Relationship between abdominal fat and methionine deficiency in broilers

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ABSTRACT: A study was conducted to determine the relationship between abdominal fat and the intake of methionine deficient diet in broilers. In this study, 66 male broilers at the age of 35 days were used. They were divided into two groups (control, n = 13, and methionine deficient group, n = 53) and all birds were housed in individual pens. During the experiment, normal and deficient diet contained 0.55% and 0.25% methionine, respectively. Control group was fed normal diet for 19 days. Treatment group received methionine deficient diet for 4 days and normal diet for 15 days. Body weight and feed intake were recorded daily. High (HG) and low (LG) groups were theoretically created according to the rates of decreases in individual feed intake. Percent decrease in feed intake of HG and LG groups was 29.4 ± 2.0 and –1.3 ± 1.7, respectively. Abdominal fat in HG and LG groups amounted to 1.62 ± 0.1 and 1.73 ± 0.2%, respectively. The feed conversion ratio of HG and LG groups was 3.1 ± 0.1 and 3.4 ± 0.2, respectively. There was a negative correlation (–0.45 in HG and –0.43 in LG) between the percent decrease in feed intake and abdominal fat.

Keywords: broiler; methionine deficiency; abdominal fat

In animal production it is necessary to improve genotypic and some environmental conditions (feeding, climate, ventilation and temperature) in order to increase the efficiency of selection methods. However, conventional methods for enhanced production in animal husbandry take longer periods of time and involve some difficulties both in keeping animals alive and controlling diseases. Therefore, methodologies rendering faster solutions and/or innovations in more economical techniques have gained more importance.

One of the factors affecting the quality of carcasses in broilers is the abdominal fat ratio. Excess fattening in chicken carcasses is not desirable because of consumer preferences, and excess fattening causes some difficulties in slaughtering and lowering the rate of feed efficiency of broilers.

As reported by Scheele et al. (1981), total body weights in broilers usually have 15–20% fat that is distributed in the carcass as follows; (1) 15% is in the blood and other organs and (2) 85% is found in some adipose tissues such as abdominal fat, skin and muscles (Evans, 1977). The abdominal fat tissue constitutes approximately 2–3% of the broiler live weight (Leenstra, 1986). Sex, age, feed efficiency, genotype and feeding are some of the main factors affecting abdominal fattening in broilers. Fat tissues are larger in female and old broilers than in male and young ones (Edwards et al., 1973). Chickens with good feed-conversion ability have less abdominal fat (Whitehead and Griffin, 1984). Differences in abdominal and carcass fats between genotypes have been shown to indicate the importance of the genetic effect in fat deposition (Edwards and Denman, 1975). Feeding factors have a considerable impact on the carcass composition of broiler chickens (McLeod, 1982).

Amino acid deficiency in feeds affects animal metabolism as it changes the feeding pattern and also causes a lowered feed intake proportional to the amino acid deficiency (Rogers and Leung, 1973; Boorman, 1979). The reason for low feed intake is a rapid decrease in the limiting amino acid concentration in blood induced by imbalanced

amino acids (Harper et al., 1970). Additionally, inadequate amino acid intake affects animal appetite, growth and reproduction (Boorman, 1979). Picard et al. (1993) studied the reactions of broiler chickens to feed intake using feeds with deficient essential amino acids and found that within the first 24 hours deficient feeds were taken up at a lower rate by 26% compared to standard feeds. Pesti et al. (1994) stated that the genetic structure plays an important role in determining the relationship between the plasma amino acid concentration and carcass composition. Similarly, Boa-Amponsem et al. (1991) reported that genetic stocks might have different responses to amino acid deficiency and/or imbalance. There are two leading factors contributing to differences in protein intake between lean and fat lines: namely, the determination of genetic effects on protein synthesis and degradation and an increased level of amino acid oxidation in FL lines (Whitehead and Griffin, 1986).

The goal of this study was to determine the relation between the levels of individual abdominal fattening insufficient methionine feed intake in broiler chickens. Thus, better feed converting chickens, fed with deficient methionine feeds and depending on the decrease in feed intake, determined based on their feed consumption in a short period of time. Namely, this method was investigated if it could be used as an indirect selection criterion.

MATERIAL AND METHODS

Animals and housing

The animal material consisted of 66 male broilers that were 35 days old (Avian). Chickens were randomly placed in individual compartments with wooden floors (45 × 45 × 45 cm in size) and wood shavings as litter. In this study individual feeders and water cups were used. Fluorescent lamps were used for lighting in a period of 23 : 1 hours (light: dark) each day.

