Effect of calcium level on properties of gastrointestinal digesta in turkeys in different growth periods

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The experiment was carried out on 160 turkeys selected from a population fed mixtures in which Ca level constituted 85%, 100%, 115% and 130% of NRC norm. The content of P was adjusted respectively to Ca:P available ratio of 2:1. In order to characterize the physical and chemical properties of gastrointestinal digesta of turkeys, 10 birds aged 4, 8, 12 and 20 weeks were slaughtered in each group. The feeding treatments applied had a small effect on the functioning of the gastrointestinal tract of the turkeys; namely: viscosity of ileum digesta increased, however intestinal and caecal pH, the content of caecal digesta and the concentration of ammonia remained unaffected by Ca level in the diet.

Key words: calcium; intestine; caeca; pH; viscosity; turkey

Introduction

Insufficient supply of organisms of fast growing slaughter turkeys with calcium and phosphorus is one of the reasons of production losses resulting from reduced growth of the birds and deformations of their skeletons (HOCKING, WHITEHEAD, 1992; ORTH, COOK, 1994). Deficiency of calcium and phosphorus leads to led rachitis (LILBURN 1994), dyschondroplasie and ostemalacie (WHITEHEAD 1997; HESTER, FERKET 1998). Due to a fast growth rate of slaughter turkeys and a consequent risk of skeleton deformation, norms of British United Turkeys [2002] recommend the application of a high dose of calcium in feed mixtures. In the last phase of fattening, calcium content is by 85% higher than that recommended in the NRC norms [1994]. Owing to a lack of data on this subject, the aim of this paper was to investigate the effect of different levels of calcium in the diet on the functioning of the gastrointestinal tract of turkeys.

Material and methods

The experiment was carried out on 160 turkeys selected from a population fed mixtures in which Ca level constituted 85%, 100%, 115% and 130% of NRC norm. The basal cereal-soybean diet was formulated to meet the nutrient requirements for turkeys (NRC, 1994). The content of P in the fed mixture was adjusted respectively to Ca:P available ratio of 2:1. Experimental groups consisted of 126 turkeys, kept in three replications, 26 birds each. In order to characterize the physical and chemical properties of gastrointestinal digesta of the turkeys, 10 birds representing an average body weight of each group were slaughtered in week 4, 8, 12 and 20 of the experiment. Their body weight accounted then for 1.11, 4.89, 8.71 and 18.10 kg, respectively. After laparotomy, the small intestine and caeca with contents were removed and weighed. The ileal and caecal pH was measured using a microelectrode and a pH/ION meter (model 301, Hanna Instruments). Ammonia was determined according to the standard Conway's method. Viscosity of intestinal digesta was determined using a Brookfield cano-plate viscometer Model LVDV-II (Broofield Engineering Laboratories Inc. Stoughton, MA).

The results were evaluated statistically using two-way ANOVA and the Duncan's multiple range test. Differences were considered significant at $P \leq 0.05$.

Results and discussion

A differentiated level of calcium in the mixture had any tangible effect on pH of intestinal digesta in consecutive analytical periods (*Table 1*). Significant differences between the groups were noted only in the eight week, yet they were not related to calcium level in the diet. Compared to the first pH measurement of jejunum digesta at the age of 4 weeks, in older turkeys – especially those at the age of 12 weeks - a significantly higher pH was observed. Such a tendency was not reported for pH of the ileum. Only in the 12-week-old was the pH of ileal digesta higher than in the other periods. In both fragments of the small intestine, the mean pH value of digesta at the age of 4-20 weeks was alike in all groups. Both the mean values as well as pH determined in particular measuring periods were relatively low, exceeding 6 in one case only. In other experiments (JUSKIEWICZ ET AL. 2004, ZDUŃCZYK ET AL. 2005), the pH values of intestinal digesta in turkeys fed standard mixtures reached 6.04 and 6.30, respectively.

Relatively high and differentiated viscosity of jejunum and ileum digesta, ranging from 1.38 to 2.19 mPas was observed in the study. In other experiments carried out on turkeys, the viscosity of small intestine digesta was found to reach 1.33 mPas (JUŚKIEWICZ et al. 2005), whereas in research conducted on broilers – to be higher than 3 units (YIN ET AL. 2000). In the reported study, the values recorded in consecutive rearing periods of the turkeys were differentiated, however on average they were similar over the entire experimental period, irrespective of calcium level in the mixture. In the ileum, upward tendencies of viscosity increase were observed in the groups fed a mixture with a higher calcium content. Significant differences were demonstrated in weeks 4 and 8 as well as on average in the entire rearing period.

