ACTA SCIENTIARUM POLONORUM *Acta Sci. Pol., Zootechnica 10 (4) 2011, 41–52*

EVALUATION OF AN IMPACT OF MIXTURES CONTAINING BREWER'S YEAST *SACCHAROMYCES CEREVISIAE* ON POST-SLAUGHTER QUALITY OF BROILER CHICKENS

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Abstract. The study assessed an influence of broiler chicken feeding mixtures characterized by a different share of brewer's yeast on post-slaughter effects of birds and the quality of their meat. It was found that the control group chickens and the birds fed mixtures in which 11 and 18% soybean protein was replaced with yeast protein obtained better slaughter performance, better musculature, and lower carcass fatness than the birds which was receipting mixtures with more yeast. An introduction of yeast in mixtures increased the crude fat content in both breast and thigh muscles. An application of mixtures with a higher share of yeast protein unfavourably influenced the composition of fatty acids of meat lipid fraction, mainly the amount of PUFA. Mixtures including brewer's yeast beneficially influenced the flavour attributes of red and white meat.

Keywords: broiler chickens, brewer's yeast, meat quality, post-slaughter results

INTRODUCTION

Yeast belongs to microogranisms which are more frequently used by modern biotechnological and agricultural and food industries [Barnett et al. 2000]. They are also universally utilized by feed, biopharmaceutical and chemistry industries [Ułaszewski 1994, Jakobsen and Narvhus 1996]. The most popular are cultures of *Saccharomyces cerevisiae* used to produce baking, wine and brewing yeast as well as feed yeast and yeast-like products [Ryszka et al. 2002, Vasudevan et al. 2002, Dobrzański et al. 2006]. Yeast and yeast-derived products are used directly in animal feeding as components of feeds, premixes, probiotics and prebiotics [Świątkiewicz i Koreleski 2007, Janocha et al. 2010]. It is believed that, as feed antibiotics have been banned since 1st Jan 2006, yeast and yeast-derived products may, to some extent, substitute them though views on the issue are ambiguous [Erasmus et al. 2005, Linge 2005, Śliżewska et al. 2006]. The nutritive value of yeast depends on its chemical composition, which in turn is conditioned by production technology, kinds of cultures used and substrates.

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The research aimed at determining the effect of mixtures with various proportions of brewing yeast *Saccharomyces cerevisiae* on post-slaughter value and quality of broiler chickens.

MATERIAL AND METHODS

An experiment included 120 Ross 308 broiler chickens which were divided into three groups (K, D5, D15), 40 birds of both sexes in each group (5 replications × 8 birds). The chickens were grown for 42 days and kept in metal cages under standard conditions with an unlimited access to water and feed. The birds were fed Starter mixtures up to 21 days of age and then Grower mixtures were applied from the 22nd to 42nd day of age. The mixtures were produced on the basis of corn, wheat, soybean oil meal, soybean oil and mineral-vitamin additives. In the mixtures for group D5 chickens 11% (Starter) and 18% (Grower) soybean protein was replaced with brewer's yeast protein. Chemical composition of brewing yeast is presented in Table 1.

Table 1. Chemical composition of brewer's yeast *Saccharomyces cerevisiae*
Tabela 1. Skład chemiczny drożdży piwowarskich *Saccharomyces cerevisiae*

Specification – Wyszczególnienie	Content – Zawartość $g \cdot kg^{-1}$
Dry matter – Sucha masa	929.4
Crude protein – Białko ogólne	410.5
Crude fat – Tłuszcz surowy	20.0
Crude fibre – Włókno surowe	–
Crude ash – Popiół surowy	66.0
N-free extractives – Bez – N wyciągowe	432.9
Gross energy, $MJ \cdot kg^{-1}$ – Energia brutto, $MJ \cdot kg^{-1}$	17.92

The mixtures applied in group D15 feeding contained 40 and 50% yeast protein in Starter and Grower mixtures, respectively. The mixture recipes were balanced according to the requirements included in Nutrient Requirements of Poultry [2005], so as to make sure they are isoenergetic and isoprotein diets. The composition and nutritive value of the feed mixtures are presented in Tables 2, 3. After rearing termination 8 birds (4 males and 4 females) from each feeding group were chosen for slaughter. After evisceration the carcasses were cooled in 0–4ºC for 24 h. Next, they were divided according to the methodology specified by Ziołecki and Doruchowski [1989]. Samples of breast and thigh muscles were taken to determine the contents of basic nutrients according to AOAC [1990], the composition and share of individual fatty acids in the lipid fraction, as well as sensory assessment. An analysis of fatty acids composition in muscle lipids was performed according to the technique of gas chromatography of methyl esters on a CHROM-5. The assessment of breast and thigh muscles was carried out by a group of eight people who followed the methodology provided by Baryłko-Pikielna [1975]. The results obtained were

statistically analysed by means of one-factor analysis of variance and the Duncan's new multiple range test was applied in order to detect significant differences between means (Statsoft®2001).

