INFLUENCE OF DIFFERENT AMOUNT OF WHOLE BARLEY IN DIETS ON PRODUCTIVITY AND DIGESTIVE PROCESSES OF BROILER CHICKENS

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Abstract. The trial was conducted to evaluate the effects of different dietary levels of whole barley grains on growth performance, feed conversion ratio, pH of gastrointestinal tract chymus, amount of dry matter and ammonia nitrogen in caecum chymus of broiler chickens. The trial with birds was carried out in an experimental poultry house of JSC "Vilniaus paukstynas" and poultry house of LUHS Veterinary Academy in 2010. A thousand Ross 308 broiler chicks (one-day-old) were allocated to five treatment groups of 200 birds each in a randomized design. The treatment groups consisted of four replicates each of 50 chicks. Groups I and II were control and the other three experimental ones. During their whole growing period, broiler chickens of control group II were fed the diet containing 2% of whole barley grains. Broiler chickens of experimental groups, depending on their age, were fed diets containing whole barley grains from 4% to 25%. Broiler chickens were reared up to 40 days old. The results of the trial showed that the weight of broilers fed diets containing from 8% to 15% of whole barley grains (experimental group I) were lower by 1% ($p>0.05$), but increasing the whole barley in the diet (12 to 25%), i. e. in the experimental groups II and III, the mentioned growth parameter decreased by 2 to 4% compared with control groups ($p<0.05$). Feed conversion ratio in all experimental groups was higher by 1 to 8% ($p>0.05$), but during the last trial period (from 36 to 40 days old), when the diets were without whole barley, there were no significant differences between the experimental groups compared with the control ones ($p>0.05$). When the diet of broiler chickens was supplemented with different levels of whole barley grains the pH and dry matter amount of gastrointestinal tract chymus and amount of ammonia nitrogen in caecum had a tendency to decrease if compared with the control groups ($p>0.05$).

Keywords: whole barley, productivity, digestive processes, broiler chickens.

SKIRTINGO KIEKIO NESKALDYTŲ MIEŽIŲ LESALUOSE ĮTAKA VIŠČIUKŲ BROILERIŲ PRODUKTYVUMUI IR VIRŠKINIMO PROCESAMS

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Santrauka. Darbo tikslas buvo ištirti neskaldytų miežių, maišytų į lesalus, įtaką viščiukų broilerių kūno masės augimo dinamikai, lesalų sąnaudoms, virškinamojo trakto turinio pH, sausųjų medžiagų ir amoniako azoto kiekiui aklosios žarnos turinyje. Bandymai su viščiukais broileriais atlikti 2010 m. AB Vilniaus paukštyno eksperimentinėje paukštidėje ir LSMU Veterinarijos akademijos paukštidėje. „Ross 308" linijų derinio 1000 viščiukų buvo suskirstyti į penkias grupes. I ir II grupės – kontrolinės, II kontrolinės grupės viščiukai broileriai, visą auginimo laikotarpį buvo lesinami lesalais su 2 proc. neskaldytų miežių. Likusios grupės buvo tiriamosios. Jų lesaluose, priklausomai nuo viščiukų broilerių amžiaus, neskaldytų miežių buvo nuo 4 proc. iki 25 proc. Viščiukų auginimo trukmė – 40 dienų. Tyrimų rezultatai parodė, kad, į lesalus įmaišius neskaldytų miežių, viščiukų broilerių kūno masė I tiriamojoje grupėje sumažėjo 1 proc. (kai kombinuotuosiuose lesaluose neskaldyti miežiai sudarė 8–15 proc.) ($p>0,05$), o II ir III tiriamosiose grupėse – 2–4 proc. (neskaldytų miežių kombinuotuosiuose lesaluose buvo 12–25 proc.) palyginti su kontrolinėmis grupėmis ($p<0,05$); lesalų sąnaudos padidėjo 1–8 proc. ($p>0,05$). Tačiau per paskutinį viščiukų broilerių auginimo tarpsnį, t. y. 36–40 amžiaus dieną, kai į kombinuotuosius lesalus nebuvo įmaišyta neskaldytų miežių, lesalų sąnaudos 1 kg priesvorio gauti neženkliai skyrėsi palyginti su kontrolinėmis grupėmis ($p>0,05$). Lesalus papildžius skirtingu neskaldytų miežių kiekiu, virškinamojo trakto atskirų segmentų turinio pH bei sausųjų medžiagų ir amoniako azoto kiekis aklojoje žarnoje turėjo tendenciją mažėti lyginant su kontrolinėmis grupėmis ($p>0,05$).

