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THE EFFECT OF ADDITION HIGH RAPE CAKE AND PHYTASE ON NUTRITIVE VALUE OF DIETS FOR BROILER CHICKENS

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The aim of this study was to evaluate the effect of high rape cake content and phytase added to phosphorus and calcium deficient diets on the nutritive value for broiler chickens. Two experiments were performed: a growth experiment on four groups of one-day-old broilers Ross 308, 30 birds per group (6 replications x 5 birds) and a digestibility experiment on 60 chickens divided into four groups of 20 birds (4 replications of 5 birds). The digestibility of the starter diets were evaluated on chickens at 7 days of age and of grower diets at 28 days of age. The diets used in the digestibility tests were the same for the growth trial. In the growth experiment four diets were prepared for the due periods: starters (1-21 day) and growers (22-49 day of chicken life). The control diet (SBM) did not contain rape cake, while experimental diets contained 15% (starters) and 20% (growers) rape cake of Lirajet cultivar. The experimental diet denoted RC HP had P and Ca contents equal the control diet (phosphorus about 7.5 g and calcium about 10 g.kg^{-1}), while the diet denoted as RC LP contained less P and Ca (5.8 g and 6.8 g.kg^{-1} respectively) than the control and RC HP diets. The diet denoted RC LP+ Phy was supplemented with an enzyme preparation containing phytase at a quantity of 875 FYT.kg^{-1}. Application of 15% of rape cake into starter and 20% into grower diets (RC HP) allowed for similar body weights and feed conversion ratio as the control group, whereas reduction of phosphorus and calcium content in the starter diet (RC LP) significantly decreased body weight at day 21. The addition of phytase to the starter diet with low level of phosphorus and calcium showed the tendency to improve body weight in this period. Application of rape cake into starter and grower diets had poor effects on fat digestibility in all groups, whereas supplementation of grower diets with a low level of phytase phosphorus and calcium improved the digestibility of total phosphorus in comparison to the control and RC HP diets. A tendency to improve the performance results for diets with rape cake (RC HP) in comparison to the control diet in the second period of fattening (grower diets) was observed. Application of rape cake into the diets had a significantly beneficial effect on slaughter yield, fleshiness and fatty acid composition of meat, but not so on the heart muscle, whereas phytase did not have an *influence on slaughter results. It was concluded that rape cake can be used in broiler diets, but a quantity of 15% in the starter and 20% in the grower diet may have a negative effect on the heart of so fed birds.*

Key words: broiler chickens, crude phosphorus, performance, phytase, rape cake

INTRODUCTION

Rape products have a high protein content, while rape-cakes have a high fat content. Consequently, they can be a valuable source of protein and energy in poultry feeding. According to Kocher *et al*. (2001) extracted soybean meal could be replaced by extracted rapeseed meal in mixture feeds for broilers without a negative effect on their productive results. Janjescic *et al*. (2002) found that it was possible to obtain the same live weight gains and feed conversion ratio after using 10 and 20% of rapeseed meal of 00 Silvia cultivar in mixtures for broilers. Rape cake (RC) is a relatively new rape product which is a by product of rape seed pressing. This technology is more cost – effective and environmentally friendly than rapeseed meal. In rape cakes a considerable part of total phosphorus occurs in the phytate form, which is largely unavailable to monogastric animals (Bozkurt *et al*., 2006). Phytates can chelate divalent cations and can reduce the availability of nutrients (Kornegay, 2001; Catala-Gregori *et al*., 2006; Ravindran *et al*., 1995). Addition of microbial phytase improved the digestibility of protein and amino acids in feedstuffs, but the magnitude of the response varied depending on the feedstuffs and amino acids considered (Ravindran *et al*., 1999). The addition of phytase to the diets caused a significant increase in mineral bioavailability. Phosphorus and other elements could be disengaged from the phytic-protein molecules as a result of phytase activity, consequently the amount of inorganic phosphorus could be reduced in mixtures (Sebastian *et al*., 1996a). In the experiment conducted by Huyghebaert *et al*. (2010) broiler chickens were fed positive (P-limiting) and negative (P-deficient) diets supplemented with 125, 250 and 500 FTU/kg of phytase in the three feeding phases (1-13-26-39 day). The authors stated the significant difference between the positive (P-limiting) and negative (P-deficient) group in chicken body weight at each stage. The body weight was significantly enhanced for each phytase dose at each stage. Supplementation with phytase (0.25g/kg of phytase preparation) of diets containing high amounts (300g) yellow and black rape cakes for broilers improved body weight in all groups, while feed conversion ratio did not change (Smulikowska *et al*., 2010).