Table 2. Materials and feed additives of feed starter mixtures and their feeding value ($g \cdot kg^{-1}$)
Tabela 2. Materiały paszowe mieszanek starter (%) i wartość pokarmowa ($g \cdot kg^{-1}$)

Specification – Wyszczególnienie		K	D5	D15
Materials and feed additives – Materiały i dodatki paszowe				
ground maize – śruta kukurydzy		23.00	27.00	22.00
ground wheat – śruta pszenicy		31.20	26.00	31.00
soybean meal – poekstrakcyjna śruta sojowa		36.00	32.30	22.30
soya oil – olej sojowy		6.00	6.00	6.00
brewer's yeast – drożdże piwowarskie		–	5.00	15.00
limestone – kreda pastewna		0.75	0.70	0.60
dicalcium phosphate – fosforan dwuwapniowy		2.00	2.00	2.10
NaCl		0.35	0.30	0.30
vitamin-mineral premix[1] – premiks witaminowo-mineralny[1]		0.50	0.50	0.50
DL-methionine (99%) – DL-metionina (99%)		0.15	0.15	0.15
L-lysine (99%) – L-Lizyna (99%)		0.05	0.05	0.05
Nutrients in kg mixtures – Składniki pokarmowe w 1 kg mieszanki				
metabolizable energy – energia metaboliczna	MJ	12.52	12.70	12.81
crude protein – białko ogólne	g	216	218	218
crude fibre – włókno surowe	g	39.5	36.7	31.6
lysine – lizyna	g	12.0	12.2	12.4
methionine – metionina	g	5.5	5.5	5.6
total Ca – Ca ogólny	g	9.3	9.4	9.6
available phosphorus – fosfor przyswajalny	g	4.4	4.5	4.2
Na	g	1.6	1.6	1.6

[1] Premix in 1 kg starter diet contained: vit. A 12 500 IU; vit. D_3 3000 IU; vit. E 50 mg; vit. K 3 mg; vit. B_1 2.5 mg; vit. B_2 8 mg; vit. B_6 5 mg; vit. B_{12} 0.02 mg; nicotinic acid 45 mg; calcium panthotenate 15 mg; biotin 0.2 mg; choline chloride 400 mg; folic acid 1.5 mg; Fe 50 mg; Mn 80 mg; Zn 60 mg; Cu 9 mg; I 0.75 mg; Co 0.3 mg; Se 0.25 mg, antioxidant and coccidiostat.
[1] Premiks w 1 kg diety starterowej zawierał: wit. A 12500 IU; wit. D_3 3000 IU; wit. E 50 mg; wit. K 3 mg; wit. B_1 2,5 mg; wit. B_2 8 mg; wit. B_6 5 mg; wit. B_{12} 0,02 mg; kwas nikotynowy 45 mg; pantotenian wapnia 15 mg; biotyna 0,2 mg; chlorek choliny 400 mg; kwas foliowy 1,5 mg; Fe 50 mg; Mn 80 mg; Zn 60 mg; Cu 9 mg; I 0,75 mg; Co 0,3 mg; Se 0,25 mg; przeciwutleniacz i kokcydiostatyki.

Table 3. Materials and feed additives of feed grower mixtures and their feeding value (g · kg^{-1})
Tabela 3. Materiały paszowe mieszanek grower (%) i wartość pokarmowa (g · kg^{-1})