Raktažodžiai: neskaldyti miežiai, produktyvumas, virškinimo procesai, viščiukai broileriai.

Introduction. Over the last 20 years, much has been achieved in the production of broiler chickens – broiler chickens growth performance and feed conversion efficiency have increased significantly. Broiler chickens of the latest cross line grow intensively and need the feed providing a lot of energy and nutrients, which would maximize their genetic potential for growth (Williams et al., 2000; McKay et al., 2000).

Production of compound feed containing high concentration of nutrients significantly increases the feed cost. In addition, grain quality does not impact optimal development of broiler chickens digestive tract. As a result, various measures were looked for to improve development of chicken digestive tract without reducing their productivity (Ravindran et al., 2006).

In the last decade, some poultry producers in Europe, Australia, and Canada have started to add whole wheat on-farm to increase the use of locally grown grains and reduce transportation and feed milling costs (Bennett, 2002). The use of whole grain is not new; however, even earlier research (McIntosh et al., 1962a) indicated that growing birds could be fed whole grain with little or no loss in performance. More recently, C.D. Bennett et al. (1995), S.P. Rose et al. (1995), and P. Biggs, C.M. Parsons (2009) reported that broiler chickens fed to whole wheat diets had the same market weight and feed conversion as the birds fed to pelleted wheat diets. Interestingly, the whole wheat inclusion usually increases digesta viscosity (Wu et al., 2004; Engberg et al., 2004). Non-starch polysaccharides increase the viscosity of digestive tract which disrupts the digestive mass movement of the gastrointestinal and nutrient conversion (Heindl et al., 2000; Leeson, 1999; Korsbak, 1998; Rostagno et al., 2000).

In two trials B. Svihus et al. (1997) found that broiler chickens fed to whole barley grew at the same rate, but had a higher feed gain ratio than those fed to rolled barley. They determined that chicken broilers fed to whole barley grew at the same intensity as the ones fed to rolled barley. However, feed consumption was higher than that of chicken broilers fed to rolled barley. M. J. Villamide and other scientists (1997) and G. W. Barbour with colleagues investigated the hulled and dehulled barley energy utilization using enzymes. Insertion of glucanase enzymes to feed with dehulled barley increased metabolic energy utilization. Analogous results are described by M. Rezaei with scientists (2008), when hull-less barley was used for the feeding of broiler chickens. Recent research has reviewed the potential interactions between feed particle size and addition of feed enzymes. On the basis of limited data, it can be concluded that the enzyme efficiency in broiler nutrition influences the degree and hardness of ground grains. These factors must be taken in to account when trying to predict the growth rate of broilers by supplementing enzymes in their diet. The interaction between feed particle size and the enzyme was observed to vary depending on the diet form (pellets or coarse). Granulation process changes the feed particle size. Granulation process affects enzyme efficiency, which depends on the feed particle size distribution after granulation. In other trials a form of feed, feed particle size, and addition of feed enzymes were determined to impact broilers productivity and nutrients utilization on feed (Svihus et al., 2004; Svihus, 2011; Amerah et al., 2007b; 2008b; 2009b).

A. M. Amerah and others (2008a; 2009a) examined the interaction between wheat, the ground particle size (small, medium, and coarse fractions), and xylanase effectiveness (endo-1, 4–β-xylanase from *Trichoderma viride*). Xylanase enzyme in the diets of the control group did not interfere, and 1000 units/kg of feed were inserted in the experimental groups diets. Studies have shown that xylanase additive does not affect the viscosity of gastrointestinal contents, but improves metabolic utilisation of metabolic energy at unequal wheat ground particle size as well as improves feed conversion efficiency at 882 μm particle size of coarsely milled wheat.

