Early growth and development of intestine in first 2-3 weeks post hatch in chickens and ducks fed diets with increased methionine level

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In two experiments performed with the Hubbard HI-Ye broiler chickens and A11 Pekin ducks the birds fed mixtures supplemented with DL-methionine (99 %) at doses from 0.30 (control), to 0.33; 0.37; 0.42 and 0.48 %. The purpose of investigations was to determine the influence of dietary methionine on the intestinal tract (IT) development during early phase of birds' life. The preliminary examination of ITs were made on day 1, exactly 5 h after hatch, with 30 chickens and 30 ducks. The rest of birds was divided into 5 groups, every in 6 (chickens) or 4 (ducks) replications. On day 1st, 3rd, 5th,7th, 14th (chickens) and 1st, 3rd, 4th, 6th and 21st (ducks) of birds' life the body weight was estimated. After weighing randomly chosen birds were killed for the IT examinations: length and weight of duodenum, jejunum and ileum. All estimations were executed always on the 12 birds per treatment, day of sampling and species. Gradual supplementation of the diets with DL-Met at the level from 0.33 up to 0.48 % significantly ($P<0.05$) affected the body weight of chickens. It was stated just on 5th day of life. The effectivity of Met at doses of 0.42 and 0.48 % was similar. On day 14 the body weight in groups fed diets with those amounts was higher by 22.4 (0.42 %) and 24.4 % (0.48 %) as compared to control. Unclear response to the increased Met supplements was stated in the duodenum length and weight related to the $BW^{0.67}$. Shorter duodenum was stated in groups receiving 0.42 and 0.48 % of additional Met in the diets. Met level has not affected the jejunum and ileum length and weight, decreased values concerning these segments as related to $BW^{0.67}$ were noted. The body weight of 6 and 21-day old ducklings was significantly improved by higher dietary Met level (0.42 and 0.48 %). The length and weight of duodenum as calculated to 100 g of $BW^{0.67}$ were in these groups significantly lower than in control. Decreasing of obtained values concerning jejunum + ileum in this species was not significant.

Keywords: methionine; chickens; ducks; intestine; development

Introduction

Many factors, such as short and immature intestinal tract (IT), absorption rate and conversion of yolk sac residues, limited possibility of feed intake and dynamic of growth create specific conditions for nutrients utilization in first days post hatch (Lilja,1983; Nitsan *et al.*,1991; Nir *et al.*,1993; Shanawany,1994; Uni *et al.*, 1996; Jamroz *et al.*,2001; Bigot *et al.*,2003).

The influence of methionine- the first limiting amino acid on birds performance is known very well, but only sparse data concerning the effects of Met on the early post-hatch development of gastrointestinal tract are available in the literature. The purpose of presented investigations was to determine the dynamic of the yolk sac content resorption and development of intestinal tract on 7th (chickens) and 6th (ducklings) day post hatch in birds fed mixtures enriched with methionine.

Materials and methods

In two experiments performed with the Hubbard HI-Ye broiler chickens and A11 Pekin ducks the birds fed mixtures supplemented with DL-methionine (99 %) at doses from 0.30 (control), to 0.33; 0.37; 0.42 and 0.48 % (*Table 1*).

Table 1 Design of experiments.

Treatments	DL-methionine supplement (in %)	Total dietary level of Met+Cys (in %)
I	-	0.67
II	0.03	0.70
III	0.07	0.74
IV	0.12	0.79
V	0.18	0.85

The preliminary examination of intestinal tracts were made on day 1, exactly 5 h after hatch, with 30 chickens and 30 ducks. The rest of birds was divided into 5 groups, every in 6 (chickens) or 4 (ducks) replications. On day 1^{st}, 3^{rd}, 5^{th},7^{th}, 14^{th} (chickens) and 1^{st}, 3^{rd}, 4^{th}, 6^{th} and 21^{st} (ducks) of birds' life the body weight was estimated. After weighing randomly chosen birds were killed for the IT examinations: length and weight of duodenum, jejunum and ileum. All estimations were executed always on the 12 birds per treatment, day of sampling and species. All registered data were evaluated statistically using ANOVA.

Results and discussion

The dynamic of yolk sac residues disappearance in **chickens**, expressed in g, within first 7 days of chickens' life was regular, without remarkable alteration depending on methionine level in the diets. The changes of chemical composition of yolk sac residues indicate the clear tendency occurring during first 5 days of chickens' life. The slightly deeper absorption of protein from yolk sac content in chickens fed diets supplemented with high doses of methionine was observed (*Table 2*).

