consumer, as for a processor of poultry, therefore this problem is studied, except chickens, also on a model avian object, i.e. Japanese quail.

The aim of the contribution is to study some problems of lipid metabolism of birds on the model of Japanese quails. When studied lipid metabolism of Japanese quail, Sadjady and Becker (1980) found in 58-day quail males 1.35 g of renal fat and its high heritability $h^2 = 0.71–0.58$. Genetic correlations between body weight and renal fat were 0.74 to 0.77. Amount of fat was finding surgically. Quails are considered by them as a suitable model including described method to study of overfat condition of broilers.

Heredity of lipid metabolism of five lines and their crossbreds in Japanese quail was studied by Wyatt et al. (1982). They also studied its dependence on body weight. The proportion of fat in hybrids was lower than in pure forms from which follows better availability of dietary proteins in crossbreds.

Maeda et al. (1986) studied genetic variability of liver fat of quails. At the age of 24 weeks the share of fat in both sexes from liver dry matter was 25%. In further period in laying females it increased to 40–50%. Positive significant correlation was found between weight and fat content in liver. The relation to body weight was not significant. They propose to select quails for high and low fat content and these were then used as model animals to study lipid metabolism.

Garwood (1987) studied genetic parameters connected with very low density lipoproteins (VLDL). He found $h^2 = 0.52$ for this trait and high (above 0.50) correlation to body fat content. Observation was done at the age of 40 days.

Csuka et al. (1995) in 11-month old quail males at the end of reproduction period studied the degree of overfat condition and found 2.12 g average weight of abdominal fat. They found phenotypic correlation $r = 0.46$ between this trait and body weight (115.9 g). Phenotypic correlation $r = 0.47$ was found between weight of abdominal fat and liver weight (1.83 g). Weight of testicles (2.91 g), VLDL, cholesterol and serum refraction and correlations among the given traits were also studied.

Csuka (1995) found in quail females of the same population lower proportion of abdominal fat (0.92%), higher body weight (130.2 g) and higher proportion of serum cholesterol. Significant correlation was found between body weight and liver weight (0.610), egg production and abdominal fat (0.492). High phenotypic correlations were also found between VLDL, cholesterol, and serum refraction (0.757–0.962).

The aim of the presented contribution was to study some problems of lipid metabolism in maturing Japanese quails.

MATERIAL AND METHOD

The trial included 60 males and 60 females of Japanese quails, line 07, aguti colour, bred at the Research Institute of Animal Production, Nitra, Station of Poultry Rearing and Breeding at Ivanka pri Dunaji. Animals were fed ad libitum with complete feed mixture for turkey-hen KR-1 rearing which contained 26.6% of crude proteins, 3.5% of fat, 4.4% of fibre, 6.6% of ash and 48.2% of N-free extract. Amount of metabolizable energy was 11.1 MJ/kg of mixture.

Animals had a free access to water and were bred on slatted batteries at 14-hour daily regime. Bird's concentration up to the age of 14 days was 30 cm^2, from 15 days of age to the end of slaughter period 110 cm^2 per quail.

Animals were slaughtered at the age of 35, 56 and 63 days. The following parameters were studied according to the sex: body weight before slaughtering, weight of ovaries and testicles, weight of liver and abdominal fat. The blood was taken into oxalate mixture at slaughtering and plasma was produced and then stored in refrigerator at –20 °C. Amount of total cholesterol, triglycerides, total lipids and non-esterified fatty acids (NEFA), plasma (biolatest Labora, Brno, Czech Republic), lipoprotein content (Homolka, 1971) and VLDL content (Whitehead, 1987) was determined. Average values and standard deviations as well as mutual correlations between them were calculated in studied parameters.

RESULTS AND DISCUSSION

Weight of male body (Tab. I) at the age of 35 days was a little higher than that of females. In further period, in the period of intensive reproduction weight of females much exceeded the weight of males (103.8 g) and at the age of 56 days it reached in females 124.0 g. During further rearing to the age of 63 days body weight of males did not change. Ovaries at the age of 35 days were only a little developed (0.09 g). Their weight at the age of 56 days much increased (6.53 g), later due to intensive egg production it slightly fell. Testicles at the age of 35 days were more developed than ovaries and gained 0.50 g, later they were intensively developed and at the age of 56 days they reached 2.42 g. In further period the growth of testicle weight was insignificant. Liver weight was slightly higher in females than in males at the age of 35 days. In females the liver weight at the age of 56 days even increased, while in males it remained unchanged. At the age of 63 days the liver weight fell slightly in both sexes.