In manufacture of poultry feed much attention is paid to the individual feed manufacturing operations, such as: milling, blending, and heat treatment, conditioning and granulating. Each of the operations may have a positive or negative effect on feed quality and productivity, and digestive tract development (Ravindran, Amerah, 2008). From feed efficiency point of view, grown broiler chickens adapt to whole grains, which results in improved feed conversion. Studies have shown that the use of whole grains has a negative impact on feed efficiency. B. Svihus with other scientists (1997) obtained analogous results. Supplemented lower or whole grains in the feed of broiler chickens at a later age made no negative effect on productivity of the birds and feed conversion (Bennett et al., 1995; Rose et al., 1995; Salah Uddin, 1996; Gabriel et al., 2008).

Barley is one of the most cultivated crops in many places of the world, because of its resistance to drought. However, the use of barley in poultry feeds (particularly for chicken) is usually limited because of the low energy values and other problems as non-starch polysaccharide concentration (Gohl et al., 1978). Barley contains β-glucans having β-1, 4 and β-1, 3 glucosidic bonds, which are the key indicators of anti-nutritional factors. These compounds are mainly found in cereal aleurone and endosperm cell. These compounds belong to non-starch polysaccharides and can be not completely hydrolyzed and increase the viscosity of the digestive tract chymus (White et al., 1983; Salih et al., 1991; McNab, Smithard, 1992; Almirall et al., 1995). As a result, changes in faecal consistency decrease the absorption of nutrients, and the growth rate (Almirall et al., 1995; Philip et al., 1995). In addition, barley endosperm cell walls may enclose nutrients and consequently, reduce their availability for digestion and absorption in the small intestine (Hesselman, Åman, 1986).

Summarizing, the literary data suggest that poultry productivity and development of the gastrointestinal tract depend on many factors such as antinutritional factors in the case of cereals, grain size fractions of grinding, heat treatment, conditioning and granulating parameters used in the composition and concentration of enzymes and

whole grains, whereas their genotype makes a qualitative and quantitative impact on different broiler growing periods.

So far in the diet of broiler chickens the whole wheat has been used. Very few data on the use of whole barley in broiler diets and their influence on the digestive tract, digestive processes, were found. Therefore, this trial was to investigate the whole barley influence for broiler chickens and the productivity of their digestive process.

The aim of the trial. To evaluate the influence of the different amount of whole barley grains on the productivity and digestive processes of broiler chickens.

Materials and methods. The scientific investigations were made following the provisions of the Republic of Lithuania (1997-11-06) for animal welfare and handling, the Law No 8 - 500 (Valstybės žinios, 1997-11-28, No 108) and a substatutory act by the State Food and Veterinary Service of the Republic of Lithuania regarding the confirmation of the order on the animals for experiments, research, storage, maintenance and operating requirements (Valstybės žinios, 2009-01-22, No. 8, 287). The work was performed in accordance with EU Directive 86/609/EEC and the EC recommendation 2007/526 EC for Animal Use and Storage for Experiments and Other Purposes.

The feeding trial was carried out with 1000 Ross 308 broiler chickens 1–40-day-old, divided into 5 groups. Each group was subdivided into 4 subgroups of 50 chickens, totalling 200 chickens per group.

The first and second groups were control and other three experimental ones.

Five experimental diets were used in the study (Table 1) including two control diets (control diet II contained 2% whole barley grains) and four diets containing from 4% to 25% whole grains of barley.

All groups of chickens from 36 to 40 days of age were fed the standard basal diet without the use of whole barley and coccidiostats.

A diet was formulated to meet the nutrient and energy requirement for broiler chickens (NRC, 1994). The feed quality parameters are presented in Table 2. During the period of 36-40 days, all groups of broiler chickens were fed crumbled feed mixtures, containing the following qualitative parameters: metabolisable energy (13.45 MJ/kg), crude protein (18.78%), crude fat (9.48%), crude ash (2.72%), crude fiber (3.76%), lysine (1.11%), methionine + cystine (0.93%), threonine (0.74%), tryptophan (0.23%), calcium (0.88%), phosphorus (0.75%), available phosphorus (0.44%), sodium (0.16%), chlorine (0.15%), and linolenic acid (1.85%).

