KRMIVA

UTJECAJ U SMJESE DODANIH POLIZYM^R PREPARATA NA PERFORMANCU BROJLERA*

INFLUENCE OF POLIZYMES^R ADDED IN FEED ON THE BROILER PERFORMANCE*

Gordana Kralik, Đ. Senčić, Zlata Maltar and B. Mandić

Izvorni znanstveni članak
UDK: 636.5 : 636.087.63.7
Primljeno: 23. listopad 1993.

SAŽETAK

Svrha istraživanja bila je da se ustanovi utjecaj dodavanja polienzimskih preparata (1. skupina kontrola, 2. skupina Polizym^R, 3. skupina Polizym^R-G i 4. skupina Polizym^R-BX) na tovna i klaonička svojstva pilića. Istraživanje je započeto s 200 jednodnevnih seksiranih pilića muškog spola provenijencije Avian K-24 a trajalo je do dobi pilića 42 dana. Prosječna živa masa kontrolne skupine pilića iznosila je 2075 g, a prosječne mase pokusnih skupina pilića bile su 2117 g, 2144 g i 2160 g. Konverzija hrane istim redoslijedom je iznosila: 2050 g : 1963 g, 1990 i 1971 g. Izračun proizvodnog broja, prosječnih stopa i faza rasta u tovu potvrđuje učinkovitost dodanih polienzimskih preparata u smjesu. Najbolji učinci postignuti su dodavanjem Polizym^R preparata u smjese za tovne piliće. Istraživanjem kakvoće trupova i fizikalno-kemijskih svojstava mišića prsa i nadbataka ustanovljeno je da su dodani polienzimski preparati u smjese utjecali na tvorbu mesa zadovoljavajuće kakvoće.

Introduction

The choice of poultry feedstuffs and the mixture composition characteristics for the feeding depends on the anatomical and physical characteristic of the digestive system. Maize represents the basic component in the feedstuffs while the usage of wheat, barley and oat is limited because of the poor digestibility of the nutrients of these crops. Addition of enzymes improves the nutritive and economic effects of poultry mixtures (DIERICK, 1989; HOTTEN, 1991; RAJMANE, 1992). The enzymes improve the digestion and the decomposition of more complex molecules into simpler ones, which the organism easily resorbs (HOTTEN, 1991) and they also increase the digestibility of nutrients and the energic feed value (FRIESEN et al., 1992). The proteoses help in the decomposition of proteins, starch amylase, while the cellulolitical enzymes (cellulase, β-glycanase and β-glycosidase, etc.) influence the decomposition of poly- and oligosaccharide of cell walls, and enable the entrance of amylolytic and proteolytic enzymes and their more efficient activity. Besides some enzymes, is often used their complex, because it has been established that the endogenous and exogenous (added) enzymes act complementary in the digestive system. Good effects have been obtained with the addition of enzymes into the mixtures containing barley, wheat and oat (HASSELMAN and AMAN, 1985 and 1986; ANNISON, 1992; ISSHIKI and NAKAHIRO, 1993). The research of MOSS et al., 1997; BROZ and FRIGG, 1986; RAJMANE, 1992 showed that the addition of enzymes into maize misces, influenced the improvement of poultry production results (Table 1).

Prof.dr. Gordana Kralik, Mr. Đuro Senčić and Dipl.eng. Zlata Maltar - Faculty of Agriculture, Osijek, Mr. Božo Mandić, DP »Belje«, Osijek, Croatia.

*Paper was presented on ANIMAL SCIENTIFIC DAYS IN KAPOSVAR - HUNGARY, 1 - 2. september 1993.
*Rad je izložen na ANIMAL SCIENTIFIC DAYS u KAPOŠVAR - MAĐARSKA, 1. do 2. rujna 1993.

