THE EFFECT OF EXPERIMENTAL CRYPTOSPORIDIOSIS AND pH OF DRINKING WATER ON PERFORMANCE OF BROILER CHICKENS*

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Two fattening trials were conducted to study drinking water pH and experimental infection of chickens with the species *Cryptosporidium meleagridis* Slavin, 1955 as affected performance. Statistically insignificant differences were recorded in live weight and feed consumption when fed with alkaline water of 10.05 pH compared to feeding with drinking water and acid water of 2.5 pH value. In experimental peroral infection of 7-day old chickens with oocysts of *C. meleagridis* in a dose of 5.105 oocysts/chick, their growth decreased on 7th day after infection. Feed consumption was negatively affected on the following day after infection. Marked increase of feed consumption and the number of died chickens were recorded in the group fed with alkaline drinking water at simultaneous experimental contagion.

chick; fattening; *Cryptosporidium meleagridis*; drinking water; performance

INTRODUCTION

Cryptosporidia are single-host coccidia of the genus *Cryptosporidium*. In birds three cryptosporidium species have been described until now. For the first time Slavin (1955) informs on findings of the protozoan in 10–14 day-old turkey chicks and named it *Cryptosporidium meleagridis*. It is an infective agent of the so-called intestinal form of infection in which protozoan develops in lower segments of jejunum, ileus and particularly in colla of caeca. Further data on findings of this cryptosporidium appeared after more than 30 years in the USA (Woodmansee et al., 1988; Goodwin et al., 1988; Bermundez et al., 1988). In the Czech Republic Pavlásek

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(1994a, b) recorded the occurrence of *C. meleagridis* for the first time. In the trials with experimental infection of broiler chickens with the species *C. meleagridis* at the age of 7, 14, 21 and 28 days, the authors (Tůmová et al., 1999) found that the infection had negative impact on the growth of chickens, mainly on 7th to 10th day after infection. Worse feed consumption was also reported after two weeks following infection. The infection had no influence on mortality of chickens.

Another avian species of cryptosporidium is *Cryptosporidium baileyi* (Current et al., 1986). This protozoan is an agent of the so-called cloaca, bursal and respiratory forms of infection (infection is denoted by localization of endogenous developmental stages of parasite). Pavlásek (1987, 1989) and Abbassi et al. (1999) found *C. baileyi* also in epithelial kidney cells. Trampel et al. (2000) report the first findings of *C. baileyi* in uterus of adult laying hens.

Pavlásek (1999) only recently has found cryptosporidium in died hens (*Gallus gallus* f. dom.) from small-scale breedings in the spleen of glandular stomach. With respect to different localization and morphometric parameters of oocysts to the level of mentioned species of cryptosporidia, the author named a protozoan *C. galli*. Pavlásek (1999) further proved that similar species of cryptosporidia appears also in some wild exotic birds.

As to epizootology and epidemiology, generally speaking, cryptosporidia are marked by very low or no host specificity. Infection can be transferred to different species of hosts within single zoological group. After Sreter and Varga (2000) *C. meleagridis* isolated from birds is close to the species *Cryptosporidium parvum* which parasites on more than 100 mammalian species. However, it follows from Pavlásek's (1984, 1989) studies that by isolate of oocysts of *C. parvum* of spontaneously infected calves it was not succeeded to infect chicks of different age categories. Doboskovacs et al. (2000) report that *C. parvum* is not transferred to birds, the same like *C. meleagridis* is not transferred to mammals. Despite the fact that birds are not sensible to infection caused by *C. parvum* and mammals to *C. meleagridis*, according to the authors hosts of these zoological group may play a significant role in transfer of infection in environment.

It is generally reported, that cryptosporidia are significant enteropathogen particularly in young animals. There are relatively little information on the meaning of these protozoan infections in poultry and no efficient remedy till now exists against these parasites. It is known from literature that performance of broiler chickens can be favourably influenced by modification of drinking water. For example Zimmermann et al. (1991) found that electronically increased pH of drinking water significantly reduced the mortality of fattening chicks, while live weight and feed consumption was improved

insignificantly. Šišák et al. (1992) report that drinking with acidified water was a good prevention against salmonelosis. Barton (1996) found a favourable effect of higher content of calcium and magnesium in drinking water particularly on feed consumption. However, these elements did not influenced excretion of pseudomonades or *Escherichia coli*.