The amount of total amino acids in the diets, using high-performance liquid chromatography system was investigated at the Institute of Animal Nutrition, Hohenheim University (Germany).

Table 1. **The amount of whole barley in the diets,** %

Period in days	Groups				
	Control I	Control II	Experimental I	Experimental II	Experimental III
1–7	–	2	4	6	8
8–21	–	2	8	12	16
22–35	–	2	15	20	25
36–40	–	–	–	–	–

Table 2. **Quality parameters of diets** (from 1–7 and 8-35 days periods), %

Parameters	Groups									
	Control I		Control II		Experimental I		Experimental II		Experimental III	
Metabolisable energy, (MJ/kg)	13.28	13.28	12.78	12.78	12.78	12.76	12.77	12.75	12.76	12.74
Crude protein, %	21.82	21.82	22.30	22.30	22.09	21.67	21.88	21.25	21.67	20.83
Crude fat, %	6.02	6.02	6.03	6.03	5.94	5.76	5.85	5.58	5.76	5.40
Crude fiber, %	2.46	2.46	2.47	2.47	2.47	2.48	2.48	2.49	2.48	2.49
Lysine, %	1.26	1.26	1.26	1.26	1.24	1.21	1.22	1.17	1.21	1.13
Methionine/Cysteine, %	0.98	0.98	0.97	0.97	0.96	0.94	0.95	0.92	0.94	0.90
Threonine, %	0.85	0.85	0.84	0.84	0.83	0.81	0.82	0.79	0.81	0.77
Tryptophan, %	0.27	0.27	0.27	0.27	0.26	0.26	0.26	0.25	0.26	0.25
Calcium, %	0.97	0.97	0.96	0.96	0.94	0.91	0.93	0.87	0.91	0.83
Phosphorus, %	0.67	0.67	0.68	0.68	0.67	0.66	0.67	0.65	0.66	0.64
Phosphorus (av.), %	0.44	0.44	0.46	0.46	0.45	0.44	0.45	0.43	0.44	0.42
Sodium, %	0.17	0.17	0.17	0.17	0.16	0.16	0.16	0.15	0.16	0.15
Chlorine, %	0.18	0.18	0.19	0.19	0.18	0.18	0.18	0.17	0.18	0.16
Linoleic acid, %	1.72	1.72	2.95	2.95	2.91	2.83	2.87	2.75	2.83	2.67

Table 3. **Enzymatic activity in the diets**

Feed	Xylanase activity (visco units/kg)	Phytase activity (FTU/kg)
Basal diet	1106	487
Basal diet + 2% barley	1074	538
Basal diet + 4% barley	1175	598
Basal diet + 6% barley	804	500
Basal diet + 8% barley	913	523
Basal diet + 12% barley	750	497
Basal diet + 15% barley	1050	613
Basal diet + 16% barley	780	512
Basal diet + 20% barley	801	498
Basal diet + 25% barley	852	566
Standard diet	843	612

Enzymes activity in the diets was verified in ADISSEO - Laboratory Carate (France) according to the methods: Q4.50 (arabinoxylans viscometer method of barley) for determination of endo-1,4-β-xylanase enzyme analysis and T020-@01 method for determination of 6 - phytase enzyme analysis.

In the standardized product of Rovabio MAX LC the activity of xylanase was composed of 1100 viscose units/kg and phytase - 500 FTU/kg. The enzyme activities of Rovabio MAX LC in the diets are given in Table 3.

During the feeding trial, body weights at the age of 1, 7, 2l, 35 and 40 days, feed conversion ratio of each subgroup at the ages of 1–7, 8–21, 22–35, and 36–40 days and birds mortality over the feeding trial were tested.

At the end of the trial (40 days old), broiler chickens were killed according to the recommendations for euthanasia of experimental animals (Close et al., 1997), and pH were determined in the content of duodenum *(Duodenum)*, small intestine *(Intestinum tenue)*, caeca *(Caecum)* and colon *(Intestinum crassum)* by pHmeter "730 Inolab". Dry matter content in the same part of guts chymus was determined by difference between wet weight and dry weight (dried at 105ºC for 3 hours).

