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Growth performance parameters and selected quality traits of meat and femoral bone of broiler chickens fed diet supplemented with amorphous diatomaceous earth

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Abstract: *Growth performance parameters and selected quality traits of meat and femoral bone of broiler chickens fed diet supplemented with amorphous diatomaceous earth.* This study was aimed at analyzing the effect of the addition of amorphous diatomaceous earth to feed on growth performance parameters and selected quality traits of meat and femoral bone of broiler chickens. The study was conducted with 60 fast-growing Ross 308 broiler chickens, reared until 42nd day of age and divided into a control group (C) and two experimental groups (D2 and D4) (20 birds each). The diatomaceous earth (diatomite) was administered to the birds' feed from the groups D2 – 2%, D4 – 4%. Individual body weight, feed intake and mortality of chickens were controlled. On day 42 of rearing, six males were selected from each group for slaughter followed by dissection. Dressing percentage, content of muscles and giblets (gizzard, liver and heart), were calculated, and in samples of breast and leg muscles the chemical and physicochemical properties were analyzed. Resistance of the femoral bone to fractures was determined. The addition of diatomite did not affect the health status of chickens. Significantly higher body weight at 42nd day of rearing was noted in the group C vs D4 ($P \leq 0.05$). Significantly higher ($P \leq 0.01$) content of pectoral muscles and lower ($P \leq 0.05$) fat in the carcass of group D2 vs C were noted. The addition of diatomaceous earth did not affect the chemical composition of the breast muscles. The fat content in leg muscles was significantly reduced ($P \leq 0.05$) and water content was increased ($P \leq 0.05$) in group D2 vs C. Femoral bones of D4 birds were significantly more resistant ($P \leq 0.05$) to breaking than in C. Direct relationship between the amount of diatomite and the strength of the femur was found. The most optimal supplementation was considered as 2%.

Key words: diatomaceous earth (diatomite), broiler chickens, growth performance, quality of meat and femoral bone

INTRODUCTION

Apart from pork, poultry meat is one of the most frequently consumed types of meat by an average Pole. In the intensive production of broiler chickens, being the main source of poultry meat in Poland, used is made of crosses with a high genetically-determined productive potential. Consumers of poultry meat are becoming increasingly interested in the welfare of animals as well as in the quality and safety of food products of animal origin. Many of them pay attention to maintenance conditions and rearing system. From the point of view of both, the producer and the consumer it is important to keep the high growth performance of chickens, but, simultaneously, to ensure their good health status and body condition. This may be achieved by appropriate feeding. For this reason, it is desirable to support bird feeding with additives of natural origin that would positively affect those two traits. Considering the necessity and willingness to satisfy customer demands, producers of broiler chickens use a variety of preparations and feed additives in their diets that may positively influence bird condition and meat quality. In addition, they are still searching for novel solutions. The proposed substance that may be applied in broiler chicken feeding is diatomaceous earth. It is a completely natural preparation, unprocessed nor fortified with any chemical substances, which is significant from the point of view of both, consumers and producers. The use of diatomaceous earth in animal feeding and its effect on the body are, however, relatively poorly recognized, especially in Poland, and available study results are full of ambiguities and inaccuracies.

Diatomaceous earth (diatomite) is a natural sedimentary rock, formed mainly by fossilized frustules of diatoms – single-celled algae. These organisms had lived many millions years ago in the aquatic environment, and then – as a result of successive drying out of water bodies – they have formed deposits of diatomaceous earth (Round et al. 1990). As reported by Fields (2000), the frustules of diatoms in diatomite are built mainly of silica (SiO_2) and trace amounts of other mineral compounds, like: aluminum, iron oxide, lime, magnesium or sodium.