Effects of using phytase in mixtures were differentiated in various studies and they depended on the kind of diet, the amount of enzyme, the non-phytic phosphorus level in the diets and stability of endogenous phytase during processing (Denbow *et al*., 1995; Sohail and Roland, 1999; Rutherford *et al*., 2002; Smulikowska *et al*., 2006). Phytase addition to corn, wheat, and barley diets increased retention of total phosphorus about 26% in the corn diet, 6% in wheat diet and 10% in barley diet, and improved calcium retention only in the corn diet

(Juanpere et al., 2005). Denbow *et al*. (1995) observed that improvement of body weight gains and feed intake was greatest when phytase was added to the diet with low nonphytate phosphorus levels. Sebastian *et al*. (1996b) established that better feed conversion could be obtained by phytase supplementation to the diets with low Ca content.

The aim of the study was to evaluate the effects of high rape cake content and phytase added to phosphorus and calcium – deficient diet on the nutritive value for broiler chickens.

MATERIALS AND METHODS

In this study two experiments were performed. Experiment 1 (growth trial) was carried out on 120 one-day-old broilers Ross 308 randomly allocated into four groups, 30 birds per group (6 replicates x 5 birds; 3 replicates of males and 3 of females). The birds were housed in metabolic cages. For the first 5 days the temperature was set at 31°C and then gradually decreased according to the recommendations of the supplier of the broiler chickens. In experiment 1 four diets were prepared: starter (1-21 day) and grower (22-49 day of age). The control diet (SBM) did not contain rape cake (RC), while experimental diets contained 15% (starters) and 20% (growers) rape cake of Lirajet cultivar. The experimental diet denoted RC HP unsupplemented and had P and Ca contents equal to the control diet (P about 7.5 g and Ca about 10 $g.kg^{-1}$), while diet denoted as RC LP contained less P and Ca (about 5.8 g and 6.8 $g.kg^{-1}$, respectively) than the respective RC HP and control diets. Diet denoted RC LP+ Phy was supplemented with enzyme preparation Ronozyme P which contained phytase at a quantity of 875 FYT, conformable to producer's information DSM. According to the supplier’s information, the enzyme preparation of phytase (min. 2500 FYT/g) was produced by a genetically modified strain of *Aspergillus oryzae* and phytase gene obtained from *Peniophora lycii*. Rape cakes were obtained in an oil mill by pressing at 400 kG/cm^2 rapeseed cv. Lirajet. The composition of experimental diets is shown in Table 1.

Table 1. Composition of experimental diets, %

Components	Starter				Grower			
	Number of groups							
	Control (SBM)[1]	RCHP 2	RC LP 3	RC LP +Phy[4]	Control (SBM)[1]	RCHP 2	RC LP 3	RC LP + Phy[4]
Wheat meal	64.00	61.00	62.20	62.20	67.00	60.20	61.10	61.10
Soybean meal	31.10	20.75	20.75	20.75	27.75	16.85	17.05	17.05
Rape cake Lirajet cv.	-	15.00	15.00	15.00	-	20.00	20.00	20.00
L-lysine (99%)	0.15	0.15	0.15	0.15	-	-	-	-
DL-methionine (99%)	0.15	0.15	0.15	0.15	0.15	0.10	0.10	0.10

cont. Table 1.

Components	Starter				Grower			
	Number of groups							
	Control (SBM)[1]	RCHP 2	RC LP 3	RC LP +Phy[4]	Control (SBM)[1]	RCHP 2	RC LP 3	RC LP + Phy[4]
Rapeseed oil	1.15	-	-	-	1.85	-	-	-
Calcium diphosphate	1.80	1.50	0.40	0.40	1.80	1.40	0.40	0.40
Limestone	0.80	0.60	0.50	0.50	0.60	0.60	0.50	0.50
Salt	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35
Mineral-vitamin premix (0.5%)*	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Nutritive value of 1 kg of diets								
Metabolizable energy, MJ (calculated)	11.43	11.58	11.67	11.67	11.77	11.80	11.92	11.92
Crude protein, % (analyzed)	20.84	20.32	20.42	20.78	20.42	20.74	20.17	20.75
Crude fibre, % (analyzed)	2.48	3.95	3.89	3.56	2.53	4.11	4.30	4.06
Crude fat, % (analyzed)	3.44	6.06	6.08	6.33	3.86	6.57	6.67	6.59
Lysine, % (calculated)	1.12	1.09	1.10	1.10	0.91	0.92	0.93	0.93
Methionine, % (calculated)	0.43	0.46	0.47	0.47	0.42	0.42	0.42	0.42
P available, % (calculated)	0.42	0.39	0.22	0.22	0.40	0.37	0.22	0.22
P total, g (analyzed)	7.55	7.69	5.85	5.85	7.48	7.67	5.76	5.76
Na,% (calculated)	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16

1 – wheat – soybean diet without rape cake (control);
2 – diet with 15% (starter) and 20% (grower) of rape cake with P and Ca equal to control diet;
3 – diet with 15% (starter) and 20% (grower) of rape cake with less P and Ca content;
4 – diet with 15% (starter) and 20% (grower) of rape cake with less P and Ca content supplemented of phytase
* – per 1 kg – Vit. A (4.000.000 j.m.); D_3 (600.000 j.m.; E (16 g); K_3 (0,6 g); B_1 (0.5 g); B_2 (1.75 g); B_6 (1.0 g); B_{12} (0.0048 g); Biotin (0.04 g); Nicotinic acid (10 g); Folic acid (0.3 g); Choline (100 g); Fe (16 g); Cu (1.8 g); Mn (16 g); Zn (14 g); Co (0.06 g); I (0.25 g); Se (0.055 g); Ca (192 g); Maxus Elanco (1.8 g); Salinomycin (12 g); BHT+Ethoxyquin (1.0 g)