Caecal contents of ammonia nitrogen were determined by Foss - Tecator ASN method 3302.

Statistical evaluation of data. Analysis of variance (ANOVA) was applied to the descriptors tested individually with significance level at $P<0.05$ to determine differences between groups. Sample comparisons were determined using Duncan test the statistical program SAS (2001). Statements of statistical significance were based on $p<0.05$.

Results and disscusion. The data of broiler chickens body weight are presented in Table 4. The feeding trial using different amounts of whole barley in the diets showed that, in comparison to control group I, in the control group II (basal diet contained 2% of whole barley grains*)* the weight of 7 days old broilers was lower (1%), but in the experimental groups I, II and III, where the amount of whole barley grains in the basal diet comprised 4%, 6% and 8% respectively, the weight of broiler chickens was by 1–2% higher ($p>0.05$). The weight of 21 days old broilers in control group II and in experimental group I (basal diet contained 8 % of whole barley grains*)* was by 1% ($p>0.05$), in experimental group II (basal diet contained 12% whole grains of barley) by 4% ($p<0.05$), and in experimental group III (addition of 16% whole barley grains) by 2% ($p>0.05$) lower as compared to the control group I. During the last feeding trial periods (35 and 40 days), the same growth tendency in all experimental groups was observed: body weight in experimental group I (at 35 days, the grains of whole barley in diets contained 15%, at 40 days – without barley supplementation), group II (at 35 days, the grains of whole barley in diets contained 20%, at 40 days – without barley) and group III (35 days, the grains of whole barley in diets contained 25%, at 40 days – without barley supplementation) was lower by 1% ($p>0.05$), 3%($p<0.05$) and 2% ($p<0.05$) respectively, in comparison to control group I.

The feed conversion ratio (FCR) of broiler chickens at different ages, expressed as kg feed/kg , and weight gain is shown in Table 5. At the beginning of the trial (period 1 to 7 days of age), the addition of different amount of whole barley grains (2–8%) in the diets had positive effect on the feed consumption: FCR in the control group II, experimental group II and III were by 2 to 3 % lower ($p>0.05$) in comparison with control group I. Only experimental group I (basal diet contained 4% whole barley grains), where the FCR was by 2 % higher in comparison with control group I ($p>0.05$) made an exception. Higher amount of whole barley grains in the diets (from 2 to16%), increased FCR of broiler chickens (from 8 to 21 days) in the control group II, experimental groups I, II and III by 5% ($p>0.05$), 10% ($p>0.05$), 12% ($p<0.05$), and 14% ($p>0.05$), respectively in comparison with control group I. During the latest feeding trial periods, i. e. involving from 22 to 35 days and 36 to 40 days, FCR of all experimental groups was by 3–12 lower ($p>0.05$), except in experimental group III (22–35 days) where FCR was by 6% higher ($P<0.05$) than in control group I. During the whole trial period (1 to 40 days), FCR in control group II, experimental groups I and II was by 1–3% ($p>0.05$) lower and in experimental group III by 4% higher compared with control group I ($P>0.05$).

Similar results were obtained by C.D. Bennett and others (2002), who found that broilers body weight decreased nearly throughout all growing periods, but feed conversion ratios in the control group were higher than in the experimental group.

The results of liveability of broiler chickens, fed diets containing different amount of whole barley grains, are presented in Table 6. During 5 weeks of feeding, supplementation of different amounts of whole barley grains to a wheat-soybean meal based diet insignificantly (p>0.05) affected broiler chickens mortality in comparison to the control group I. Liveability in all groups of chickens was similar compared with the control group I (p>0.05). In experimental groups I and III, the mortality of broilers was higher by 1% and 0.5% respectively, but in control group II and experimental group II this index was lower by 1.5% and 2%, respectively compared with control group I (p>0.05). During the last growing period of broilers (36–40 days), when they were fed to the standard basal diet without the use of whole barley grains, chicken liveability in all groups decreased by 0.5%, except in experimental group II, where this index decreased by 1% (p>0.05) compared with control group I.