The mechanism of action of diatomaceous earth in an animal body may be discussed from two perspectives. The diatomaceous earth administered to animals with feed passages through the gastrointestinal tract and is absorbed, in a small amount, to the bloodstream in the form of orthosilicic acid (H_4SiO_4). This acid is synthesized through the reaction of silica with two molecules of water and in nature is the biologically-active form of silica and silicon. Diatoms may, therefore, constitute the source of bioavailable silicon (Abraham 2005). In addition, diatomaceous earth is applied as an anti-parasitic agent (Quarles 1992, Fields 2000, Dawson 2004, Maurer et al. 2009, Wiewióra et al. 2015). By passing through the gastrointestinal tract, frustules of diatoms destroy the encountered parasitic organisms and their forms, and then are excreted. These events are mechanical in character, the rough surface of frustules rubs against forms of parasites, causing their damage, which leads to their death or incapability of further reproduction. In addition, the cylindrical frustules of diatoms have pores that absorb water from the extrinsic environment, which contributes to dehydration of pathogen bodies and leads to their death as a result of dehydration (Haney 2016). According to Haney (2016), diatoms are not identical in all deposits of diatomaceous earth. The saltwater deposits contain a mixture of different types of diatoms having various shapes, and their fossilized frustules are relatively fragile. In turn, the freshwater deposits are characterized by a stable content of diatoms with a uniformly-shaped (cylindrical) and resistant frustules. The stable structure and unchangeable composition of diatomaceous earth are important for the effectiveness of its action. A significant aspect in this case is also the amorphous (non-crystalline, namely unordered) form of the applied diatomaceous earth. The amorphous silica is delicate, it smoothly rubs against the gastrointestinal tract, causing no damages. In turn, the crystalline silica has very sharp, hard and relatively thick particles that may be hazardous to the walls of the gastrointestinal tract of animals – it is mainly applied in filtration systems. According to Norton (2015), owing to its adsorptive properties, diatomaceous earth may be used to eliminate from the body toxins secreted by bacteria, fungi or other infections, including yeast-like Candida. In addition, the administration of diatomite improves the generally understood body condition of animals and may also improve their production results (Carlisle 1986). Any negative impact of the amorphous diatomaceous earth on health or condition of animals has been document so far.

This study was aimed at analyzing the effect of the addition of amorphous diatomaceous earth to feed on production performance indices and selected quality traits of meat and femoral bone of broiler chickens.

MATERIAL AND METHODS

The experimental material included 60 fast-growing Ross 308 broiler chickens (males) kept until 42nd day of age at the experimental farm of Wilanów-Obory. One-day poults were vaccinated against Marek's diseases, Gumboro disease, and infectious bronchitis. Afterwards, they were weighed, tagged with individual tags, and randomly allocated to experimental groups. On the first day of experiment, the chicks were randomly divided into three groups of 20 birds (five birds in four replicates), i.e. control group (C) and two experimental groups in which diets were supplemented with diatomaceous earth: D2 (2%) and D4 (4%). The differentiating factor in the experiment was feeding the chickens from the experimental groups with a feed mixture supplemented with 2 and 4% of diatomaceous earth. The birds were fed *ad libitum*, in a three-stage system: starter (days 1–14), grower (days 15–35), finisher (days 36–42) – Table 1.

The diatomaceous earth used in the experiment originated from freshwater deposits, its dietary quality was suitable for men and animals and it was ground to the consistency of meal. Its composition was presented in Table 2.

Individual body weights, feed intake and mortality rate of the chickens were controlled throughout the study. On day 42 of production, six males with body weight close to the average body weight in a group were selected from each group. The selected birds were fasted for 12 h, with constant access to water, and then slaughtered. Carcasses were chilled with the air method at a temperature of 4°C for 24 h. Then, dissection was performed. Afterwards, a total of 18 carcasses (six from control group and six from each experimental group) were dissected following the methodology described by Ziołecki and Doruchowski (1989). Dressing percentage was calculated, i.e. content of muscles and content of giblets (gizzard, liver and heart), in respect of the body weight before slaughter. The collected breast and leg muscles were weighed, individually marked, protected, and left for further analyses.

The dissected breast and leg muscles were subjected to the chemical and physicochemical analysis. The proximate chemical composition of breast muscles

TABLE 1. Feed mixture composition and nutritional value

Specification	Feed mixture		
	starter (days 1–14)	grower (days 15–35)	finisher (days 36–42)
Component (%)			
Corn	10.00	11.40	10.00
Wheat	53.00	55.00	60.80
Soybean meal	30.60	27.40	21.60
Limestone	1.19	1.20	0.97
Sodium bicarbonate	0.20	0.14	0.16
NaCl	0.24	0.28	0.26
Dicalcium phosphate	1.18	0.78	0.64
Soybean oil	2.10	2.40	4.40
Methionine 84% calcium salt	0.48	0.42	0.28
Lysine	0.36	0.34	0.28
Threonine	0.14	0.13	0.10
Premix 0.5%	0.50	0.50	0.50
Nutritional value			
ME (kcal)	2 990	3 047	3 217
Crude fat (%)	3.67	4.00	5.92
Crude protein (%)	21.99	20.78	18.51
Crude fiber (%)	3.60	2.55	2.41
Crude ash (%)	5.83	5.35	4.67
Lysine (%)	1.38	1.28	0.97
Methionine + + cystine (%)	1.08	1.01	0.76
Available phosphorus (%)	0.45	0.38	0.35

