IMPROVING PHOSPHORUS AVAILABILITY IN BROILER DIETS BASED ON CORN-SOYBEAN MEAL USING MICROBIAL PHYTASE

MILICA ŽIVKOV-BALOŠ[1], Ž. MIHALJEV1, DUBRAVKA POTKONJAK[1], MARIJA VUKAŠINOVIĆ[2], MARINA VUKIĆ-VRANJEŠ[3]

[1] Veterinary Scientific Institute "Novi Sad", Rumenački put 20, Novi Sad, R. Serbia;
[2] Veterinary Specialized Institute "Kraljevo", Žička 34, Kraljevo, R. Serbia;
[3] "Alltech Serbia", Temerinska 119, Novi Sad, R. Serbia
milica@niv.ns.ac.yu

Summary

The effects of the microbial phytase in nutrition of broilers on carcass and meat quality were observed. Trial was carried out on 300 Arbor Acres broilers of both sexes divided into six groups. The broilers in control groups (K and K+) were fed with complete mixtures of standard raw materials and chemical composition, in which dietary available phosphorus (AP) level was formulated at the level of 0.46%. In diets for broilers in the experimental groups, by reducing (O-I and O-I+) and complete excluding dicalcium phosphate (O-II and O-II+), the AP in mixtures was reduced to 0.25% and 0.10%, respectively. Diets for broilers in the experimental groups (K+, O-I+ and O-II+) were supplemented with phytase. During the experiment, that lasted 42 days performances were investigated. At the end of the trial dressing percentages (yields) and carcass conformation measures were monitored.

Reduction of the dietary TP and AP level for experimental broilers induced lower body mass, gain and feed consumption as well as higher fed conversion. However, by introduction phytase into diets negative effects of P reduction were, to some extent, alleviated. The obtained results show that dressing percentages of broilers from the experimental group varied less comparing to the broilers from the control group. Supplementation of phytase into diets increased the share of the breast part and waiter thigh in chicken carcasses.

Key words: broilers, phytase, production performance, slaughter yield

Quality and the characteristics of broiler meat present important parameters in poultry production for which are interested not only food producers but also final consumers of poultry meat and products.

In industrial system of production, as for example in breeding of broiler poultry, many demands have to fulfill. The most important are high feed efficiency and production without harmful matter, but preserving health status of poultry with the least pollution of the environment. The scandal with beef (BSE) led finally to a deep and persistent nonconfidence of the consumers. The result was general loss in image of meat. The shrap increase in poultry production and intensified aspects of poultry production regarding animal protection and demands of ecological associations. Demands of ecology associations relate to all technological

normative, also to nutrition. They insist on nutritive elements of herbal origin, first of all cereals (Ristić, 2001).

In order to solve this problem, supplement of enzymes into feed of poultry attracts more attention of nutritionists. A special effect and efficiency should be given to phytase. The supplement exogenous enzymes in feed for animal has one aim: to supplement activity of enzymes, remove anti-nutritive factors (phytate), some nutritive matters make available for resorbtion, increase of energetic and nutritive values of lower quality and reduce excretion of nutritive matters into the environment (Broz, 1993). The results in supplement of phytase in diets for broilers have been incomplete and often contradictory, especially if related to the influence of phytase in characteristics and quality of meat. Therefore, having in mind importance of the problem, the aim of our work was to examine influence of phytase parameters when using raw materials of domestic origin (maize, soybean meal).

Materials and methods

The experiment was carried out on 300 one day old chicken Arbor Acres provenience, both sexes, divided in six groups. Application of preventive measures, housing, care, as well as feeding and drinking regime, were adjusted to raising on litter.

Table 1.