In this study we have concentrated on verification and judgement of the effect of different pH of drinking water at simultaneous infection with the species *C. meleagridis* in broiler chickens.

MATERIAL AND METHOD

Experiment 1

The trial included 60 one-day old cockerels Ross 208. Chickens were divided into three groups by pH of drinking water. Each group had two replications with 10 chicks. Animals of group 1 were given drinking water. Group 2 was given alkaline water (pH 10.5) and group 3 acid water (pH 2.5).

Fattening continued 42 days and was divided into two periods. The first period (1st to 21st day) was fed with feed mixture BR 1, in the second period (22nd to 42nd day) with the mixture BR II. Commercial feed mixtures were supplied by Obila, a.s., Kutná Hora and did not contain any anticoccidics. The nutrient content in feed mixtures determined by analysis is presented in Table I.

I. The content of nutrients in feed mixtures

Index	Trial 1		Trial 2	
	BR I	BR II	BR I	BR II
Dry matter (%)	92.31	92.76	91.46	91.25
Crude protein (%)	21.78	20.13	22.13	20.85
Metabolizable energy (MJ)+	12.3	12.4	12.6	12.6
Fat (%)	4.42	4.74	4.51	4.76
Fibre (%)	2.63	3.0	2.97	2.98
Ashes (%)	5.38	7.23	5.21	5.17
Calcium (%)	1.51	1.60	1.57	1.49
Phosphorus (%)	0.70	0.65	0.65	0.67

+by calculation

Experiment 2

The trial comprised 80 one-day old cockerels Ross 308. The trial was divided into four groups; each group contained 20 cockerels in two replications (2 x 10 birds). Group 1 was drunk with drinking water. Chicks of group 2 received alkaline water (pH 10.5). Group III was drunk with drinking water and on day 7 of age they were infected per orally with oocysts *C. meleagridis* in a dose 5.105 oocyst/chick. Chickens of group 4 were drunk with alkaline water and similar to group 3 they were infected with *C. meleagridis*. Original isolate oocyst of this cryptosporidium was obtained from one breeding of spontaneously infected broiler chickens in Western Bohemia. In laboratory conditions 10 seven-day chickens were infected, from which during patent period (period of excretion of oocysts in faeces) were gradually obtained and gathered oocysts of *C. meleagridis* by the method after Pavlásek et al. (1989). Prior to the trial itself approximately 30 days they were kept in 2.5% solution of potassium bichromate at the temperature 4 °C.

Fattening lasted 35 days and was divided into two periods. Feed mixture BR I was fed in the first period (1st to 21st day), the feed mixture BR II was fed in the second period (22nd to 35th day). Feed mixture s were commercial ones from ZZN (Agricultural Supply and Purchase) Mělník and they did not contain any anticoccidics. The content of nutrients in feed mixtures as determined by analysis is in Table I.

Chickens in both trials were housed in boxes on litter. Conditions of external medium corresponded to ordinary requirements. 24-hour photoperiod was used. The birds were fed and watered *ad libitum*. In experimental groups water with electrochemically adjusted pH was used. The so-called acid water (pH 2.5) was prepared in the laboratory Fyzap on original instrument "forced osmosis flow electrolyzer". Apparatus for electrochemical water treatment STEL 80-d produced alkaline water (pH 10.5).

At the beginning of trials chickens were divided into groups after weighing and marking by wing tags. Chickens were weighed individually in week-intervals. Feed consumption and mortality were finding in groups for a period. The chickens were examined for salmonelosis on the first day. The result of examination was negative.

After finishing the fattening, carcass analysis was done in five cockerels in each group. Cocks of similar weight were chosen for carcass analysis. Muscle percentage is presented without skin.

Mixed samples of chick faeces were examined parasitologically on the following day after experimental infection and further in two to five-day intervals by faeces examination after Breza (1957) and Pavlásek (1991).

The results of growth were processed by variance analysis by the program SAS, significance of differences among groups was tested by Scheffe's method on the level of significance $P < 0.05$.