I. Average and standard deviation of weight parameters of experimental animals

Parameter	Statistical values n (20)	Age of experimental animals in days					
		35		56		63	
		♀	♂	♀	A	♀	♂
Body weight (g)	$\bar{x}$	82.95	83.80	124.02	103.78	114.20	103.70
	s	4.36	6.36	5.10	2.13	3.17	4.45
Liver weight (g)	$\bar{x}$	2.50	2.24	3.44	2.21	3.17	2.01
	s	0.36	0.17	0.59	0.59	0.48	0.33
Ovary weight (g)	$\bar{x}$	0.09	–	6.53	–	5.07	–
	s	0.08	–	1.12	–	1.05	–
Testicle weight (g)	$\bar{x}$	–	0.50	–	2.42	–	2.82
	s	–	0.31	–	1.44	–	0.47

The presence of abdominal fat at the age of 35 days has not been found even in single quail. Later, at the age of 56 days fat was found only in one male at the amount of 0.79 g, at the age of 63 days retroperitoneal fat was found neither in single experimental animal. The male in which fat was present was not distinguished in studied parameters from the average, only its weight of liver was much lower (1.24 g).

Out of the parameters of lipid metabolism of blood plasma the lowest changes were recorded in cholesterol, while the level of cholesterol in plasma in all investigated periods was significantly lower in females than in males (Tab. II).

The level of triglycerides in female plasma increased significantly from 35 days to 56 days and then again decreased. On the other hand, the level of triglycerides in plasma of males remained unchanged during the whole period under study and was low.

There were no differences between sexes in the VLDL level at the age of 35 days. Up to the age of 56 days the VLDL level in males doubled and in females it increased four times. In further period the VLDL level it fell more significantly in males than in females. The level of total lipoproteins in the first studied periods up to the age of 56 days was increasing, while it was

II. Average and standard deviation of plasmatic parameters of experimental animals

Parameter	Statistical values n (20)	Age of experimental animals in days					
		35		56		63	
		♀	♂	♀	A	♀	♂
Total cholesterol (mmol/l)	$\bar{x}$	3.680	4.512	3.852	4.464	2.742	4.564
	s	0.761	0.746	1.199	0.827	0.389	0.588
Triglycerides (mmol/l)	$\bar{x}$	1.490	1.780	7.732	1.536	3.702	1.600
	s	0.291	0.498	4.81	0.143	1.414	0.189
VLDL (extinction units)	$\bar{x}$	0.130	0.128	0.440	0.150	0.277	0.140
	s	0.049	0.039	0.350	0.011	0.068	0.033
Lipoproteins (extinction units)	$\bar{x}$	0.757	0.582	1.067	0.663	0.597	0.860
	s	0.150	0.202	0.445	0.146	0.173	0.147
Total lipids (mmol/l)	$\bar{x}$	5.232	6.328	15.086	5.704	9.128	6.572
	s	1.313	1.120	10.730	1.141	1.943	1.837
NEFA (mmol/l)	$\bar{x}$	0.402	0.680	–	–	0.692	0.844
	s	0.251	0.408	–	–	0.161	0.388

higher in females. In the third studied period it was further increasing in males and much fell in females.

The level of total lipids in plasma was lower in males than in females and was balanced in all investigated periods. In females it much increased from 35 days to 56 days and then it fell on the medium level. The NEFA level was investigated only in the beginning and at the end of experimental period. Their level was higher in males than in females and to the end of investigated period it increased in both sexes.

Correlations between parameters of lipid metabolism of blood serum at the age of 35 days were significant mainly between cholesterol and total lipids and between cholesterol and triglycerides (Tab. III). Relatively low positive correlation was found between triglycerides and total lipids and also between total fats and VLDL.

