

Differences between metabolic profiles of egg-type and meat-type hybrid hens

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ABSTRACT: The main objective of this study was to compare the metabolic profile (i.e. selected haematological and biochemical parameters in blood plasma) of production egg-type hybrid hens (E, MORAVIA BSL) with that of meat-type hybrid hens (M, COBB 500), and to evaluate dynamic changes occurring during the laying period from the 25th to 50th week of age. The study was prompted by both poultry farmers and veterinary practitioners since parameters defining the health of layers are absent. Selected parameters of the metabolic profile of layers were monitored regularly in 5-week intervals during egg laying. Samples of blood for haematological and biochemical examination were obtained by puncture of the *vena basilica* and stabilized by heparin. The study has revealed that monitored parameters of the metabolic profile significantly vary with factors such as production type, nutrition, and egg-laying intensity. Enhanced metabolism in egg-type hens was reflected in erythropoiesis which increased (in comparison with meat-type hens) highly significantly ($P \leq 0.01$), particularly for erythrocyte count 2.36 T/l (2.14 T/l), haematocrit level 0.32 l/l (0.30 l/l), content of haemoglobin 94.48 g/l (84.18 g/l) and leukocyte count 17.06 G/l (13.22 G/l). Similarly, enhanced metabolism in egg-type hens also led to a highly significant increase ($P \leq 0.01$) in the levels of biochemical parameters in blood plasma, particularly the total level of protein was 57.62 g/l (50.98 g/l), glucose 14.03 mmol/l (13.36 mmol/l), cholesterol 5.34 mmol/l (3.73 mmol/l) and calcium 6.52 mmol/l (5.52 mmol/l). In the case of the plasma level of phosphorus, no significant difference was found between egg-type hens (1.58 mmol/l) and meat-type hens (1.59 mmol/l). The reported results are based on the total of 180 haematological and biochemical analyses performed during the laying period. The results are crucial not only for future development of avian haematology and biochemistry, but also in respect to veterinary practice.

Keywords: egg-type and meat-type hens; haematology; biochemistry of blood

The study focuses on a comparison of haematological and biochemical parameters in the blood of two types of production hybrid hens (egg-type hens, meat-type hens) in order to gain insight into the dynamics of changes in these parameters during the laying period. With respect to animal welfare and quality production over the whole egg-laying period it is necessary to maintain the metabolic profile of layers within physiological ranges characteristic of particular hybrid combination, age and production type. Objective assessment of health is based on both haematological and biochemical

tests performed with blood. The authors have attempted to address issues raised by both experts and veterinary practitioners concerning the lack of data on exact haematological and biochemical blood parameters in clinically healthy egg-type and meat-type hens. Until now no detailed studies have been published in scientific literature which would deal with dynamic changes in individual haematological and biochemical parameters of blood in layers during egg laying. Haematological and biochemical examinations in scientific papers are mostly reported only as supplementary informa-

This research was performed in the framework of Project No. 524/01/P022 (supported by the Grant Agency of the Czech Republic), and Research Plan No. 162700005 "Investigation of Current Hygienic Aspects of the Production of Food and Raw Materials Originating from Animals in Respect to Food Safety."

