
The influence of phytase on broiler productivity and nutrient digestibility

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The effect of the RONOZYME P enzyme preparation on broiler chickens' productivity, feed conversion ratio, *tibia* bone mineralisation, also on nutrient digestion was studied, using variously processed rape cake. The feeding experiment showed that a too significant phosphorus and calcium reduction increased the feed conversion and slowed the growth of chickens. However, the mentioned enzyme supplement improved feed nutrient digestibility. During the feed nutrient digestibility experiment, addition of non-shelled rape cake showed that the digestibility of crude proteins, total phosphorus and calcium improved by 3.0%, 2.8% and 3.0% ($p > 0.05$) respectively, and using shelled rape cake with the mentioned enzyme supplement, in comparison to the control group, the digestibility of crude protein, total phosphorus and total calcium improved by 1.1%, 18.3% and 9.6% ($p > 0.05$), respectively. Phytase supplement in feed, together with smaller amounts of phosphorus in non-shelled rape cake, increased phosphorus levels in the *tibia* by 0.8% ($p > 0.05$) and with shelled rape cake by 1.1%.

Key words: phytase enzyme preparation, shelled and non-shelled rape cake, broiler chickens, productivity

INTRODUCTION

Phosphorus is one of the basic mineral elements in all feed rations, having a greater influence on biological systems than any other element. It is a component of bones, muscles, brain, nucleic acids, phosphoproteids, various enzymes and organism liquids, but it also improves the use of energy. Under phosphorus deficiency, feeding and reproduction diminishes, as does weight gain, bones "soften", and various metabolic disruptions occur [13]. For monogastric animals, including birds, this life-giving nutrient occurs in feed ingredients in a form that is almost indigestible [14]. The major proportion of the phosphorus is stored in a special way: six phosphorus molecules are bound to phytic acid in a ring form. This phytic acid ring is called phytate. According to various literature, phytate phosphorus amounts in cereal grains can be as high as 50–80%, in legumes 50–68%, in oil-producing plant seeds and their by-products 51–76% [2, 5, 12, 14]. A large part of

phosphorus in phytic acid is indigestible by birds, since their gastrointestinal tracts lack sufficient amounts of endogenous enzyme, to catalyze phytate reduction [4]. So phosphorus supplements are necessary (nonorganic or of animal origin) in feed to suit the needs of the bird organism.

Besides, phytate creates a large number of insoluble salts with divalent and trivalent cations such as calcium, magnesium, potassium, iron, manganese or zinc. The interaction of protein/phytate and starch/phytate obstructs the digestion of protein and carbohydrates [7, 14, 16]. Therefore, just like phosphorus, these valuable nutritive substances are also lost to animal as excreted in the faeces. Phytic acid also suppresses the activity of certain enzymes such as α -amylase, trypsin, tyrosinase and pepsin, thereby suppressing crude starch and crude protein digestion [1, 11, 16].

The solution to avoid the negative influence of phytate on the digestibility of phosphorus, other

minerals and nitrogen is the enzyme phytase [6, 10, 14]. It is the enzyme known to release the ortho-phosphate group from the phytate molecule. Improving the availability of phytate, P would reduce the necessity to include feed phosphates in the diet and enable a reduction of the dietary P content, without jeopardizing the bird's health and productivity. In turn, this would result in a lower P excretion per unit of edible product (eggs, meat), and reduce P-linked environmental pollution problems by intensive livestock production [8, 15].

The aim of this investigation was to determine the influence of the synthetic phytase preparation RONOZYME P made from *Peniophora lycii* culture, its effect on broiler chickens productivity, feed conversion ratio, bone mineralisation, crude protein and other nutrient digestion in the bird organism.

MATERIALS AND METHODS

In order to analyse the influence of a synthetic phytase preparation feed supplement on broiler chickens growth and feed conversion ratio, an experiment was conducted using 600 Hybro G breed broiler chickens 1–35-day-old. The chicks were divided into 2 groups. Each group was subdivided into 3 subgroups of 100 chickens, totalling 300 chickens per group. The both groups were fed crumbled feed mixtures (with 20% non-shelled rape cake) *ad libitum*. The feed mixture of the experimental group contained no monocalcium phosphate additive, though was supplemented with phytase preparation. The birds were maintained on deep litter and watered from stationary waterers. The feed composition is showed in Table 1.

