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The effect of herbs on the share of abdominal fat and its fatty acid profile in broiler chickens

Wpływ dodatku ziół na udział tłuszczu sadełkowego i profil kwasów tłuszczowych w tłuszczu sadełkowym kurcząt brojlerów

Summary. In the experiment involving 210 ROSS broiler chickens, divided at random into one control (C) and 6 experimental groups (1–6), the effect of substituting 2% of dried herbs for AGP (flavomycin) on the weight and share of abdominal fat and its FA profile was studied. The herbs fed to experimental broilers were as follows: 1. hop cone, 2. lime tree, 3. lemon balm, 4. pansy, 5. peppermint and/or 6. nettle. Compared to the AGP, pansy, peppermint and/or nettle substituted for AGP significantly decreased the weight and share of abdominal fat in broiler chickens, whereas the beneficial effect on its weight was shown only for the lime tree. It was noted that every examined herb improved the UFA/SFA proportion. Hop cone remarkably increased the sum of MUFA and lowered the sum of PUFA in abdominal fat, compared to AGP. Hop cone and lime tree were the only herbs which had an adverse effect on PUFA n-6/PUFA n-3 proportion in broilers' abdominal fat.

Key words: broiler chickens, fatty acids, abdominal fat, herbs

INTRODUCTION

The ban on antibiotic growth promoters (AGP) in animal nutrition turned and increased the attention to herbs as a feed supplement. For the centuries herbs are believed to possess plenty of valuable, however frequently absolutely different traits. Due to a high content and diversity of bioactive constituents, spectrum of herbs' activity can be very broad. It seems that herbs can become a significant dietary supplement, especially in poultry (due to rapid metabolism and as a consequence high nutritional requirements), since it was reported that apart from the numerous beneficial effects of herbs, e.g. the increment of immunity, weight gain, feed conversion and stress tolerance, the changes in carcass composition were also noted [Faruga and Pudyszak 1997, Wężyk *et al*. 2000, Czaja and Gornowicz 2004].

The investigations dealing with carcass composition usually focus on the edible parts, what is justifiable from a human-consumer standpoint. The abdominal fat is not an edible part of carcass, however it perfectly reflects and brings into relief the changes occurring in intramuscular fat, which predestines the abdominal fat as a subject of presented research, focusing on the effect of hop cone (*Humulus lupulus* L.), lime tree *(Tilia cordata* L.), lemon balm *(Melissa officinalis* L.), pansy (*Viola tricolor* L.), peppermint *(Mentha piperita* L.) and nettle (*Urtica dioica* L.) on the weight and share of abdominal fat in chilled carcass and on its fatty acid profile as well.

MATERIAL AND METHODS

The experiment was carried out on 210 ROSS broiler chickens divided at random into 7 groups (1 control and 6 experimental groups), 3 replications each. The rearing period lasted 42 days and the birds were kept in cages, under regular environmental conditions. All the chickens were fed *ad libitum* granulated compound feeds, respectively starter 1st through 10th day, grower 11th through 35th day and finisher 36th through 42nd day. Chickens were provided with an unlimited access to drinking water.

Table 1. Experimental design
Tabela 1. Układ metodyczny

Group Grupa	Experimental factor Czynnik doświadczalny
C	premix with AGP – dried green forage 2% premiks z antybiotykiem – susz z zielonek 2%
1	premix without AGP – dried hop cone 2 % premiks bez antybiotyku – susz z chmielu 2%
2	premix without AGP – dried lime tree 2% premiks bez antybiotyku – susz z lipy 2%
3	premix without AGP – dried lemon balm 2% premiks bez antybiotyku – susz z melisy 2%
4	premix without AGP – dried pansy 2% premiks bez antybiotyku – susz z bratka 2%
5	premix without AGP – dried peppermint 2% premiks bez antybiotyku – susz z mięty 2%
6	premix without AGP – dried nettle 2% premiks bez antybiotyku – susz z pokrzywy 2%

Starting the first day of experiment (1st day of rearing) the broilers were fed according to the experimental design (Tab. 1). The compound feed fed to the control group (C) contained AGP (flavomycin), whereas in the experimental feeds 2% of dried herbs were substituted for AGP. The herbs were derived from Herbapol Lublin S.A. and they were a waste product, however of a full biological value. The herbs were free from both organic and mineral contaminants. In order to elude the effect of herbal crude fibre *per se* on the results of experiment, the control mixture (with AGP) was supplemented with 2% of dried regular green forage. The composition of feeds is given in Tab. 2.