tion about particular experiments. Partial haematological and biochemical studies can be found in publications by Uko and Ataja (1996) and Itoh *et al.* (1995). These authors report the mean value of total erythrocyte count being $22.7\text{--}25.2 \times 10 \text{ mm}^3$ (2.27 to 2.52 T/l). These results are in good agreement with haematological findings by Straková *et al.* (2001), who showed that during egg laying the count of erythrocytes dropped from 2.51 T/l to 2.16 T/l, haematocrit levels from 0.29 l/l to 0.26 l/l and the content of haemoglobin from 92.52 g/l to 75.29 g/l. Tůmová *et al.* (2004) reported increased levels of total erythrocyte count in the blood of control layers (3.15 T/l) in comparison with experimental layers (2.88 T/l and 2.83 T/l) which were administered digitonin. Mean leukocyte counts ranged according to the above authors as follows: 17.65 G/l, 18.41 G/l, and 16.59 G/l. Lichovníková *et al.* (2002) published the following levels of haematological parameters in layers: total count of erythrocytes: 2.08–2.27 T/l, haemoglobin: 76.23–84.41 g/l, haematocrit value: 28.2–31.1%, and total count of leukocytes: 21.74 to 21.76 G/l. The dynamics of selected biochemical parameters in the blood plasma of layers was studied by a number of authors. Molar concentrations of plasma cholesterol were reported for example by Máchal (2000), who found that mean levels of cholesterol during egg laying ranged from 2.52 to 4.12 mmol/l, while Tůmová *et al.* (2004) reported the range of 3.40–7.53 mmol/l, Suchý *et al.* (1999) the range of 2.73–6.18 mmol/l, and Lichovníková *et al.* (2002) the range of 3.56–3.57 mmol/l. Some authors, for example Puvadolpirod and Thaxton (2000), related the level of plasma cholesterol in layers to stress as Pavlík *et al.* (2004) did in the case of plasma glucose. These authors found that during the laying period the mean levels of plasma glucose ranged from 12.48 to 14.08 mmol/l and that in the second half of egg laying the concentration of glucose in blood increased. The levels of plasma calcium and phosphorus also represent important diagnostic parameters often used to monitor the quality of eggshell. Řezáč *et al.* (2000) found that the mean levels of calcium and phosphorus in the blood plasma of layers were ca 6.5 mmol/l and 1.7 mmol/l, respectively.

MATERIAL AND METHODS

The main aim of the study was to compare the metabolic profile of two types of production hybrids

(egg-type hens, meat-type hens) on the basis of haematological and biochemical tests, and to assess dynamic changes in monitored haematological and biochemical parameters which occur during the laying period (from the 25th to the 50th week of age). An experiment was carried out with 30 clinically healthy egg-type hens (MORAVIA BSL) aged 20 weeks with average live weight of $1.89 (\pm 0.230)$ kg, and with 30 meat-type hens (parent material, COBB 500) aged 20 weeks with average live weight $2.62 (\pm 0.296)$ kg. Egg-type production hens were reared individually in cages while meat-type production hens were kept on deep bedding in an accredited experimental enclosure at the Institute of Dietetics, Zoo-Technology and Zoo-Hygiene at FVHE VFU in Brno, with air-conditioning and controlled light and feeding regimens. The respective technological requirements for management of individual hybrid combinations of laying hens were observed throughout the rearing. Basic microclimatic parameters during the experiment were as follows: air temperature ranged between 13 and 18°C, relative humidity was kept between 70 and 75%. The length of daylight during the experiment was gradually extended till the 30th week, reaching 16 hours, then it remained on this level. Blood samples were collected by puncture of *vena basilica* in 5-week intervals between 7–8 a.m. during the laying period and subjected to haematological and biochemical examination. Blood samples were collected into test tubes containing heparin. The following haematological parameters were determined: total counts of erythrocytes (Er) and leukocytes (Le) (using a flask dilution method and counting blood cells using a Bürker chamber), content of haemoglobin (Hb) (photometrically using a Drabkin solution at a wavelength of 540 nm); haematocrit level was determined by a capillary micro-haematocrit method according to Janetzki. Blood plasma was also subjected to the following biochemical tests: total protein (TP), glucose (Gl), cholesterol (Chol), plasma levels of calcium (Ca) and phosphorus (P) (photometrically with commercially available kits Bio-La-Tests made by Pliva-Lachema, a.s.). Results were processed using mathematical and statistical methods implemented in the statistic programme Statgraphic.

RESULTS

The results of haematological and biochemical tests in egg-type hens (E) and meat-type hens (M)

obtained during egg laying, i.e. from the 25th to the 50th week of age, including statistical parameters are provided in Tables 1 and 2. Six examinations were performed regularly in 5-week intervals in 30 hens of each group during egg laying (i.e. the total of 180 examinations).