During the feeding experiment, individual chicken body weight, feed conversion ratio and mortality were analysed.

The phytase supplement influence on crude protein and other nutrient digestibility in the birds was tested using two feed nutrient digestibility experiments.

The experiment of feed nutrient digestibility was performed with 10 broiler chickens fed non-shelled rape cake. The experiment began with 21-day-old broiler chickens. The chickens were divided into 2 groups of 5 birds each, identically housed (individually) and fed. The feed ration was the same as shown in Table 1.

Analogously, another experiment of feed nutrient digestibility was performed. The composition of the ration containing 20% of shelled rape cake is shown in Table 2.

During the experiment of feed digestibility the birds were fed limited amounts of feed (95% of that consumed in the prep period), housed identically, individually, each having their own feeding trough and waterer. During the investigation, individual bird's excrements were collected twice daily, frozen and kept until chemical analysis was to be performed.

The accumulation rate of phosphorus in the tibia was determined according to the method where the left tibiae were boiled for 5 min, then the surrounding meat and cartilaginous caps were removed. This very short heat treatment of the bones only denaturated the protein of the surrounding meat. Then, the proximal tibiataarsi were split in order to subject to gross examination for tibial dyschondroplasia. Further these bones were dried in a forced-air oven for 16 h at 60°C and ashed for 16 h at 600°C, tibia ash-percentage was defined as the ash weight/dry bone weight ratio*100 [3].

Components	Control group	Experimental group
Wheat	14.00	14.00
Corn	35.00	35.30
Soya bean meal 48	19.00	19.00
Rape cake	20.00	20.00
Fish meal 66	3.00	3.00
Sunflower oil	6.00	6.00
Monocalcium phosphate	0.80	–
Limestone	1.00	1.30
NaCl	0.30	0.30
Methionine	0.10	0.10
Premix	1.00	1.00
Enzyme preparation*	–	0.03
Calculated values, %:		
ME (MJ/kg)	12.63	12.67
Crude protein	22.00	22.02
Crude fat	10.46	10.47
Crude fiber	7.46	7.48
Lysine	1.25	1.25
Methionine/Cystine	0.89	0.89
Methionine	0.52	0.52
Threonine	0.91	0.91
Tryptophane	0.27	0.27
Ca	0.83	0.80
P (total)	0.72	0.53
Na	0.16	0.16

* Enzyme preparation of phytase (*Ronozyme P*). Product activity is 2500 FYT/g.

Table 2. Feed digestibility experiment using shelled rape cake, feed ration composition and nutritiousness, %

Components	Control group	Experimental group
Wheat	14.40	14.40
Corn	35.00	35.50
Soya bean meal 46	20.00	20.00
Rape cake	20.00	20.00
Fish meal 70	3.00	3.00
Sunflower oil	4.50	4.50
Monocalcium phosphate	0.80	–
Limestone	1.00	1.30
NaCl	0.30	0.30
Lysine	0.30	0.30
Methionine	0.25	0.25
Premix	1.00	1.00
Enzyme preparation*	–	0.03
Calculated values, %:		
ME (MJ/kg)	12.84	12.90
Crude protein	22.19	22.23
Crude fat	7.46	7.48
Crude fiber	4.76	4.00
Lysine	1.19	1.19
Methionine/Cystine	0.87	0.87
Methionine	0.57	0.57
Threonine	0.68	0.68
Tryptophane	0.20	0.20
Ca	0.86	0.84
P (total)	0.73	0.54
Na	0.16	0.16

*Enzyme preparation of phytase (*Ronozyme P*). Product activity is 2500 FYT/g.

Footnote: the methionine, lysine and enzyme preparation was mixed with the premix.