RESULTS AND DISCUSSION

Experiment 1

It is evident from the results of fattening (Table II) that chickens drunk with alkaline water (group 2) reached higher live weight at the end of the trial (by about 4% against the group fed with drinking water) and lower feed consumption, but the differences among the groups were not statistically significant. This is in agreement with the results recorded by Zimmermann et al. (1991). They also found insignificant weight increase and improvement of feed consumption at watering of higher pH. No mortality of chickens in any group was recorded during our trial. No significant differences were recorded in most indices of carcass analysis (Table III) as well. Significantly higher muscle percentage from hot carcass and lower percentage of abdominal fat ($P < 0.05$) were found in groups fed with alkaline and acid water.

Experiment 2

Similar to experiment 1 chickens drunk with alkaline water had insignificantly higher live weight and better feed consumption compared with the chickens in the group drunk with drinking water (Table IV). There was also no difference between the number of died chickens. Experimentally infected chickens with *C. meleagridis* (groups 3 and 4) had lower live weight. In the group fed with alkaline water at simultaneous infection with *C. meleagridis* also more conspicuous increase of feed consumption and mortality occurred. Results of growth manifest that experimental infection decreased significantly the growth of chickens mainly on 7th day after infection. Feed consumption, too, (Table V) was negatively affected the week following the infection. Authors' previous trials with experimental infection of chickens with the species *C. meleagridis* (Tůmová et al., 1999) manifested negative influence of experimental infection with this protozoan on the growth and feed consumption in the first to second week after infection. Drinking with alkaline water had adverse effect on the results of fattening, particularly on increase in mortality (Table IV). Carcass analysis (Table VI) did not show significant differences between different groups. In the group drunk with alkaline water we did not record higher percentage of breast muscle like in experiment 1. This would be caused by the fact that chickens of lower weight

II. Experiment 1 – Results of fattening

Group	Index		
	live weight on 42nd day of age (g)	feed consumption per 1 kg of weight gain (kg)	mortality on 1st to 42nd day (chickens)
Drinking water	1991	2.00	–
Alkaline water	2078	1.89	–
Acid water	1996	1.97	–

III. Experiment 1 – Carcass analysis

Index	Group		
	drinking water	alkaline water	acid water
Live weight (g)	2060	2063	2037
Carcass weight (g)	1356	1376	1362
Breast muscle weight (g)	272	289	276
Thigh muscle weight (g)	274	304	311
Dressing percentage (%)	72.2	73.0	73.4
Percentage of breast muscle from carcass (%)	20.0	20.4	20.8
Percentage of thigh muscle from carcass (%)	20.2^{a}	22.0^{ab}	23.0^{b}
Percentage of muscle from carcass (%)	40.2^{a}	43.0^{b}	43.2^{b}
Percentage of abdominal fat (%)	3.0^{b}	1.8^{a}	2.0^{a}

^{a,b} $P < 0.05$

IV. Experiment 2 – Results of fattening

Group	Index		
	live weight on 35th day of age (g)	feed consumption per 1 kg of weight gain (kg)	mortality on 1st to 35th day (chickens)
1	2019	1.69	1
2	2107	1.61	1
3	1892	1.59	–
4	1931	1.85	4

V. Experiment 2 – Average weight gain per chick and day, and feed consumption per chick and day in g

Weeks of age	Weight gain (chick.day^{-1})				Feed consumption (chick.day^{-1})			
	group				group			
	drinking water	alkaline water	drinking water + infection	alkaline water + infection	drinking water	alkaline water	drinking water + infection	alkaline water + infection
1	17.5	19.1	16.8	17.8	46	35	23	33
2	42.3	42.9	36.3	32.7	65	64	57	51
3	57.5	57.3	59.4	45.7	79	84	83	80
4	80.1	83.8	77.9	70.6	126	128	119	112
5	81.8	87.4	73.9	63.6	153	158	140	151

VI. Experiment 2 – Carcass analysis

Index	Group			
	1	2	3	4
Live weight (g)	2008	2031	1979	2026
Carcass weight (g)	1445	1478	1440	1481
Breast muscle weight (g)	333	316	300	346
Thigh muscle weight (g)	277	292	282	267
Dressing percentage (%)	75.8	76.6	76.7	76.9
Percentage of breast muscle from carcass (%)	23.1	21.4	20.8	23.3
Percentage of thigh muscle from carcass (%)	19.2	19.8	19.6	18.0
Percentage of muscle from carcass (%)	42.2	41.1	40.4	41.4
Percentage of abdominal fat (%)	1.5	1.3	1.3	1.2

in this group were chosen for carcass analysis than was an average of the group at the end of fattening. It corresponds also to this prerequisite that insignificantly higher percentage of breast muscle was recorded in the group fed with alkaline water and infected with *C. meleagridis*.