Specification – Wyszczególnienie		K	D5	D15
Materials and feed additives – Materiały i dodatki paszowe				
ground maize – śruta kukurydzy		27.00	27.00	27.00
ground wheat – śruta pszenicy		31.90	32.30	32.30
soybean meal – poekstrakcyjna śruta sojowa		31.50	26.00	16.00
soya oil – olej sojowy		6.00	6.00	6.00
brewer's yeast – drożdże piwowarskie		–	5.00	15.00
limestone – kreda pastewna		0.70	0.70	0.75
dicalcium phosphate – fosforan dwuwapniowy		1.90	2.00	2.00
NaCl		0.35	0.35	0.30
vitamin-mineral premix[1] – premiks witaminowo-mineralny[1]		0.50	0.50	0.50
DL-methionine (99%) – DL-metionina (99%)		0.15	0.15	0.15
Nutrients in kg mixtures – Składniki pokarmowe w 1 kg mieszanki				
metabolizable energy – energia metaboliczna	MJ	12.99	13.11	13.28
crude protein – białko ogólne	g	199	200	201
crude fibre – włókno surowe	g	37.8	34.9	31.2
lysine – lizyna	g	11.5	11.6	11.7
methionine – metionina	g	5.2	5.2	5.3
total Ca – Ca ogólny	g	9.2	9.3	9.4
available phosphorus – fosfor przyswajalny	g	4.0	4.1	4.2
Na	g	1.7	1.7	1.7

[1] Premix in 1kg grower diet contained: vit. A 11 000 IU; vit. D_3 2500 IU; vit. E 40 mg; vit. K 2.5 mg; vit. B_1 2 mg; vit. B_2 7 mg; vit. B_6 4 mg; vit. B_{12} 0.02 mg; nicotinic acid 40 mg; calcium panthotenate 12.5 mg; biotin 0.15 mg; choline chloride 300 mg; folic acid 1.0 mg; Fe 45 mg; Mn 70 mg; Zn 55 mg; Cu 7.5 mg; I 0.6 mg; Co 0.25 mg; Se 0.2 mg, antioxidant and coccidiostat.
[1] Premiks w 1 kg diety growerowej zawierał: wit. A 11000 IU; wit. D_3 2500 IU; wit. E 40 mg; wit. K 2,5 mg; wit. B_1 2 mg; wit. B_2 7 mg; wit. B_6 4 mg; wit. B_{12} 0,02 mg; kwas nikotynowy 40 mg; pantotenian wapnia 12,5 mg; biotyna 0,15 mg; chlorek choliny 300 mg; kwas foliowy 1,0 mg; Fe 45mg; Mn 70 mg; Zn 55 mg; Cu 7,5 mg; I 0,6 mg; Co 0,25 mg; Se 0,2 mg; przeciwutleniacz i kokcydiostatyk.

RESULTS AND DISCUSSION

The slaughter analysis of carcasses (Table 4) showed that group D5 chickens, fed mixtures with a lower share of brewer's yeast protein, were characterized by a significantly ($P \leq 0.05$) higher slaughter performance (74.72%) than the birds of the group D15. In turn, the replacement of 40 and 50% of soybean protein with yeast protein decreased group D15 birds' musculature, which is indicated by significantly ($P \leq 0.05$) lower share of muscles in the cooled carcass (by 6–7%), in particular breast muscles (by 9–10%), compared to group K and D5 chickens. Group D15 chickens were at the same time more fatty, which

is illustrated by a significantly (P≤0.05) higher share of abdominal fat (by 25%) and skin with subcutaneous fat (by 14%) compared to the control group birds. The results of carcass dressing percentage were close to the optimum values for Ross hybrids with body weights above 2 kg (Parameters 2002). Janocha and Osek [2006] applied cereal-soybean mixtures with an addition of protein preparation HP 300 as a soybean protein substitute in the amounts of 50 and 40%, and obtained a similar slaughter performance (74.34%, respectively) and muscle content in the carcass (44.13%, respectively) compared to the results for group D5 birds. Similar research values were obtained after applying a considerably smaller amount of soybean substitute (brewer's yeast). Mikulski et al. [2006] used dried yeast in mixtures for broiler chickens (5/7.8%) and demonstrated that slaughter value (70.5%) was much lower than the findings reported in the present study. Similarly, Paryad and Mahmoudi [2008] found that slaughter value was lower (71.8%) in chickens fed the yeast-based diet.

The results reflecting adiposity do not correspond with the findings of other authors Zhang et al. 2004, Zhang et al. 2005, Paryad and Mahmoudi 2008] who reported significant reduction in abdominal fat and skin with subcutaneous fat in chickens offered diets containing yeast.