At the age of 56 days very high correlation was found between triglycerides and total lipids content in serum, between VLDL on one side and between triglycerides and total lipids on the other side. Medium strong correlation was found between lipoproteins and total lipids and between lipoproteins and triglycerides. At the age of 63 days strong correlation was again confirmed in three pairs of traits and medium strong correlation in two pairs of traits.

Non-esterified fatty acids (NEFA) were determined only in the first and third period of investigation. Of the calculated correlations between NEFA

III. Correlations between plasmatic parameters of experimental animals (♀ + ♂, n = 40)

Parameter		Age of animals in days		
		35	56	63
Cholesterol	triglycerides	+0.308*	–0.151	+0.219
	VLDL	+0.141	–0.229	+0.013
	lipoproteins	–0.105	+0.213	+0.366
	total lipids	+0.583***	+0.073	+0.083
Triglycerides	VLDL	+0.168	+0.876***	+0.856***
	lipoproteins	–0.153	+0.482**	+0.480**
	total lipids	+0.247	+0.926***	+0.768***
Lipoproteins	VLDL	+0.104	+0.397**	+0.654
Total lipids	VLDL	+0.257	+0.952***	+0.864***
	lipoproteins	–0.174	+0.670***	+0.589***

Minimum values of significance of correlation coefficients: $r_{0.05}(40) = 0.304^{*}$, $r_{0.01}(40) = 0.393^{**}$, $r_{0.001}(40) = 0.490^{***}$

and other lipid parameters of serum at the age of 35 days medium strong relation was found between NEFA on one side and cholesterol and VLDL on the other side. Not neglectable is also the coherency between NEFA and total lipids or lipoproteins, respectively. At the age of 63 days correlations of all parameters to NEFA were negative and relatively low (Tab. IV).

Correlation between parameters of lipid metabolism of serum and body weight or weight, resp. liver weight was computed only in animals slaughtered at the age of 63 days. Very low and insignificant correlations were found, except the relation between cholesterol of serum and body weight of quail females (Tab. V). As it can be seen from Tab. VI the weight of ovaries does not correlate with investigated lipid parameters with studied lipid parameters of serum in the single period under study, except for weaker relationship ($r = +0.359$) to cholesterol. Similarly, no significant relationship was found between weight of testicles and studied lipid parameters, except for medium relationship ($r = +0.411$) to total lipids at the age of 35 days (Tab. VII). Our finding that weight of female body in the period of maturity is higher, is in congruency with the finding of Yalcin et al. (1995) and Csuka (1995).

Average weight of liver found by us is higher than that found by Radcliffe et al. (1982) in 13-week old quails and is close to the values found by Murai et al. (1995), and is lower than the value found by Csuka (1995) in adult quails in the end of reproduction period at the age of 11 months. The quoted authors also found greater weight of liver in females than in males.

Average weights of testicles found are in congruency with earlier data of Baumgartner (1982), and Csuka, Baumgartner (1994). The determined higher level of serum cholesterol in males is in congruency with earlier finding of Baumgartner et al. (1991), Michalská, Stepinská (1994) and Csuka et al. (1995). In congruency with the results of the presented study Siegel et al. (1995) found that the cholesterol level of serum in ovulating females is lower than that in males. The concentrations of cholesterol found in serum is close to the values recorded by Baumgartner et al. (1991) and Michalská, Stepinská (1994).

In not adult females and males of all age groups the level of triglycerides are balanced and are many times higher in the period of laying. The values found and statements are in harmony with earlier results of Radcliff et

IV. Correlations between non-esterified fatty acids and other characteristics of lipaemia (♀ + ♂, $n = 40$)

Parameter		Age of animals in days	
		35	63
NEFA	cholesterol	+0.558***	–0.240
	triglycerides	+0.110	–0.294
	VLDL	+0.485**	–0.248
	lipoproteins	+0.421**	–0.203
	total lipids	+0.425**	–0.363*

Minimum values of significance of correlation coefficients: $r_{0.05}$ (40) = 0.304*, $r_{0.01}$ (40) = 0.393**, $r_{0.001}$ (40) = 0.490***