The analyzed parameters were calculated to averages. The data were processed according to Tukeys Honest Significant Difference test.

RESULTS

The experiment of feed nutrient digestibility (using non-shelled rape cake) data (Table 3) showed that the phytase supplement efficacy was not remarkable. The weight of 21–35-day-old broilers was by 3.0% less as compared to the control group. Feed conversion ratio using the phytase supplement was by 3–4% larger than in the control group. According to the literature [9], by using the phytase enzyme preparation at a dose of 300 g/t of feed, it is possible to reduce the amount of the total phosphorus to 2970 g/t of feed or to 891 g of digestible phosphorus. In this case, according to the recommendations, the addition of phytase could reduce the amount of total phosphorus to 0.69%, but it was reduced to 0.53%. So, the balance between phosphorus and calcium was disturbed. Therefore poor maintenance of the phosphorus reduced the weight

of broiler chickens by 3.0% and increased the feed conversion ratio.

The metabolism experiment using non-shelled rape cake show (Table 4) that, in comparison to control group, in the experimental group the digestibility of crude fat and crude fiber was lower (3.8% and 3.4%, respectively), and that of crude protein, total calcium and total phosphorus increased by 3.0%, 2.8% and 3.0%, respectively ($p > 0.05$).

During this investigation, phosphorus mineralisation in the *tibia* was also analysed. It was determined that the phosphorus content (%) in the control group (*tibia*) was 39.3 ± 1.3 and in the experimental group 40.1 ± 1.8 ($p > 0.05$).

The results of experiment of nutrient digestibility (Table 5) show that phytase enzyme preparation in feeds containing 20% of shelled rape cake and no additional phosphorus, organic matter, crude fat and crude fiber has a lower digestibility – 1.0%, 3.3% and 0.1%, respectively. Crude protein, total calcium and total phosphorus digestibility was higher – 1.1%, 18.3% and 9.6%, respectively ($p > 0.05$).

Accumulation of phosphorus in the *tibia* was also analyzed, showing that

Table 3. Results of feeding experiment

Group	Control group	Experimental group
Chick age, days	Weight (g/broiler)	
1	41.5 ± 0.4	41.5 ± 0.4
21	647* ± 5	625 ± 4
	100	97
35	1640* ± 12	1592* ± 13
	100	97
	Feed conversion ratio (kg feed/kg weight gain)	
1–21	1.62 ± 0.04	1.68 ± 0.04
	100	104
21–35	1.78 ± 0.00	1.83 ± 0.10
	100	103
1–35	1.71 ± 0.00	1.77 ± 0.00
	100	103
	Mortality, %	
1–21	1	2
21–35	1	2
1–35	2	4

* Data differences probability (Turkey test, $p < 0.05$).

Table 4. Results of metabolism experiment using non-shelled rape cake

Digestibility, %	Control group	Experimental group
Organic matter	80.5 ± 0.0	80.5 ± 0.0
Crude protein	82.1 ± 1.5	85.1 ± 0.6
Crude fat	89.1 ± 1.0	85.3 ± 2.0
Crude fiber	17.8 ± 3.7	14.4 ± 1.9
Ca	33.9 ± 1.9	36.7 ± 4.0
P	45.2 ± 2.0	48.2 ± 2.7

Table 5. Results of metabolism experiment using shelled rape cake

Digestibility, %	Control group	Experimental group
Organic matter	75.5 ± 1.0	74.5 ± 1.0
Crude protein	83.0 ± 2.0	84.1 ± 1.0
Crude fat	88.3 ± 1.0	88.2 ± 2.0
Crude fiber	17.4 ± 4.0	14.1 ± 3.0
Ca	32.1 ± 3.6	50.4 ± 9.7
P	38.3 ± 5.4	47.9 ± 5.8

control group was 40.4 ± 2.6%, in the experimental group 41.5 ± 2.3% ($p > 0.05$).

CONCLUSIONS

1. The use of feed mixtures containing 20% of rape cake ensure the growing parameters of birds and correspond to growth recommendations of broiler chickens of the strain Hybro G.