Table 4. **Effect of whole barley on broiler chickens weight,** g

Chickens age in days	Groups				
	Control I	Control II	Experimental I	Experimental II	Experimental III
1	46.85±0.29	46.87±0.20	46.86±0.22	46.86±0.20	46.88±0.18
7	174.42±1.55	173.23±1.48	176.35±1.52	178.54±1.55	175.62±1.40
21	957.15±9.37	950.11±8.98	950.14±8.42	921.38±9.25*	934.14±8.66
35	2337.51±19.11	2364.49±17.87	2321.84±18.15	2276.71±19.03*	2286.15±19.34*
40	2911.17±21.29	2867.44±21.22	2870.48±19.96	2821.13±22.65*	2857.68±21.40

* Data statistically significant (p<0.05)

Table 5. **Effect of whole barley on broiler chickens feed conversion ratio,** (kg/kg)

Chickens age in days	Groups				
	Control I	Control II	Experimental I	Experimental II	Experimental III
1–7	0.92±0.02	0.91±0.02	0.94±0.02	0.90±0.01	0.90±0.04
8–21	1.54±0.04	1.63±0.06	1.69±0.09	1.73±0.07*	1.76±0.07
22–35	1.99±0.08	1.86±0.03	1.99±0.03	1.91±0.10	2.11±0.07*
36–40	2.73±0.11	2.66±0.25	2.44±0.43	2.54±0.22	2.60±0.30
1-35	1.74±0.03	1.70±0.01	1.79±0.03*	1.75±0.04	1.88±0.06
1–40	1.93±0.05	1.86±0.05	1.91±0.09	1.89±0.06	2.01±0.09

* data statistically significant (p<0.05)

Table 6. **Effect of whole barley on broiler chicken liveability,** %

Chickens age in days	Groups				
	Control I	Control II	Experimental I	Experimental II	Experimental III
1–7	99	98.5	98.5	100	98
8–21	97.5	98.5	96	98	98
22–35	98.5	99.5	99	99	98.5
36–40	99.5	99.5	99.5	99	99.5
1-35	95	96.5	94	97	94.5
1–40	94.5	96	93.5	96	94

Data statistically insignificant (p>0.05)

The effect of different amount of dietary whole barley on pH values of digestive tract of broiler chickens is summarized in Table 7. The pH in duodenum content of chickens was higher (from 0.1 to 0.19) compared with control group I (p>0.05). The same tendency was observed in control group II and experimental groups II and III, where pH of small intestine was higher (from 0.14 to 0.38) compared with control group I (p>0.05). However, the results of conducted trial revealed the whole barley to decrease pH values in caecum chymus of broiler chickens (from 0.07 to 0.28) and colon of chickens in control group II (5.45 compared with 5.90) and in experimental group I (5.51 compared with 5.90) compared to control group I (p>0.05). A pH level of the population dynamics of microorganisms in different parts of the digestive tract of birds and influenced considerably the digestibility of feed nutrients and consumption. Most of the pathogens grow at pH 7 and above. Positive micro-organism population is favourable in acidic medium (pH 5.8 to 6.2). This environment provides optimal conditions

to multiply and compete with pathogenic microflora (Boling et al., 2001; Rahmani, Speer, 2005). Decrease of pH creates acidity killing many pathological organisms able to cause various diseases (Conway, 2001; Gibson, 2004).

The addition of whole barley grains in the diets did not significantly change dry matter concentration in duodenum, small intestine, cecum and colon of broiler chickens (Table 8). Whole barley increased dry matter concentration of duodenum content by 1.77% in experimental group III and in control group II, experimental groups I and II dry matter concentration was reduced by 0.93%, 1.61% and 0.69%, respectively compared to control group I (p>0.05). Dry matter concentrations of small intestine content in control group II, experimental groups II and III were lower by 0.57–1.45%, but in experimental group I they were higher by 0.51% compared with control group I (p>0.05). On the contrary, dry matter concentrations in caecum content of control group II, experimental groups I and II were higher by 3%, 3.18% and 0.32% respectively, but in experimental group III they were lower by 0.74% compared to control group I (p>0.05). In the content of colon in broiler chickens of experimental groups, lower dry matter concentration were determined (0.57–2.43%) compared to control group I (p>0.05). With higher dry matter content in the intestinal digesta, bird excrement is dryer, thus improvement of the microclimate and litter quality parameters produce a positive effect on bird health.

