Praca oryginalna *Original paper*

Effect of a grower mixture of reduced energetic value on the chemical composition of broiler hearts and livers

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Summary

The purpose of the study was to determine whether the use of a grower mixture of reduced energetic value can affect the chemical composition of the heart and liver in broiler chickens. The experiment involved 144 broiler chickens of the Cobb line, bred in the cage system. One-day-old nestlings were divided through random sampling into two groups: control and experimental, 72 birds in each. Until day 21 the nestlings in both groups were fed the same typical crushed starter mixture containing 20.5% of total protein, whose energetic value was 3065 kcal EM per 1 kg. From day 22 the diets were diversified. The control group was fed a standard granulated grower mixture containing 19.5% of total protein and with an energetic value of 3200 kcal EM per 1 kg (energy to protein ratio of about 164 kcal ME_N/1% crude protein), whereas the experimental group was fed a mixture with a 19% share of total protein and 2900 kcal EM per 1 kg (energy to protein ratio of about 153 kcal ME_N/1% crude protein). The use of a grower mixture of reduced energetic value did not lead to any significant differentiation in the body weight of the chickens. Neither did it affect the giblets (heart and liver). The energetic value of the grower mixture had a significant influence on decreasing the content of crude ash and total protein in the broilers' hearts.

Keywords: chicken, energy, giblets

Broiler chickens bred THESE days can be characterized by relatively varied nutritional requirements, thus the information concerning the composition of feed mixtures should take into account the specific nutritional demands from the perspective of production output and lower fat deposits (4, 11, 14). Alterations in the composition of feed mixtures should refer not only to the quality of their nutrition – using components regarded as „ecologically secure" – but also to the nutritional value of the mixtures. Limiting the nutritional value, especially the energetic value, aims at improving the animals' welfare, protecting them against metabolic diseases, such as the so called „sudden death syndrome", which often occurs in the final days of fattening, as well as at changing the quality of poultry meat beneficial for the consumer (10).

A small amount of fat in the muscles and the skin of slaughter poultry is favorable as it creates an energy stock and insulation for internal organs, improving the meat's tenderness and succulence and facilitating its processing (5). However, high fat content in broiler chickens is unfavorable, both for dietary and economic reasons. The dietary problem results from the fact that fat has a decisive meaning in the development of atherogenic changes in arteries, particularly in the coronary arteries (15). The economic problem connected with lower fat content in meat tissue is caused by the fact that during slaughter of large numbers of chickens with excessive fat deposits large amounts of waste fat remain which need to be managed. With a large number of slaughtered birds, decreasing the fat content in chickens by only 1% leads to a significant reduction in waste fat (14). There is an increasing number of trials aiming at limiting the amount of fat in chickens due to lowering the energetic value of feed mixtures (10). According to Szkucik et al. (12), feeding broiler chickens with a mixture of reduced energetic value results in a significant difference in the content of fat in the carcass compared to the control group receiving a mixture of standard energetic value. In the chicks fed the experimental mixture an increase of fat in poultry meat was observed. Different results were observed by Książkiewicz (8), who noted a significant decrease in poultry meat fat in ducks fed a diet of reduced energetic value.

What is more, this may result in lower costs of the feed used to produce 1 kg of slaughter livestock and thus improve the economic effectiveness of broiler fattening (6).

The aim of the study was to assess the influence of feeding broilers with a grower mixture of reduced energetic value on the chemical composition of the giblets; i.e. the heart and the liver.

Material and methods

The experiment involved 144 broiler chickens of the Cobb line, bred in the cage system. One-day-old nestlings were divided by random sampling into two groups: control group K and experimental group D, 72 birds in each (3 repetitions, 24 birds in each). Until day 21 the nestlings in both groups were fed the same typical crushed starter mixture containing 20.5% of total protein, whose energetic value was 3065 kcal EM per 1 kg. From day 22 the diets were diversified. The control group was fed a standard granulated grower mixture containing 19.5% of total protein and energetic value of 3200 kcal EM per 1 kg (energy to protein ratio of about 164 kcal ME_N/1% crude protein), whereas the experimental group was fed a mixture with a 19% share of total protein and 2900 kcal EM per 1 kg (energy to protein ratio of about 153 kcal ME_N/1% crude protein). Finisher mixtures administered to the chickens from day 35 did not differ from the equivalent grower mixtures, yet they did not contain kokcydiostatics. The chickens were fed and watered *ad libitum*. Feed utilization was recorded during the experiment, the chickens fed experimental mixture showed about a 10% increase in food intake.

