Effect of age upon utilisation of iron in chickens

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ABSTRACT: The effect of age upon iron retention in cockerels of laying and meat type hybrids was examined within 46 subsequent balance periods. Chickens were fed *ad libitum* a diet with the content of 312 mg Fe per 1 kg. The dependence of Fe utilisation upon age from Day 3 to Day 100 was expressed by the second degree parabolas with minimum values in the tenth week of age. The dependence of Fe content in weight gains on age was highly significant ($P < 0.01$). The course of this dependence was expressed by parabolas with minimum values on Day 38 and Day 28 in slow and fast growing chickens, resp. The growth rate of total amount of Fe in the body was by 6 per cent lower ($P < 0.01$) than that of live weight of chickens.

Keywords: chickens; age; growth rate; iron retention

Approximately 60% of body Fe is presented as haemoglobin. Myoglobin completes the transfer of oxygen from haemoglobin into the cell. Iron is an essential part of the cytochrome enzymes. Iron-containing catalase and peroxidases remove potentially dangerous products of metabolism, while iron-activated hydroxylases influence the connective tissue development (Underwood and Suttle, 1999). Only when Fe is supplied by the diet in sufficient amounts, enzymes can be synthesized in the body (Surai, 2002).

Iron absorption is higher in deficient than in iron-sufficient animals. Absorbed iron is delivered as ferric iron on the serosal surface where it is bound to transferrin for transport. Ferritin is the main iron storage compound of the body and its concentration in the tissues, together with that of haemosiderin, reflects the iron status of the animal (Underwood and Suttle, 1999).

Iron absorption is affected by such factors as the iron status of the body and age (Underwood and Suttle, 1999). Mohanna and Nys (1998) estimated percentages of Fe retention and concentrations of body iron in chicks of the age of 0, 4, 11, 21, 29, 40 and 50 days. The highest retention of Fe was recorded during the first days of life. The percentage of Fe utilisation decreased rapidly till Day 21 of age; thereafter, the observed changes were only very small. Body retention of Fe for the period Days 0 to 50 was 10% of intake. Fe concentration in the organism was high until Day 11 of age; the minimum value was recorded on Day 21 and thereafter the measured values increased. The effect of age was highly significant ($P < 0.001$). Cao *et al.* (1996) observed in an experiment with broilers that the tissue iron concentration increased with the increasing level of dietary Fe. Gruhn and Anke (1965) estimated the Fe content in featherless total bodies of female chicks at 2-week intervals in the period from hatching to the 12th week of age. The content of Fe was found to be the highest on Days 14 and 28 (875 and 803 mg/kg, resp.) and declined thereafter continuously till Day 85 (43 mg/kg).

MATERIAL AND METHODS

Retention of iron was studied in a balance experiment with 52 cockerels of meat type hybrid Ross 208 and 95 males of laying hybrid Isa Brown from the

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3rd to the 22nd day of life in one-day periods and from the 23rd to the 100th day in three-day periods. The pelleted practical type of feed mixture with the content of 312 mg Fe per 1 kg including 35 mg of Fe added as iron sulphate was supplied *ad libitum*. The coefficients of apparent retention were estimated by the chromic oxide indicator method.

The content of Fe in feed and freeze-dried excreta was estimated after dry mineralisation (APION, Tessek Prague, Ltd., 25°C – 400°C, oxidative medium $O_3 + NO_x$) by the flame atomic absorption spectrometry using Varian SpectrAA-30 Atomic Absorption Spectrometer at wavelengths 248.3 nm. There were three replications in each determination. The differences between parallel estimations were lower than 3 relative per cent. Our results of reference materials (feed mixtures for poultry for interlaboratory tests of the Central Institute of Supervising and Testing in Agriculture of the Czech Republic) were in agreement with certified values. The recovery for Fe was 96.85 ± 0.933 per cent (mean ± standard error of the mean; 20 determinations). The content of chromic oxide was estimated iodometrically (Mandel *et al.*, 1960).

