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RELATIONSHIP BETWEEN SOME BLOOD BIOCHEMICAL PARAMETERS AND FATTY LIVER WEIGHT IN FORCE FEEDING OF MULE DUCKS

V. GERZILOV and P. PETROV
Agricultural University, Department of Animal Science, Faculty of Agronomy, BG - 4000 Plovdiv, Bulgaria

Abstract

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The purpose of this study was to determine the phenotype correlation between fatty liver weight (FLW) and some blood serum biochemical parameters in mule ducks – alanine aminotransferase (ALAT), aspartate aminotransferase (ASAT), total cholesterol (Chol), alkaline phosphatase (AP), gamma-glutamyl transferase (GGT), triglycerides (TG) and creatinine (Creat), and their possible role as predictors of the fatty liver yield.

The birds were fattened and slaughtered under commercial conditions. The gavage of ducks with maize began at 74 days of age and continued for 13 days.At the time of flock slaughtering (total number of ducks – 620 from both sexes) blood samples were randomly collected from 25 male and 21 female mule ducks. FLW was measured individually by analytical scales (accuracy 0.01 g).

We established positive phenotypic correlations between the FLW and some blood serum parameters for male and female mule ducks as followed: ALAT – $r_p = 0.475$ ($P < 0.01$) and $r_p = 0.626$ ($P < 0.001$); ASAT – $r_p = 0.495$ ($P < 0.01$) and $r_p = 0.547$ ($P < 0.01$); Chol – $r_p = 0.649$ ($P < 0.001$) and $r_p = 0.564$ ($P < 0.001$). The phenotype correlations between FLW and the other biochemical parameters (AP, GGT, TG and Creat) were weak and insignificant. A strong positive correlation between pre-slaughter live body weight and FLW was established for female mule ducks – $r_p=0.808$ ($P < 0.001$), while for male mule ducks it was weak – $r_p = 0.114$ ($P > 0.05$).

Keywords: mule duck, force-feeding, fatty liver, blood biochemical parameters, phenotype correlation

Introduction

Under natural conditions, some wild waterfowl are more likely to show non-pathological hepatic steatosis as a result of energy storage before migration (Pilo and George, 1983; Han et al., 2008). This specific capability is known and used very well since 2500 B.C. in Ancient Egypt for fattening of geese and receiving fatty liver production (Guemene and Guy, 2004).

At present, together with France and Hungary, Bulgaria is among the three world leading producers of this gourmet product from mule ducks and geese, also known as "foiegras". On an annual basis, about 5.5 million mule ducks and a very small number of geese (a few thousands) are reared in Bulgaria – the annual produce for year 2014 is 2962 tones - Bulletin № 294, 2015 (Ministry of Agriculture and Food, 2015).

The fatty liver is the most valuable product in duck production systems (Theron et al., 2012). In response to overfeeding a great part of the synthesised triacylglycerols is stored into the hepatocytes and may cause a dramatic hepaticsteatosis (Hermier et al., 1991, 1999 a, b; Andre et al., 2007). In a previous research, we found out that the liver of the overfed mulards increased 7.32 times in males and 5.65 times in females (Gerzilov et al., 2013) whereas Gabarou et al. (1996) reported for livers attaining ten times their natural weight. Hepatic steatosis is related to considerable changes in liver functional enzymes (ALAT, ASAT, AP) and other metabolites as triacylglycerols, creatinine, serum lipids and proteins, cholesterol, uric acid and etc. (El-Medani et al., 1990; El-Senosi, 2004; Janan et al., 2004). Moreover, some of studied parameters - ASAT, ALAT, total cholesterol and triglycerides – exhibited a several fold increase (Gabarou et al., 1996; Gerzilov et al., 2013).

Correspondence author: v_gerzilov@abv.bg

The relationships between specific physiological indicators on one hand, the yield and quality of fatty liver and the behavior of ducks during gavage have raised a significant interest (Le Neindre et al., 1998).

The purpose of the present study was to investigate the phenotype correlations between some blood biochemical parameters on one hand, and live weight and fatty liver weight on the other, as well as the potential of predict fatty liver weight on the basis of regression models.