Feed mixtures used in feeding the birds in the control group were purchased, whereas the experimental mixtures of reduced energetic value had been prepared on the basis of ground and extracted meals.

The chickens in both groups were weighed individually on the 42nd day of the experiment, which was the last day for control broilers. On this basis the selection of birds for dissection was carried out. In the experimental group, starting with day 42, 10 randomly selected birds were weighed every day, which aimed at establishing a slaughter weight comparable with the value obtained on the 42nd day of fattening for the chickens from the control group. After 47 days, chickens were slaughtered and dissected.

On the last day of fattening all the chickens of a particular group were weighed, which was followed by selecting 8 birds, – 4 ♂ and 4 ♀, with the body weight similar to the mean value for each sex in the group, for further investigation. The birds selected for dissection were not fed for 10 hours, but their access to water was not limited. Next, they were slaughtered and subjected to a simplified dissection analysis (18). Liver, heart and pericardiac fat were taken for analysis and their natural weight was determined. On the basis of direction results the share of giblets (heart and liver) in chilled poultry meat was calculated.

The content of dry matter, crude ash, total protein and crude fat were determined for heart and liver. The chemical composition was determined with the use of standard methods (1).

The results obtained were subject to a statistical analysis, using Statistica Version 5, with ANOVA single-factor variance test, adopting 0.01 as significance level ($p \leq 0.01$). Significance of differences between means was determined by Tukey's test.

Results and discussion

The body weight of the chickens fed a mixture of reduced energetic value and the chickens from the control group was similar (tab. 1). In the dissection analysis and during the investigation of the chemical composition of the muscles and giblets no danger of significantly varied body weight occurred, which could affect the value (17). Significant differences were observed, however, between the sexes in both groups. Roosters reached higher body weight than hens, which, according to Śliwa and Radzki (13), results from the systemic distinctness affected by sex and growth hormones. The same interrelation was noted by Waldroup et al. (16).

Administering the experimental mixture to chickens did not result in any significant changes in the weight of the heart muscle or in its share in the body weight in comparison with the control group (tab. 1). The results obtained were similar. The values of the assessed heart parameters in the authors' studies vary from the results obtained by Książkiewicz (8), who, as a result of using feed mixtures of decreased energetic value, noted a lower heart weight in the chickens.

Tab. 1. Effect of sex and feed mixture on body and heart weight (g), share of in the body weight and chemical composition (%)

Group – age (day)	Sex	Body weight (g)	Heart weight (g)	Pericardiac fat weight (g)	Share of giblets (%)	Share of heart in the body weight (%)	Dry matter (%)	Crude ash (%)	Crude protein (%)
K-42	♂	2587.51^a	11.10	0.89^a	2.56	0.42^a	23.99	1.23	18.14
	♀	2275.00^b	12.07	2.34^b	2.69	0.53^b	24.13	1.26	18.45
	$\bar{x}$	2431.2 ± 173.1	11.59 ± 0.77	1.61^a ± 0.85	2.62 ± 0.09	0.48 ± 0.06	24.06 ± 0.50	1.25 ± 0.04	18.30 ± 0.84
D-47	♂	2562.50^a	11.12	0.71^a	2.73^a	0.43^a	23.49	1.19	17.71
	♀	2225.00^b	12.10	1.05^b	2.41^b	0.54^b	23.03	1.19	17.24
	$\bar{x}$	2393.7 ± 186.0	11.61 ± 0.81	0.88^b ± 0.47	2.58 ± 0.02	0.49 ± 0.06	23.26 ± 1.73	1.19 ± 0.03	17.47 ± 0.57
Effect of sex		*	NS	*	*	* (D-47)	NS	NS	NS
Effect of feed mixture		NS	NS	*	NS	NS	NS	NS	NS