Composition of feed mix in the trial with chicken aged 1-21 days*, [%]

Feeding stuffs	Mixtures for experimental broilers					
	K	**K$_+$**	**O-I**	**O-I$_+$**	**O-II**	**O-II$_+$**
Maize	51.8	51.8	52.3	52.3	52.5	52.5
Soybean meal	33.2	33.2	33.2	33.2	33.2	33.2
Sunflower meal	4.0	4.0	4.0	4.0	4.0	4.0
Yeast	2.0	2.0	2.0	2.0	2.0	2.0
Vegetable oil	4.6	4.6	4.6	4.6	4.6	4.6
DL Methionine	0.2	0.2	0.2	0.2	0.2	0.2
Limestone	0.7	0.7	1.6	1.6	2.2	2.2
Dicalcium phosphate	2.2	2.2	0.8	0.8	-	-
Salt	0.3	0.3	0.3	0.3	0.3	0.3
Mineral-vitamin mixture	1.0	1.0	1.0	1.0	1.0	1.0
Phytase	-	+	-	+	-	+

**Mix used for nutrition of broilers aged 21-35 and 35-42 days was very similar in number of ingredients and chemical composition, adjusted to the needs of poultry in the experiment.*

The broilers were given diets with 0.46%, 0.25% or 0.10% available phosphorus (AP), with or without phytase. The broilers in control group (K) was fed with diets (standard chemical composition), without feed of animal origin with 0.46% AP. The main source of phosphorus was dicalcium phosphate. In diets for

broilers in experimental groups, by reducing (O-I and O-I+) and complete excluding (O-II and O-II+) dicalcium phosphate, the available phosphorus in mixtures was reduced to 0.25% and 0.10%, respectively (Table 1). The mixtures for chicken in the experimental groups (K+, O-I+ and O-II+) were supplemented with phytase of the producer Alltech, USA (250 PU/kg). During the experiment, that lasted 42 days in three phases (1-21, 21-35 and 35-42 days), performances were investigated. Control measurement of the experimental broiler determined the average body weight, and the difference of body weight in total gain, while the daily gain was calculated on duration of the whole trial. During the experiment total quantity of the mix given to the groups was measured. From the obtained data on consumption and gain, feed conversion was calculated.

At the end of the trial body mass of all the animals was monitored, but one out of 10 was sacrificed by the method of random choice for further examination. Every broiler was measured before and after sacrifice, and also after cooling the carcasses. Cooling was carried out by combined continual procedure (water – air) lasting 110 minutes. The final temperature of 4^{o}C was achieved and the carcasses were dry.

The carcasses were prepared and processed as "ready to cook" – with giblets and "oven ready carcass" - without giblets procedure, than dressed for determining yield and proportion of some parts, but also ration of tissue in more valuable parts of the trunk (breast, thigh and waiter thigh).

Dressing percentage was calculated as the difference between cooled carcass and body mass before slaughter, whereby abdominal fat was measured separately.

Results and discussions

Body mass range, average daily weight gain and food conversion values are summarized in Table 2. Body mass, average daily weight gain and food conversion values in the control group (K) were within the margins of technologic normative for Arbor Acres provenience. It is to be emphasized that values for cited parameters were somewhat higher in broilers fed diets containing recommended phosphorus content and phytase supplement. Reduction of phosphorus content in diets for experimental groups resulted in corresponding reduction of body mass, daily weight gain and food conversion rate, and differences among groups were highly significant ($p<0,01$). Supplementation of phytase to low-phosphorus diets substantially increased the body mass, daily weight gain and food conversion rates in the experimental groups ($p<0,01$); however, the effect was not sufficient to reach the corresponding parameter values in the control groups.

Similar values for body mass in broilers fed diets containing approximately same calcium and phosphorus concentrations and phytase supplement are reported by Perney et al. (1993), Simons and Versteegh (1993), Rutkowski et al. (1997) and Ahmad et al. (2000). Effect of phytase on body mass increase was, however, not sufficient to provide the same body mass increase rate as in the

control groups. This strongly supports the thesis that phytase-related phosphorus content in broiler diets is determined not only by phytase content, but also by the total phosphorus and calcium concentration in the diet (Rama Rao et al., 1999).

Table 2.

Body weight, daily gain and feed conversion ratio of experimental broilers

	BODY WEIGHT [G]
GROUP	**42 DAY**
K	2216.1 ± 268.6^{x}
K+	2259.5 ± 313.0^{x}
O-I	1865.0 ± 234.0^{y}
O-I+	1973.7 ± 246.8^{y}
O-II	1282.2 ± 259.2^{z}
O-II+	1388.6 ± 295.0^{w}
	Daily gain [kg]
GROUP	**1 - 42 DAY**
K	51.11 ± 6.42^{x}
K+	54.10 ± 7.33^{x}
O-I	43.51 ± 5.56^{y}
O-I+	46.11 ± 5.87^{y}
O-II	29.65 ± 6.20^{z}
O-II+	32.18 ± 7.01^{z}
	Feed conversion ratio [kg]
GROUP	**1 - 42 DAY**
K	1.76
K+	1.73
O-I	1.87
O-I+	1.76
O-II	1.72
O-II+	1.92