Materials and Methods

The experiment was carried out at the poultry farm forforce-feeding mule ducks (mulards) in the Haskovo region. The growing mule ducklings (from 0 to 74 days of age) were fed *ad libitum* with mixed fodder and reared on straw deep-litter system in a barn with yards for walk (after 28 days of age). After 74 days of age, the birds (n = 620 from both sexes) were housed in open lift cages (four birds in cage) and force-fed with corn for 13 days. The birds were slaughtered under manufacturing conditions in poultry slaughter house near town of Parvomay in accordance with the Regulation № 22 (2005) and Regulation № 36 (2006). At the time of slaughter blood samples forbiochemical analyses were collected from v. *Subcutanea ulnaris* of randomly selected 46 mulards (25 males and 21 females). The blood was allowed to clot for two hours at room temperature (20°C) and the samples were centrifuged at 2000×g for 10 min. The blood serum biochemical parameters alanine aminotransferase (ALAT), aspartate aminotransferase(ASAT), γ-glutamyltransferase (γ-GT), alkalinephosphatase (AP), total cholesterol (Chol), triglycerides (TG), and creatinine (Creat) were determined with an automated biochemical analyzer BS–120 Mindray atan accredited biochemical lab (Provet – Plovdiv). Fatty liver weight was measured individually by analytical scales (with accuracy 0.01 g).

The assayed blood biochemical parameters, live weight and fatty liver weight of mule ducks were used for:

- Calculation of phenotype correlation coefficients (r_{xy}): $r_{xy}=cov_{xy}/(\sigma_x.\sigma_y)$ $at –1 \le r_{xy} \le +1$
- Performance of regression analysis using the model: $y=ax^2+bx+c$,

where y is dependent variable; x - isvector of independent variables; a, b, c - unknown parameters.

Results and Discussion

The analysis of results showed that preslaughter live weight of male ducks was by 21.10% higher than that of female birds ($P < 0.001$), and the yield of fatty liver – by 36.67% higher ($P < 0.001$). As a result of the crammer effect, the proportion of liver vs the live weight attained 10.92% in male and 9.68% in female mule ducks. With respect to blood biochemical parameters, a statistically significant difference between genders was demonstrated only for alkaline phosphatase ($P < 0.05$) - Table 1.

Various phenotype correlations were established between blood biochemical parameters and liver weight. Significant positive correlation coefficients were calculated between fatty liver weight (FLW) and blood ALAT, ASAT, total cholesterol in both genders. The correlation coefficients between ALAT and FLW, ASAT and FLW were higher in female birds than in males –Table 2. Negative phenotype correlation coefficients were established between GGT and FLW ($P < 0.05$), and between Creat and FLW ($P < 0.05$) only in male ducks.

A very strong positive relationship was found out between live weight of force-fed female mule ducks and fatty

Table 1
Studied traits of overfed mule ducks

Trait	Males (n=25)	Females (n=21)
Live body weight, g	6010.40±102.76a	4962.86±112.13 a
Fatty liver weight, g	656.40±28.44a	480.29±26.72a
Aspartate aminotransferase (ASAT), U/L	196.86±23.33	150.38±16.37
Alanine aminotransferase (ALAT), U/L	139.82±17.20	130.16±13.85
Alkaline phosphatase (AP), U/L	611.12±67.77c	435.52±19.47c
Gamma-glutamyl transferase (γ-GT), U/L	7.26±0.95	6.30±0.43
Triglycerides (TG), mmol/L	9.79±0.35	9.26±0.50
Totalcholesterol (Chol), mmol/L	9.19±0.47	8.52±0.38
Creatinine (Creat), μmol/L	13.86±0.96	14.84±1.08

Note: a – P<0.001; b–P<0.01, c–P<0.05 within the same row

Table 2
Phenotypic correlation coefficient (r_p) between serum biochemical parameters, body weight and fatty liver weight

Sex of birds	Biochemical parameter							Body weight
	ASAT	ALAT	AP	GGT	Trigl	Chol	Creat	
Males	0.495 b	0.475 b	0.042	-0.353 c	-0.017	0.649 a	-0.279 c	0.114
Females	0.713 a	0.547 a	-0.111	0.001	0.061	0.564	-0.164	0.808

liver weight – r_p = 0.808 ($P < 0.001$), while in male birds the correlation was low and statistically insignificant. Having in mind that the live weight of female mule ducks was lower as compared to males, it could be affirmed that this trait influenced greatly the fatty liver yield. In other experiment, Marie-Etancelin et al. (2010) established that phenotypically, the correlation between carcass weight and fatty liver weight (+ 0.43) was not as stronger as with thigh+shank weight (+ 0.66). The crammer effect for these overfeeding traits was very high forthe carcass and fatty liver weights.

Blood serum triglycerides, which were found to increase almost twice in liver steatosis, did not correlate with liver weight.

In an experiment with two breeds of geese, Xu et al. (2010) demonstrated that in Sichuan white geese, fatty liver weight positively correlated with plasma triglycerides ($r = 0.68$, $P < 0.05$) and very low-density lipoprotein concentrations ($r = 0.55$, $P < 0.05$), while in Landes geese the same relationships were not significant.