The diets (in a mash form) and water were given *ad libitum:* from the 1st to the 21st day of experiment chickens were fed starter diets and from day 22 to day 49 grower diets. On the 1st , 21st, 42nd and 49th day of age the birds were weighed and feed consumption was recorded. At the end of the experiment, 6 chickens (3 males and 3 females, one bird per cage) were randomly selected from each group, slaughtered, wet plucked, eviscerated and chilled for 24 hours at 4°C.

Dressing percentage of carcasses was calculated in relation to the weight of birds before slaughter. Slaughter analysis was performed by the method described by Ziolecki and Doruchowski (1989). From the breast and leg muscles samples were collected and chemical and fatty acids composition of meat were analyzed. Experiment 2 (digestibility trial) was carried out on 60 chickens divided into four groups of 20 birds (4 replications of 5 birds). The diets used in the digestibility trial were the same as for the growth trial. The digestibility test was carried out by the total collection method. The digestibility test included an adaptation period (six days) and collection period (3 days) during which all excreta were quantitatively collected and feed consumption was recorded. The excreta from starter diets conducted on chickens at 7-10 days of age and grower diets at 28-31 days of age were collected. All the excreta were dried at 60°C, ground and subjected to chemical analyses (Yi *et al*., 1996). The chemical composition of rape cakes, diets, excreta and meat samples were analyzed by the procedure of AOAC (1990). The phosphorus content was assayed by the colorimetric method (AOAC, 1990). Fecal nitrogen content was determined by the procedure with uranyl acetate (Hartfiel, 1961). Uranyl acetate was used for separation of uric acid from excreta for the determination of faeces nitrogen content. For fatty acid analyses the extracted fat was hydrolyzed by means of 0.5 M KOH in methanol and esterified with 5% HCL in methanol (Matyka, 1976). Next, 0.2 mL of hexane was added and fatty acid methyl esters were separated and quantified using the gas chromatography apparatus CHROM 5 equipped with a column of 2.5 m flame ionization detector and integrator (temperature profile 250°C/194°C/250°C; column packing Silar Mesh 80/100). The identification of fatty acid peaks was carried out by comparison with retention times of fatty acid standards purchased from Fluka and fatty acids were expressed as weight percents. Apparent digestibility of nutrients was calculated following the total collection method using the equation given by Guevara *et al*. (2008).

The obtained results were analyzed by one-way analysis of variance (ANOVA). Significance of differences between th means was tested by Duncan’s multiple range test. The calculations were performed using the STATISTICA software package ver. 8, StatSoft Inc.

RESULTS AND DISCUSSION

Rape cake of Lirajet cultivar contained of 909.6 g organic matter; 49.1 g crude ash; 268.4 g crude protein; 282 g crude fat and 8.16 g total phosphorus and 2.1 g available phosphorus. The content of crude fat was higher than for rape cakes evaluated by Smulikowska *et al*. (2006), which was probably due to diffent pressing procedures. Podkówka *et al*. (2006) showed variability in nutrients in rapeseed cakes, and particularly of crude fat dependent on technology of pressing. The introduction of rape cakes obtained from the Lirajet cultivar increased the crude fibre and crude fat content in experimental diets in comparison to the control (Table 1). Body weight of broilers fed mixtures containing rape cakes, on the 21st day, was smaller than in broilers fed the control mixture, whereas a significant decrease in body weight in broilers fed mixtures with the reduced contents of total phosphorus and calcium was found (Table 2).

The addition of phytase to the diet with low level of phosphorus and calcium showed a tendency to improve body weight during the starter period.

Table 2. Body weight and feed efficiency of broiler chickens

Item	Experimental groups				
	Control (SBM)	RC HP	RC LP	RC LP + Phy	S.E.M
Body weight of chickens, g					
(♀+♂); 21 day	505^{a}	491^{ab}	452^{b}	466^{ab}	13.6
(♀+♂); 42 day	1784	1863	1728	1797	63.1
(♀+♂); 49 day	2254	2438	2351	2334	133.7
♀	2070	2128	2128	2055	60.0
♂	2491	2656	2411	2426	99.3
Feed/gain ratio in period, kg/kg					
1-21 day	1.74	1.87	1.89	1.82	0.05
22-42 day	1.94	1.71	1.89	1.84	0.12
22-49 day	2.08	1.84	1.98	1.99	0.12
1-42 day	1.88	1.74	1.90	1.83	0.09
1-49 day	2.00	1.84	1.96	1.96	0.01