Feeds and feeding

Two different diets were applied: the one was prepared normally (ND) while the other was deficient in methionine (MD). The only difference between normal diet and methionine-deficient one was the content of synthetic crystallized DL-methionine (Table 1).

Table 1. Composition of methionine-deficient (MD) and normal (ND) diets

	Diets				
Ingredients (g/kg)	MD	ND	Calculated composition (%)	MD	ND
Maize	774.1	776.3	Energy (kcal ME/kg)	3 200	3 200
Soybean meal	167.7	163.1	Protein	15	15
Maize oil	19.5	18.6	Energy/Protein	213	213
Limestone	11.9	11.9	Calcium	0.80	0.80
Dicalcium phosphate	12.6	12.6	Phosphorus (av)	0.35	0.35
NaCl	4.6	4.6	Sodium	0.20	0.20
Vitamin-mineral premix*	2.5	2.5	Arginine	0.89	0.87
DL-methionine	–	3.1	Lysine	1.20	1.20
L-lysine HCL	7.1	7.3	Methionine	0.25	0.55
Total	1.000	1.000	SAA (Methionine + Cystine)	0.52	0.81
			Threonine	0.55	0.54
			Tryptophan	0.15	0.15

*supplied per kg of diets: retinol 4.05 mg; cholecalcipherol 0.05 mg; tocopherol 13.5 mg; menadione 2.25 mg; thiamin 1 mg; choline 375 mg; riboflavin 5.4 mg; pantothenic acid 13.5 mg; pyridoxine 1.1 mg; cyanocobalamin 0.01 mg; nicotinic acid 40 mg; biotin 0.15 mg; I 2.1 mg; Co 1.4 mg; Se 0.43 mg; Cu 7.2 mg; Mn 86 mg; Zn 57 mg; Fe 65 mg; Mg 110 mg

Table 2. Feeding periods

Days	10	2	2	2	3
Diets	ND	MD	ND	MD	ND
Periods	ND1	MD1	ND2	MD2	ND3
Age (days)	36–45	46–47	48–49	50–51	52–54

ND = normal diet, MD = methionine-deficient diet

At the beginning, chickens were divided into two groups according to their live weights in such a way that one group was a treatment group (MD) (1695 ± 23 g, n = 53) and the other was a control group (1715 ± 54 g, n = 13) with no statistical difference. Feeding was carried out in different periods during the growth period as shown in Table 2. All chickens were fed normal diet for the first 10 days (ND1). Control group received normal diet throughout the study. Treatment group was fed methionine-deficient diet on the 11th and 12th day (MD1) and on the 13th and 14th day it received normal diet (ND2); then on the 15th and 16th day methionine-deficient diet (MD2), and finally on the 17th, 18th, and 19th day the birds received normal diet.

Measurements

Live weight and feed intake were measured on a daily basis, at 5:00 pm throughout the study. At the end, all chickens were slaughtered and their abdominal fat and carcass weights were measured with a digital scale (±1 g sensitivity).

Decrease in feed intake, forming the groups and the analysis

To determine the relationship between abdominal fattening and decrease in feed intake, the following relation was used in treatment groups:

$$DFI = [(A - B)/A] \times 100 \quad (1)$$

where: DFI = percent decrease in feed intake (%)
A = average amount of feed taken during the period of ND2 (g)
B = average amount of feed taken during the period of MD2 (g)

Because of possible behavioural problems in chickens fed methionine-deficient diet in period 1 for the first time, the decreases in feed intake recorded in the second period were taken as a basis for our calculations (Kare and Rogers, 1976).

Groups were formed on the basis of feed intake values calculated from equation 1. These values were arranged in an ascending order, and 10 chickens with the highest decrease in feed intake were designated as the high group (HG). Other 10 chickens with the lowest decrease were included in the low (LG) groups. Statistical analysis was carried out using SPSS (version 10.0) software.

