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BIOTECHNOLOGICAL SOLUTIONS FOR THE GROWTH STIMULATION OF BROILERS

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Invited paper

Abstract: "Biotechnology" is a term that includes the complementary use of biology and technology in livestock production. In order to managed to maintain, feed industry, because of the more significant changes in habitual and edible habits of the people, as well as new regulatory requirements, should respect the opinion of the consumer and try to offer a safe animal products whose production does not pollute the environment. As a basic tool of biotechnology during the past decade has imposed the introduction of alternative solutions that are intended to improve feed efficiency and consequently improve production results of farmed animals. In order to stimulate growth in broilers, commonly have been used enzymes, chelating forms of trace elements and in recent years more attention is paid to the use of probiotics. The aim of the adding the enzyme is addition to activity of endogenous enzymes of animals, elimination of anti nutritional factors, increasing energy and nutritional value of feed and decreasing the excretion of less usable nutrients in the environment. Today of practical importance are enzymes of NSP and cellulolytic complex, protease, amylase and phytase. Our trials have shown that the use of amylase allows the use of meals with lower energy content (5%) with no negative impact on performance and also lowers the value of consumed feed per kilogram of gain. Use of phytase in the quantity of 1000FU/kg can replace about 30% of the total, or 50% of available phosphorus in diets for broilers without significant changes of production results. Probiotics are ecological way of control pathogenic bacteria and the ability to stimulate the growth by using physiological potentials and mechanisms of animals. The results of our research with the use of different bacterial cultures have shown the positive effects on weight gain with less consumption of feed and consequently better feed conversion. Beside the inorganic forms of minerals today are increasingly used so-called "chelating" forms, or organically bound trace elements. It was observed that the minerals associated with the amino acid or peptide is better protected during the passage through the stomach to the site of absorption than inorganic salts. Results

obtained in testing of using organically bound selenium pointed to the positive impact on the increase in carcass weight and meat yield of broilers that received chelating form of selenium. Summing up the obtained results of investigations that have been carried out, we are able to draw the conclusion that the use of growth promoters as a biotechnology solution in broilers diet has its nutritional, medical and economic justification.

Key words: broilers, biotechnology, growth stimulants, probiotics, enzymes

Introduction

"Biotechnology" implies the complementary application of biology and technologies in livestock production. In order to managed to maintain feed industries, due to the pronounced changes in habitual and edible habits of the people, as well as new regulatory requirements, should respect the opinion of consumers and try to provide a safe animal products whose production does not pollute the environment. Modern intensive livestock production places heavy demands in front of the organism of domestic animals where one of the imperatives of industrial animal keeping is to achieve as lower feed consumption per unit gain in the shortest possible time. The production of broiler meat during the last years records a rise in the world and represents 85.56% of the total poultry meat production (*Bigili*, 2002). Based on the evaluation, production of chicken meat should be noted a further increase due to several factors-good conversion compared to other species, it is accepted by all cultures and religions, a small amount of fat and a large quantity of meat, from a health point of view attractive properties, low price, fast and quick reproductive cycle. According to estimates of Anonymous & FAO (2002) it is expected in 2015 to produce 100 million tons and in 2030 even 143 million tons of chicken meat. However, it is unrealistic and impossible to expect optimal performance in production if it is not successful and adequate solved the issue of their nutrition. Diet must contain all the necessary nutrients that will satisfy not only the needs of animals to sustain life, but also for their production (*Šefer*, 2002). As a basic tool of biotechnology during the past decade has imposed the introduction of alternative solutions that are intended to improve feed efficiency and consequently improve production results of farmed animals. To get a better feed efficiency, longer preservation, easier handling, and ultimately increase production and improve the quality of food of animal origin, beside the basic nutrients, feed mixture contains a number of additives that have different purposes. Additives are substances added into the meal in small quantities,

emphasizing useful and suppressing harmful effects (*Sinovec* i Šefer, 2004). Recently, special attentions of the scientific community, and certainly the consumer, have caused growth stimulants. Data of the results of using different growth promoters are incomplete and often contradictory, which increases the importance and timeliness of this issue. In broilers nutrition as growth stimulants commonly are used enzymes and chelate forms of microelements and during the recent years, increased attention is paid to the use of probiotics.