[1] – wheat – soybean diet without rape cake (control);
[2] – diet with 15% (starter) and 20% (grower) of rape cake with P and Ca equal to control diet;
[3] – diet with 15% (starter) and 20% (grower) of rape cake with less P and Ca content;
[4] – diet with 15% (starter) and 20% (grower) of rape cake with less P and Ca content supplemented of phytase;
[a-b] – Values in the same row without a common superscript letter are significantly different ($p<0.05$);
SEM – pooled standard error of mean; Values without a letters are not significantly different

Body weight of broilers day 42, and at day 49, did not differ significantly. Feed conversion ratio in the first three weeks was similar and did not differ between groups. Feed conversion ratio of grower mixtures until day 42 and day 49 also did not differ significantly. However, the lowest feed conversion ratio was in RC HP group. Efficiency of mixtures with phytase up to day 21 and day 42 of life was higher than without phytase, however, it did not differ significantly throughout the whole period of rearing. The research presented by Osek *et al*. (2002; 2003) showed a positive effect of ground rapeseeds added to mixtures for broilers. Zeb *et al*. (1999) stated that using extracted rapeseed meal up to 15% in mixtures for broilers did not decrease their live weight gains, but feed conversion ratio decreased by about 5%. According to Sebastian *et al*. (1996b) application of 600 FTU of phytase in mixtures with 0.31% of non-phytic phosphorus increased broiler body weight and feed conversion ratio, while Rutkowski *et al*. (1997)

showed that for a significant improvement of performance of chickens fed maize-rapeseed meal diets 750 or more units of phytase are required. Dressing percentage in broilers fed mixtures with rape-cakes was significantly larger than in the control group (Table 3).

Table 3. Results of slaughter analysis

Specification	Experimental groups				
	Control (SBM)	RC HP	RC LP	RC PL + Phy	S.E.M
Slaughter yield, %	69.73[b]	72.49[a]	73.61[a]	74.07[a]	0.85
Content in cold carcass, %					
breast muscle	21.88[b]	24.67[a]	23.76[a]	24.35[a]	0.62
thigh muscles	11.67	11.75	11.91	11.82	0.73
shank muscles	9.00	9.40	9.33	9.24	0.24
muscles total	42.55[b]	45.82[a]	45.00[ab]	45.41[a]	0.75
abdominal fat	1.86	1.55	1.41	1.18	0.20
skin with subcutaneous fat	11.46[b]	9.76[a]	10.32[ab]	10.54[ab]	0.39
Relative organ weight (g/100 g b.w)					
edible giblets	3.35	3.39	3.47	3.64	0.10
heart	0.35[a]	0.44[b]	0.47[b]	0.53[b]	0.02
liver	1.72	1.65	1.74	1.77	0.07
gizzard	1.16	1.27	1.26	1.34	0.10

[1] – wheat – soybean diet without rape cake (control);
[2] – diet with 15% (starter) and 20% (grower) of rape cake with P and Ca equal to control diet;
[3] – diet with 15% (starter) and 20% (grower) of rape cake with less P and Ca content;
[4] – diet with 15% (starter) and 20% (grower) of rape cake with less P and Ca content supplemented of phytase;
[a-b] – Values in the same row without a common superscript letter are significantly different ($p<0.05$);
SEM – pooled standard error of mean; Values without a letters are not significantly different

The rapeseed cake had not influence on liver and abdominal fat weight, while the hearts were enlarged. Almost all of the increase in dressing percentage was connected with larger breast muscle and total muscle contents in broiler carcasses, but not with the degree of fatness, while the skin and subcutaneous tissue content in group RC HP was significantly higher in comparison to the control group. Ajuyah *et al*. (1991) report that breast yield was highly correlated with carcass or body weight, and data obtained by Szymczyk *et al*. (2001) show that the relative proportion of breast and leg muscles (% of carcass weight) may improve by increasing levels of dietary CLA.

Banaszkiewicz and Osek (1996) and Osek *et al*. (2002; 2003) showed an increase in total muscle content in the carcasses of broilers fed mixtures with rape cakes. Significantly larger hearts were measured in broilers fed mixtures containing rape cakes (Table 3). An increasing relative heart weight in carcasses of broilers fed mixtures with rape cakes of three rape cultivars (Kana, Lirajet and Marita) was also found in studies by Banaszkiewicz and Borkowska (2009). No significant differences in muscle composition in broilers of particular groups were found (Tables 4 and 5), however, fatty acid content in the lipid fractions of both breast and leg muscles differed significantly.