2. The feeding experiment using non-shelled rape cake without monocalcium phosphate additive, though supplemented with phytase preparation showed a 3.0% decrease in body weight when compared to the control group ($p < 0.05$), and the feed conversion ratio was by 3.0% better than in the control group ($p > 0.05$). A too significant decrease of a phosphorus and calcium increased the feed conversion ratio and hampered the growth of chickens. Therefore, when using phytase preparations in feed, monocalcium phosphate should be added to avoid negative effects on chickens productivity.

3. The enzyme preparation supplement had no influence on mortality.

4. The above-mentioned enzyme preparation improved the digestibility of crude protein by 3.0%, total calcium 2.8% and total phosphorus by 3.0% ($p > 0.05$) in feed containing non-shelled rape cake.

The feed nutrient digestibility investigation with shelled rape cake showed that the enzyme addition improved the digestibility of crude protein, total calcium and total phosphorus in comparison with the

control group by 1.1%, 18.3% and 9.6%, respectively ($p > 0.05$).

5. Phytase supplement in feed with a decreased level of phosphorus in the ration that includes 20% non-shelled rape cake component increases accumulation of phosphorus in the tibia bone by 0.8% ($p > 0.05$) and in the experiment using shelled rape cake by 1.1% ($p > 0.05$).

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References

1. Deshpande S. S. a. Cheryan M. Effect of phytic acid, divalent cations and their interaction on alpha amylase activity // Journal of Food Science. 1984. Vol. 49. P. 10–14.
2. Eeckhout W., De Peape M. Phytata- und Phytata-P in Futtermitteln // Animal Feed Science and Technology. 1994. Vol. 47. P. 19–29.
3. Huyghebaert G. The response of broiler chicks to phase feeding for P, Ca and phytase // Archiv für Geflügelkunde. 1996. Vol. 60(3). P. 132–141.
4. Iragavarapu R., Doerge T. Manure phosphorus – problems, regulations and crop genetics solutions // Pioneer Hi-Bred International, Incorporation 1999. P. 1–3.
5. Jeroch H. et al. Futtermittelkunde. Gustav Fischer Verlag, Jena-Stuttgart, 1993. S. 307–322.
6. Knap I. H. New information about Phytase // Enzyme DA, Novo Nordisk A/S, Denmark, 1995. P. 5–6.
7. Knuckles B. et al. Effect of Myo-inositol phosphate esters on *in vitro* and *in vivo* digestion of protein // Journal Food Science. 1989. Vol. 54(5). P. 4–9.
8. Kornegay Z. Yi, E. T., Ravindran V. et al. Phytase and phosphorus availability // Poultry Science. 1996. Vol. 75. P. 240–249.
9. Korsbak A. Phytase // Ronozyme P information for LCF. 2001.
10. Leeson S., Summers J. D. Commercial Poultry nutrition (Second Edition) // University Books. 1997. P. 77–79.
11. Nair V. C., Duvnjak Z. Reduction of phytic acid content in canola meal by *Aspergillus ficuum* in solid state fermentation process // World Journal of Microbiology and Biotechnology. 1990. Vol. 34. P. 183–188.
12. Oloffs K., Cossa J., Heroch H. Phosphorus utilization from different vegetable feedstuffs by laying hens // Arch. Geflügelk. 2000. Vol. 64(1). P. 24–27.
13. Phosphor täglich Mineralfutter // Täglich Mineralfutter Voraussetzung für Gesundheit, Fruchtbarkeit, Langlebigkeit, Leistung. Fachverband der Futtermittelindustrie. Bonn, 2000. P. 11–12.
14. Phytate. A problem posed by nature // Feed International. 2000. Vol. 10. P. 2–7.
15. Van Der Klis J. D., Versteegh H. A. J., Simons P. C. M. et al. The efficacy of phytase in corn-soybean meal-based diets for laying hens // Poultry Science. 1997. Vol. 76. P. 1535–1542.