Table 4. Results of slaughter analysis of broiler chickens
Tabela 4. Wyniki analizy rzeźnej kurcząt brojlerów

Specification – Wyszczególnienie	Group – Grupa			SEM
	K	D5	D15	
Body weight before slaughter, g Masa ciała przed ubojem, g	2079^{a}	2035^{ab}	1937^{b}	37.69
Cold weight carcass, g Masa tuszki schłodzonej, g	1525^{a}	1520^{ab}	1410^{b}	38.51
Dressing percentage, % Wydajność rzeźna, %	73.35^{ab}	74.72^{a}	72.79^{b}	0.74
Share in cold carcass, % Udział w tuszce schłodzonej, %				
Muscles total Mięśnie ogółem	44.81^{a}	44.19^{a}	41.56^{b}	0.63
including – w tym				
breast – piersiowe	23.00^{a}	22.70^{a}	20.68^{b}	0.50
thigh – udowe	12.63	12.78	12.02	0.45
drumstick – podudzi	9.18	8.71	8.86	0.18
Abdominal fat Tłuszcz sadełkowy	2.20^{b}	2.18^{b}	2.76^{a}	0.18
Skin with subcutaneous fat Skóra z tłuszczem podskórnym	13.65^{b}	13.37^{b}	15.57^{a}	0.56

A, B – significante of difference at P≤0.01 – A, B – różnice istotne na poziomie P≤0,01.
a, b – significante of difference at P≤0.05 – a, b – różnice istotne na poziomie P≤0,05.

The kind of mixture applied significantly differentiated the white and read meat chemical composition (Table 5 and 6).

In breast muscles (Table 5) of chickens fed the mixtures containing a higher share of yeast protein (group D15) there were found significantly (P≤0.05) lower contents of dry matter, crude ash and crude protein than in the muscles of the control group of birds. However there was more crude fat than in the muscles of the remaining birds.

In red meat (Table 6) significant (P≤0.05) intergroup differences were found with respect to crude fat, the amount of which was the largest in the meat of the birds belonging to group D15 in which 40 and 50% of soybean protein was replaced with brewer's yeast protein. The results obtained correspond with the findings reported by Paryad and Mahmoudi [2008].

Table 5. Chemical composition of breast muscles (%) and fatty acid profile (% total FA)
Tabela 5. Skład chemiczny mięśni piersiowych (%) i udział kwasów tłuszczowych (% sumy KT)

Specification – Wyszczególnienie	Group – Grupa			SEM
	K	D5	D15	
Basal nutrient – Składniki pokarmowe				
Dry matter – Sucha masa	25.83^{a}	25.04^{ab}	24.63^{b}	0.20
Crude ash – Popiół surowy	1.17^{a}	1.17^{a}	1.14^{b}	0.01
Crude protein – Białko ogólne	23.34^{a}	22.81^{ab}	22.05^{b}	0.28
Crude fat – Tłuszcz surowy	1.21^{b}	1.13^{b}	1.41^{a}	0.06
Fatty acids – Kwasy tłuszczowe				
$C_{14:0}$	0.13	0.12	0.12	0.009
$C_{16:0}$	21.15^{Bb}	22.43^{Aa}	21.92^{ABa}	0.19
$C_{16:1}$	2.18^{A}	1.93^{B}	2.20^{A}	0.01
$C_{18:0}$	4.92	5.12	4.99	0.20
$C_{18:1}$	34.15	32.95	34.78	0.57
$C_{18:2}$	34.50	34.78	33.18	0.55
$C_{18:3}$	1.47^{a}	1.13^{b}	1.46^{a}	0.07
SFA – Nasycone	26.43^{B}	27.91^{A}	27.17^{AB}	0.15
UFA – Nienasycone	73.38^{A}	71.94^{B}	72.73^{AB}	0.13
MUFA – jednonienasycone	36.65	35.17	37.29	0.58
PUFA – wielonienasycone	36.73	36.77	35.24	0.63
DFA – Hipocholesterolemiczne (UFA + $C_{18:0}$)	78.30^{a}	77.06^{b}	77.52^{b}	0.18
OFA – Hipercholesterolemiczne ($C_{14:0}$ + $C_{16:0}$)	21.28^{B}	22.55^{A}	22.04^{AB}	0.17

A, B – significante of difference at P≤0.01 – A, B – różnice istotne na poziomie P≤0,01.
a, b – significante of difference at P≤0.05 – a, b – różnice istotne na poziomie P≤0,05.