Table 4. Chemical composition of breast muscle

Specification	Experimental groups				
	Control (SBM)	RC HP	RC LP	RC LP + Phy	S.E.M
Dry matter, %	26.43	26.59	27.61	25.96	0.34
Crude ash, %	1.16	1.12	1.18	1.16	0.02
Crude protein, %	23.95	23.75	24.18	23.70	0.29
Crude fat, %	1.27	1.59	1.52	1.19	0.27
Fatty acids (% in total acids)					
C14:0	0.16^{a}	0.16^{a}	0.10^{b}	0.09^{b}	0.01
C14:1	0.05	0.05	0.04	0.03	0.003
C16:0	26.13^{a}	22.71^{b}	23.08^{b}	22.39^{b}	0.69
C16:1	5.25^{a}	3.63^{b}	3.07^{b}	2.96^{b}	0.21
C18:0	4.53	4.21	4.26	4.26	0.16
C18:1	50.72^{b}	54.52^{a}	56.39^{a}	56.72^{a}	0.98
C18:2	11.74	12.81	11.59	12.15	0.67
C18:3	0.77^{b}	1.14^{a}	0.96^{ab}	0.89^{b}	0.07
C20:1	0.13	0.15	0.11	0.11	0.006
C20:2	0.05^{a}	0.05^{a}	0.02^{b}	0.03^{b}	0.007
C20:3	0.04^{a}	0.04^{a}	0.03^{b}	0.02^{b}	0.006
C20:4	0.25^{ab}	0.32^{a}	0.17^{b}	0.18^{b}	0.034
C22:0	0.05	0.06	0.05	0.04	0.007
Others	0.13	0.15	0.13	0.13	0.009
sumSAT	27.87^{b}	27.14^{a}	27.49^{a}	26.78^{a}	0.59
sumMUFA	56.15	58.35	59.61	59.82	0.58
sumUNSAT	69.00^{b}	72.71^{a}	72.38^{a}	73.09^{a}	0.59
sumn-6	12.08	13.22	11.81	12.38	0.25
sumn-3	0.77^{b}	1.14^{a}	0.96^{ab}	0.89^{b}	0.07

[1] – wheat-soybean diet without rape cake (control);
[2] – diet with 15% (starter) and 20% (grower) of rape cake with P and Ca equal to control diet;
[3] – diet with 15% (starter) and 20% (grower) of rape cake with less P and Ca content;
[4] – diet with 15% (starter) and 20% (grower) of rape cake with less P and Ca content supplemented of phytase;
[a-b] – Values in the same row without a common superscript letter are significantly different ($p<0.05$);
SEM – pooled standard error of mean; Values without letters are not significantly different

Chickens fed the rapeseed cake diets deposited significantly higher amounts of $C_{18:1}$; $C_{18:3}$, total unsaturated and total n-3 fatty acids in the breast muscles then the control group. Broiler chickens fed the control diet accumulated significantly higher amounts of $C_{16:0}$; $C_{16:1}$ and total saturated fatty acids (Table 4). Chickens fed the rapeseed cake diets contained significantly higher amounts of $C_{18:0;}$ $C_{18:1;}$ $C_{18:2}$,$C_{18:3}$, total unsaturated, total n-6 and total n-3 fatty acids and significantly lower amounts of $C_{16:0;}$ $C_{16:1}$ and total saturated fatty acids in the leg muscles than the control group (Table 5).

Table 5. Chemical composition of leg muscles

Specification	Experimental groups				
	Control (SBM)	RC HP	RC LP	RC LP + Phy	S.E.M
Dry matter, %	26.15	24.95	25.07	25.37	0.41
Crude ash, %	1.02	1.02	1.04	1.04	0.01
Crude protein, %	19.12	18.59	18.85	18.80	0.22
Crude fat, %	5.54	5.25	5.24	5.33	0.51
Fatty acids (% in total acids)					
C14:0	0.12	0.11	0.14	0.12	0.006
C14:1	0.05	0.03	0.04	0.03	0.002
C16:0	27.58^{a}	22.96^{b}	22.45^{b}	21.41^{b}	0.74
C16:1	5.76^{a}	3.57^{b}	3.88^{b}	3.68^{b}	0.34
C18:0	2.51^{a}	3.09^{ab}	3.69^{b}	3.37^{b}	0.24
C18:1	54.85^{b}	57.58^{a}	56.38^{ab}	58.02^{a}	0.82
C18:2	8.33^{b}	10.70^{a}	11.68^{a}	11.82^{a}	0.66
C18:3	0.42^{c}	0.83^{b}	1.16^{a}	1.07^{ab}	0.10
C20:1	0.11	0.15	0.21	0.15	0.014
C20:2	0.03	0.03	0.03	0.03	0.002
C20:3	0.02	0.01	0.02	0.01	0.002
C20:4	0.09^{a}	0.09^{a}	0.21^{b}	0.16^{ab}	0.03
Others	0.13	0.10	0.11	0.13	0.005
sumSAT	30.21^{b}	26.16^{a}	26.28^{a}	24.90^{a}	0.62
sumMUFA	60.77	61.33	60.51	61.88	0.34
sumUNSAT	69.66^{b}	72.99^{a}	73.61^{a}	74.97^{a}	0.62
sumn-6	8.47^{b}	10.83^{a}	11.94^{a}	12.02^{a}	0.48
sumn-3	0.42^{c}	0.83^{b}	1.16^{a}	1.07^{ab}	0.10