The amount of consumed feed from which elements deposited in the body originated was calculated on the basis of chromic oxide concentration in feed mixture and excreta and the amount of quantitatively collected excreta. At the age of 2 days seven chickens were killed and the contents of Fe in their bodies were determined. For older birds the contents of Fe in the live weight gain (μg/g) were calculated using feed consumption as determined by the method described above, content of this micronutrient in the diet, coefficients of its utilisation and live weight gain in the balance period. The live weight of chickens was estimated at the end of each balance period.

For the expression of the relation between iron retained in the body and live weight of chickens a power function $Y = aX^b$ (Brody, 1945) was used. The regressions of determined values were computed according to Snedecor and Cochran (1967).

RESULTS AND DISCUSSION

The average coefficients of dietary Fe utilisation estimated in Isa Brown and Ross 208 were 0.195 ± 0.0138 (mean ± standard error of the mean) and 0.211 ± 0.0104, resp. Slow growing cockerels of laying hybrid retained 61 ± 4.3 μg and fast growing broilers 66 ± 3.2 μg of Fe per each gram of consumed feed mixture. The difference between hybrids was not significant ($P > 0.05$).

The dependence of Fe utilisation upon the age of chickens from 3 to 100 days of age was expressed by linear regression equations, for Isa Brown:

$$Y = 0.268 – 0.0018\,X;\ r = 0.582$$

and for Ross 208:

$$Y = 0.281 – 0.0017\,X;\ r = 0.748$$

The daily decrease 0.18% in slow growing hybrids and 0.17% in meat type chickens was highly significant ($P < 0.01$).

The dependence on age was much better ($P < 0.01$) expressed by the convex parabola (Figure 1). Similarly like in the experiment conducted by

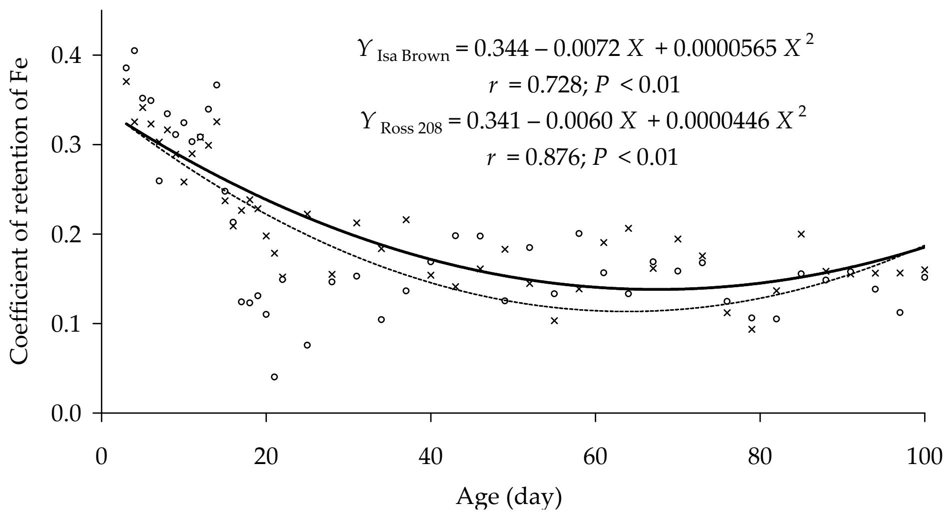

Figure 1. Dependence of Fe utilisation on the age of chickens (× Ross 208; ○ Isa Brown)