Table 2. Formulas of compound feeds (%)
Tabela 2. Receptury mieszanek paszowych (%)

Ingredients – Komponenty	Starter		Grower – Finisher	
	C	1–6	C	1–6
Corn. Ground – Śruta kukurydziana	55.5	55.5	59.0	59.0
Soybean solvent, meal – Śruta sojowa poekstrakcyjna	33.0	33.0	28.0	28.0
Green forage, meal – Mączka z suszu zielonek	2.0	-	2.0	-
Herbs meal * – Mączka z ziół *	-	2.0	-	2.0
Soybean oil – Olej sojowy	3.0	3.0	4.0	4.0
Dicalcium phosphate – Fosforan 2-Ca	1.5	1.5	2.0	2.0
DicaLimestone – Kreda pastewna	1.5	1.5	1.5	1.5
NaCl	0.5	0.5	0.5	0.5
Premix with AGP – Premiks z antybiotykiem	1.0	-	1.0	-
Premix without AGP – Premiks bez antybiotyku	-	1.0	-	1.0
Nutritive value per 1kg – Wartość pokarmowa 1 kg				
Metabolizable energy, kcal – Energia metaboliczna, kcal	3045	3042	3114	3114
Crude protein, g – Białko ogólne, g	214.1	214.1	194.2	194.2
Crude fibre, g – Włókno surowe, g	34.3	34.3	33.3	33.3

* in experimental compound feeds respectively: 1. hop cone, 2. lime tree, 3. lemon balm, 4. pansy, 5. peppermint, 6. nettle – w mieszankach doświadczalnych odpowiednio: 1. chmiel, 2. lipa, 3. melisa, 4. bratek, 5. mięta, 6. pokrzywa

On the very last day of rearing, 8 broilers from each group (4 cockerels and 4 hens of a body weight as close to average as possible) were selected and sacrificed after 10 h lasting starvation (with free access to drinking water). The sacrificed broiler submitted to the simplified carcass analysis by Ziołecki and Doruchowski [1989]. During the dissection abdominal fat was excised, weighed with the accuracy +/- 1g and than it was frozen (-18^{o}C) untill the fatty acid (FA) profile examination. FA profile was established by the gas chromatography (GC) method using VARIAN CP 3800 with a 60 metres column.

All the experimental data underwent multiple analysis of variance.

RESULTS

Substituting dried herbs for an antibiotic growth promoter differentiated broiler chickens' body weight and consequently affected the weight of abdominal fat (Tab. 3). Compared to the control group, the addition of 2% of dried lime tree, pansy, peppermint and/or nettle decreased significantly ($p \leq 0.01$) the weight of abdominal fat. Furthermore, it should be emphasized that almost all the herbs (except lime tree) also lowered the share of abdominal fat in chilled carcass. The differences between the groups were substantial and they ranged from 20% (peppermint) through 35% (nettle). It should be noted, however, that hop cone and lemon balm did not decrease the weight of abdominal fat significantly, and the hop cone, lemon balm and lime tree had no positive effect on the share of abdominal fat in chilled carcass. Furthermore, none of the herbs had an adverse effect on the investigated results, what predestines them to stand in for AGP.

Table 3. The weight (g) and the share (%) of abdominal fat in chilled carcass
Tabela 3. Masa tłuszczu sadełkowego (g) i jego udział w tuszce schłodzonej (%)

Characteristic Cecha	Group – Grupa						
	C	1 hop cone chmiel	2 lime tree lipa	3 lemon balm melisa	4 pansy bratek	5 pepper mint mięta	6 nettle pokrzywa
Weight Waga	21.7^{ACa}	21.1^{ACa}	17.0^{B}	24.1^{Cc}	17.1^{B}	17.5^{B}	16.8^{B}
Share Udział	2.0^{AB}	2.3^{A}	1.8^{BC}	2.0^{AB}	1.5^{CD}	1.6^{CD}	1.3^{D}

A, B... – differences significant at $p \leq 0.01$; a, b... – differences significant at $p \leq 0.05$
A, B... – różnice istotne przy $p \leq 0.01$; a, b... – różnice istotne przy $p \leq 0.05$

Table 4. Fatty acid profile of the abdominal fat and proportions of SFA, MUFA, PUFA and PUFA n-6 and PUFA n-3 (percentage of sum)
Tabela 4. Profil tłuszczu sadełkowego i proporcje SFA, MUFA, PUFA oraz PUFA n-6 i PUFA n-3 (% sumy)