Table 2 Composition of yolk sac residues in chickens (g $100g^{-1}$ of yolk sac contents) (means, ±SD).

Days of life	Methionine level in diets									
	0.30		0.33		0.37		0.42		0.48	
	Dry matter									
1	47.4	±1.40	49.9	±5.47	48.6	±1.81	49.4	±3.05	51.4	±4.11
3	45.5	±4.48	45.2	±4.54	45.4	±3.58	45.2	±6.32	46.0	±3.37
5	38.4	±4.12	37.8	±11.57	38.6	±3.53	36.4	±3.32	31.9	±1.64
7	35.5	±4.07	36.0	±3.12	40.9	±6.53	34.0	-	42.3	±15.34
	Crude protein									
1	26.1	±3.29	23.0	±2.17	24.8	±1.82	25.9	±3.03	26.4	±2.68
3	23.0	±1.98	20.2	±5.06	24.0	±3.66	19.5	±6.82	20.7	±5.08
5	18.3ab	±3.68	18.4ab	±4.62	18.9b	±2.11	12.3a	±0.27	15.5ab	±1.76
7	17.3	±1.43	18.4	±1.62	18.2	±3.79	15.2	-	21.2	±9.69
	Crude fat									
1	11.5	±3.46	17.8	±5.68	14.3	±2.62	14.1	±5.68	15.3	±5.70
3	12.7	±2.15	15.4	±2.77	12.4	±3.78	16.3	±4.71	15.5	±3.68
5	13.0ab	±2.98	9.7a	±3.44	12.4ab	±1.17	17.7b	±4.45	10.8a	±0.78
7	12.9	±5.76	11.8	±0.04	16.7	±3.35	13.3	-	13.9	±3.84

Differences designed with a, b, c significant by $p<0.05$

In very young **ducks** the dynamic of nutrients absorption from yolk sac was not such regular as in chickens; increased Met level in applied diets was without significant influence on rate of protein, fat and dry matter absorption (*Table 3*).

Table 3 Chemical composition of yolk sac in ducks (g 100 g^{-1}) (means, ±SD).

Days of life	Methionine level in diets (%)									
	0.30		0.33		0.37		0.42		0.48	
	Dry matter									
1	60.0	±4.51	58.1	±3.59	60.9	±4.30	63.8	±3.74	57.7	±3.81
3	53.4	±6.77	49.7	±6.70	50.0	±8.29	50.7	±6.54	49.9	±5.30
4	35.7	±9.31	39.9	±4.68	31.4	±3.57	44.8	±8.87	41.9	±12.09
6	31.6	±3.89	25.6	±1.64	32.2	±5.51	26.8	±12.12	30.2	±9.77
	Crude protein (N x 6.25)									
1	18.8	±3.18	19.4	±3.91	17.7	±2.85	21.0	±3.09	20.6	±3.13
3	14.5	±2.53	11.5	±1.78	13.8	±3.33	12.5	±2.45	13.1	±1.81
4	11.8	±3.11	12.4	±2.06	10.3	±1.35	15.8	±0.68	13.1	±4.35
6	14.0	±0.30	15.9	±2.64	12.4	±1.64	13.8	±3.48	12.1	±4.71
	Crude fat									
1	33.4	±4.47	29.7	±3.77	36.1	±4.12	31.5	±3.40	28.6	±4.26
3	29.1	±5.16	32.6	±4.69	29.3	±4.14	30.1	±4.52	31.0	±4.02
4	19.0	±4.61	24.1	±4.06	18.0	±2.96	22.3	±6.15	24.1	±5.26
6	14.7	±2.02	9.1	±1.46	12.1	±1.15	10.9	±7.41	10.0	±2.85

The absolute body weight values were calculated to the metabolic body weight in purpose to create the possibilities for comparison of body weight of both bird species.

Supplementation of the diets with DL-Met at the level from 0.33 up to 0.48 % significantly ($P<0.05$) affected the absolute and metabolic body weight of **chickens**. It was stated just on 5th day of life, but the effectiveness of Met at doses of 0.37; 0.42 and 0.48 % was similar. On day 14 the absolute body weight in groups fed diets with those amounts was higher by 22.4 (0.42 %) and 24.4 % (0.48 %) as compared to control. Similarly in **ducks** the greatest absolute and metabolic body weight was observed in day 4, 7 and 21 in groups fed diets with highest Met levels ($P<0.05$ and 0.01) (*Table 4*).

Table 4 Metabolic body weight (BW $^{0.67}$) of chickens (g) (means, ±SD).