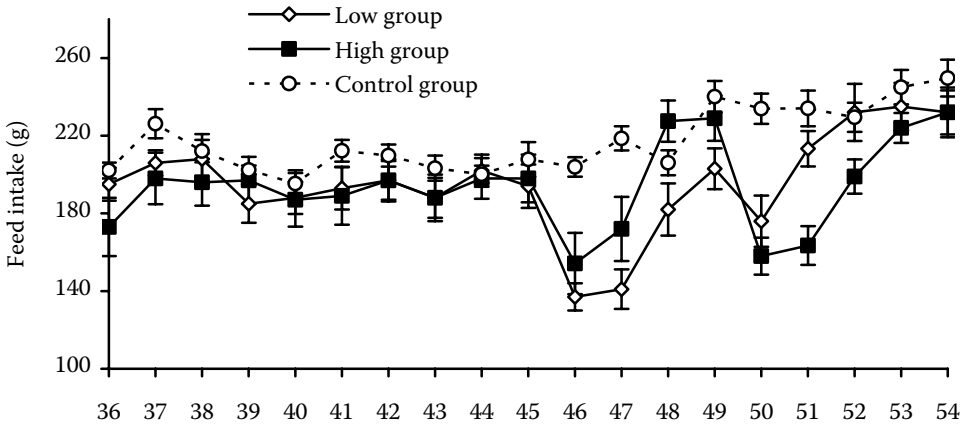
RESULTS

Daily feed intake

Average feed intake with standard error values taken from 10 chickens is represented by a whisker diagram (period of days 36–45 in Figure 1). During the first 10-day period of feeding an adequate dietary methionine content, the feed intake values of three groups showed a similar pattern resulting in an insignificant difference (Figure 1). In the first two-day period of methionine-deficient feeding (days 46–47), LG and HG groups had the markedly lowest feed intake. After that period, on the first day (period of days 48–49 in Figure 1) when normal diets were given to chickens, the feed consumption increased in both groups (LG and HG). A similar feed intake pattern was also observed in the second period (period of days 49–54 in Figure 1) of methionine-deficient feeding. Both groups increased their average daily feed intake up to the control level on the third day of normal feeding period (ND3).

Average feed intake in different feeding periods

In the first 10-day period, the analysis of feed consumption indicated no significant differences between groups (Table 3). In the MD1 period, feed intake values differed significantly between the groups ($P < 0.01$). There was no difference between control group (CG) and HG in the first period in which normal feeding was low in ND2, however, LG was significantly different ($P < 0.01$) compared to CG. In the MD2 period, feed intake values significantly differed between the three groups ($P < 0.01$), but there was no difference between the three groups in the third period.



Diets	ND	MD	ND	MD	ND
Periods	ND1	MD1	ND2	MD2	ND3
Days	10	2	2	2	3

Figure 1. Daily trend of feed intake values based on age for feeding periods

Live weight

Live weight values (average of 10 chickens) of control group were higher compared to the other groups in all feeding periods ($P < 0.05$). The difference was even more pronounced starting from the 46th day of methionine-deficient feeding.

Feed consumption and feed conversion ratio

In the first 10-day period, the feed conversion ratio, live weight gain and feed consumption values of LG and HG indicated that HG feed efficient values were higher than LG. However, there was no significant difference between the groups (Table 4).

Relation between decrease in feed intake (DFI %) and abdominal fat

In LG and HG groups, the values of a decrease in feed intake and abdominal fat were –1.3, 29.4 (%) and 1.73, 1.62 (g/100g LW), respectively (Table 5). The correlations between abdominal fat (AF) values and decrease in feed intake (DFI) were –0.43 and –0.45 for the LG and HG groups, respectively. The regressions of AF on DFI resulted in the following coefficients:

For LG group: AF = –0.0435 [DFI] + 1.6748

For HG group: AF = –0.0222 [DFI] + 2.2676

Table 3. Standard errors and average values (g/day) of feed intake for feeding periods

Periods	CG (n = 13)	LG (n = 10)	HG (n = 10)
ND1 (days 36–45)	207 ± 1.2^{a}	196 ± 6.2^{a}	193 ± 10.6^{a}
MD1 (days 46–47)	212 ± 5.3^{c}	139 ± 6.3^{a}	164 ± 12.7^{b}
ND2 (days 48–49)	223 ± 4.8^{b}	193 ± 7.6^{a}	228 ± 10.8^{b}
MD2 (days 50–51)	233 ± 7.1^{c}	195 ± 6.8^{b}	161 ± 7.4^{a}
ND3 (days 52–54)	241 ± 6.6^{a}	233 ± 10.6^{a}	218 ± 7.9^{a}