Application of enzymes in broilers nutrition

Enzymes (former ferments) are protein catalysts of chemical reactions in the organism and other biological systems. By the texture they are proteins and have a role to accelerate the chemical reactions, needed in small quantities and they do not deplete during the reaction. Enzymes help the complex chemical reactions in the body to conduct strictly controlled at relatively low temperatures (37 ° C or lower), with nearly neutral pH. The importance and effectiveness of using the enzymes in food stems are not only from the knowledge of physiological characteristics of nutrition of individual species and categories of animals, but also the knowledge of forms and amounts of certain nutrients and anti-nutritional substances in the plant feed. Enzymes, as well as the positive effects of their use in order to improve the nutritional value of meals have been known for years. Today, as food additives, of practical importance are enzymes of cellulolytic e complex (cellulase and pectinase), NSP complex (β-glucanase, xylanase, β-galactosidase), protease, amylase and phytase.

In human and animal nutrition the most important polysaccharide is starch. It is a major reserve nutrient of plant organisms and also the main source of energy in the diet of broilers. Grain contains about 60-80% starch and legumes 40% (Šefer and Sinovec, 2008). Starch in plants is in the form of small granules (cells) in which there are hydrogen bonds which make them resistant to water penetration and hydrolytic enzymes that break it down by hydrolysis. *Noy and Sklan (1995)* found that the ileal digestibility of starch is about 85%. Several important parameters affects the digestibility of starch (*Tester and Karalas 2006):* structure of the starch, form of granule, content of amylose, the amount of double helices in the starch grain, size and a mixture of granules. *Helbert et al. (1996)* have identified several steps in the breakdown of starch by α amylase:

1) Diffuse deployment of the enzyme on the surface of granules.
2) Start of hydrolysis.
3) The centripetal hydrolysis leading to the formation of the channel pores that leading to the central part of the grain.

4) Centrifugal degradation of granules which starts by enzymes breaking through inside it.

Exact data on effects of using α-amylase are few, and to a large extent contradictory.

Zanella et al. (1999) claimed that the digestibility of starch can be increased by the use of enzymes in 37-day-old broilers by 1.8%. *Noy and Sklan* (*1995)* reported that the secretion of amylase in the duodenum of broilers is low in the first 4 days of life and gradually increases up to 21 days. On the other hand *Uni et al. (1995)* found that the secretion of amylase in the duodenum of broilers is also low in the first 4 days of life, but it only grows up to 7 days after which the secretion of amylase is stabilized. *SL Vieira et al. (1994)* carried out the experiment on Cobb provenance of broilers where the control group was fed a diet of standard raw and chemical composition. Experimental groups were fed identical diets as the control group, but the content of energy was less than the control by 60, 90 and 120kcal/kg. Experimental group which had the energy value less for 120kcal/kg were added the 200, 300 and 400 g / t Ronozyme A (200 kilo α-amylase units / gram). Adding of enzymes fully compensated lower energy value of the meal. *Gracia et al. (2003)* performed an experiment in order to examine the impact of adding amylase on production performances of broilers fed diets based on corn and soybeans. Adding enzyme α-amylase in broiler ration in the experimental group resulted in greater weight gain (4.7%) improved consumption (3,78%) and a lower conversion (1,3%) of food compared to the control group of broilers. The aim of the experiment conducted by *Pavlović (2008)*, which was set up under the guidance of Department of Nutrition and Botany, Faculty of veterinary medicine (FVM) in Belgrade, was to monitor production performances and health of broiler chickens fed diets with standard raw and chemical composition and the diets with reduction of energy followed by the addition of α-amylase. The experiment was conducted on a total of 100 broilers, divided into two equal groups of 50 animals. The first group of chickens (control) was fed with complete feed mixtures for fattening broilers based on standard raw components and chemical composition, without enzymes. The second group (experimental group I) was fed diets in which the energy content was decreased by 5% with the addition of the enzyme α amylase 40 KNU per kg of complete feed mixture. In the middle of the experiment (21. day) broilers of the experimental group I have achieved significantly lower ($p < 0,01$), body weight (698,40 g) compared to broilers of the control group (745,40 g). At the end of the experiment (42 days) broilers fed diets added with α-amylase (experimental group I) achieved numerically higher body weight (2241g) compared to the control group of broilers (2193g) without statistically significant differences ($p > 0,05$). During the first phase of the experiment (from 1 to 21 days) experimental group I achieved a lower weight gain (33,26 g) compared to the control group (35,45 g), but the difference was statistically significant ($p < 0,001$) . In the second phase (from 21 to 42 days) that experimental group fed a diet