TABLE 2. The composition of diatomaceous earth (MSDS diatomite 2016)

Chemical substance	Content (%)
SiO_2 amorphous	92.00
SiO_2 crystalline	<0.10
Al_2O_3	4.52
Fe_2O_3/FeO	1.16
P_2O_5	0.02
CaO	0.71
MgO	0.55
$Na_2O + K_2O$	0.28
S	0.01
Cl	0.02
MnO	0.02

and leg muscles was determined with standard methods: protein content – with the Kjeldahl's method using a conversion factor of 6.25 (PN-75/A-04018); and fat content – with the Soxhlet's method (AOAC 2005). Color parameters (L*, a*, b*) were measured in comminuted breast and leg muscles using a CR-410 colorimeter (Minolta) following producer's instructions. Each parameter was measured in five replications, and the mean value of five replications was assumed as measurement result. The parameter L* (lightness) may attain values from 0 to 100. Parameters a* and b* are trichromaticity coordinates and may attain positive and negative values: +a* denotes red color, –a* denotes green color, +b* denotes yellow color, and –b* denotes blue color.

Tests of femoral bone resistance to fractures were performed in a testing machine Zwick Roell 25.0 equipped in a head with the maximum force of 1 kN. Speed of the loading element was 50 mm/min.

The data obtained were analyzed statistically using a one-way analysis of variance using SPSS 23.0 software (SPSS, Chicago, IL, USA). Differences were found significant at $P \leq 0.05$ and $P < 0.01$.

RESULTS AND DISCUSSION

Results of analyses of growth performance and slaughter analysis of the broiler chickens were presented in Tables 3 and 4. On 42nd day of rearing, significantly ($P \leq 0.05$) highest body weight was noted in the group of control birds (3,249 g). Feed conversion ratio in group D2 (1.57 kg/kg of body weight gain) was the lowest, compared to the other groups (C – 1.59, D4 – 1.64 kg/kg of body weight gain). No deaths of birds were recorded in any of the groups. It may be indicative of very good microclimatic conditions and welfare of the chickens maintained throughout the rearing period, as well as of the lack of negative effects of diatomaceous earth administration on birds mortality rate. Worthy of notice is, however, that there are ample research reports and works concerning the positive effect of dietary inclusion of diatomite on production performance and generally understood health status of animals, including poultry (Carlisle 1972, 1976, Bennett et al. 2011). Although some differences were noted between groups in growth performance parameters, the effects achieved should be found satisfactory and comparable with these reported by other authors.

TABLE 3. Growth performance of broilers – average body weight (BW), feed conversion ratio (FCR), mortality

Group	BW (g), day 42	FCR (-), days 1–42	Mortality (%)
C	3 249^{a}	1.588	0
D2	3 132^{ab}	1.571	0
D4	3 072^{b}	1.638	0
SEM	43.88	0.02	–

Means within a column with different superscripts are significantly different at $P \leq 0.05$.

TABLE 4. Average results of slaughter analysis of broiler chickens (%)

Group	Dressing percentage	Muscles		Giblets			Abdominal fat
		breast	legs	gizzard	liver	heart	
C	73.54	23.36^{B}	15.03	0.60	1.80	0.45	0.51^{ab}
D2	76.05	26.56^{A}	14.78	0.55	1.90	0.45	0.48^{b}
D4	74.70	24.46^{AB}	15.26	0.58	1.83	0.45	0.77^{a}
SEM	0.85	0.70	0.33	0.03	0.11	0.01	0.08

Means within a column with different superscripts are significantly different: A, B at $P \leq 0.01$, a, b at $P \leq 0.05$.