[1] – wheat-soybean diet without rape cake (control);
[2] – diet with 15%(starter) and 20%(grower) of rape cake with P and Ca equal to control diet;
[3] – diet with 15%(starter) and 20%(grower) of rape cake with less P and Ca content;
[4] – diet with 15%(starter) and 20%(grower) of rape cake with less P and Ca content supplemented of phytase;
[a-c] – Values in the same row without a common superscript letter are significantly different ($p<0.05$); Values without a superscript are not significantly different; SEM-pooled standard error of mean

Use of rape cakes in feed mixtures decreased saturated and increased unsaturated fatty acids content (Tables 4 and 5). There was an increase in MUFA and PUFA content and decrease in n-6/n-3 ratio in broiler's meat as a result of applying mixtures with oil plant seeds in the studies conducted by Ajuah *et al*. (1991), Banaszkiewicz (1997) and Nguyen *et al*. (2003). Digestibility coefficients of basic nutrients and total phosphorus in the tested mixtures are presented in Table 6.

Table 6. Apparent digestibility of nutrients in experimental diets

Experimental group	Apparent digestibility coefficients, %				
	Organic matter	Crude protein	Crude fat	N-free extracts	Crude phosphorus
Starter diets					
Control(SBM)	86.52	88.38	89.12[a]	76.60	70.98
RC HP	85.54	84.02	67.44[b]	70.72	62.89
RC LP	83.24	83.78	70.01[b]	66.83	61.04
RC LP + Phy	85.23	85.04	70.42[b]	70.35	63.27
S.E.M	1.84	2.36	4.93	4.41	5.43
Grower diets					
Control (SBM)	87.82	88.34	86.54[a]	73.34	46.00[b]
RC HP	86.82	87.15	72.38[ab]	69.03	45.66[b]
RC LP	86.78	83.02	56.53[c]	62.99	51.22[ab]
RC LP + Phy	86.10	84.23	65.09[bc]	66.35	57.87[a]
S.E.M	2.14	1.89	4.62	4.17	3.29

[1] – wheat-soybean diet without rape cake (control);
[2] – diet with 15% (starter) and 20% (grower) of rape cake with P and Ca equal to control diet;
[3] – diet with 15% (starter) and 20% (grower) of rape cake with less P and Ca content;
[4] – diet with 15% (starter) and 20% (grower) of rape cake with less P and Ca content supplemented of phytase;
[a-c] – Values in the same column without a common superscript letter are significantly different ($p<0.05$);
SEM-pooled standard error of mean; Values without a superscript are not significantly different

Application of rape cake into starter and grower diets had significantly negative effects on fat digestibility in comparison to the control group, but addition of phytase increased fat digestibility in the low P diet in the grower, but not in the starter period (Table 6). Fat digestibility may well have been the best in the soybean control since this was the only diet with added rapeseed oil and perhaps this was of higher digestibility than the fat within rape cake. Significantly the best digestibility of phosphorus was found in grower mixtures with low level of phosphorus supplemented with phytase. Supplementation of grower diets with low level of phytase phosphorus and calcium improved the digestibility of total phosphorus in comparison to control and RC HP diets. The fact that addition of phytase to the grower low P diet and not to the starter improved digestibility of phosphorus suggest a degree of adaptation capacity to low P diets which takes time to become significant. Data suggest that the amount of endogenous phytase is extremely low in young birds, but that it increases with age (Sebastian *et al*., 1998). Rutherford *et al*. (2002) reported no statistically significant effects of added phytase on total and phytate P digestibility. There was no significant interaction between the effect of type of RC and phytase supplementation on P retention in the study conducted by Smulikowska *et al*. (2006). In the present study there was no significant difference in protein digestibility (Table 6), which was also shown in studies by Zhang *et al*. (1999).

CONCLUSION

Application of 15% of rape cake into starter and 20% into grower diets allowed for similar body weight and feed conversion ratio, but had significant negative effect on fat digestibility in the first period of fattening, and a positive effect on slaughter results and fatty acid composition of meat.

Reduction of phosphorus and calcium contents significantly decreased body weight of younger chickens and the application of phytase improved the digestibility of crude phosphorus, but it did not have a significant effect on rearing and slaughter results. It was concluded that rape cakes can be used in broiler diets, but at a quantity of 15% in the starter and 20% in the grower diets may have negative effects on the birds heart.

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REFERENCES

1. *Ajuyah AO, Lee KH, Hardin RT, Sim JS,* 1991, Changes in the yield and in the fatty acid composition of whole carcass and selected meat portions of broiler chickens fed full-fat oil seeds, *Poult Sci,* 70, 2304-14.
2. AOAC, Association Official Analytical Chemists, 1990, Official Methods of Analysis, 14th Edition, Washington, DC, USA.
3. *Banaszkiewicz T, Osek M,* 1996, Slaughter analysis of broiler chickens fed diets including rapeseed oil cake and meal (In Polish), *Roœliny Oleiste-Oilseed Crops,* XVII, 2, 483-93.
4. *Banaszkiewicz T,* 1997, Effect of rapeseed products on choice indices of broilers meat quality (In Polish), *Roœliny Oleiste-Oilseed Crops* , XVIII, 2, 565-73.
5. *Banaszkiewicz T, Borkowska K,* 2009, The estimation of diets with rapeseed cakes from new cultivars for broiler chickens (In Polish), *Roœliny Oleiste-Oilseed Crops*, XXX, 1, 133-42.
6. *Bozkurt M, Cabuk M, Alcicek A,* 2006, The effect of microbial phytase in broiler grower diets containing low phosphorus, energy and protein, *Poult Sci,* 43, 29-34.