Figures 1–4 present the regression equations depicting the relationships between fatty liver weight in both genders with

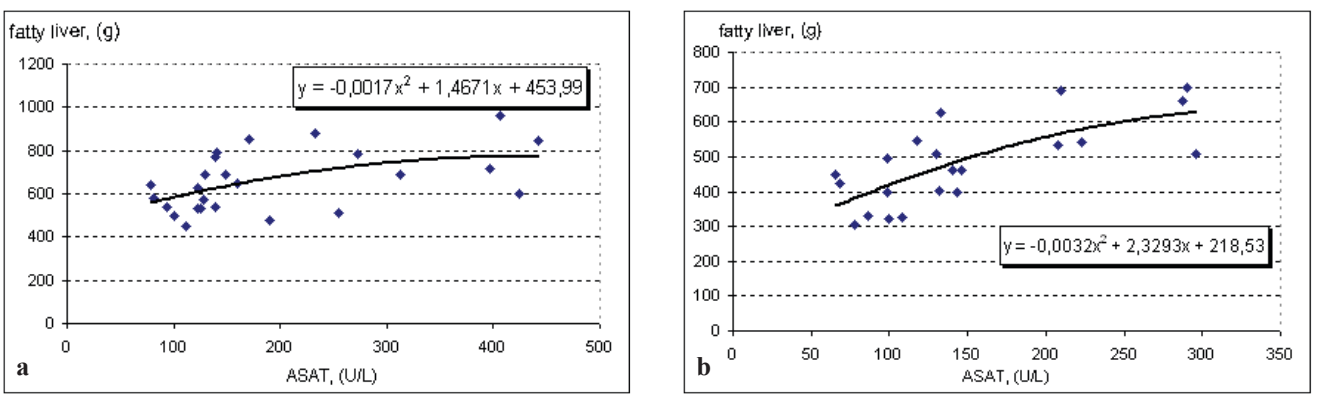

Fig. 1. Regression relationships between ASAT and fatty liver weight in male mulards (a) and female mulards (b)

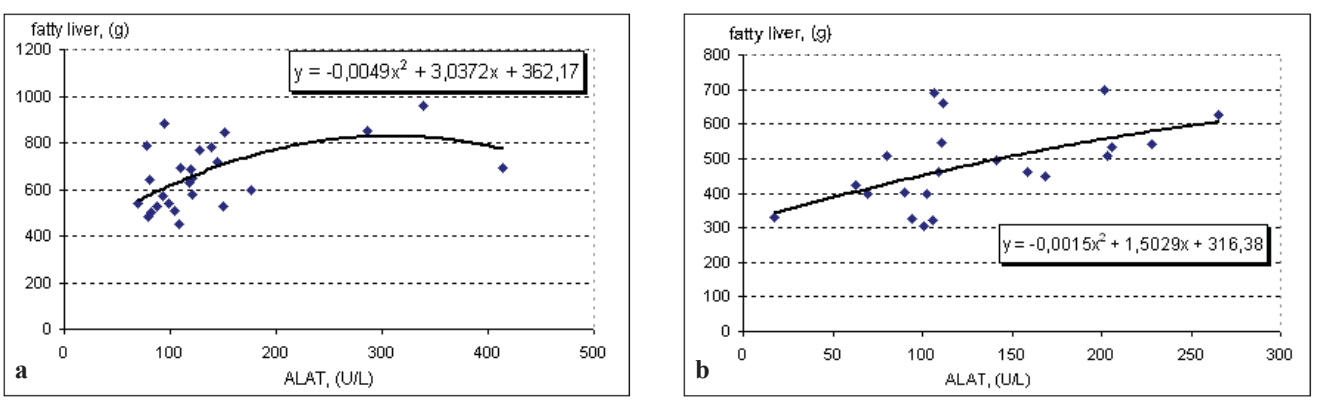

Fig. 2. Regression relationships between ALAT and fatty liver weight in male mulards (a) and female mulards (b)