The total count of erythrocytes in egg-type hens during egg laying varied in the range from 2.16 T/l to 2.54 T/l while in meat-type hens the mean levels of total erythrocyte count during egg laying ranged

from 1.73 T/l to 2.41 T/l. A statistically highly significant difference ($P \leq 0.01$) between egg-type hens and meat-type hens was found in the mean count of erythrocytes in 30th, 45th and 50th week while in the 35th week of age the difference was statistically significant ($P \leq 0.05$). The mean levels of haematocrit in egg-type layers increased from 0.26 l/l (in the 25th week) to 0.36 l/l (in the 40th week), and then they remained unchanged till the end of the monitored period. Meat-type hens showed mean haematocrit

Table 1. Comparison of average levels of haematological parameters in egg-type hens and meat-type hens during the laying period

Week	Group	Er (T/l)	Hc (l/l)	Hb (g/l)	Le (G/l)
25	E	2.16 (0.402)	0.26 (0.028)	75.29 (7.760)	17.65 (5.660)
	M	1.97 (0.420)	0.29** (0.029)	80.06* (9.743)	13.13** (4.039)
30	E	2.40 (0.400)	0.28 (0.032)	84.28 (7.772)	12.85 (4.754)
	M	1.73** (0.293)	0.27 (0.021)	75.78** (9.614)	13.97 (4.193)
35	E	2.26 (0.404)	0.31 (0.020)	105.30 (12.009)	17.13 (5.358)
	M	2.41* (0.350)	0.29* (0.044)	91.55** (10.921)	11.83** (2.106)
40	E	2.54 (0.332)	0.36 (0.030)	101.61 (11.112)	19.87 (5.669)
	M	2.41 (0.311)	0.29** (0.029)	83.52** (6.185)	14.32** (5.753)
45	E	2.28 (0.297)	0.36 (0.023)	100.18 (13.136)	16.69 (4.345)
	M	2.36** (0.480)	0.32** (0.035)	87.86** (11.126)	12.70** (1.815)
50	E	2.52 (0.501)	0.36 (0.043)	100.20 (6.772)	18.19 (6.229)
	M	1.95** (0.490)	0.31 (0.045)	86.30 (15.035)	13.35** (3.431)
\bar{x}	E	2.36 (0.389)	0.32 (0.029)	94.48 (9.760)	17.06 (5.336)
	M	2.14** (0.391)	0.30** (0.034)	84.18** (10.437)	13.22** (3.556)

E = egg-type hybrid (MORAVIA BSL); M = meat-type hybrid (COBB 500); () = (standard deviation)

Er = erythrocytes; Hc = haematocrit; Hb = haemoglobin; Le = leukocytes

* $P \leq 0.05$; ** $P \leq 0.01$

Table 2. Comparison of average levels of biochemical parameters in egg-type hens and meat-type hens during the laying period

Week	Group	TP (g/l)	Gl (mmol/l)	Chol (mmol/l)	Ca (mmol/l)	P (mmol/l)
25	E	60.45 (8.478)	13.80 (0.880)	3.13 (1.045)	6.29 (0.997)	1.25 (0.291)
	M	41.51** (3.733)	13.63 (0.794)	2.83 (0.625)	5.00** (1.117)	1.87** (0.154)
30	E	56.82 (5.293)	13.36 (0.675)	5.45 (1.615)	6.30 (0.685)	1.43 (0.311)
	M	50.28** (5.625)	12.63** (0.759)	4.12** (0.767)	5.08** (1.238)	1.34 (0.227)
35	E	58.58 (5.641)	13.59 (0.866)	6.18 (2.004)	6.72 (0.884)	1.90 (0.169)
	M	49.85** (5.734)	12.34** (1.218)	3.90** (0.722)	5.18** (1.440)	1.44* (0.204)
40	E	57.77 (5.878)	13.81 (1.345)	5.69 (1.688)	7.19 (0.778)	1.79 (0.431)
	M	56.54 (4.701)	12.94** (0.931)	4.85* (0.669)	6.22** (0.981)	1.70 (0.258)
45	E	56.03 (6.889)	14.97 (0.805)	5.76 (1.974)	6.67 (1.091)	1.37 (0.691)
	M	56.88 (4.615)	14.27** (0.828)	4.48** (1.196)	6.20 (1.060)	1.72* (0.309)
50	E	56.09 (5.072)	14.65 (0.776)	5.80 (2.251)	5.92 (0.952)	1.76 (0.784)
	M	50.84** (7.735)	14.34 (1.379)	2.18** (0.801)	5.43* (0.772)	1.41* (0.249)
x	E	57.62 (6.209)	14.03 (0.891)	5.34 (1.763)	6.52 (0.898)	1.58 (0.446)
	M	50.98** (5.357)	13.36** (0.985)	3.73** (0.797)	5.52** (1.101)	1.59 (0.234)