supplemented with α-amylase (experimental group I) achieved higher daily weight gain (73,24 g) compared to the control group of broilers (69,01 g), with differences that were highly significant (p <0,001). Differences in body weights and daily gains showed that the largest effect of addition of α-amylase activity were expressed during the second period of fattening (21.- 42. day) that coincides with the results of *SL Vieira et al. (1994), Gracia et al. (2003)* and *Yuste et al. (1991)* who found that the digestive tract in 21 day old chicks is not fully developed and able to digest starch so that there is a good reason to add α-amylase in the later stages of broilers life. Throughout the entire experiment from 1 to 42 days (*Pavlovic*, *2008)* experimental group of broilers fed diets supplemented with α-amylase (experimental group I) achieved higher average daily gain (53,25 g) compared to the control group of broilers (52,23 g) without statistically significant differences (p> 0,05). Observed for the entire experiment, broilers fed diets in which the energy content was decreased by 5% with the addition of amylase achieved better conversion (1,827) compared to the control (1,837). These results are consistent with the findings of *SL Vieira et al. (1994), Gracia et al. (2003)* who found that the addition of α-amylase in broiler diet improved feed conversion.

The use of selenium and vitamin E in the diet of broilers

Selenium is an essential element in the poultry nutrition and participated in protection against exudative diathesis and pancreatic fibrosis, and supports the activity of glutathione peroxidase. Selenium together with Vitamin E represents a multi-component system that protects biological membranes from oxidative degeneration. The recommended concentration of vitamin E in diets for broilers is 15-20 mg / kg feed. Numerous studies have shown that the use of significantly higher amounts of vitamin E is an effective way to improve the quality and sustainability of broilers meat (*Janssens,* 1998). Daily needs for selenium during the intensive farming is 0,15 mg / kg (*National Research Council NRC*, *1994*). Selenium which is used as an additive in vitamin mineral premixes can be in one of two basic forms: organically bound to amino acids or as inorganic salt (usually sodium selenite). The richest sources of selenium are inorganic sources, or certain salts of selenium (selenite, selenate). Beside the inorganic forms, often is used organically bound selenium ("chelated"). Organically bound selenium has two important advantages:
Animals can deposit it for periods when the need for it increases (eg, when selenium deficient diet or stress). Selenium content of meat increases along with the addition of Se-amino acids, which includes it in the food chain of people.