Fatty acid – Group Kwas tłuszczowy – Grupa	C	1	2	3	4	5	6
C14:0	0.42^{A}	0.43^{A}	0.40^{AB}	0.41^{AB}	0.38^{B}	0.40^{AB}	0.39^{AB}
C16:0	18.22	18.09	17.48	17.84	16.99	17.08	17.45
C16:1	3.30^{A}	3.96^{C}	3.39^{A}	3.24^{A}	2.84^{B}	3.04^{AB}	2.64^{B}
C18:0	5.96^{AC}	5.24^{B}	6.00^{AC}	5.64^{C}	6.13^{A}	5.86^{AC}	5.87^{AC}
C18:1	47.87^{A}	52.92^{B}	49.29^{C}	48.87^{AC}	49.06^{AC}	48.71^{AC}	47.76^{A}
C18:2	20.39^{A}	16.28^{B}	20.03^{A}	19.99^{A}	20.62^{A}	20.63^{A}	21.41^{A}
C18:3	2.68^{A}	1.81^{B}	2.44^{A}	2.74^{A}	2.64^{A}	2.79^{A}	2.81^{A}
C20:0	0.13^{AB}	0.12^{AB}	0.13^{AB}	0.10^{B}	0.14^{A}	0.12^{AB}	0.15^{A}
C20:1	0.36^{A}	0.30^{A}	0.48^{AB}	0.53^{B}	0.62^{B}	0.59^{B}	0.66^{B}
C20:2	0.11^{A}	0.08^{B}	0.10^{A}	0.09^{AB}	0.09^{AB}	0.09^{AB}	0.10^{A}
C20:3	0.11^{AB}	0.11^{AB}	0.10^{A}	0.12^{B}	0.10^{A}	0.11^{AB}	0.11^{AB}
C20:4	0.05^{A}	0.19^{B}	0.08^{A}	0.08^{A}	0.01^{A}	0.02^{A}	0.19^{B}
MUFA	51.53^{A}	57.18^{B}	53.01^{Aa}	52.62^{A}	52.47^{A}	52.36^{A}	51.07^{Ab}
PUFA	23.00^{A}	18.46^{B}	22.74^{A}	22.75^{A}	23.47^{A}	23.63^{A}	24.60^{C}
PUFA/MUFA	0.45^{B}	0.32^{A}	0.43^{B}	0.43^{B}	0.45^{B}	0.45^{B}	0.48^{B}
UFA/SFA	3.01^{Aa}	3.15^{b}	3.16^{b}	3.14^{b}	3.24^{B}	3.24^{B}	3.17^{b}
PUFA n-6/PUFA n-3	7.60^{Aa}	8.99^{B}	8.21^{b}	7.29^{Aa}	7.81^{Aab}	7.39^{Aa}	7.62^{Aa}

A, B – differences significant $p \leq 0.01$; a, b – differences significant $p \leq 0.05$
A, B – różnice istotne statystycznie przy $p \leq 0.01$; a, b – różnice istotne przy $p \leq 0.05$

The obtained results reveal that every examined herb substituting for AGP decreased the share of saturated fatty acids (SFA) in broilers' abdominal fat. All the differences were significant at ($p \leq 0.01$). It was obvious that the share of unsaturated fatty acids (UFA) in abdominal fat increased significantly, however in this case the effect of herbs was neither so clear no univocal. Although the share of monounsaturated FA (MUFA) in the experimental broilers' abdominal fat (with the exception for group 6) was not lower,

compared to the control group, the only herb that increased MUFA significantly was hop cone. As a consequence, hop cone had an adverse effect on polyunsaturated FA (PUFA). The share of PUFA established in the relevant group was remarkably lower not only related to the control group but also compared to any other experimental one. On contrary, the influence of nettle was positive and beneficial; the share of PUFA in abdominal fat of the broilers fed this herb was significantly higher than in any other group (including control).

All the investigated herbs had positive effect on the UFA/SFA proportion (Tab. 4). The differences between groups of broilers fed pansy and/or peppermint and the control group were up to 8% ($p \leq 0.01$). On the other hand, the MUFA/PUFA proportion proved to be only slightly sensitive to substituted herbs for AGP. With respect to mentioned proportion, the only one group differing significantly, comparing to the control, was this in which hop cone was supplied. It was not, however, the change of desired direction since parallel massive worsening of PUFA-n6/PUFA-n3 was noted either. The deterioration of n-6/n-3 polyenoic FA relation was observed also with feeds supplemented with lime tree. The other herbs did not change this proportion significantly.

DISCUSSION

The research revealed that some of examined herbs can change the weight of abdominal fat effectively, which is beneficial, since this fat is not edible part of broiler carcass and furthermore, it decreases dressing percentage and as a waste product it must be considered as a environmental pollutant [Pikul 1996]. The positive effect was observed with respect to nettle, lime tree, pansy and/or peppermint. All the mentioned herbs with the only exception for lime tree also positively affected the share of abdominal fat in broiler' carcass. The lowest weight and the share of fat were noted in broilers given nettle. Observations dealing with this herb correspond with these by Zięba [2006]. It should be noticed that Fritz *et al*. [1999] proved also that nettle (fed to broilers as a water extract) lowered the share of abdominal fat. This result is undoubtedly caused by the high content of bioactive constituents in nettle, e.g. vitamins, organic acids, tannins, flavones, carotenes, chlorophyll, xanthophylls, amines, mucus and waxes [Milczarek-Szałkowska 1999, Chojnacka and Krześniak 2000].