E = egg-type hens (MORAVIA BSL); M = meat-type hens (COBB 500); () = (standard deviation)

TP = total protein; Gl = glucose; Chol = cholesterol; Ca = calcium; P = phosphorus

* $P \leq 0.05$; ** $P \leq 0.01$

levels ranging from 0.27 l/l (in the 30th week of age) to 0.32 l/l (in the 45th week of age). Highly significant differences ($P \leq 0.01$) in mean haematocrit levels were found between egg-type hens and meat-type hens in the 25th, 35th, 40th and 45th week of age. From the beginning of the experiment haemoglobin levels gradually increased in both types of hens till the 35th week of age, i.e. from 75.29 g/l to 105.30 g/l in egg-type hens and from 75.78 g/l to 91.55 g/l in meat-type hens. Between the 40th and 50th week of

age, haemoglobin levels were constant. Statistically highly significant ($P \leq 0.01$) differences were detected between average levels of haemoglobin in the 30th, 35th, 40th, 45th and 50th week of age. Average levels of total leukocyte count in egg-type hens ranged between 12.85 G/l (in the 30th week of age) and 19.87 G/l (in the 40th week of age). Significantly lower counts of leukocytes were found in meat-type hens (11.83–14.32 G/l). Except for the 30th week of age, all examinations showed statistically highly

significant differences ($P \leq 0.01$) in mean leukocyte counts between egg-type hens and meat-type hens. As far as the biochemical parameters are concerned, attention was particularly focussed on total plasma protein, glucose, cholesterol, calcium and phosphorus (Table 2). In egg-type hens the average levels of total plasma protein during the monitored period ranged between 56.03 and 60.45 g/l, while in meat-type hens it varied between 41.51 and 56.88 g/l. The mean levels of plasma protein in meat-type hens aged 25, 30, 35 and 50 weeks were highly significantly ($P \leq 0.01$) lower. The monitoring of the dynamics of glucose in hens during egg laying revealed significant differences between egg-type hens (13.36–14.97 mmol/l) and meat-type hens (12.34–14.34 mmol/l) in particular weeks. These differences in the mean levels of glucose were found to be statistically highly significant ($P \leq 0.01$) for most examinations. The average levels of cholesterol in egg-type hens during the monitored period ranged between 3.13 mmol/l and 6.18 mmol/l. The average levels of cholesterol in meat-type hens were lower with high statistical significance ($P \leq 0.01$), ranging from 2.18 to 4.85 mmol/l. Analogously, the average plasma levels of calcium in meat-type hens (5.00–6.22 mmol/l) were highly significantly ($P \leq 0.01$) lower in most cases compared with those of egg-type hens (5.92–7.19 mmol/l). The average levels of plasma phosphorus varied considerably in both egg-type hens (1.25–1.90 mmol/l) and meat-type hens (1.34–1.87 mmol/l).

DISCUSSION

The study focuses on the monitoring of differences and dynamic changes in the metabolic profile of production egg-type and meat-type hybrid layers during the laying period. These were assessed on the basis of selected haematological and biochemical parameters of blood plasma. The findings documented in Tables 1 and 2 show that both types of production hens differ significantly in most haematological and biochemical parameters monitored but dynamic changes in individual parameters were very similar in both groups of layers during laying.

The results of haematological tests (Table 1) indicate enhanced haematopoiesis in egg-type hens compared with meat-type hens. This is confirmed by the fact that average levels of haematological parameters increased every 5 weeks and also over the whole laying period (180 examinations). The total count of erythrocytes in egg-type hens was

significantly higher ($P \leq 0.01$; 2.36 T/l) compared with that in meat-type hens (2.14 T/l) over the whole laying period (Table 1).