Adding selenium in substrate resulted in production of the so-called "selenium yeast" in which the most of Se is incorporated into the Se-methionine, selenium form that is easily absorbed by all animal species (Marković et al., 2011). Great number of researchers have confirmed in their experiments reasonable

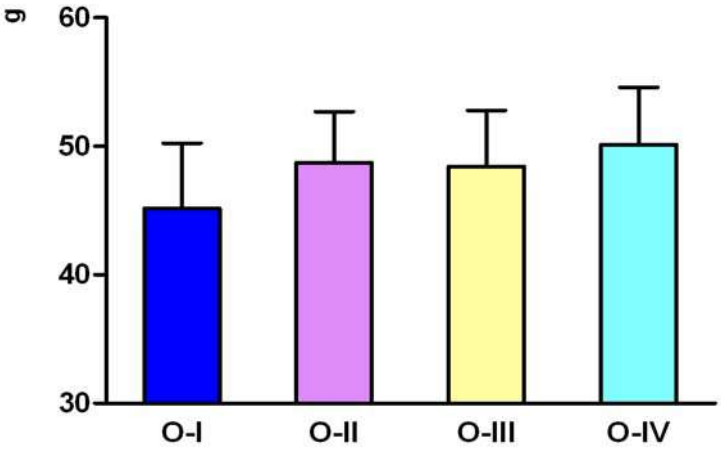
substitute of inorganic form with organic selenium (Sel -Plex), showed by better results in the production of broilers. *Edens* (*2001*) in trials with broiler chickens showed that the final body weight at 42. day in the control group (food containing selenium in an amount from 0,28 mg / kg without subsequent addition of selenium) was 2,38 kg. After the addition of inorganic selenium (0,2 mg / kg) body weight was 2,43 kg, and after the addition of Sel-Plex (0,2 mg / kg) it was 2,45 kg. The positive effects of Sel-Plex on conversion confirmed the trials of *Edens et al*., (*2001*). Effect of organic selenium (0,15 ppm) on the growth performances and mortality have been showen by a *Stolić et al*. 2002) in experiments on broilers. Growth rate was better by 4,2% and conversion by 9,8% when used Sel-Plex, compared to the group that received the same amount of sodium selenite in feed. The experiment in Brazil (*Arruda et al., 2004*) performed at 2400 Ross broiler hybrids (1-42 days old), adding 0.1 ppm selenium (Sel-Plex) in combination with 0,2 ppm selenium (as sodium selenite) resulted in an improved growth and conversion in comparison with the group of broilers that received 0,3 ppm of sodium selenite in feed. Highest body weight, weight gain and the best conversion was obtained in experiments in which broilers were supplemented with 12,50 mg / kg Se and 300 IU of vitamin E (*Swain et al., 2000*). The combination of 0,3 ppm organic selenium and 250 mg / kg of vitamin E affected the mortality reduction, the positive effect in stressful conditions and improved production performance in broilers (*Roch et al*., *2000*). In the experiment (M*arkovic*, *2008)* which was organized by the Department of Nutrition and Botany FVM in Belgrade, the main task of the study was to determine the effect of feeding broilers diets with different sources of selenium and different amounts of vitamin E on the performance and health of broilers. The trial lasted 42 days and included a 240-day old chickens of Cobb 500 provenance, both sexes, average initial body weight of 41,25 ± 2,97g divided into four equal groups of 60 animals in each. All groups were fed with standard raw and chemical composition feed mixtures predicted for a given provenance with the difference in the amount and type of additive, as shown in Table 1.

Table 1. Content of selenium and vitamin E in the diets, [mg / kg DM feed]

Groups	Selenium		Vitamin E
	Sodium selenite	Sel-Plex	
Experimental -I	0,3	-	20
Experimental -II	-	0,3	20
Experimental -III	0,3	-	100
Experimental -IV	-	0,3	100

At the end of trial (42. day) the average body weight of broilers of the experimental group-I was 1938,46 ± 215,16 g and was significantly lower ($p < 0,01$) compared to

the average weight of broilers in the experimental groups II, III and IV (experimental group-II 2087,74 ± 168,68 g, experimental group-III 2079,09 ± 184,39 g and experimental group-IV 2146,79 ± 189,48 g). There were no significant differences (P> 0,05) between the average weight of broilers of II, III and IV experimental group. Daily weight gain of broilers is shown in Figure 1. During the all stages of fattening, experimental group II, III and IV achieved a statistically significant (p <0,05) to highly significant (p <0,01), higher weight gain compared to the experimental group-I. These results are in agreement with the statements of many authors (*Anciuti et al., 2004 Srimongkol et al.*, *2004; Edens and Gowdy, 2004*).