It is evident from parasitary examinations that oocysts of *C. meleagridis* started to be excreted 2 to 4 days after infection. Patent period in group 3 lasted 10 days with greatest intensity of excretion of oocysts between 12th and 16th day of age, in group 4 this period lasted 8 days and greatest intensity was reached on 14th to 16th day of age of chickens.

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Vliv experimentální kryptosporidiové nákazy a pH napájecí vody na užitkovost brojlerových kuřat.

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U ptáků jsou dosud známy tři druhy kryptosporidií: *Cryptosporidium baileyi*, původce tzv. kloakální, bursální a respiratorní formy infekce (označení infekce je podle lokalizace endogenních stadií prvoka), dále málo známý druh *Cryptosporidium meleagridis*, původce tzv. střevní formy nákazy (lokalizace parazita je zejména v dolních úsecích jejuna a ilea, zejména krčků slepých střev), a nový druh *Cryptosporidium galli*, zjištěný ve sliznici žlaznatého žaludku.

Cílem práce bylo posoudit vliv pH napájecí vody a experimentální nákazy druhem *C. meleagridis* na výsledky výkrmu brojlerových kuřat.

Do pokusu 1 bylo zařazeno 60 jednodenních kohoutků Ross 208. Kuřata byla po zvážení a označení křídelními plombami rozdělena po 20 kusech do tří skupin. Každá skupina měla dvě opakování po 10 kusech. První skupina byla napájena pitnou vodou, ve 2. skupině dostávala kuřata zásaditou vodu, ve 3. skupině vodu kyselou. Kyselá voda byla vyrobena v laboratoři Fyzap na přístroji „Průtokový elektrolyzér na nucenou osmozu", pH 2,5, zásaditá voda přístrojem na elektrochemickou úpravu vody STEL 80-d, pH 10,5. Ve druhém pokusu bylo použito 80 jednodenních kohoutků Ross 308. Kuřata byla po zvážení a označení křídelními plombami rozdělena po 20 kusech do čtyř skupin. Každá skupina měla dvě opakování po 10 kusech. Kuřata ve skupinách 1 a 2 byla napájena pitnou vodou, kuřata ve skupinách 2 a 4 dostávala zásaditou vodu, stejnou jako v pokuse 1. Ve skupinách 3 a 4 byla kuřata 7. den věku

experimentálně perorálně infikována oocystami *C. meleagridis* v dávce 5.10^5 oocyst na kuře.

V pokusu 1 se mezi skupinami nezjistily signifikantní rozdíly v růstu. Kuřata napájená zásaditou vodou měla na konci výkrmu o více než 4 % vyšší živou hmotnost než kuřata napájená pitnou vodou či kuřata napájená vodou kyselou. Tato skupina měla také nejnižší spotřebu krmiva na 1 kg přírůstku (skupina 1 – 2,00 kg, skupina 2 – 1,89 kg, skupina 3 – 1,97 kg). Skupiny napájené vodou s upraveným pH měly statisticky významně vyšší podíl svalstva z jatečného trupu a nižší podíl abdominálního tuku.

V pokusu 2 experimentální nákaza snížila růst kuřat zejména 7. den po infekci. Spotřeba krmiva byla negativně ovlivněna v týdnu následujícím po infekci. Zásaditá napájecí voda ve skupině 2 zvýšila přírůstek živé hmotnosti a snížila spotřebu krmiva. Ve skupině 4 ve spojení napájení zásaditou vodou s infekcí došlo k výraznému zvýšení spotřeby krmiva a k úhynům. Z parazitárních vyšetření bylo zřejmé, že oocysty *C. meleagridis* se začaly vylučovat dva až čtyři dny po infekci a doba vylučování trvala přibližně deset dní.

kuře; výkrm; *Cryptosporidium meleagridis*; napájecí voda; užitkovost

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