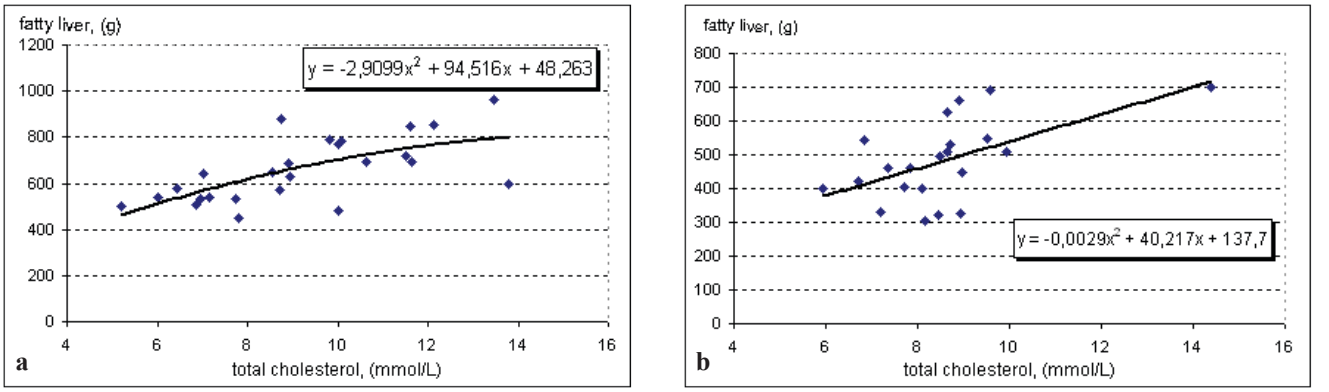

Fig. 3. Regression relationships between total cholesterol and fatty liver weight in male mulards (a) and female mulards (b)

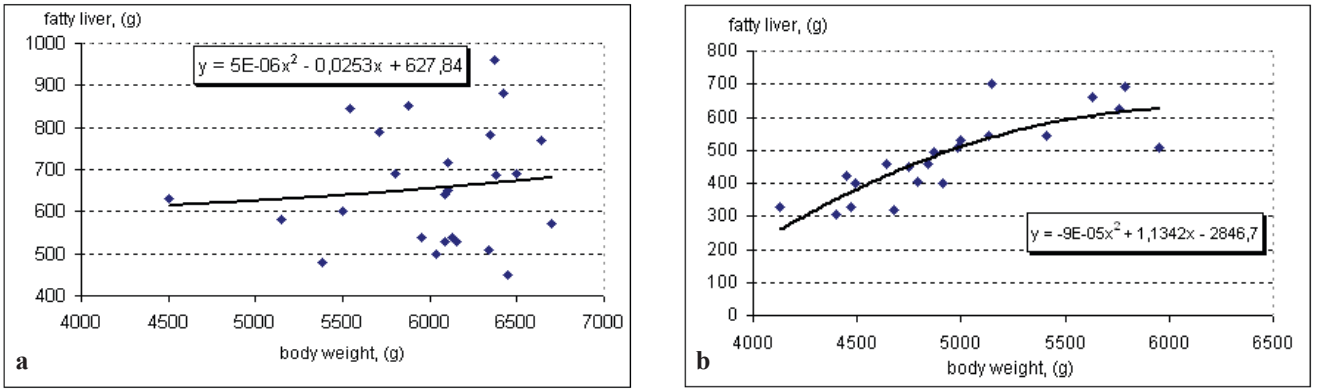

Fig. 4. Regression relationships between live body weight and fatty liver weight in male mulards (a) and female mulards (b)

blood serum ALAT, ASAT, total cholesterol and live body weight. It could be seen that the regression trend lines were with positive slopes, and that the relations between both variables (x and y) was almost liner and better manifested for female ducks – especially as live weight and fatty liver yield was concerned. We therefore agree with Theron et al. (2012) that blood biochemical measures may better predict technological yield of foie gras.

Conclusion

In this study were found positive phenotypic correlations between fatty liver weight and next biochemical parameters: ALAT – $r_p = 0.475$ ($P < 0.01$) and $r_p = 0.626$ ($P < 0.001$); ASAT – $r_p = 0.495$ ($P < 0.01$) and $r_p = 0.547$ ($P < 0.01$); Chol – $r_p = 0.649$ ($P < 0.001$) and $r_p = 0.564$ ($P < 0.001$) for male and female mule ducks respectively.

High positive phenotype correlation between preslaughter live body weight and foie gras were established for the females – $r_p = 0.808$ ($P < 0.001$), while for the males it was weak – $r_p = 0.114$ ($P > 0.05$).

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References

André, J. M., G. Guy, K. Gontier-Latonnelle, M. D. Bernadet, B. Davail, R. Hoo-Paris and S. Davail, 2007. Influence of lipoprotein-lipase activity on plasma triacylglycerol concentration and lipid storage in three genotypes of ducks. *Comparative Biochemistry and Physiology, Part A,* **148** (4): 899-902.

El-Medany, N., S. M. Karima, M. Shehata and M.A. Affifi, 1990. Production of fatty liver in the local geese. *Annals of Agricultural Science Moshtohor*, **28** (4): 2062-2072.