Table 1. Influence of enzymes added into the feed on the production results of chickens
Tablica 1. Utjecaj dodanih enzima u hrani na proizvodne rezultate pilića

Enzyme	Added g/kg feed Dodano hrani g/kg	Chicken age (days) Dob pilića (dana)	Feed basis osnova hrane	Improvement (%) poboljšanje (%) Mass masa	Conversion konverzija	Author Year autor godina
α-amylase	2	42	maize kukuruz	0 - 10.5	1.4 - 6.5	MOSS et al. (1977)
			barley ječam	5.9 - 8.4	3.7 - 9.5	
β-glycanase	0.5	19	barley ječam	25.4 - 27.6	14.8 - 18.3	HASSELMAN and AMAN (1986)
Phytase	200-800 V/kg	14	maize - kukuruz soyabean - soja	5.5 - 10.8	0.7 - (-1.3)	SCHONER et al. (1991)
Protease, amylase, lypase, pectynase	0.5 - 1.0	42	maize kukuruz	0.8 - 9.0	5.7 - 9.7	RAJMANE (1992)
Polizym^{R}	0.5	42	maize kukuruz	4.8	5.9	Faculty of Agronomy (1991) Zagreb
β-glycanase	2	21	barley ječam	22.7 - 25.8	-	ROTTER et al. (1990)
β-glycanase	0.5 - 2	8 - 25	maize kukuruz	0 - 4.1	0.6 - 1.2	BROZ and FRIGG
			barley ječam	0 - 16.6	3.8 - 9.1	(1986a)
Cellolase	0.1 - 0.5	8 - 25	maize kukuruz	0 - 2.0	0	BROZ and FRIGG
			wheat pšenica	0 - 2.0	2	(1986b)

In the research we applied the enzyme preparations produced by the »Krka« Novo Mesto, Slovenia, under the trade name »Polizym^{R}«, »Polizym^{R}-G« and »Polizym^{R}-BX.

The purpose of our work was to investigate the influence of adding polienzymatic preparations, on the fattening and slaughtering characteristics of broilers (quality of carcasses and meat), since such complex research has not been reported at our disposal.

Material and Methods

The research started with 200 one-day old sexed male chicks, of Avian K-24 provenance. The chicks were randomly divided into four groups (50 chicks in each) and after individual weighing were put into deep bedding for fattening. During the research a technological process usual for the production of fattening broilers was carried out. The research lasted from May 17 till June 28, 1993 and during that period the temperatures were extremely hugh, specially at the end of fattening, so that the temperatures inside the object with chickens were sometimes above the optimal limits. At the age of 14 days the chicks were vaccinated graft-nasally against the New Castle disease. The research lasted 42 days and the health condition of the chickens was regularly controlled. The feeding and watering was ad libitum. The feed was supplied by the feedfactory »Valpovka«, and the »Đuro Salaj« from Valpovo. The chickens were fed with mixture A Huntill the third week and from the fourth to the sixth week with mixyture B (Table 2).

Table 2. Mixture composition

Tablica 2. Sastav smjesa

Feed (%) Krmiva (%)	Mixture A Smjesa A	Mixture B Smjesa B
Maize - kukuruz	56.80	62.60
Feed meal stočno brašno	4.00	4.00
Alfalfa meal lucerna	2.00	5.00
Sunflower grits suncokretova sačma	4.00	3.00
Soya grits sojina sačma	20.00	14.00
Fish meal riblje brašno	7.00	5.00
Meat meal mesno brašno	1.00	2.00
Fat - mast	2.00	2.00
Salt - sol	0.20	0.20
limestone - vapnenac	0.45	0.35
Dicalcium phosphate	0.55	0.55
Premix	1.00	1.00
Chemical analysis (%) - Kemijska analiza (%)		
Dry matter - ST	90.72	90.23
Crude protein - SB	23.51	20.06
Crude fat - SM	7.98	7.55
Crude fibers - SV	3.16	2.77
Crude ash - Pe	6.82	5.09
ME MJ/kg	12.41	12.59

The chickens of the first group (control) were fed with the mixture without additional enzymes, while the chickens in the 2nd, 3rd and 4th group (trial group), were given in their feed 0.5 g/kg enzyme preparations Polizym^{R}, Polizym^{R}-G and Polizym^{R}-BX. The producer of the preparations declares the following contents of enzymes:

Polizym^{R}: n-protease, α-amylase, β-glycanase, cellulase, hemicellulase and β-glycosidase

Polizym^{R}-G: α-amylase, cellulase, β-glycanase, xylanase and pectynase

Polizym^{R}-BX: n-protease, α-amylase, β-glycanase and xylanase.

The chickens was weighed mass individually, and in groups every week and according to the data the average weekly weight gain and the increment rate were determined. The quantity of the consumed feed was determined and the conversion of nutrients into the live mass increment was calculated. The weekly increment rate of chickens was calculated according to the following pattern:

$$SP_i = (y_i - y_{i-1}) / y_{i-1}$$

where: i = 1...6 weeks, y_i = chicken mass at the end of i- week.