**Values exspresed as* $\bar{X} \pm Sd$ ^{a,b} $p < 0.05$ ^{x,,y,z,w,q} $p < 0.01$

The dressing percentages and share of the parts of carcass in the mass of experimental broilers before slaughter are displayed in the Table 3. From these data it can be noticed that the yield or carcasses in the procedure "ready to cook" and "oven ready" have almost no difference in nutrition between the groups with recommended level of total phosphorus regardless to phytase supplement. Reducing the level of phosphorus in the mix yield of the carcass decreases, and the differences are expressed proportionally in reducing phosphorus. Negative effect of phosphorus deficiency is somehow alleviated by adding the mix with lower content of phosphorus.

Some effects were noticed according to the findings of Lukić (2001) who reports on mild negative trend of dressing percentages proportional content of total and available phosphorus in a diet. The results are according to Rutkowski et al.

(1997). On the bases of a trial with the broilers fed by mix based on maize–rape-seed oil meal with different level of total phosphorus and calcium, and different quantity of phytase, the authors report on positive influence of the enzyme on dressing percentage and meat yield. On the other hand, the obtained results are not according to data of Lević et al. (1997) who report on the increase of slaughter yield in broilers fed by mix with lower content of phosphorus than recommended, with simultaneous using of phytase. The results in examining portion of edible parts of the carcass are in considerable proportion according to the reports by Ellen et al. (1973), Zurovac-Kuzman (2001) and Lukić (2001).

Table 3.

Slaughter analysis, % of live body weight.

Dressing percentage (%)		
GROUP	**Ready to rost (%)**	**Oven ready carcass (%)**
K	74.67 ± 2.00 $^{a, x}$	69.43 ± 2.49 ^{x}
K+	74.07 ± 1.08 $^{a, x}$	69.06 ± 1.03 ^{a}
O-I	72.56 ± 2.45 ^{a}	67.44 ± 2.24
O-I+	73.96 ± 1.69 ^{a}	68.87 ± 1.64 ^{a}
O-II	70.19 ± 4.90 ^{b}	65.04 ± 5.18 ^{y}
O-II+	71.35 ± 3.43 $^{b, y}$	65.98 ± 3.90 $^{b, y}$

Share of some parts of chicken carcases (%)			
GROUP	**Thigh (%)**	**Waiter thigh (%)**	**Breasts (%)**
K	10.07 ± 0.65 ^{a}	11.72 ± 0.46 ^{x}	22.27 ± 2.05 $^{a, x}$
K+	10.33 ± 0.63	12.22 ± 0.54 $^{a, x}$	23.26 ± 1.40 ^{x}
O-I	10.13 ± 0.65 ^{a}	11.38 ± 0.64 $^{b, x}$	21.63 ± 1.79 ^{a}
O-I+	10.81 ± 0.49 ^{b}	12.00 ± 0.52 ^{x}	21.15 ± 1.99
O-II	10.61 ± 0.84	10.74 ± 1.70 ^{y}	19.93 ± 2.55 $^{b, y}$
O-II+	10.09 ± 0.73 ^{a}	10.22 ± 0.91 ^{y}	19.20 ± 4.15 $^{b, y}$

**Values exspresed as* $\bar{X} \pm Sd$ ^{a,b} $p < 0.05$ ^{x,,yq} $p < 0.01$

Besides sporadic statistically important differences, it can be concluded that shares of thigh in mass of animal before slaughter does not depend from the treatment. However, waiter thighs and breasts in the body mass of animals before the slaughter decreased proportionally to reducing the content of phosphorus in mix. Adding of phytase in mix only alleviated negative consequences of relative or absolute deficiency of phosphorus but only in the case of thigh, while the similar effect were not present in the proportion of breasts. The obtained results are in accordance to Lukić (2001) who reports that the parameters monitored in the broilers fed by mix with lower phosphorus level than recommended were not importantly different comparing to the same parameters in the control group of broilers.