* O-I, O-II, O-III, O-IV (experimental group-I, experimental group-II, experimental group-III, experimental group-IV, respectively)

Figure 1. Daily weight gain of broilers during the experiment 1-42nd day [g]

Feed conversion of broilers in experimental groups II, III and IV was lower than in the experimental group-I during all phases of the experiment. The experimental group-IV achieved the best feed conversion (2,01 kg of feed per kg of weight gain). Broilers of experimental groups II, III and experimental group-I had a higher conversion (1,49%, 3,48%, 5,97%, respectively) compared to the broilers of experimental group-IV. The results of the conversion are in agreement with the results *Anciuti et al. (2004), Naylor et al, (2000), Edens and Gowdy (2004)*.

The use of probiotics as growth promoters.

Probiotics were originally described as micro-organisms and substances which contribute to the maintenance of the intestinal microbial balance and "eubiosis" *(Lilly and Stillwell, 1965)*. Subsequent definitions considered probiotic as supplements of live microorganisms that cause beneficial effects in animal hosts by maintaining eubiosis, which excluded antibiotics from this term *(Parker, 1974; Fuller, 1977; Vanbelle et al., 1990)*. Lately, more often is used the term DFM (direct fed microbial), which implies a source of viable microorganisms, including bacteria, fungi and yeasts *(Milles and Botwalla, 1991)*. In gastrointestinal tract develops a large number of bacteria, which may be characterized as a protective, supportive, neutral or harmful *(Hakkinen et al., 1997)* Probiotics represents environmentally friendly way to control pathogenic bacteria and possibility of stimulating the growth based upon physiological potential and mechanisms of animal. By using the probiotics it can be achieved similar effects as with the use of antibiotics without possible side effects such as residues, waiting period, resistance, allergies, genotoxicity, etc.(Šefer et al., 2011). Beneficial microflora acts in two ways in the digestive tract: antagonistic activity against pathogenic bacteria and competitive exclusion. Antagonistic activity of lactic acid bacteria toward pathogens is possible thanks to the production of bactericidal substances such as bacteriocins, organic acids and hydrogen peroxide *(Gilland and Speck, 1977)*. Competitive exclusion (CE - competitive exclusion) is a complex of interplay of microbes, nutrients and host factors that selectively prevent specific groups or genera / species / strains of microorganisms that inhabit the intestinal tract *(Stavric et al., 1985; Blenkenship et al., 1990)*. Beside the competitive mechanisms, *Dunham et al (1993*) consider that the poultry feed diet supplemented with the *L. reuteri* has longer villi and deeper crypts in the ileum, which affect the intensification of activity of T-lymphocytes and increases the synthesis of IgM antibodies against Salmonella. *Nahashon et al. (1994a, b)* adds that the use of lactobacilli increases cellularity of Payers plate in ileum through which stimulates the immune system of the mucosa, which corresponds to antigen stimulation by production of immunoglobulins (IgA). Some experiments conducted on broilers heve suggested that probiotic products increased the growth, improved feed conversion and significantly reduced mortality *(Tortuerro, 1973, Tortuero et al., 1989, Watkins et al., 1982, Han et al., 1984; Meluzzi et al., 1986; Owings et al., 1990; Mohan et al., 1996; Marković et al.,2008)*. By examining the effect of adding culture *L. Acidophilus* to the feed for broilers on production results it has been established an increase in daily gain. With the identical consumption broilers achieved slightly better feed conversion *(Petersen, 1998)*. It should be noted that some studies with probiotics passed without positive results in broilers *(Watkins*