The average rates of growth according to the groups were calculated as the geometrical mean weekly increment rates:

$$SP = G\ (sp_1, sp_2, sp_3, sp_4, sp_5, sp_6)$$

$$SP = \sqrt[6]{sp_1 \cdot sp_2 \cdot sp_3 \cdot sp_4 \cdot sp_5 \cdot sp_6}$$

On the basis of average body masses the upgrowth curves were made. For that purpose the assymetric S-function was used:

$$f(t) = \frac{A}{(1 + be^{-c\,\gamma\ t})^{1/\gamma}}$$

The stages of mass increment were determined by time terms t_B and t_c:

$$t_B = \frac{i}{c\,\gamma}\ 1n\ \frac{2b}{\gamma\ (\gamma + 3) + \gamma\ (\gamma + 1)(\gamma + 5)}$$

$$t_C = \frac{i}{c\,\gamma}\ 1n\ \frac{2b}{\gamma\ (\gamma + 3) - \gamma\ (\gamma + 1)\ (\gamma + 5)}$$

The interval ($t \leq t_B$) represents the stage of growth forming and the interval ($t_B \leq t \leq t_C$) the stage of intensive growth, while the interval ($t \geq t_C$) represents the stage of slowing down growth (SCITOVSKI, 1993).

The production number (PN) has been calculated for the purpose of comparison of production results between the chicken groups:

$$PN = \frac{\% \text{ of fattened chickens x average live mass (g)}}{\text{duration of fattening (d) x conversion (g)}}$$

In the 42nd day of fattening the chickens missed the meals for 12 hours and were then delivered to the slaughter house and the carcasses were processed for the »grill«. The measurement of the carcass mass and the pH of meat were taken on the entire sample, both 60' p.m. (pH_1) and after 24 hours of cooling physical-chemical properties of breast muscles were carried out on 12 samples from each chicken group. The indicators of the carcass and meat quality, with the applied research methods are given in the following illustration:

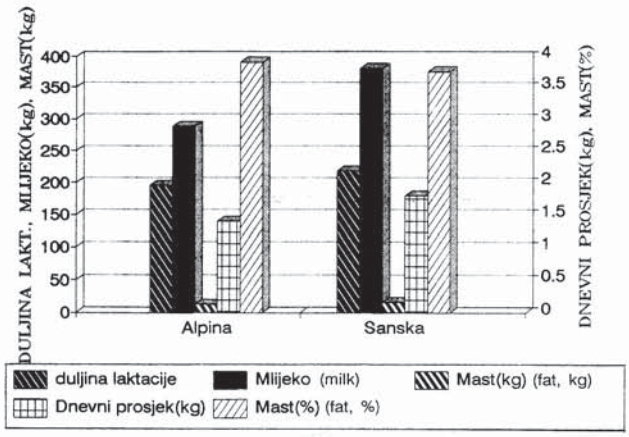
Methods of carcass and chicken meat research

Indicator	Method / Instrument
Carcass mass	Measurement (accurateness 0.1 g)
Shares of basic parts	Shown in % on the mass of cooled carcass
Shares of tissues in parts	Shown in % on the mass of parts
pH value of meat	Digital pH-meter »Iskra« MA-5122
Water holding capacity	Method per Grau-Hamm
Impedance module	Meat-Checker Device
Water content	Drying at 105 °C
Ash content	Sample burning on 550 °C
Protein content	Method per Kjeldahl
Fat content	Method per Soxhlet

Splitting and dissection of carcasses were performed according to the Regulation Book on Poultry Meat Quality. In the basic parts were dissected: muscular, bones and skin with subcutaneous fat tissue. The differences of the arithmetic means between the chicken groups were obtained by »t« test.

Results and Discussion

Some differences appeared among the chicken groups, in the indicators of growth, consumption and utilization of feed (Table 3), although without statistical importance regarding the influence of enzymes added into the mixtures. Chickens of the 2nd group (Polizym^R had higher average live mass on the 42nd fattening day by 102 g, the 3$_{rd}$ group (Polizym^R-G)) by 69 g and the 4th group (Polizym^R-BX) by 85 g. The average growth rates in groups depended on effected live mass increments. No differences were observed among the chicken groups in mixture consumption, by feeding by choice. From the standpoint of feed utilization, it was noticed that the added polienzymatic preparations improved the transformation of nutrients into the live mass gain - chicken group 3 by 3% and groups 2 an d 4 by 4%. Feed conversion per one kilo of carsass was 5% better in the chicken group 2 compared to the group 1: 4% in group 4 and 2% in group 3.