El-Senosy, Y., 2004. Certain biochemical studies on the effect of forced feeding in pekin ducks. First Ann. Conf. *FVM*, Moshtolor, pp. 87-94.

Gabarrou, J. F., M. R. Salichon, G. Guy and J. C. Blum, 1996. Hybrid ducks overfed with boiled corn develop an acute hepatic steatosis with decreased choline and polyunsaturated fatty acid level in phospholipids. *Reproduction Nutrition Development*, **36** (5): 473-84.

Gerzilov, V., P. B. Petrov and A. Bochukov,2013.Effect of force-feeding on fatty liver and serum biochemical parameters in mule ducks. *Agro Life Scientific Journal*, **2** (1): 193-196.

Guemene, D. and G. Guy, 2004. The past, present and future of force feeding and "foie gras" production. *World's Poultry Science Journal*, **60** (2): 210-222.

Han, C., J. Wang, H. Xu, L. Li, J. Ye, L. Jiang and W. Zhuo, 2008. Effect of overfeeding on plasma parameters and mRNA expression of genes associated with hepatic lipogenesis in geese. Asian-Aust. *Journal of Animal Science*, **21** (4): 590- 595.

Hermier, D., M. R. Salichon, G. Guy and R. Peresson, 1999 a. Differential channelling of liver lipids in relation to susceptibility to hepatic steatosis in the goose. *Poultry Science*, **78** (10): 1398-1406.

Hermier, D., A. Saadoun, M. R. Salichon, N.Sellier and D. Rousselot-Pailley, 1991. Plasma lipoproteins and liver lipids in two breeds of geese with different susceptibility to hepatic steatosis: Changes induced by development and force-feeding. *Lipids*, **26** (5): 331-339.

Hermier, D., M. R. Salichon, G. Guy, R. Peresson, J. Mourot and S. Lagarrigue, 1999 b. La stéatose hépatique des palmipèdes gavés : bases métaboliques et sensibilité génétique. *INRA Productions Animales*, **12**: 265-271.

Janan, J., L. Bódi, G. Ágota, L. Bárdos, P. Rudas and J.Kozák, 2000.Relationships between force-feeding and some physiological parameters in geese bred for fatty liver. *Acta Veterinaria Hungarica*, **48** (1): 89-97.

Le Neindre, P., P. Willeberg, P.Jensen, D. Broom, J. Hartung, R. Dantzer, D. Morton, P. Bénard, M. Verga, J. M. Faure, I. Estevez and B. Nicks, 1998. Welfare aspects of the production of foie grasin ducks and geese. Report of thescientific committee on animal health and animal welfare, pp. 89.

Marie-Etancelin, C., B. Basso, S. Davail, K. Gontier, X. Fernandez, Z. G. Vitezica, D. Bastianelli, E. Baéza, M-D. Bernadet, G. Guy, J-M. Brun and A. Legarra, 2010. Genetic parameters of product quality and hepatic metabolism in fattened mule ducks. *Journal of Animal Science,* **89** (3): 669-679.

Ministry of Agriculture and Food, 2015. Bulletin № 294, 2015, Activity of white meat slaughter houses in Bulgaria in 2012. *Ministry of Agriculture and Food*, Department Agrostaistics, Republic of Bulgaria.

Pilo, B. and J. C. George, 1983. Diurnal and seasonal variations in liver glycogen and fat in relation to metabolic status of liver and m. pectoralis in the migratory starling, *Sturnus roseus*, wintering in India. *Comparative Biochemistry and Physiology, Part A,* **74** (3): 601-604.

Regulation № 22, 2005. Regulation № 22, To minimize animal suffering during slaughter or killing, 14 December, 2005, *State gazette,* 42, 2006 (Bg).

Regulation № 36, 2006. Regulation № 36, The specific requirements for production, transportation and marketing of raw materials and foodstuffs of animal origin, 23 March 2006, *State gazette,* 35, 2006 (Bg).

Theron, L., M. Cullere, M. Bouillier-Oudot, H. Manse, A. Dalle Zotte, C. Molette, X. Fernandez and Z. G.Vitezica, 2012. Modeling the relationships between quality and biochemicalcomposition of fatty liver in mule ducks. *Journal of Animal Science,* **90** (9): 3312-3317.

Xu, H., Y. Wang, C.Han, L. Jiang, W. Zhuo, J. Ye and J. Wang, 2010. Estimation of lipoprotein-lipase activity (lpl) and other biochemicalchanges in two breeds of overfeeding geese. *Asian-Australian Journal of Animal Science*, **23** (9): 1221-1228.

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