Table 6. Chemical composition of leg muscles (%) and fatty acid profile (% total FA)
Tabela 6. Skład chemiczny mięśni nóg (%) i udział kwasów tłuszczowych (% sumy KT)

Specification – Wyszczególnienie	Group – Grupa			SEM
	K	D5	D15	
Basal nutrient – Składniki pokarmowe				
Dry matter – Sucha masa	26.07	25.49	25.94	0.31
Crude ash – Popiół surowy	1.05	1.05	1.01	0.01
Crude protein – Białko ogólne	18.60	18.72	18.31	0.22
Crude fat – Tłuszcz surowy	5.91^{b}	5.62^{b}	6.43^{a}	0.39
Fatty acids – Kwasy tłuszczowe				
$C_{14:0}$	0.13	0.12	0.11	0.006
$C_{16:0}$	19.78^{b}	20.45^{ab}	20.58^{a}	0.19
$C_{16:1}$	2.50^{b}	2.66^{ab}	3.00^{a}	0.09
$C_{18:0}$	3.33	2.89	3.63	0.19
$C_{18:1}$	34.99	34.28	35.99	0.81
$C_{18:2}$	36.77^{ab}	37.13^{a}	34.09^{b}	0.68
$C_{18:3}$	1.40^{B}	1.34^{B}	1.85^{A}	0.67
SFA – Nasycone	23.49^{Bb}	23.73^{ABb}	24.42^{Aa}	0.11
UFA – Nienasycone	76.32^{Aa}	76.10^{ABa}	75.40^{Bb}	0.11
MUFA – jednonienasycone	37.77	37.23	39.21	0.88
PUFA – wielonienasycone	38.55	38.87	36.19	0.78
DFA – Hipocholesterolemiczne (UFA + $C_{18:0}$)	79.65^{a}	78.99^{b}	79.03^{b}	0.15
OFA – Hipercholesterolemiczne ($C_{14:0}$ + $C_{16:0}$)	19.91^{b}	20.57^{ab}	20.69^{a}	0.18

A, B – significante of difference at P≤0.01 – A, B – różnice istotne na poziomie P≤0,01.
a, b – significante of difference at P≤0.05 – a, b – różnice istotne na poziomie P≤0,05.

An influence of mixtures with a different share of yeast protein on the level of individual fatty acids in meat lipids was also detected. Breast muscles (Table 5) of group D5 birds contained significantly (P≤0.01) more palmitic acid ($C_{16:0}$) classified as hypercholesterolemic (OFA). The amount of neutral and hypocholesterolemic acids (DFA) was smaller, which was the result of a significantly (P≤0.05) lower share of linolenic acid ($C_{18:3}$) in the meat lipids of group D5 chickens compared to the birds of the remaining groups. This finding is unfavourable from the consumer's point of view because the linolenic acid is a precursor of such fatty acids as eicosapentaenoic and decosahexaenoic acids whose major role is to prevent sclerosis [Mieczkowska et al. 1999].

Intramuscular fat (Table 6) of chickens fed mixtures in which the soybean protein substitution with yeast protein (group D15) was higher compared with the remaining feeding groups, was characterised by a significantly (P≤0.01) higher content of saturated fatty acids (SFA) and, at the same time, a lower content of unsaturated fatty acids (UFA). In leg muscle fat of group C chickens the UFA content by 6 to 7% lower than group A and B birds.

The organoleptic meat assessment (Figs. 1, 2) carried out showed that breast muscles of the birds fed the mixtures in which 40 and 50% of soybean protein was replaced with

yeast protein were given higher scores for all the flavour attributes (smell, juiciness, tenderness and taste) (4.05 points, on average) than the control group (3.64 points). The best flavour attributes were characteristic of thigh muscles of chickens belonging to the group which was fed mixtures with the lowest share of yeast protein, the group obtaining especially high scores for taste (4.50 points) and juiciness (4.51 points). Similarly, in the studies by Janocha and Osek [2006] the dominance (by 0.4 points, on average) of meat flavour attributes of chicken fed mixtures including protein preparations (HP 300, brewer's yeast) as a substitute of soybean oily meal was found in comparison to the control group.