Graph 1. Relative effects of Polizymes^R on the broiler performance

All chicken groups were in satisfactory health condition. Forty-eight broilers were delivered to the slaughter per group, which makes 96% of the total number of chickens included in the research. The result of the production number, which is based on feeding characteristics and percentage of broiler survival during the research, indicates the positive effects of mixtures into added polienzymic preparations. The best effect (PN = 253) was attained by feeding with Polizym^R, although Polizym^R-G and Polizym^R-BX (PN = 246 resp. 250_ also proved efficient compared to the test-group (PN = 231).

The results of our research are in accordance with the data indicated by MOSS et al. (1977), BROZ and FRIGG 1983 ab when considering the positive influence of added enzymes α-amylase, β-glycanase and cellulase into maize feedstuffs. The research at the Faculty of Agronomy in Zagreb showed that addition of Polizym^R

Table 3. Results of growth, consumption and feed conversion
Tablica 3. Rezultati rasta, konzumpcije i konverzije hrane

Indicator	Group 1		Group 2		Group 3		Group 4	
		1/1		2/1		3/1		4/1
Početna težina, g Beginning mass, g	38	100	39		39		39	
Završna težina, g Final mass, g	2075	100	2177	104	2144	102	2160	102
Klaonička težina g Carcass mass, g	1405	100	1479	105	1436	102	1457	104
Uzimanje hrane, g/kom Feed consumption, g/pc	4253	100	4275	100,5	4267	100,3	4255	100
Konverzija, g/kg žive težine Conversion, g/kg of live mass	2050	100	1963	96	1990	97	1971	96
Konverzija, g/kg Conversion g/kg of a carcass, trupa	3027	100	2890	95	2971	98	2920	96
Proizvodni broj Production number	231	100	253	109	246	106	250	108
Stupanj rasta, % Growth rate, %7	79,2	100	79,9	100,9	79,3	100,1	79,9	100,7

into the mixture for fattening chickens influenced the improvement of poultry production. RAJMANE (1992) added into the mixture 1 g/kg multienzymic preparation containing protease, amylase, lypase and pectynase, ich resulted in improved carcass mass and conversion of approx. 9%. It could be assumed that a higher dose of polienzymic preparations in our research would have resulted in better production effects.

Table 4 indicates the parameters of functions - growth model for some chicken groups. The phases of the progressive chicken growth are determined by t_B and t_C

Table 4. Parameters of functions - chicken growth model
Tablica 4 Parametri funkcija - modela vrsta pilića

Parameter	Group 1	Group 2	Group 3	Group 4
b	0.4836	0.4899	0.4800	0.4721
c	0.2918	0.3021	0.2937	0.3005
t_I	5.40	5.26	5.34	5.16
y_I	1.85	1.85	1.85	1.85
t_B	2.09	2.06	2.05	2.05
t_C	8.71	8.46	8.63	8.68

The phases of progressive growth appeared earlier and lasted a shorter time in chicken group 2 (Polizym^{R}) compared to the control chicken group. Adding Polizym^{R} into the mixture resulted im better production effects compared to other preparations. The parameters of assymetric S-function show that the genetic potential of Avian K-24 chickens would be better utilized by prolonged fattening till 9th week. In that case, owing to Polizym^{R} efficiency the progressive phase of growth would be shortened by 1.5 day. The prognossis of average chickens masses at the end of 9th fattening week is as follows: 1st group (control) 3526 g, 2nd group (Polizym^{R}) 3622 g, 3rd group (Polizym^{R}-G) 3556 g, 4th group (Polizym^{R}-BX) 3539 g.

Relative shares of basic parts in a carcass (Tab. 5) did not deffer significantly ($P > 0.05$) between the control and trial groups of chickens.

However, a significantly higher share of breast ($P < 0.05$) was established in group 4 (Polizym^{R}-BX) compared to group 2 (Polizym^{R}) and group 3 (Polizym^{R}-G). The dissection showed that the differences in the relative shares of muscular tissues and skin with subcutaneous fatty tissue were significant ($P < 0.05$) between group 2 (Polizym^{R}) and group 4 (Polizym^{R}-BX) of chickens. Statistical analysis confirmed also the significant diffe-

rences ($P < 0.05$) in shares of muscular tissue and skin bewtween group 4 (Polizym^R-BX) and other chicken group (Tab. 5).