Explanations: a, b means with different superscript letters differ significantly at $p \leq 0.01$; * – $p \leq 0.01$; NS – not significant

Significant differences in the share of the heart and the weight of pericardiac fat were affected by the chickens' sex (tab. 1). In both groups hens had a significantly higher share of the heart in the total body weight, compared to roosters. Decreasing the energetic value of the mixtures led to as much as a 45% reduction of the weight of pericardiac fat.

Including an experimental factor in feed mixtures did not affect the liver weight (tab. 2). Janocha's et al. (7) studies revealed a higher liver weight resulting from the use of a mixture of increased energetic value. A similar opinion is presented by other authors (3, 14). The results obtained can be explained by a different length of the fattening period of the chickens. In the authors' studies, the fattening period of experimental chickens lasted until the moment when the birds reached the same slaughter weight as the chickens in the control group and, consequently, an approximately comparable weight of internal organs. In Książkiewicz's (8) experiment the fattening periods finished at the same time, which must have been reflected in the results obtained.

Tab. 2. Effect of sex and feed mixture on liver weight of the chicken (g), share in the body weight and chemical composition (%)

Group – age (day)	Sex	Liver weight	Share of liver in the body weight	Dry matter	Crude ash	Crude fat	Crude protein
K-42	♂	55.15	2.13	31.84[a]	1.57[a]	4.04	21.44
	♀	49.52	2.17	27.99[b]	1.39[b]	4.10	21.53
	$\bar{x}$	52.34 ± 7.07	2.15 ± 0.25	29.92 ± 3.49	1.48[a] ± 0.17	4.07[a] ± 0.51	21.49 ± 1.08
D-47	♂	58.87[a]	2.30[a]	27.07	1.35	3.57	19.90
	♀	41.65[b]	1.87[b]	27.57	1.36	3.76	20.75
	$\bar{x}$	50.26 ± 9.37	2.08 ± 0.24	27.32 ± 0.68	1.36[b] ± 0.06	3.67[b] ± 0.05	20.33 ± 2.72
Effect of sex		* (D-47)	* (D-47)	* (K-42)	* (K-42)	NS	NS
Effect of feed mixture		NS	NS	NS	*	*	NS

Explanations: as in tab. 1

The assessed liver weight and its share in the body weight of the hens fed the experimental diet was lower than in the roosters (tab. 2).

The energetic value of feed mixtures used in chickens' nutrition significantly modify the chemical composition of the chickens' liver. However, it was observed that the use of the experimental diet of reduced energetic value (19% of total protein and 2900 kcal EM per 1 kg) resulted in a decreased content of assessed crude ash and crude fat in comparison to the content of these components in the liver of the chickens fed a standard mixture (19.5% of total protein and 3200 kcal EM per 1 kg). Moreover, a higher content of the dry matter and crude ash was observed in the livers of the roosters, compared to the hens, in the group fed the control diet.

Unfortunately, the available bibliography does not offer any data that could clearly indicate in what way the grower mixture of reduced energetic value affects the amount of fat and the chemical composition of the heart and the liver in broiler chickens.

The essential problem in chicken fattening is the ability to maintain the adequate balance between production parameters, such as body weight gain, and the use of feeds, and the quality properties – the amount of fat in poultry meat. That is why special attention should be paid to proper nutrition of the chickens, which should be based on providing the appropriate concentration of nutritional components in the mixture, depending on its metabolic energy content, in order to avoid excessive fat content in the chickens and, consequently, to protect them against numerous diseases.