In particular analytical periods, significant differences were found for some parameters of caecal digesta of the turkeys (*Table 2*). The differences concerned the mass of whole caeca at 4 weeks, the mass of caecal digesta at 20 weeks, dry matter content at 20 weeks and ammonia content at 8 weeks of age of the birds. Whole caeca and caecal digesta mass, related to the body mass of the turkeys, were very differentiated, especially depending on the age of the birds. Compared to the turkeys aged 4 weeks, the mass of caecal digesta of turkeys aged 8, 12 and 20 weeks decreased from 9.10 g to 3.62, 2.57 and 1.93 g/kg BW, respectively. The results demonstrated in this study were consistent with data of JUŚKIEWICZ ET AL. (2004) reported for 8-week-old turkeys and with those of ZDUŃCZYK ET AL. (2005) reported for older turkeys. Similar average values from the entire experimental period indicate that the content of calcium in the mixture had no effect on the mass of turkeys caeca.

Table 1. pH and viscosity of the intestinal digesta

Age, Ca level, %	pH		Viscosity, mPas	
	Jejunum	Ileum	Jejunum	Ileum
4 weeks				
NRC – 85	5.48±0.42	5.46±0.68	1.49^{ab}±0.17	1.58^{b}±0.24
NRC – 100	5.24±0.34	5.20±0.45	1.38^{b}±0.17	1.53^{b}±0.12
NRC – 115	5.36±0.45	5.20±0.57	1.41^{b}±0.22	1.72^{ab}±0.21
NRC – 130	5.64±0.56	5.31±0.69	1.69^{a}±0.38	1.87^{a}±0.24
SEM	0.07	0.09	0.042	0.038
8 weeks				
NRC – 85	4.83±0.37	5.99^{a}±0.52	1.61±0.17	1.47^{c}±0.11
NRC – 100	5.61±0.98	5.65^{ab}±0.34	1.62±0.20	1.61^{bc}±0.16
NRC – 115	5.57±1.16	5.70^{ab}±0.26	1.71±0.18	1.77^{ab}±0.16
NRC – 130	5.56±0.93	5.58^{b}±0.44	1.79±0.34	1.91^{a}±0.24
SEM	0.15	0.06	0.037	0.038
12 weeks				
NRC – 85	6.05±0.54	5.81±0.79	1.86^{a}±0.20	1.61±0.23
NRC – 100	5.91±0.52	5.88±0.80	1.96^{a}±0.31	1.88±0.31
NRC – 115	5.99±0.68	5.95±0.43	2.00^{a}±0.24	1.73±0.37
NRC – 130	5.76±0.49	5.46±0.84	1.64^{b}±0.16	1.61±0.28
SEM	0.09	0.12	0.042	0.049
20 weeks				
NRC – 85	5.85±0.54	5.37±0.85	2.19±0.30	1.97±0.30
NRC – 100	5.85±0.40	5.03±0.47	1.94±0.47	1.79±0.37
NRC – 115	5.74±0.67	5.22±0.41	2.08±0.44	1.83±0.40
NRC – 130	5.57±0.48	5.24±0.58	1.87±0.34	1.81±0.38
SEM	0.08	0.09	0.063	0.057
Age, average				
4 weeks	4.58^{a}±0.32	3.06^{a}±0.39	5.43^{c}±0.45	5.29^{b}±0.59
8 weeks	4.75^{b}±0.28	3.69^{b}±0.43	5.66^{bc}±0.59	5.36^{b}±0.91
12 weeks	4.99^{a}±0.42	3.93^{a}±0.39	5.93^{a}±0.55	5.78^{a}±0.73
20 weeks	4.64^{bc}±0.41	3.51^{c}±0.42	5.75^{ab}±0.52	5.22^{b}±0.60
Ca level, average				
NRC – 85	5.71±0.55	5.37±0.76	1.79±0.34	1.66^{b}±0.29
NRC – 100	5.74±0.52	5.39±0.74	1.71±0.39	1.70^{ab}±0.29
NRC – 115	5.68±0.64	5.49±0.75	1.80±0.38	1.76^{ab}±0.29
NRC – 130	5.64±0.52	5.39±0.75	1.75±0.32	1.80^{a}±0.30