Physical and chemical properties and impedance module are shown in Table 6. The determined mean values for pH_1 in the breast meat were lower in all trial groups compared to the control group, although the difference was significant only between group 4 (Polizym^R) and group 1 ($P < 0.05$).

Measurement of hydrogen ions concentration in the breast musculature after 24 hours of carcass cooling, showed that the added preparations Polizym^R-G and Polizym^R-BX influenced a significant decrease of pH values (pH_2 = 6.9; 5.91; 5.94 and 5.81). However, it is important to emphasize that all samples were within the normal limits. No anomalies in connection with the appearance of PSE or DFD of meat were recorded. The water holding capacity more favorable compared to the control and groups 2 and 4 (W.H.C. = 5.55; 6.70; 6.96 and 6.66 cm^2). The impedance modules, as indicators of muscular quality, measured 60' p.m. and after 24 hours of cooling were in all chicken groups within the limits of meat of good technological properties (KRALIK et al., 1993a, 1993b). The tested differences among the mean values of impedance module per groups were statistically not significant ($P > 0.05$). The analysis of protein content in the breast musculature indicated a certain increase of this component in trial groups compared to the control chicken group (23.33%; 23.40%; 23.42%; 23.31%), although the significance between mean values ($P < 0.05$) was not confirmed also. An insignificant increase of fat content was recorded in the breast muscles in trial groups compared to the control chicken group. The data on physical and chemical meat structure of both trials and control chicken groups show satisfactory - mat quality. This research also presented the carcass characteristics of chicken hybrid Avian K-24 for the first time.

Table 5. Indicators of chicken carcass quality
Tablica 5. Pokazivači kakvoće trupova pilića

Indicators	Groups of chickens - Skupine pilića							
	1		2		3		4	
	x	Vk	x	Vk	x	Vk	x	Vk
klaonička težina, g Carcass mass, g	1465.83	11.41	1521.67	7.97	1501.67	14.44	1515.83	9.17
	Share of parts and abdominal fat in carcass, % Prinos dijelova i abdominalne masnoće u trupu, %							
Breast - prsa	28.20	7.48	29.97*	4.25	27.92*	4.40	29.55	5.68
Tight and drumstick Batak i podbatak	31.11	5.46	31.75	5.66	30.86	6.22	32.49	8.46
Back - leđa	25.57	5.90	25.50	7.60	26.56*	6.80	23.46	13.87
Wings - Krila	13.24	11.93	12.77	7.98	12.62	6.65	12.33	8.51
Abd. fat. - Trbušna mast	1.88	33.86	2.01	38.30	2.01	37.31	2.17	33.64
	Share of tissues in breast, % Prinos tkiva u prsima, %							
Muscles - mišičje	70.60	5.94	72.65*	3.63	69.19	5.40	67.94	6.34
Bones - kosti	19.12	13.89	18.04	11.75	19.73	16.78	19.81	13.22
Skin - koža	10.28	22.85	9.31*	30.18	11.08	20.66	12.25	25.14
	Share of tissues in thights and drumsticks, % Prinos tkiva u batacima i podbacima, %							
Muscules - mišičje	66.18*	4.85	67.73*	4.81	66.63*	5.05	63.04	6.12
Bones - kosti	23.07	12.31	23.18	10.14	24.13	11.35	23.58	13.10
Skin - koža	10.75*	13.21	9.09*	24.09	9.24*	25.11	13.38	21.52

* A significant difference ($P < 0.05$) has been compared to group 4

Table 6. Indicators of breast muscles quality
Tablica 6. Pokazivači kakvoće prsnih mišića

Indicators	Groups of chickens - Skupine pilića							
	1		2		3		4	
	x	Vk	x	Vk	x	Vk	x	Vk
vrijednost PH_1 - value	6.33	3.47	6.31	2.54	6.29	1.90	6.22**	1.29
vrijednost PH_2 - value	6.09	1.31	5.91*	1.35	5.94*	1.68	5.81**	1.37
sp,v.v. W.H.C., cm^2	6.70	26.11	6.96	18.96	5.55	26.85	6.66	20.42
Imped. module, Ω_1	278.33	29.54	317.50	16.55	260.00	27.39	272.50	26.00
Imped. module, Ω_2	175.00	27.61	165.88	35.60	141.67	24.61	172.50	28.52
voda Water, %	75.06	0.51	75.01	0.71	74.73	0.77	74.83	0.80
mast Fat, %	0.50	12.80	0.54	0.54	0.75	24.53	0.60	21.66
bjelančevine Proteins, %	23.31	1.55	23.33	23.33	23.40	2.35	23.42	1.98
pepeo Ash, %	1.13	5.04	1.13	1.13	1.15	3.74	1.15	2.70