The addition of lower amount of whole barley in the diet (Table 9), i. e. control group II and experimental group I, the ammonia nitrogen content in caeca increased by 1.3 mg/g and 0.44 mg/g, respectively compared to control group I (p>0.05). On the contrary, the ammonia nitrogen content in caeca in experimental groups II and III (higher amount of whole barley) was reduced (0.27 mg/g and 0.23 mg/g, respectively) compared to control group I (p>0.05). With a lower amount of ammonia in the gut of lower inject into the blood, the nutrients consumption in the gut and general health of the birds are improved (Ghadban, 2002).

Table 7. **The effect of whole barley on pH value in the gastrointestinal tract of broiler chickens**

Different part of gastrointestinal tract	Groups				
	Control I	Control II	Experimental I	Experimental II	Experimental III
Duodenum *(Duodenum)*	5.88±0.05	5.89±0.09	6.07±0.10	5.98±0.02	6.07±0.12
Small intestine *(Intestinum tenue)*	5.27±0.27	5.41±0.60	4.97±0.23	5.64±0.34	5.65±0.30
Caeca *(Cecum)*	6.19±0.15	6.43±0.18	5.91±0.22	6.12±0.14	6.11±0.27
Colon *(Intestinum crassum)*	5.90±0.29	5.45±0.10	5.51±0.07	5.96±0.31	6.30±0.40

Data statistically insignificant (p>0.05)

Table 8. **The effect of whole barley on dry matter concentration in the gastrointestinal tract of broiler chickens,** (%)

Different part of gastrointestinal tract	Groups				
	Control I	Control II	Experimental I	Experimental II	Experimental III
Duodenum *(Duodenum)*	17.74±0.92	16.81±0.72	16.13±0.98	17.05±0.91	19.51±1.39
Small intestine *(Intestinum tenue)*	17.20±0.72	16.63±1.68	17.71±1.12	16.58±0.93	15.75±0.56
Caeca *(Cecum)*	15.38±1.09	18.38±0.91	18.56±1.25	15.70±1.43	14.64±2.19
Colon *(Intestinum crassum)*	18.88±1.18	19.61±0.86	18.31±1.86	17.95±0.73	16.45±0.78

Data statistically insignificant (p>0.05)

Table 9. **The effect of whole barley on ammonia nitrogen in the caeca of broiler chickens** (mg/g)

Groups				
Control I	Control II	Experimental I	Experimental II	Experimental III
2.67±0.41	3.97±0.34	3.11±0.38	2.40±0.13	2.44±0.26

Data statistically insignificant (p>0.05)

Conclusions

1. The body weight of broilers fed diets containing from 8% to 15 % of whole barley grains (experimental group I) was lower by 1% (P>0.05) and in the experimental groups II and III (12–25% of whole barley grains in the diets), the mention growth parameter decreased by 2–4% compared with control groups (P<0.05).

2. Feed conversion ratio in all experimental groups was higher by 1–8% (P>0.05), but during the last trial

period (from 36 to 40 days old), when the diets were without whole barley, there were no significant differences between the groups compared with control groups (P>0.05).

3. During 5 weeks, feeding a wheat-soybean meal based diet supplemented with different amount of whole barley grains insignificantly (P >0.05) affected broiler chickens' mortality in comparison to the control group I.

4. Whole barley grains in the diets increased pH values in the content of duodenum, small intestine and colon of broiler chickens. Whole barley also increased the dry matters content in duodenum. Different amount of whole barley in broiler diets reduced pH values in the caecum, and dry matters content in the small intestine, caecum and colon compared to the control group I (P>0.05).

5. The ammonia nitrogen content in caecum of experimental groups II and III (higher amount of whole barley) was reduced by 0.27 mg/g and 0.23 mg/g, respectively compared to control group I (P>0.05).

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