In reference to the analyzed parameters, no significant differences were demonstrated in dressing percentage – its highest value (at the significance boundary of $P = 0.056$) was noted in group D2 (76.05%), whereas the lowest one in the control group – 73.54% (Table 4). The application of diatomaceous earth in diet for broiler chickens reared until 42nd day of age had a significant effect on the contribution of leg muscles and giblets in carcasses (Table 4). Analyses demonstrated a significant ($P \leq 0.01$) increase in the content of breast muscles and a lower fat content ($P \leq 0.05$) after diet supplementation with 2% of diatomite, which may be of great significant from the consumer's perspective. According to research reports, today, consumers of poultry meat purchase mainly those parts of carcasses that may be easily and quickly prepared for consumption – next to thigh muscles, these parts include breast muscles (Nowak and Trziszka 2010). In addition, consumers pay great attention to the nutritive value of food products, and poultry meat is commonly perceived as dietetic meat, hence a low fat content is desirable in this product (Nowak and Trziszka 2010, Zdanowska-Sąsiadek et al. 2013). The production of chickens with a higher content of breast muscles and a lower content of fat in carcass is, therefore, economically beneficial to the producer.

Results obtained in this study point to the feasibility of applying diatomite in feed mixtures for broiler chickens – though not necessarily in the large--scale commercial production owing to the possibility of reduced body weight, but definitely in the free-range, bio, and household systems – and indicate that it would potentially yield some economical benefits and would not deteriorate the growth performance of chickens. In case of the broiler chickens from group D2, even improvement was observed in the production effectiveness manifested in a reduced feed conversion ratio, compared to the control group, which ensures another economic benefit to the producer. Results of this study confirm findings reported by other authors. Research reports on the effects of diatomaceous earth demonstrate, e.g., the mechanism of agglutination of food particles in the gastrointestinal tract and separation of these particles from one to another (Ewuola et al. 2014). By this means, it is feasible to enlarge the available surface of digestion for enzymes and to retard digesta passage through the gastrointestinal tract, which results in more efficient absorption of nutrients from feed mixtures and in enhanced effectiveness of digestion. In addition, diatomaceous earth affects body detoxification and bowel purgation (also from residues of veterinary pharmaceuticals), which increases feed intake by animals. What is more, according to other researchers, the intake of fine-grain feed additives may improve absorption of nutrients in poultry (Quisenberry 1967, van der Meulen et al. 2008).

Poultry feeding affects not only the basic indices of post-slaughter yield and nutritive value of meat, but also significantly models the aroma and taste of meat. Inappropriate choice of feed components may cause some deviations towards deterioration of palatability, but through feeding it is also possible to regulate the level of indispensable components in meat, being the basis of its nutritive value. Meat plays a key role in man's diet, especially in developed countries (Speedy 2003). It is affected by many factors like, e.g., social status, wealth, the size of animal productions, and socio-economical status of the country, which explains the higher consumption of meat in Western populations (Speedy 2003).

A typical muscle tissue consists of about 75% of water, 20% of protein, 3% of fat, and 2% of solubles non-protein substances. Results of chicken meat quality analysis were presented in Tables 5 and 6. In most cases, the addition of diatomaceous earth to the feed mixture had no significant effect on the proximate chemical composition of breast muscles. The chemical composition of leg muscles (Table 5) was, generally, similar in all groups, however significantly the highest content of crude fat was determined in leg muscles of the chickens from control group (7.34%), and the lowest one – in these of the chickens from group D2 (5.89%). A similar tendency was observed in breast muscles. Generally, leg muscles contain more fat than breast muscles (Castellini et al. 2002), however, it needs to be emphasized that fat has a positive impact on taste, juiciness, and tenderness of meat (Aberle et al. 2001). As reported by Niewiarowicz (1993) the increasing content of fat is accompanied by a decreasing content of protein or by an increasing dry matter content of mus-

TABLE 5. Chemical composition of chicken meat (%)

Group	Breast muscles				Leg muscles			
	water	protein	fat	collagen	water	protein	fat	collagen
C	74.06	22.10	3.71	1.17	72.33^b	19.44	7.34^a	1.16
D2	74.39	21.80	3.33	1.11	73.78^a	19.68	5.89^b	1.22
D4	73.69	22.32	3.54	0.96	72.79	19.49	6.91	1.15
SEM	0.28	0.22	0.25	0.09	0.38	0.18	0.45	0.09

Means within a column with different superscripts are significantly different at $P \leq 0.05$.