Days of life	Methionine level in diets (%)									
	0.30		0.33		0.37		0.42		0.48	
	Chickens									
1	14.0	±0.94	13.4	±0.89	13.6	±0.85	14.1	±0.68	14.0	±0.49
3	16.1	±1.33	15.9	±1.25	16.4	±0.63	16.5	±1.17	16.2	±0.66
5	20.0a	±1.61	21.1ab	±1.65	21.4b	±0.89	21.5b	±0.85	21.6b	±0.71
7	22.0a	±1.96	22.1a	±1.93	22.8ab	±1.90	23.9b	±1.59	23.9b	±1.33
14	45.6a	±5.35	47.3a	±4.71	48.4a	±4.41	52.3b	±3.80	52.9b	±3.67
	Ducks									
1	14.5	±0.86	14.5	±0.81	14.1	±0.93	14.8	±0.69	14.9	±0.93
3	18.9	±1.67	18.8	±1.52	19.3	±1.74	19.5	±2.92	19.8	±1.02
4	21.6a	±1.40	22.2ab	±1.95	22.7ab	±1.94	23.2b	±1.53	23.4b	±2.66
6	30.3A	±2.03	29.6A	±2.00	30.4A	±1.93	32.3B	±1.49	32.8B	±1.93
21	107.1a	±2.70	107.8ab	±1.91	108.6ab	±1.90	112.4b	±1.70	109.1ab	±1.91

Differences designed with A, B significant by $p<0.01$; designed with a, b significant by $p<0.05$

Unclear response to the increased Met supplements was stated in the intestine length and weight related to the $BW^{0.67}$ (*Table 5*).

Table 5 Development of intestine length (cm 100^{-1} g $BW^{0.67}$) (means, ±SD).

Days of life	Methionine level in diets (%)									
	0.30		0.33		0.37		0.42		0.48	
					Chickens - duodenum					
1	74	±9.3	72	±8.5	71	±6.9	67	±7.0	71	±5.9
3	76ab	±5.1	79b	±4.7	73a	±5.8	75ab	±6.4	71a	±7.9
5	74	±5.8	69	±5.7	70	±6.0	70	±4.6	70	±3.2
7	70 A	±5.7	72 A	±4.9	67 AB	±6.9	66 AB	±3.8	65 B	±6.0
					Chickens – jejunum + ileum					
1	239	±24	293	±23	302	±30	286	±27	293	±18
3	325	±25	337	±22	324	±23	332	±27	327	±33
5	328	±29	320	±29	321	±26	313	±21	323	±16
7	296	±34	312	±29	314	±24	309	±16	293	±25
					Ducks – duodenum					
1	70	±8.0	66	±6.0	71	±7.6	65	±7.0	68	±7.5
3	69	±6.2	66	±5.9	68	±9.0	64	±4.8	65	±5.7
4	65	±5.5	67	±3.8	63	±6.8	62	±4.8	64	±12.7
6	56 AB	±4.9	59 B	±4.9	58 AB	±5.8	54 AB	±4.3	53 A	±4.3
					Ducks – jejunum + ileum					
1	254	±44	272	±22	268	±22	259	±23	267	±23
3	338	±30	322	±21	332	±39	322	±25	317	±22
4	332	±30	337	±17	319	±23	321	±27	318	±31
6	303	±22	313	±14	304	±21	303	±22	296	±24

On 7 day post hatch the shorter duodenum, as related to $BW^{0.75}$, was stated in groups of **chickens** receiving 0.37; 0.42 and 0.48 % of additional Met in the diets ($P<0.01$). Met level insignificantly affected the jejunum and ileum length and weight; there the tendency of decreasing of values concerning these segments, as related to $BW^{0.67}$, were noted.

In **ducklings** from groups fed diets with higher Met supplements the length and weight of duodenum as calculated to 100 g of $BW^{0.67}$ were significantly lower than in control. Also decreasing of obtained values concerning jejunum + ileum in this species was not significant.

Shortening of IT length, related to the $BW^{0.67}$, occurred as the effect of faster body weight growth than IT development.

Through the increasing of methionine level, important also in energy metabolism as a donor of methyl groups, only the weak effect on early growth and development of IT was obtained. The weak response of chickens and ducks in first 5 days post hatch may be explained as the effect of yolk sac resorption process and utilization of nutrients from it (Chamblee *et al*.,1992; Jamroz et al.,2004). On the basis of studies by Bigot *et al*.(2003); Wertelecki and Jamroz,(2003); Jamroz *et al*.,(2004) it could be stated that the content of yolk sac residues covers the maintenance requirement of very young birds and utilization of dietary methionine could be still relatively low.

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