Similarly, the mean levels of monitored haematological parameters in egg-type hens were significantly ($P \leq 0.01$) higher (compared with those of meat-type hens). This particularly concerns haematocrit levels: 0.32 l/l (0.30 l/l); content of haemoglobin: 94.48 g/l (84.18 g/l), and total leukocyte count: 17.06 G/l (13.22 G/l). Mean levels of individual haematological parameters correspond well with data published by Uko and Ataja (1996), Straková *et al.* (2001) and Lichovníková *et al.* (2002). However, Tůmová *et al.* (2004) and Lichovníková *et al.* (2002) report slightly higher levels of the total count of erythrocytes and leukocytes, respectively. Similar differences between egg-type and meat-type hens were found in biochemical parameters of blood plasma, except for plasma phosphorus. Individual mean levels calculated for the whole laying period are as follows: plasma protein 57.62 g/l (50.98 g/l), glucose 14.03 mmol/l (13.36 mmol/l), cholesterol 5.34 mmol/l (3.73 mmol/l) and calcium 6.52 mmol/l (5.52 mmol/l). Differences between these mean levels were found highly significant ($P \leq 0.01$). In the case of plasma phosphorus, i.e. 1.58 mmol/l (1.59 mmol/l), the average levels in both types of hens were almost the same. Similarly, the levels of biochemical parameters varied within ranges reported by Máchal (2000), Tůmová *et al.* (2004), Pavlík *et al.* (2004), and Řezáč *et al.* (2000). The differences in haematological and biochemical parameters probably arise due to the differences between the particular types of production layers which differ by the intensity of metabolism. A high laying intensity in egg-type hens results in enhanced intermediary metabolism which is expressed by increased haematopoiesis and elevated levels of the biochemical parameters monitored. The results of this study have brought a new insight into avian haematology and biochemistry and may also be used in veterinary practice to assist in more accurate interpretation of haematological and biochemical examination of poultry blood.

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Received: 04–04–22

Accepted after corrections: 04–05–12

ABSTRAKT

Rozdíly v metabolickém profilu u nosného a masného hybrida nosnic

Cílem práce bylo poznání rozdílů v metabolickém profilu (hematologické a vybrané biochemické ukazatele krevní plazmy) užitkového hybrida nosného (N) typu MORAVIA BSL a masného (M) typu nosnic (COBB 500) a dynamických změn, ke kterým dochází v období snášky od 25. do 50. týdne věku. Stanovený cíl práce vycházel přímo z požadavků chovatelské a veterinární praxe, kde tyto charakteristiky zdravotního stavu nosnic zcela chybí. Vybrané ukazatele metabolického profilu nosnic byly sledovány v pravidelných pětítýdenních intervalech v průběhu snáškového období. Krev pro hematologická a biochemická vyšetření byla získána punkcí *vena basilica* a stabilizována heparinem. Studie přináší nové poznatky o tom, že v souvislosti s odlišným užitkovým typem, a s tím i související rozdílnou úrovní a systémem výživy a s rozdílnou intenzitou snášky, dochází k výrazným rozdílům ve sledovaných ukazatelích metabolického profilu. Intenzivnější metabolismus u nosného typu slepic se projevil i vyšší úrovní erytropoézy, která se manifestovala (oproti masnému typu slepic) vysoce průkazně ($P \leq 0,01$) vyšší průměrnou koncentrací erytrocytů 2,36 T/l (2,14 T/l), hematokritovou hodnotou 0,32 l/l (0,30 l/l), vyšším obsahem hemoglobinu 94,48 g/l (84,18 g/l) a počtem leukocytů 17,06 G/l (13,22 G/l). Intenzivnější metabolismus u nosných slepic se manifestoval i vysoce průkazně ($P \leq 0,01$) vyššími hladinami u biochemických ukazatelů krevní plazmy, a to u celkové bílkoviny 57,62 g/l (50,98 g/l), glukózy 14,03 mmol/l (13,36 mmol/l), cholesterolu 5,34 mmol/l (3,73 mmol/l) a vápníku 6,52 mmol/l (5,52 mmol/l). Pouze u fosforu nebyly prokázány rozdíly v krevní plazmě mezi nosnými (1,58 mmol/l) a masnými (1,59 mmol/l) slepicemi. Výše uvedené průměrné hodnoty vycházejí ze 180 hematologických a biochemických rozborů provedených v průběhu snáškového období. Dosažené výsledky lze považovat za velmi přínosné nejen pro další rozvoj aviární hematologie a biochemie, ale i z hlediska veterinární praxe.

Klíčová slova: nosný a masný typ slepic; hematologie; biochemie krve

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