TABLE 6. Color parameters of breast and leg muscles

Group	Breast muscles			Leg muscles		
	L*	a*	b*	L*	a*	b*
C	50.99	6.44^a	3.45	53.76	9.07	6.76^a
D2	51.81	4.32^b	4.13^a	53.13	8.91	5.67
D4	50.58	4.65	2.79^b	53.59	8.41	5.44^b
SEM	1.09	0.62	0.40	0.83	0.46	0.41

a* – represents colors from green (–a) to red (+a), b* – represents colors from blue (–b) to yellow (+b), L* – the axis of lightness. L* is perpendicular to the hue plane and cuts it through at the site of crossing with axis a* and b*. The L* values range from 0 (black) to 100 (white), and between them there are all hues of grey.

Means within a column with different superscripts are significantly different at $P \leq 0.05$.

cles, which was confirmed in this study (Table 5). Simultaneously, as mentioned earlier, the lower content of fat in poultry meat may be desirable by consumers.

Breast muscles of broiler chickens contain ca. 25% of protein (Lonergan et al. 2003). A higher content of protein was determined in the breast than in the leg muscles. The highest content of protein in breast muscles was assayed in group D4 (22.32%), and the lowest one in group D2 (21.80%). In the case of leg muscles, the highest protein content was found in group D2 (19.68%), and the lowest one in the control group (19.44%). Nevertheless that above results are consistent with findings of other authors, according to whom the mean content of protein in breast muscles of chickens ranged from 17.8 to 20.2% (Gawęcki and Gornowicz 2000). In case of leg muscles, analyses showed a significantly ($P \leq 0.05$) higher content of water in group D2 than in the control group (73.78 and 72.33%, respectively). Results obtained by Grabowski (1993) demonstrated an inversely proportional dependency between water content and fat content, which was confirmed in our study in case of significant differences. The content of water decreases along with bird age, which is linked with increasing adiposity and processes ongoing in muscles.

Color sensation is one of the key criteria taken into account during the choice and purchase of a food product by consumers. Based on the visual assessment of this trait, a customer is concluding about the freshness or even quality of meat. The statistical analysis of results of color measurements demonstrated that diet supplementation with diatomaceous earth had no effect on the values of L* parameter in breast muscles of birds. Observations confirmed no effect of various dietary doses of diatomite on better muscle coloration compared to the control group (Table 6). The color of meat is determined by, among other things, concentration of heme pigments and pH value. The highest values of saturation with red color (parameter a*) were found in breast and leg muscles of the control birds, however these values were confirmed statistically only in case of breast muscles. The contribution of yellow and blue color is indicated by values of parameter b*. Results obtained regarding this color parameter demonstrated breast and leg muscles saturation with yellow color. The highest value of saturation with yellow color (parameter +b*) was determined in breast muscles of birds from group D2 (4.13) and in leg muscles of birds from the control group (6.76), whereas the lowest values of this parameter were noted in both breast and leg muscles of birds from group D4. According to Kirkpinar et al. (2001), the more beneficial coloration of carcasses of broiler chickens is indicated by lower values of L* parameter and by higher values of a* and b* parameters. Therefore, diet supplementation with diatomaceous earth had no explicit positive or negative effect on color parameters of chicken meat.

Current conditions of rearing and breeding as well as feeding and genetic modification of domestic fowl are supposed to ensure, most of all, a high growth rate. The fast increase of body weight but also no balance between muscle mass gain and bone mass may increase the risk of deformations or fractures of different bones. The selection of broiler chickens for the highest possible muscle mass has led to disruption of body homeostasis which results from the non-uniform development of the whole organism (Wnuk et al. 2013). The greatest problems faced by producers are these linked with skeleton incapability to lift such a heavy body of chickens, especially in the last weeks of the production cycle. Considering bone resistance expressed by means of the breaking force (Table 7), dietary inclusion of diatomaceous earth was demonstrated to have a significant effect on the value of this trait. Femoral bones of birds from group D4 were characterized by a significantly greater resistance (395.83 N) to the breaking force than these of the control birds (369.66 N). In addition, a growing tendency was observed in bone resistance along with an increasing diatomite dose in the feed mixture. There is growing need for understanding the bone resistance in poultry because bone fractures and resultant infections often contribute to deterioration of dressing percentage and quality of carcass. One of the aims of diatomite addition to feed mixtures for chickens is to supplement their bodies with silicon. Negative effects of a silicon-poor diet were demonstrated by Carlisle (1972) – deficiency of this element caused skeleton deformation and incorrect joint development in chickens. The effect of diatomaceous earth on the improvement of skeleton resistance and condition was also confirmed in studies conducted by Calomme et al. (2002) and López-Álvarez et al. (2009). Feed supplementation with silicon may, additionally, significantly affect the appropriate development of young organisms, which was proved by Carlisle (1972) – one-day cockerels fed a diet based on amino acids were later characterized by inhibited growth and development, whereas those administered a feed mixture supplemented with silicon were characterized by a 50% higher growth rate and normal development. Another study by Carlisle (1976) demonstrated the presence of silicon at the active sites of calcium attachment in bones of young hens. In turn, our previous studies (Wiewióra 2016 – unpublished data) confirmed the effect of diatomite on skeleton strengthening in hens, i.e. femoral bones of laying hens receiving a feed mixture with the addition of diatomaceous earth were significantly more resistant to fractures.