Underlining-worthy is the influence of herbs supplementation on FA profile in abdominal fat in broilers. In every experimental group the share of SFA was lower, compared to the control group, what is beneficial (if valid also with respect to FA profile of edible parts of carcass, and there is no reason to presume it is not true) in the terms of dietetics. SFA contained in animal fat increase the blood cholesterol level [Przysławski and Bolesławska 2006] and they are to a greater extent responsible for occurrence of obesity, diabetes type II, cardio-vascular diseases and cancer as well [Kannel *et al*. 1979, WHO 1990]. In this context the examined herbs proved their desirable values.

The addition of every examined herb increased to a certain extent the share of MUFA in broiler chickens' abdominal fat, but hop cone was the only supplement causing significant difference, what corresponds to results obtained by Zięba [2006], dealing with the profile of monoenoic FA in breast muscles intramuscular fat. Unfortunately the increment of MUFA happened at the cost of PUFA, instead of SFA. It seems to be a specific reaction to about 30 compounds of hop cone [Anioł-Kwiatkowska 1993].

The share of PUFA in abdominal fat was positively affected by the nettle supplementation, which significantly ($p \leq 0.01$) increased the pool of polienoic FA related to the control group. Among PUFA. The fatty acids of a special importance are: linoleic and α-linolenic acids, recognized as essential (EFA). They are necessary in a human diet and act as precursors of some metabolites responsible for correct functions of an organism [Crowford *et al*. 1989, Zölner and Tató 1992].

The results of research reveals that the most of examined herbs doesn't change the PUFA n-6/PUFA n-3 proportion, and these which show significant activity like hop cone and lime tree operate in undesirable direction. According to Gertig and Przysławski [2007] in a properly balanced human' diet the proportion of n-6 to n-3 FA should equal 5, whereas Wood and Ensner [1997] establish it as not higher than 4. With the proportion higher than 10, the n-6 FA content is usually substantial (especially with respect to linoleic acid) and the content of n-3, mainly linolenic acid is too low. Comparing own results with the quoted requirements one can state that the PUFA n-6/PUFA n-3 proportion is lower than 10, however it's value is too high in both control and experimental broilers.

CONCLUSIONS

1. Supplements of pansy, peppermint and/or nettle substituted for AGP significantly decrease the weight and share of abdominal fat in broiler chickens, whilst lime tree declines only its weight.

2. Every examined herb improved the UFA/SFA proportion.

3. Hop cone substituted for antibiotic increased remarkably the sum of MUFA and lowered the sum of PUFA in abdominal fat whilst nettle increased PUFA profile significantly, compared also to other examined herbs.

4. Supplements of hop cone and/or lime tree worsened significantly PUFA n-6/PUFA, n-3 proportion in broilers' abdominal fat.

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Streszczenie. Doświadczenie obejmujące 210 sztuk brojlerów typu ROSS, podzielonych losowo na 1 grupę kontrolną (C) i 6 grup doświadczalnych (1–6) przeprowadzono w celu określenia wpływu zastąpienia AGP (flawomycyny) dodatkiem 2% suszu z ziół na masę i udział tłuszczu sadełkowego oraz profil jego kwasów tłuszczowych. Zioła podawano w grupach doświadczalnych zgodnie z układem: chmiel, lipa, melisa, bratek, mięta i/lub pokrzywa. W porównaniu z AGP bratek, mięta i/lub pokrzywa znacząco obniżyły masę i udział tłuszczu sadełkowego kurcząt brojlerów, podczas gdy lipa wykazała korzystny wpływ jedynie na masę tłuszczu sadełkowego. Zaobserwowano, że wszystkie zastosowane zioła polepszyły stosunek kwasów UFA/SFA. W porównaniu z AGP chmiel podwyższył znacząco sumę kwasów MUFA i obniżył sumę kwasów PUFA w tłuszczu sadełkowym. Chmiel i lipa jako jedyne wywołały niekorzystny wpływ na proporcje kwasów PUFA n-6/PUFA n-3 w tłuszczu sadełkowym kurcząt brojlerów.

Słowa **kluczowe**: kurczęta brojlery, kwasy tłuszczowe, tłuszcz sadełkowy, zioła