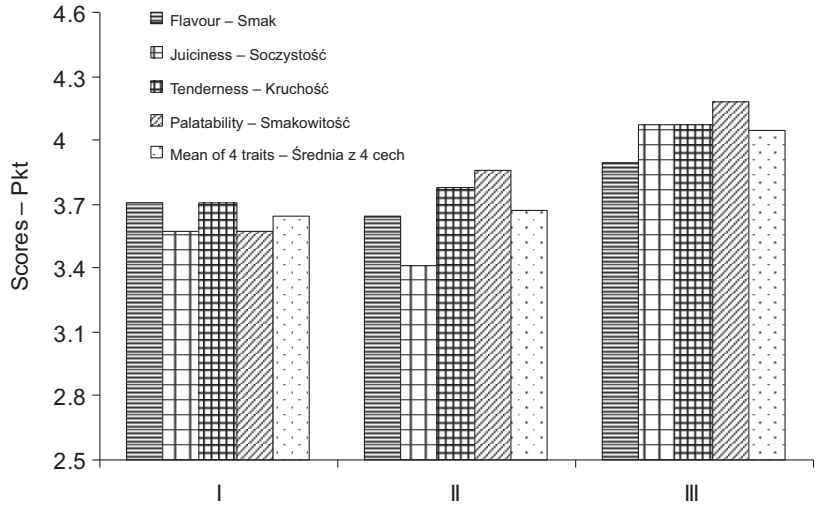

Fig. 1. Results of sensory scores of breast muscles
Rys. 1. Wyniki analizy sensorycznej mięśni piersiowych

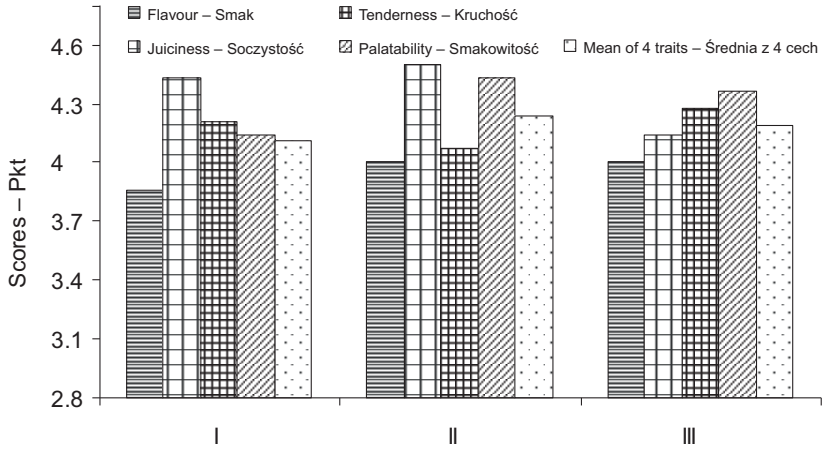

Fig. 2. Results of sensory scores of thigh muscles
Rys. 2. Wyniki analizy sensorycznej mięśni udowych

CONCLUSIONS

Substituting 11 and 18% of soybean protein with brewer's yeast protein beneficially influenced post-slaughter indicators of broiler chickens.

The replacement in mixtures of 40 and 50% soybean protein with brewer's yeast significantly reduced the breast muscle share in the carcass and, simultaneously, it increased chicken fatness. This factor significantly reduced the content of unsaturated fatty acids, especially those belonging to the PUFA group.

The results obtained allow concluding that such a high substitution of soybean protein with brewer's yeast protein is not recommended. Despite the fact that the mixtures containing yeast favourably influenced the flavour attributes of both red and white meat, which is beneficial from the consumer's point of view, a significant drop in post-slaughter indicators' values and meat quality indicates the necessity of limiting an introduction of brewer's yeast into mixtures.

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OCENA WPŁYWU MIESZANEK Z UDZIAŁEM DROŻDŻY *SACCHAROMYCES CEREVISIAE* NA WARTOŚĆ POUBOJOWĄ KURCZĄT BROJLERÓW

Streszczenie. W badaniach oceniono wpływ żywienia kurcząt brojlerów mieszankami z różnym udziałem drożdży piwowarskich na efekty poubojowe ptaków i jakość mięsa. Stwierdzono, że kurczęta grupy kontrolnej i żywione mieszankami, w których 11 i 18% białka soi zastąpiono białkiem drożdży, uzyskały najlepszą wydajność rzeźną, lepsze umięśnienie i mniejsze otłuszczenie w porównaniu z ptakami otrzymującymi mieszanki z większą ilością drożdży. Wprowadzenie drożdży do mieszanek zwiększyło zawartość tłuszczu surowego zarówno w mięśniach piersiowych, jak i udowych. Zastosowanie mieszanek z większym udziałem białka drożdży wpłynęło niekorzystnie na ilość kwasów tłuszczowych frakcji lipidowej mięsa, głównie na ilość

PUFA. Mieszanki z udziałem drożdży piwowarskich miały pozytywny wpływ na walory smakowe mięsa białego i czerwonego.

Słowa kluczowe: drożdże piwowarskie, jakość mięsa, kurczęta brojlery, wartość rzeźna

Accepted for print – Zaakceptowano do druku: 14.11.2011