7. *Catala-Gregori P, Garcia F, Hemandez F, Madrid J, Ceron JJ,* 2006, Response of broilers to feeding low-calcium and phosphorus diets plus phytase under different environmental conditions: body weight and tibiotarsus mineralization, *Poult Sci,* 85,1923-31.
8. *Denbow DM, Ravindran V, Kornegay ET, Yi Z, Hulet RM,* 1995, Improving phosphorus availability in soybean meal for broilers by supplemental phytase, *Poult Sci,* 74, 1831-42.
9. *Guevara P, Claeys T, Janssens GPJ,* 2008, Apparent digestibility in meat-type guinea pigs as determined by total collection or by internal marker, *Vet Med-Czech,* 53, 4, 203-6.
10. *Hartfiel W,*1961,The estimation of feeds in study of broiler chickens, III. Comparative studies of chemical separation of urinary nitrogen and faecal nitrogen in chicken's excreta modified uranylacetate method (In German), *Arch Geflugelkd,* 25, 469.
11. *Huyghebaert G, Delezie E, Maertens L, De Gussem K, Vereecken M*, 2010, The impact of phytase on zootechnical performances in laying hens, broiler chickens and turkey poults, XXII Internat Poult Sym, PB WPSA, Olsztyn 6-8 Sept, 2010.
12. *Janjescic Z, Grbesa D, Muzic S, Curic S, Rupic V,* 2002, Influence of rapeseed meal on productivity and health of broiler chicks, *Acta Vet Hung,* 50, 1, 37-50.
13. *Juanpere J, Perez-Vendrell AM, Angulo E, Brufau J,* 2005, Assessment of potential interactions between phytase and glycosidase enzyme supplementation on nutrient digestibility in broilers, *Poult Sci,* 84, 571-80.
14. *Kocher A, Choct M, Morrisroe L, Broz J,* 2001, Effect of enzyme supplementation of the replacement value of canola meal for soybean meal in broiler diets, *Aust J Agr Res,* 52, 447-52.
15. *Kornegay ET,* 2001, Digestion of phosphorus and other nutrients, The role of phytases and factors influencing their activity, In: Bedford MR, and Partridge GG, CABI Publishing, Enzymes in farm animal nutrition, Walinford , UK, 239.
16. *Matyka S,* 1976, Routine determination method of composition and fatty acids content in mixtures and feed components (In Polish), *Biul Inf Przem Pasz,* 15, 38-42.
17. *Nguyen CV, Smulikowska S, Mieczkowska A,* 2003, Effect of linseed and rapeseed or linseed and rapeseed oil on performance, slaughter yield and fatty acid deposition in edible parts of carcass in broiler chickens, *J Anim Feed Sci,* 12, 2, 271-88.
18. *Osek M, Janocha A, Wasilowski Z,* 2002, Rearing results, slaughter value and meat quality of broiler chickens fed mixtures without animal protein but containing seeds of oil plants (In Polish), *Roœliny Oleiste-Oilseed Crops*, XXIII, 2, 515-30.
19. *Osek M, Janocha A, Wasilowski Z,* 2003, The nutritive value of seeds from winter oilseed rape cultivars Batory for broiler chickens (In Polish), *Roœliny Oleiste-Oilseed Crops,* XXIV, 2, 537-46.
20. *Podkówka W, Podkówka Z, Petkov K,* 2006, Nutritive value of rapeseed cake, In: Application of basic science achievement in cattle breeding (In Polish), Ed by Cracow Agricult University, Cracow, 109-15.
21. *Ravindran V, Cabahug S, Ravindran G, Bryden WL,* 1999, Influence of microbial phytase on apparent ileal amino acid digestibility of feedstuffs for broilers, *Poult Sci,* 78, 699-706.
22. *Rutherford SM, Chung TK, Moughan PJ,* 2002, The effect of microbial phytase on ileal phosphorus and amino acid digestibility in the broiler chicken, *Br Poultry Sci,* 43, 598-606.
23. *Rutkowski A, Sliwinski B, Wiaz M,* 1997, The use of phytase in broiler chicken diets containing maize and soyabean or rapeseed meal, *J Anim Feed Sci,* 6, 533-40.
24. *Sebastian S, Touchburn SP, Chavez ER, Lagué PC,* 1996a, The effect of supplemental microbial phytase on the performance and utilization of dietary calcium, phosphorus, copper and zinc in broiler chickens fed corn-soybean diets, *Poult Sci,* 75, 729-36.
25. *Sebastian S, Touchburn SP, Chavez ER, Lagué PC,* 1996b, Efficacy of supplemental microbial phytase at different dietary calcium levels on growth performance and mineral utilization of broiler chickens, *Poult Sci,* 75, 1516-23.
26. *Sebastian S, Touchburn SP, Chavez ER,* 1998, Implications of phytic acid and supplementalmicrobial phytase in poultry nutrition, a review, *World Poultry Sci J,* 54,1, 27-47.
27. *Smulikowska S, Mieczkowska A, Czerwiñski J, Weremko D, Nguyen CV,* 2006, Effect of exogenous phytase in chickens fed diets with differently processed rapeseed expeller cakes, *J Anim Feed Sci,* 15, 237-52.