and Kratzer, 1984; Maiolini et al., 1992) and laying hens *(Goodling et al., 1987)*. In a series of experiments *(Jin et al., 1996a; 1997)* were identified the positive effects of the use of monocultures or a mixture of lactobacilli and other bacteria on the growth performances of broilers. The results of trials conducted on Arbor Acres broilers hybrids *(Jin et al., 1996a)* indicate that by the use of lactobacilli as a nutritional supplement broilers achieved significantly greater weight gain, with the recommended use in the amount of 0,1% DM of food. *Jin et al. (1998)* investigated the impact of adding 0,05% to 0,015% adhesive *Lactobacillus* cultures in the mixture for broilers on growth performances. They found a significant increase in body weight of broilers (1,91 vs. 1,98-2,08 kg) and decreased feed conversion ratio (2,00 vs. 1,74-1,88 kg) by adding probiotics in the amount of the 0,05% and 0,10% but not by using a feed mixture with 0.15% (1,93 and 1,95 kg), which is in accordance with results of other authors *(Kim et al., 1988; Jin et al., 1996a; Mohan et al., 1996; Yeo et al. 1997)*. *Newman (1999)* reported the results of experiments performed in order to investigate the effect of probiotics on the performance of broilers. Using *L. acidophilus* in the amount of 0,1% DM of feed broilers have accomplished a higher body mass by 1,1% and improved feed conversion by 0,6%. Statistical differences in mortality between the groups were not determined, but the mortality was numerically lower in the treatment group. *Radakovic* (2001) set the trial under the guidance of the department of nutrition and botany, FVM in Belgrade with the aim of determining the effect of different type of probiotics on the growth performances of broilers. For the experiment it was used 204 one-day old broiler chickens Arbor Acres provenance, both sexes, average body weight 40,07 ± 0,33 g, divided into four equal groups of 51 individuals in each. The first group of chickens (control) was fed with complete feed mixtures for fattening broilers, made of standard raw components and chemical composition without the addition of probiotics, while the experimental group, in order, received the same meal as the control but with the addition of certain probiotics: Probios, Paciflor and Bioplus - 2B as presented in Table 2.

Table 2. Contents of different probiotics in diets, %

Probiotic, %	group			
	Control group-K	Experimental group -I	Experimental group -II	Experimental group - III
Probios	-	0,10-0,05	-	-
Paciflor	-	-	0,01-0,005	-
Bioplus – 2B	-	-		0,05

At the end of the experiment all experimental groups achieved higher body weight of 1,00 to 4,36% compared to the control group-K. When looking at the daily weight gain for the entire trial, 1-42. day, we can see the better weight gain in the experimental groups compared to the control and these differences were not statistically significant (p> 0,05) with the best results in Experimental group -III (50,70 g) compared to Control group-K (48,50 g). The results are consistent with the results of Jin et al. (1998) who investigated the impact of adding 0,05% to 0,015% adhesive cultures of *Lactobacillus* in the mixture for broilers on the growth performances and find out a significant increase in body weight of broilers (1,98-2,08 vs. kg 1,91) and decreased feed conversion ratio (1,74-1,88 vs. 2,00). With regards to the daily feed consumption for the entire experiment 1.- 42. day, Experimental group-I (99,52g), Experimental group-II (105,00g) and Experimental group-III (103,81g) had a lower consumption compared to the control group-K (105,48g). The movement of food conversion in the experiment during the all stages is presented in Table 3.

Table 3. Trend of feed conversion per phases of the experiment (kg)

Period of the experiment (days)	groups			
	Control group-K	Experimental group-I	Experimental group-II	Experimental group-III
1-21	1,75	1,60	1,69	1,80
21-35	2,19	2,20	2,20	2,07
35-42	2,79	2,29	2,62	2,34
1-42	2,17	2,03	2,13	2,05

In the last stage of fattening, as well as during the entire experiment all experimental groups acomplished better feed conversion ratio compared to the control group of broilers, (1.90 up to 6.50%), which is consistent with the findings of most researchers dealing with a given problem *(Tortuerro , 1973, Tortuero et al., 1989, Watkins et al., 1982, Han et al., 1984; Meluzzi et al., 1986; Owings et al., 1990; Mohan et al., 1996; Kalavathy et al 2003).*

Conclusions

Based on the results of our own experiments set up in the Department of Nutrition and Botany FVM in Belgrade and confirmed with the results of numerous national and international authors, we can derive the following conclusions:

1. Adding α amylase enzyme allows the use of a meal with lower energy content (5%) with no negative impact on the performance of broilers.