16. Zyla K. Mould phytases and their application in the food industry // World Journal of Microbiology and Biotechnology. 1992. No. 8. P. 467–472.

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FITAZĖS ĮTAKA VIŠČIUKŲ BROILERIŲ PRODUKTYVUMUI BEI LESALŲ MAISTO MEDŽIAGŲ VIRŠKINIMUI

S a n t r a u k a

Tirta fitazės fermentinio preparato Ronozyme P įtaka viščiukų broilerių produktyvumui, lesalų sąnaudoms, kaulų *tibia* mineralizacijai, taip pat lesalų su skirtingai apdorotomis rapso išspaudomis maisto medžiagų virškinamumui. Lesinimo bandymo tyrimai parodė, kad dėl nepakankamo fitazės bei mažesnių fosforo ir kalcio kiekių apie 3,0% padidėjo lesalų sąnaudos 1 kg priesvorio gauti ir sulėtėjo viščiukų augimas. Tačiau dėl minėto fermentinio preparato priedo pagerėjo lesalų maisto medžiagų virškinamumas. Lesalų su nelukštentų rapso sėklų išspaudomis maisto medžiagų virškinamumo bandymo metu baltymų, bendrųjų kalcio ir fosforo virškinamumas buvo geresnis atitinkamai 3,0, 2,8 ir 3,0% ($p > 0,05$), o bandyme su lukštentų rapso sėklų išspaudomis dėl naudoto fermentinio preparato priedo pagerėjo baltymų, bendrųjų kalcio ir fosforo virškinamumas, palyginti su kontroline grupe, atitinkamai 1,1, 18,3 bei 9,6% ($p > 0,05$). Dėl fitazės priedo lesaluose su mažesniu fosforo kiekiu bandyme su nelukštentų rapso sėklų išspaudomis fosforo susikaupimas paukščių šlaunikaulyje (*tibia*) padidėjo 0,8% ($p > 0,05$), o bandyme su lukštentų rapso sėklų išspaudomis – 1,1%. Paukščių išsaugojimui fermentinių preparatų priedas jokios įtakos neturėjo.

Raktažodžiai: fitazės fermentinis preparatas, nulukštentos ir nelukštentos rapso sėklų išspaudos, viščiukai broileriai, produktyvumas

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ВЛИЯНИЕ ФИТАЗЫ НА ПРОДУКТИВНОСТЬ ЦЫПЛЯТ-БРОЙЛЕРОВ И ПЕРЕВАРИМОСТЬ ПИТАТЕЛЬНЫХ ВЕЩЕСТВ КОРМА

Р е з ю м е

В опытах было исследовано влияние ферментного препарата Ронозyme Р на продуктивность, затраты корма и минерализацию костей *tibia*, а также на переваримость питательных веществ корма – рапсового жмыха различной степени обработки.

Результаты кормления показали, что при недостатке фитазы и пониженном содержании кальция и фосфора в кормах затраты корма на 1 кг прироста живой массы увеличились примерно на 3,0%, а интенсивность роста цыплят снизилась. Однако добавление указанного ферментного препарата улучшило переваримость питательных веществ корма.

Результаты балансового опыта показали, что при использовании жмыха из нелущёных семян рапса переваримость белка, общего кальция и фосфора улучшилась соответственно на 3,0, 2,8 и 3,0% ($p > 0,05$) по сравнению с контрольной группой; при использовании жмыха из лущёных семян рапса добавление фермента способствовало повышению переваримости белка, общего кальция и фосфора соответственно на 1,1, 18,3 и 9,6% ($p > 0,05$). Добавление фитазы в корм с пониженным содержанием фосфора при использовании рапсового жмыха из нелущёных семян повысило степень минерализации в костях *tibia* на 0,8% ($p > 0,05$), а при использовании рапсового жмыха из лущёных семян – на 1,1%. Добавление ферментного препарата Ронозyme Р не оказывало никакого влияния на сохранность птиц.

Ключевые слова: добавление ферментного препарата, рапсовый жмых из лущёных и нелущёных семян, цыплята-бройлеры, продуктивность