28. *Smulikowska S, Czerwiński J, Mieczkowska A, Piotrowska A, Bartkowiak -Broda I,* 2010, Effect of phytase on performance of broiler chickens fed diets with press cakes from yellow-or black-seeded rapeseed, XXII International Poult Symp PB WPSA, Olsztyn 6-8 Sept, 2010.
29. *Sohail SS, Roland DA,*1999, Influence of supplemental phytase on performance of broilers four to six weeks of age, *Poult Sci,* 87, 550-5.
30. *Szymczyk B, Pisulewski P, Szczurek W, Hanczakowski P,* 2001, Effects of conjugated linoleic acid on growth performance, feed conversion efficiency, and subsequent carcass quality in broiler chickens, *Brit J Nutr,* 8, 465-73.
31. *Yi Z, Kornegay ET, Denbow DM,* 1996, Effect of microbial phytase on nitrogen and amino acid digestibility and nitrogen retention of turkey fed corn-soybean meal diets, *Poult Sci,* 75, 979-90.
32. *Zeb A, Sattar A, Meulen U,* 1999, Effect of feeding different levels of rapeseed meal on the performance of broiler chicks, *Arch Geflugelkd,* 63, 2, 77-81.
33. *Zhang X, Roland DA, McDaniel OR, Rao SK,* 1999, Effect of Natuphos phytase supplementation to feed on performance and ileal digestibility of protein and amino acids of broilers, *Poult Sci,* 78, 1567-72.
34. *Ziolecki J, Doruchowski W,* 1989, The method of estimation of poultry slaughter analysis (in Polish), Ed. COBRD, Poznañ.

UTICAJ DODAVANJA POGAČA ULJANE REPICE I FITAZE NA HRANLJIVU VREDNOST OBROKA ZA BROJLERE

BANASZKIEVIEWICZ TERESA

SADRŽAJ

Cilj ovih ispitivanja je bio da se procene efekti visokog sadržaja pogača uljane repice i dodavanja fitaze u obroke siromašne u sadržaju fosfora na njihovu hranljivu vrednost. Sprovedena su dva odvojena ogleda. U prvom je ispitivan porast pilića u četiri grupe jednodnevnih Ross 308 brojlera sa po 30 jedinki (6 ponavljanja sa po 5 pilića). U drugom ogledu je ispitivana svarljivost hraniva u 4 grupe od po 20 brojlera (4 ponavljanja sa po 5 pilića). Svarljivost je određivana 7. i 28. dana a obroci su bili isti kao u prvom ogledu. Korišćene su dve krmne smeše: starter (1-21 dan) i grover (22-49 dan). Kontrolni obrok (SBM) nije sadržavao repine pogače (serovar Lirajet) dok je oglednim grupama ona dodavana u koncentraciji od 15% (starter) i 20% (grover). Eksperimentalni obrok je označen kao RC HP i sadržavao je Ca i P u istoj količini kao i kontrolni (7,5 g P i 10 g Ca kg^{-1}). Obrok označen kao RC LP sadržavao je manje fosfora i kalcijuma (5,8 g P i 6,8 g Ca kg^{-1}). Obrok označen kao RC LP+ sadržavao je preparat sa fitazom u količini od 875 FYT kg^{-1}. Dodavanje pogače uljane repice u starter (15%) i grover (20%) obroke (RC HP) imalo je za posledicu slične prosečne vrednosti telesne mase i sličnu konverziju hrane kao i u kontrolnoj grupi. Smanjenje količine fosfora i kalcijuma (RC LP) rezultiralo je značajnim smanjenjem telesne mase 21. dana, a dodavanje fitaze je korigovalo telesnu masu. Dodavanje pogače uljane repice u starter i grover obroke nije bilo isplativo u pogledu svarljivosti masti ali je dodatak fitaze u starter obrok sa smanjenom količinom kalcijuma i fosfora povećavao iskoristivost

fosfora u poređenju sa kontrolnom i RC HP grupama. Zapažena je i tendencija poboljšanja performansi u drugom periodu ogleda u RC HP grupama. Primena pogača uljane repice imala je pozitivan efekat na prinos mesa, boju i masno-kiselinski sastav ali ne i na težinu srca. Dodavanje fitaze nije uticalo na klanične parametre.