a,b - P≤0.05

Table 2. Amount and properties of the caecal digesta

	Whole caeca, g/kg BW	Caecal digesta, g/kg BW	DM, %	pH	Ammonia, mg/g
4 weeks					
NRC – 85	14.39^{ab}±3.78	8.45±2.93	16.49±2.53	5.48±0.32	0.41±0.17
NRC – 100	16.76^{a}±3.08	10.37±2.77	16.09±2.25	5.15±0.22	0.39±0.14
NRC – 115	16.14^{ab}±3.65	9.75±3.42	15.08±3.78	5.37±0.48	0.50±0.11
NRC – 130	13.30^{b}±2.90	7.84±2.77	15.55±2.81	5.42±0.46	0.50±0.14
SEM	0.54	0.48	0.45	0.06	0.02
8 weeks					
NRC – 85	6.45±1.66	3.41±1.63	16.36±2.68	6.10±0.60	0.74^{a} ±0.24
NRC – 100	6.48±1.59	3.24±1.35	16.37±2.53	5.84±0.47	0.68^{ab}±0.11
NRC – 115	7.24±1.38	3.79±1.31	16.93±2.16	5.80±0.68	0.57^{b}±0.08
NRC – 130	7.48±1.50	4.02±1.17	17.71±2.74	5.99±0.59	0.57^{b}±0.07
SEM	0.24	0.21	0.40	0.06	0.02
12 weeks					
NRC – 85	4.97±1.40	2.54±1.32	18.18±3.10	6.10±0.60	0.78±0.26
NRC – 100	5.49±1.28	2.97±1.31	18.62±2.46	5.84±0.47	0.70±0.21
NRC – 115	4.98±1.04	2.28±0.98	17.32±2.82	5.80±0.68	0.72±0.30
NRC – 130	5.09±1.11	2.48±0.99	17.17±3.03	5.99±0.59	0.67±0.24
SEM	0.19	0.18	0.45	0.06	0.04
20 weeks					
NRC – 85	3.46±0.49	1.46^{b}±0.48	15.82^{b}±1.74	6.32±0.50	0.72 ±0.20
NRC – 100	4.12±0.80	2.07^{ab}±0.71	15.98^{a}±2.15	6.09±0.52	0.77±0.16
NRC – 115	4.10±0.48	2.25^{a}±0.52	13.82^{a}±0.89	6.28±0.29	0.76±0.17
NRC – 130	4.10±0.98	1.92^{ab}±0.81	14.56^{ab}±2.49	6.18±0.47	0.72±0.16
SEM	0.12	0.11	0.32	0.07	0.03
Age, average					
4 weeks	15.15^{a}±3.48	9.10^{a}±3.04	15.81^{bc}±2.84	5.36^{c}±0.39	0.45^{a}±0.14
8 weeks	6.92^{b}±1.56	3.62^{b}±1.37	16.74^{ab}±2.48	5.74^{b}±0.42	0.64^{b}±0.15
12 weeks	5.13^{c}±1.19	2.57^{c}±1.15	17.82^{a}±2.87	5.93^{b}±0.58	0.72^{a}±0.25
20 weeks	3.95^{d}±0.75	1.93^{c}±0.69	15.04^{c}±2.05	6.22^{a}±0.44	0.74^{a}±0.17
Ca level					
NRC – 85	7.31±4.69	3.97±3.23	16.71±2.68	5.98^{a}±0.57	0.66±0.26
NRC – 100	8.22±5.44	4.67±3.78	16.66±2.48	5.69^{b}±0.53	0.63±0.21
NRC – 115	8.11±5.21	4.52±3.63	15.79±2.91	5.79^{ab}±0.55	0.64±0.21
NRC – 130	7.49±4.01	4.07±2.82	16.25±2.96	5.80^{ab}±0.56	0.62±0.18

a,b - P≤0.05

In the discussed experiment, differences were reported in the dry matter content of digesta of turkeys at different age; in those aged 8 and 12 weeks the values were higher than in the birds aged 4 and 20 weeks. However, the average content of dry matter in the caecal digesta of the turkeys fed a diet with a

different calcium level was generally similar. The caecal digesta of older turkeys appeared to characterized by a significantly higher level of pH and a higher content of ammonia. The average pH value and ammonia content were similar to data reported by other authors (JUŚKIEWCZ ET AL. 2004, ZDUŃCZYK ET AL. 2005) and were independent of calcium level in the diet.

Conclusions

Relatively large differences in Ca content of feed mixtures, ranging form 85% to 130% of NRC recommendation, were demonstrated to affect the functioning of the gastrointestinal tract of turkeys to a little extent.

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