2. Feeding broilers with complete mixture enriched with organic selenium (selenized yeast and vitamin E) leads to a significant increase in production results in all phases of it.
3. The use of probiotics in broilers nutrition has given a positive impact on performance without negative impact on health.
4. The use of enzymes, organic selenium and probiotics as a biotechnological solutions for better feed efficiency in fattening broilers have their nutritional, medical and economic justification.

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Biotehnološka rešenja u stimulaciji rasta brojlera u tovu

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Rezime

„Biotehnologija“ je izraz koji podrazumeva komplementarnu primenu biologije i tehnologije u stočarskoj proizvodnji. Da bi industrija hrane za životinje uspela da se održi, zbog sve izraženijih promena habitualnih i jestivih navika ljudi, kao i novih zakonskih regulativa, treba da uvaži mišljenje potrošača i da pokuša da ponudi bezbedne proizvode animalnog porekla čijom se proizvodnjom ne zagađuje životna sredina. Kao osnovno oruđe biotehnologije u poslednjoj deceniji se nametnulo uvođenje alternativnih rešenja koja imaju za cilj poboljšanje iskorišćavanja hrane i posledično poboljšanje proizvodnih rezultata gajenih životinja.

U ishrani brojlera u silju stimulacije rasta najčešće se koriste enzimi, helatni oblici mikroelemenata a poslednjih godina sve veća pažnja se poklanja upotrebi probiotika.

Cilj dodavanja enzima je dopuna aktivnosti endogenih enzima životinja, otklanjanje antinutritivnih materija, povećanje energetske i hranljive vrednosti hraniva kao i smanjvanje izlučivanja slabije iskoristivih hranljivih materija u spoljašnju sredinu. Danas su od praktičnog značaja enzimi celulolitičkog i NSP kompleksa, proteaze, amilaza i fitaza. Naša istraživanja su pokazala da upotreba amilaze omogućava korišćenje obroka sa nižim sadržajem energije (5%) bez negativnog uticaja na proizvodne rezultate a ujedno snižava vrednost utrošene hrane po kilogramu prirasta. Upotrebom fitaze u količini od 1000FU/kg moguće je

zameniti oko 30% ukupnog, odnosno 50% iskoristivog fosfora u smešama za brojlere bez značajnijih promena proizvodnih rezultata.

Probiotici predstavljaju ekološki način kontrole patogenih bakterija i mogućnost stimulacije rasta korišćenjem fizioloških potencijala i mehanizama životinja. Rezultati naših istraživanja pri upotrebi različitih kultura bakterija ukazuju na pozitivne efekte na visinu dnevnog prirasta uz manju konzumaciju hrane I posledično bolju konverziju hrane.

Pored neorganskih formi mineralnih materija danas se sve više koriste tzv. „helatne“ forme, odnosno organski vezani mikroelementi. Zapaženo je da su minerali vezani sa aminokiselinom ili peptidom bolje zaštićeni za vreme pasaže kroz želudac do mesta resorpcije nego neorganske soli. Rezultati koje smo dobili u ispitivanjima upotrebe organski vcezanog selena ukazala su na pozitivan uticaj na povećanje mase trupa i prinosa mesa kod brojlera koji su dobijali helatni oblik selena u hrani.

Sumirajući dobijene rezultate sprovedenih istraživanja u prilici smo da izvedemo zaključak da korišćenje stimulatora rasta kao biotehnoloških rešenja u ishrani brojlera ima svoje nutritivno, medicinsko i ekonomsko opravdanje.

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