V. Correlations of body and liver weight to lipemic parameters of serum at the age of 63 days ($n = 20$)

Lipemic parameters	Body weight		Liver weight	
	♀	♂	♀	A
Cholesterol	+0.359	–0.016	–0.016	+0.001
Triglycerides	+0.031	–0.216	+0.008	+0.039
VLDL	+0.060	+0.301	+0.028	+0.004
Lipoproteins	–0.107	–0.087	+0.022	–0.003
Total lipids	–0.013	–0.103	+0.012	–0.007
NEFA	+0.001	–0.016	–0.051	+0.003

Minimum values of significance of correlation coefficients: $r_{0.05}$ (20) = 0.423*, $r_{0.01}$ (20) = 0.537**, $r_{0.001}$ (20) = 0.652***

VI. Relationship of ovary weight to lipemic parameters of serum (♀ + ♂, $n = 20$)

Parameter		Age of animals in days		
		35	56	63
Ovary weight in g	cholesterol	+0.022	+0.359	–0.121
	triglycerides	+0.040	+0.031	–0.156
	VLDL	+0.166	+0.060	–0.066
	lipoproteins	+0.027	–0.107	–0.061
	total lipids	+0.138	–0.013	+0.067
	NEFA	+0.106	–	+0.075

Minimum values of significance of correlation coefficients: $r_{0.05}$ (20) = 0.423*, $r_{0.01}$ (20) = 0.537**, $r_{0.001}$ (20) = 0.652***

VII. Relationship of testicle weight to lipemic parameters of serum (♀ + ♂, $n = 20$)

Parameter		Age of animals in days		
		35	56	63
Testicle weight in g	cholesterol	–0.042	–0.016	+0.018
	triglycerides	+0.203	–0.216	+0.043
	VLDL	–0.011	–0.301	+0.012
	lipoproteins	+0.239	–0.087	+0.010
	total lipids	+0.411	–0.103	–0.007
	NEFA	+0.006	–	+0.011

Minimum values of significance of correlation coefficients: $r_{0.05}$ (20) = 0.423*, $r_{0.01}$ (20) = 0.537**, $r_{0.001}$ (20) = 0.652***

al. (1982). There is no comparison from literature for further lipid parameters found. The VLDL level in serum is similar to that in triglycerides. Phenotypic correlations between cholesterol of serum and body weight at the age of 63 days in females ($r = 0.359$) and in males ($r = -0.016$) found by us are not in congruency with the finding made by Michalská and Stepinská (1994) who found correlation $r = 0{,}09$ and 0.10, neither with earlier results of Csuka (1995) and Csuka et al. (1995) in Japanese quails.

The correlation found between VLDL and total lipids in serum confirms the connection between agents of lipid metabolism found by Garwood (1987) and we also confirmed his finding that the weak connection is between body weight and VLDL level. Correlations between lipid parameters of serum are mutually manifested as late as in the period of sexual maturity of quails at the age of 56 and 63 days and are in harmony with earlier results of Csuka (1995).

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Vývoj niektorých parametrov tukového metabolizmu počas dospievania prepelíc.

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U dospievajúcich samcov a samičiek japonských prepelíc vo veku 35, 56 a 63 dní sme študovali hladiny lipémie na základe stanovenia obsahu cholesterolu, triglyceridov, VLDL, lipoproteínov, celkových lipidov a neesterifikovaných mastných kyselín (NEFA) v krvnom sére, ako aj základné hmotnostné ukazovatele tela, pečene, semenníkov a vaječníkov. Pri hladine cholesterolu, triglyceridov celkových lipidov, VLDL a NEFA u 35dňových samcov a samičiek neboli rozdiely. V období pohlavného dospievania sa u samičiek zvýšili niektoré lipemické ukazovatele na dvojnásobok a vyššie. Hladina lipoproteínov však zostala stabilná a bola nezávislá od pohlavia a veku.

Medzi hmotnosťou samcov a samičiek vo veku 35 dní neboli výrazné rozdiely, v ďalšom období bola u samičiek hmotnosť tela a pečene vyššia. Korelácie medzi triglyceridmi, lipoproteínmi, celkovými lipidmi a VLDL u prepelíc vo veku 56 a 63 dní prevýšili hodnotu $r = 0,5$.

japonská prepelica; pohlavné dospievanie; tukový metabolizmus; VLDL; cholesterol

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