* $P < 0.05$ ** $P < 0.01$

Conclusion

Research results of the influence of adding Polizym^{R}, Polizym^{R}-G and Polizym^{R}-BX into the mixtures for fattening chickens in quantity of 0.5 g/kg allow for the following conclusions:

The average live masses of Avian K-24 broilers at the age of 42 days, after addition of already mentioned preparations into the mixtures, were 2117 g, 2144 g and 2160 g, while the live mass in the control group (without added enzymes) was 2075 g. Feed conversion g/kg of live mass in the same order, was: 1963 g, 1990 g and 1971 g contrary to the control group, where the established feed conversion was 2050 g. The differences stated in the fattening characteristics between trials and control groups were not statistically significant ($P > 0.05$).

Production number, as efficiency indicator of polienzymic preparations (PN = 253, 246 and 250 : 231), justifies, from the biological standpoint, their usage.

Efficiency of Polizym^{R}, Polizym^{R}-G and Polizym^{R}-BX use is confirmed by increased growth rates of trial groups compared to the control group (97.9%, 79.3% and 79.8% : 79.2%).

Application of asymmetric S-function in investigation of growth phases indicates that the enzymes added into the mixtures induce the progressive growth phase in chickens.

Analysis of physical, chemical and bioelectrical properties (pH_1, pH_2, W.H.C., contents of nutritive composition and impedances (Ω_1 and Ω_2) indicates that the addition of the above mentioned polyenzymatic preparations into the mixtures for fattening chickens has resulted, in nutritive and technological view, in meat of satisfying quality.

Uvod

Izbor krmiva i sastav smjesa za hranidbu peradi ovise o anatomskim i fizikalnim specifičnostima probavog sustava peradi. Osnovu u sastavljanju obroka čini kukuruz, dok je upotreba pšenice, ječma i raži ograničena jer perad lošije probavlja hranjive tvari ovih krmiva. Dodavanje enzima poboljšava nutritivne i ekonomske učinke smjesa za perad (DIERICK, 1989; HOTTEN, 1991; RAJMANE, 1992). Enzimi pospješuju probavu i razgradnju kompleksnijih molekula na jednostavnije, koje organizam lako resorbira (HOTTEN, 1991), povećavaju probavljivost hranjivih tvari i energetsku vrijednost hrane (FRIESEN i sur. 1992; SALOBIR i sur. 1992). Proteaze pomažu razgradnji bjelančevina, amilaze škroba dok celulolitički enzimi (celuloza, b-glukonaza i b-glukozidaza i dr.) utječu na razgradnju poli- i oligosaharida staničnih ovojnica, omogućavaju slobodniji pristup amilolitičkim i proteolitičkim enzimima i njihovo efikasnije djelovanje. Česta je upotreba, uz pojedine enzime, i njihovog kompleksa jer je utvrđeno da endogeni i egzogeni (dodani) enzimi djeluju komplementarno u probavnom sustavu. Dobri učinci kod peradi postignuti su dodavanjem enzima u smjese koje su sadržavale ječam, pšenicu i zob (HASSELMAN I AMAN, 1985 i 1986; ANNISON, 1992; ISSHIKI I NAKAHIRORO, 1993). Istraživanja (MOSS i sur. 1977; BROZ I FRIGG, 1986a; RAJMANE, 1992.) su pokazala da dodavanje enzima i u smjese na bazi kukuruza utječe na poboljšanje proizvodnih rezultata peradi (tab. 1).

Svrha našeg rada bila je istražiti utjecaj dodavanja polienzimskih preparata, pored tovnih, i na klaonička svojstva brojlera (kakvoću trupova i mesa) budući da ovako opsežna istraživanja iz pregleda nama dostupne literature, do sada nisu obavljena. U istraživanju smo upotrijebili enzimske preparate koje prouzvodi »Krka« u Novom Mestu u Sloveniji, pod trgovačkim nazivima Polizym^R, Polizim^R-G i Polizim^R-BX.