CG = control group, LG = cow group, HG = high group
MD = methionine-deficient diet, ND = normal diet
^{a,b,c} = values within a row with no common superscripts differ significantly ($P < 0.01$)

Table 4. Feed consumption, live weight gain and feed conversion ratio of groups in the period of ND1 (days 36–45)

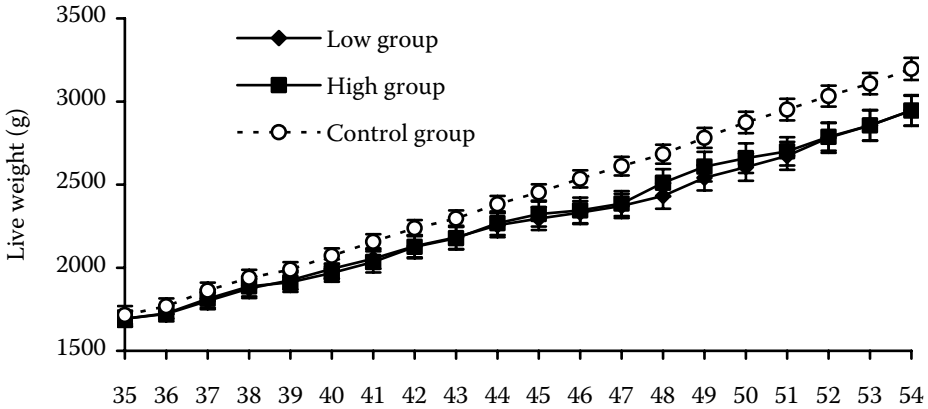
Traits	LG (n = 10)	HG (n = 10)
Feed consumption (g)	1 956 ± 62	1 921 ± 106
Live weight gain (g)	603 ± 41	631 ± 53
Feed conversion ratio	3.4 ± 0.2	3.1 ± 0.1

LG = low group, HG = high group

Table 5. The average values and standard errors of abdominal fat (AF), decrease in feed intake (DFI), carcass weight (g) and carcass percentage (carcass weight/live weight) in low (LG) and high (HG) groups

Traits	LG (n = 10)	HG (n = 10)
Decrease in feed intake (DFI) (%)	–1.3 ± 1.7	29.4 ± 1.2
Abdominal fat (AF) (g/100g LW)	1.73 ± 0.2	1.62 ± 0.1
Carcass weight (g)	2 021 ± 74	2 063 ± 71
Carcass percentage (%)	68.4 ± 0.7	70.1 ± 0.8

LG = low group, HG = high group



Diets	ND	MD	ND	MD	ND
Periods	ND1	MD1	ND2	MD2	ND3
Days	10	2	2	2	3

Figure 2. Daily trend of live weights depending on age

DISCUSSION

In this study, the first symptom of amino acid deficiency in diets was a decrease in animals' appetite similarly like in previous studies (Rogers and Leung, 1973; Picard et al., 1993). When given adequate feeding after methionine-deficient diet the feed intake values adjusted to the normal level on the same day similarly like in Almquist (1954) and Picard et al. (1993).

This research indicated that the values of abdominal fattening of the two experimental broiler groups were numerically different. Although the

feed intake values of LG group were higher than those in HG group, these fattened LG group chickens had lower live weight gains indicating that HG was more feed efficient than LG. Similarly, in previous studies lean lines (LL) had better feed conversion efficiency than fat lines (FL) (Leclercq, 1983; Whitehead and Griffin, 1985). This result agrees with the study of Geraert et al. (1990), who stated that the need of some amino acids might vary depending on the genotype and the ideal balance of amino acids might show differences between fat and less fat lines. This opinion was also supported by Pesti et al. (1994) and Saunderson (1988), who reported differences in the metabolism of 1 amino acid between the fat and lean lines, and by Leclerq et al. (1983) and Geraert et al. (1987), who found out differences in plasma profiles of 2 amino acids between the LL and FL lines. Pym (1990) explained differences in both metabolism and nutrition requirements via genetic variation in birds.

CONCLUSION

This study indicated that the amino acid need in broilers differs depending on fatty and less fatty groups. The less fatty group (HG) needs a higher amount of methionine, therefore it is more sensitive to methionine deficient feeding. Consequently, the use of methionine-deficient feeding against abdominal fattening might be utilized in broiler chickens as an indirect selection criterion.

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Receipt: 04–09–29
Accepted after corrections: 05–03–10

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