TABLE 7. The strength of the femur bone

Group	Strength (N)
C	369.7[b]
D2	371.3[ab]
D4	395.8[a]
SEM	8.17

Means within a column with different superscripts are significantly different at $P \leq 0.05$.

CONCLUSION

Results obtained in the study enable presenting the following summary and conclusions:

1. The application of diatomite in the feed mixture had no effect on deterioration of the health status nor on mortality rate of broiler chickens, and ensured other production effects at a comparable level.
2. The amorphous diatomaceous earth may be applied in broiler chicken feeding as an additive safe to the environ-

ment and to bird welfare, which provides a source of biologically-active silicon to birds and has a potentially positive effect on their organisms.

3. Diatomaceous earth may be applied in broiler chicken feeding as an additive improving the resistance and condition of bones, which may be desirable from breeder's and producer's perspective, and most of all from the perspective of animal welfare.

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Streszczenie: *Wskaźniki odchowu oraz wybrane cechy jakości mięsa i kości udowej kurcząt brojlerów żywionych paszą uzupełnioną amorficzną ziemią okrzemkową.* Celem badania była analiza wpływu dodatku amorficznej ziemi okrzemkowej do paszy na wyniki odchowu oraz wybrane cechy jakości mięsa i kości udowej kurcząt brojlerów. Badanie przeprowadzono na 60 szybkorosnących kurczętach Ross 308 utrzymywanych do 42. dnia życia i podzielonych na grupę kontrolną (C) i dwie grupy doświadczalne (D2 i D4), po 20 sztuk w każdej. Ziemię okrzemkową (diatomit) podawano z paszą ptakom z grupy D2 – 2%, D4 – 4%. W doświadczeniu kontrolowano masę ciała, spożycie paszy oraz śmiertelność kurcząt. W 42. dniu odchowu z każdej grupy ubito po sześć kogutów i wykonano dysekcję. Obliczono wydajność rzeźną, udział mięśni oraz podrobów jadalnych (żołądka mięśniowego, wątroby oraz serca), a w próbach z mięśni piersiowych i nóg wykonano analizy chemiczne i fizykochemiczne. Określono również wytrzymałość kości udowej na złamanie. Dodatek diatomitu nie wpłynął na status zdrowotny kurcząt. Większą masę ciała w 42. dniu odchowu odnotowano w grupie C względem D4 ($P \leq 0{,}05$). Stwierdzono większy ($P \leq 0{,}01$) udział mięśni piersiowych oraz mniejszy ($P \leq 0{,}05$) udział tłuszczu w tuszce w grupie D2 względem C. Dodatek ziemi okrzemkowej do paszy nie różnicował składu chemicznego mięśni piersiowych. W mięśniach nóg kogutów D2 stwierdzono zmniejszenie ($P \leq 0{,}05$) zawartości tłuszczu oraz zwiększenie ($P \leq 0{,}05$) zawartości wody w porównaniu do grupy C. Kości udowe ptaków z grupy D4 charakteryzowały się większą ($P \leq 0{,}05$) wytrzymałością na złamanie niż kości kurcząt z grupy C. Stwierdzono wprost proporcjonalną zależność między ilością zastosowanego diatomitu w paszy a wytrzymałością kości udowej. Za najbardziej optymalną uznano suplementację do paszy na poziomie 2%.

Słowa kluczowe: ziemia okrzemkowa (diatomit), kurczęta brojlery, jakość mięsa i kości udowej

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