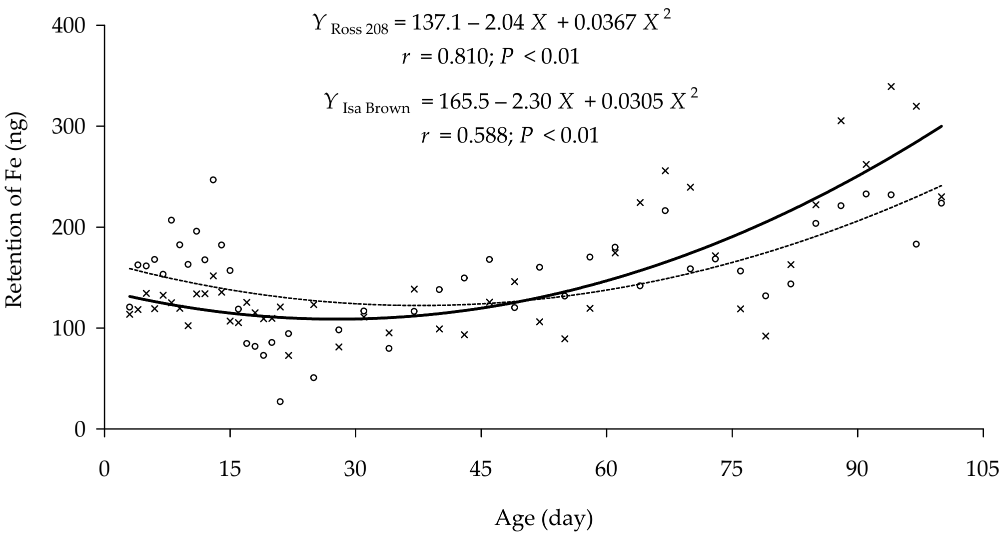

Figure 2. Retention of Fe per 1 g of weight gain (× Ross 208; ○ Isa Brown)

Mohanna and Nys (1998), a rapid decrease in coefficients of Fe retention gradually slowed down and the minimum values were recorded on Days 64 and 68 in laying and meat type chickens, resp.; thereafter, an only slight increase in measured values was observed.

The average contents of Fe per 1 g of live weight gain in laying and meat type cockerels were 151 ± 7.4 and 149 ± 9.6 µg, resp. The difference between hybrids was insignificant ($P > 0.05$). The content of Fe in body tissues was much higher than the values published by Mohanna and Nys (1998). In accordance with observations described by Cao *et al.* (1996) it could be caused by the fact that the content of dietary Fe was higher than in the experiment of the authors mentioned above.

The course of dependence of Fe content in weight gain on age was expressed by 2nd degree parabolas with minimum value on Day 38 and 28 in slow and fast growing chickens, resp. (Figure 2). In broiler chickens, the dependence of body Fe concentration on age (Mohanna and Nys, 1998) was similar to the dependence of Fe retention per unit of weight gain found in our study.

The relation of total amount of iron in the body in mg (Y) and live weight of chickens in g (X) was expressed by the equation for Isa Brown:

$Y = 0.0991\ X^{0.940};\ I_{YX} = 0.975$

and for Ross 208:

$Y = 0.0999\ X^{0.937};\ I_{YX} = 0.963$

Correlation indexes were highly significant ($P < 0.01$).

The growth rate of total amount of Fe in the body was by 6 per cent lower than that of live weight of chickens. Since the growth requirement for iron is predominantly for haemoglobin and the increase in red-cell mass constitutes a progressively smaller component of live weight as animals grow, the need in terms of dietary iron concentration will decline with age (Underwood and Suttle, 1999). Utilisation of Fe decreases if the dietary level of this microelement remains unchanged.

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ABSTRAKT

Vliv věku kuřat na využití železa

Retence železa byla sledována u kohoutků nosného a masného typu ve věku 3 až 100 dní ve 46 bezprostředně na sebe navazujících bilančních obdobích. Kuřata byla krmena *ad libitum* směsí obsahující v 1 kg 312 mg Fe. Závislost využití železa na věku byla vyjádřena rovnicemi konvexních parabol s minimem v desátém týdnu života. Závislost obsahu Fe v přírůstcích živé hmotnosti na věku kuřat byla vysoce průkazná ($P < 0,01$); byla vyjádřena parabolami s minimem u pomalu rostoucích kuřat ve 38. a u rychle rostoucích brojlerů ve 28. dni života. Relativní rychlost růstu celkového množství Fe uloženého v organismu byla o 6 % nižší ($P < 0,01$) než relativní rychlost růstu živé hmotnosti kuřat.

Klíčová slova: kuřata; věk; rychlost růstu; retence železa

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