References

1. AOAC: Official Methods of Analysis. Association of Official Analytical Chemist's. 16 Edition, Arlington, 1995, VA.
2. *Azman M. A., Çerçi I. H., Birben N.*: Effects of various dietary fat sources on performance and body fatty acid composition of broiler chickens. Turk. J. Vet. Anim. Sci. 2005, 29, 811-819.
3. *Banaszkiewicz T.*: Effect of double low rapeseed on slaughter value and abdominal composition of broiler chickens. Rośliny Oleiste 1995, 16, 413-422.
4. *Barteczko J.*: Badania nad metabolizmem energii kurcząt brojlerów. Zesz. Nauk. AR Kraków. Rozprawy 2003, 288, 1233-4189.
5. *Gandemer G.*: Lipid and meat quality: lipolysis, oxidation, Maillard reaction and flavour. Sci. Aliments 1999, 19, 439-458.
6. *Jankowski J., Malinowski R., Majewska T.*: The effect of energy content in the diet on the performance of broiler chicks. Zesz. Nauk. Przegl. Hod. Chów i Hodowla Drobiu 1998, 36, 399-401.
7. *Janocha A., Osek M., Klocek B., Krasuska Z.*: Rape seeds of low glucosinolate var. Leo as an energy source in mixtures for chickens. Rośliny Oleiste 1998, 19, 543-554.
8. *Książkiewicz J.*: Wpływ żywienia roślinnymi mieszankami paszowymi o zmniejszonej zawartości białka ogólnego i energii metabolicznej na cechy reprodukcyjne kaczek. Zesz. Nauk. Drob. 1993, 8, 87-95.
9. *Menge E. O., Kosgey I. S., Kahi A. K.*: Bio-economic model to support breeding of indigenous chicken in different production systems. Int. J. Poult. Sci. 2005, 4, 827-839.
10. *Moghadam H. K., McMillan I., Chambers J. R., Julian R. J., Tranchant C. C.*: Heritability of sudden death syndrome and its associated correlations to ascites and body weight in broilers. Br. Poultry Sci. 2005, 46, 54-57.
11. *Musa H. H., Chen G. H., Cheng J. H., Shuiep E. S., Bao W. B.*: Breed and sex effect on meat quality of chicken. Internat. J. Poultry Sci. 2006, 5, 566-568.
12. *Szkucik K., Pisarski R. K., Paszkiewicz W., Pijarska L.*: Jakość tuszek, skład chemiczny i cechy sensoryczne mięsa kurcząt brojlerów żywionych mieszanką o zmniejszonej wartości energetycznej. Medycyna Wet. 2009, 3, 184-187.
13. *Śliwa E., Radzki R.*: The resistance and resilience changes in the limb bones of broiler chickens during the first 10 weeks of life. Medycyna Wet. 1995, 51, 287-289.
14. *Świerczewska E., Niemiec J., Mroczek J., Siennicka A., Grzybowska A., Grochalska D.*: Wpływ żywienia kurcząt mieszankami różniącymi się zawartością białka na wyniki produkcyjne, skład tkankowy tuszek i skład chemiczny mięsa. Zesz. Nauk. Prz. Hod. 2000, 49, 365-369.
15. *Tamagaki T., Sawada S., Imamura H., Tada Y., Yamasaki S., Toratani A., Sato T., Komatsu S., Akamatsu N., Yamagami M., Kobayashi K., Kato K., Yamamoto K., Shirai K., Yamada K., Higaki T., Nakagawa K., Tsuji H., Nakagawa M.*: Effects of high-density lipoproteins on intracellular pH and proliferation of human vascular endothelial cells. Atherosclerosis 1996, 123, 73-82.
16. *Waldroup P. W., Tidwell N. M., Izat A. L.*: The effects of energy and amino acid levels on performance and carcass quality of male and female broilers grown separately. Poultry Sci. 1990, 69, 1513-1521.
17. *Wójcik S., Plaur K.*: Wpływ wartości energetycznej i poziomu białka w mieszankach na ilość i skład tłuszczu zapasowego kurcząt rzeźnych. Rocz. Nauk Rol. 1986, 103, 67-75.
18. *Ziołecki J., Doruchowski W.*: Metoda oceny wartości rzeźnej drobiu. Wyd. COBRD, Poznań 1989.

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