Conclusions

On the bases of the obtained results from the experiment, we can bring up the following conclusions:

- adding phytase in a mix gives better production results, that is reflected in production number;
- reducing phosporus contect in the mix, dressing percentages and slaughter yields declines, but the differences are expressed in proprotional reduction of phosphorus. Adding of phytase into mix is allevated to a certain level;
- share of thigh in the body weight before the slaughter was not influenced by the treatment. However, share of thigh and breasts in the mass of animals before the slaughter was reduced proportionally to reducing the content of phosphorus in mix. Addition of phytase in mix only alleviated negative consequences of relative of absolute deficiency of phosphorus only in the case of waiter thighs, while the similar effects were not present in case of the breasts share.
- Using microbial phytase may be applied, followed by certain reduction of dietary phosphorus and calcium.

References

1. **Ahmad T, Rasool S, Sarwar M, Ahsan-ul Haq Zia-ul Hasan:** Effect of microbial phytase produced from a fungus Aspergillus niger on bioavailability of phosphorus and calcium in broiler chickens. Animal Feed Science and Technology, 83, 2, 103-14, 2000.
2. **Broz, J.** (1993): Enzymes as feed aditives in poultry nutrition – Current applications and future trends. Monatshefte fur veterinarmedizin 48, 4, 213-7, 1993.
3. **Ellen L., Bouwkamp E., Bihbee C., Wabek J**.: Strain influences on broiler parts yields. Polut. Sci., 52, 327-33, 1973.
4. **Lević J., Stojanović S., Ševković N., Isakov V., Sredanović S., Popović V., Džinić N**.: Oplemenjivanje suncokretove sačme upotrebom enzima. VII Simpozijum tehnologije stočne hrane, Tara, 266-76, 1997.
5. **Lević J., Sredanović S**.: Enzymes in broiler chicken feeding. - Biotechnology in Animal Husbandry, 15 (5-6), 297-302, 1999.
6. **Lukić M**.: Uticaj fitaze u ishrani brojlera na proizvodne rezultate i zdravstveno stanje, , Magistarska teza, Poglavlja 5.6 i 6.6, Veterinarski fakultet Beograd, Katedra za ishranu, 2001.
7. **NATIONAL RESERCH COUNCIL**: Nutrient Requirements Of Poultry, National Academy Press, Washington D.C., 1994.
8. **Perney K.M., Cantor A.H., Straw M.L., Herkelman K.L.:** The effect of dietry phytase on growth performance and phosphorus utilization of broiler chicks. Poult. Sci., 72, 2106-14, 1993.

9. **Rama Rao S.V, Ramasubba Reddy V., Ravindra Reddy V.:** Non-phytin phosphorus requirements of commercial broilers and White Leghorn layers. Animal Feed Science and Technology, 80, 1-10, 1999.
10. **Ristić M**.: Development trends in the poultra production-yesterday, today and tomorrow, Tehnologija mesa, 42, 5-6, 327-43, 2001.
11. **Rutkowski A., Sliwinski B., Wiaz M.:** The use of phytase in broiler chicken diets containig maize and soyabean or rapeseed meal. Journal of Animal and Feed Sciences, 6, 533-40, 1997.
12. **Simons P.C.M., Versteegh H.A.J.:** Role of Phytases in poultry nutrition. Enzymes in animal nutrtion, Proceedings of the 1st Symposium Kartause Ittingen, Switzerland 181-6, 1993.
13. **Tolimir Nataša, Petrović D., Petrović Milka, Matić M., Maletić Radojka, Bogosavljević-Bošković Snežana**: Uporedno ispitivanje proizvodnih i klaničnih osobina tri provenijence brojlerskih pilića, Savremena poljoprivreda, 51, 3-4, 223-6, 2002.
14. **Zurovac-Kuzman, O.**: Efikasnost modifikovanog klinoptiolita u ublažavanju toksičnih efekata ohratoksina A na proizvodne rezultate i kvalitet mesa brojlera. Doktorska disertacija, Katedra za ishranu, Fakultet veterinarske medicine, Beograd, 2001.
15. **Živkov-Baloš M., Mihaljev Ž., Mašić Z**.: Mogućnosti korišćenja različitih izvora fosfora u ishrani živine, Savremena poljoprivreda, 51, 3-4, 227-30, 2002