Materijal i metode

Istraživanje je započeto s 200 jednodnevnih seksiranih pilića muškog spola, porijekla Avian K-24. Pilići su podijeljeni slučajnim izborom u četiri skupine (po 50 pilića u svakoj) a nakon pojedinačnog vaganja stavljeni u tov na duboku stelju. Za vrijeme istraživanja provodio se uobičajeni tehnološki postupak karakstičan za proizvodnju tovnih pilića. Istraživanje je trajalo od 17. svibnja do 28. lipnja 1993. godine a kako su u tom razdoblju, naročito pred kraj tova, bile izrazito visoke vanjske temperature, to su temperature u nastambi gdje su se nalazili pilići, povremeno prelazile optimalne granice. Pilići su u dobi od 14 dana cijepljeni okulo-nazalno protiv njukaslske bolesti. Istraživanje je trajalo 42 dana uz redovito praćenje zdravstvenog stanja pilića. Hranjenje i pojenje pilića bilo je po volji. Sva krmiva upotrebljena u istraživanju, nabavljena su od TSH »Valpovka«, i PPK »Đuro Salaj« iz Valpova. Pilići su hranjeni do 3. tjedna smjesom A, a od 4. do 6. tjedna smjesom B (tab. 2).

Pilići prve skupine (kontrola) hranjeni su smjesama bez dodanih enzima dok su pilići 2., 3. i 4. (pokusne) skupine dobivali u hrani 0,5 g/kg enzimskih preparata: Polizym^R, Polizym^R-G i Polizym^R-BX. Proizvođač preparata deklarira sljedeći sadržaj enzima:

Polizym^R: n-proteaza, α-amilaza, β-glukanaza, celulaza, hemicelulaza i β-glukozidaza

Polizym^R-G: α-amilaza, celulaza, β-glukanaza, ksilanaza, i pektinaza

Polizyn^R-BX: n-proteaza, α-amilaza, β-glukanaza i ksilanaza

Svakih tjedan dana mjerene su mase pilića pojedinačno i prema skupinama, na osnovi čega su utvrđeni prosječni tjedni prirasti i stope prirasta. Istovremeno, utvrđena je količina konzumirane hrane i izračunata konverzija hranjivih tvari u prirast žive mase. Tjedne stope prirasta pilića izračunate su pomoću sljedećeg obrasca:

$$SP_i = (y_i - y_{i-1}) / y_{i-1}$$

gdje je: i = 1...6 tjedana, y_i - masa pilića na kraju i-tog tjedna.

Prosječne stope rasta prema skupinama izračunate su kao geometrijska sredina tjednih stopa prirasta:

$$SP = G\,(sp_1, sp_2, sp_3, sp_4, sp_5, sp_6)$$

$$SP = \sqrt[6]{sp_1 \cdot sp_2 \cdot sp_3 \cdot sp_4 \cdot sp_5 \cdot sp_6}$$

Na osnovi prosječnih tjelesnih masa modelirane su krivulje rasta. U tu svrhu upotrebljena je asimetrična S-funkcija:

$$f(t) = \frac{A}{(1 + be^{-c\,\gamma\,t})^{1/\gamma}}$$

Faze rasta mase pilića određene su vremenskim terminima t_b i t_c

$$tB = \frac{i}{c\,\gamma}\,1n\,\frac{2b}{\gamma\,(\gamma + 3) + \gamma\,(\gamma + 1)(\gamma + 5)}$$

$$tC = \frac{i}{c\,\gamma}\,1n\,\frac{2b}{\gamma\,(\gamma + 3) - \gamma\,(\gamma + 1)\,(\gamma + 5)}$$

Interval ($t \leq t_B$) predstavlja fazu formiranja rasta, interval ($t_B \leq t \leq tc$) fazu intenzivnog rasta, a interval ($t \geq tc$) predstavlja fazu usporavanja rasta (SCITOVSKI, 1993).

U svrhu usporedbe proizvodnih rezultata između skupina pilića, izračunat je proizvodni broj (PN):

$$PN = \frac{\%\ \text{utovljenih pilića x prosječna živa masa (g)}}{\text{trajanje tova (d) x konverzija (g)}}$$

U 42. danu tova pilići su, nakon 12-satnog gladovanja otpremljeni u klaonicu i zaklani uz obradu trupova »pripremljeno za roštilj«. Mjerenje klaoničkih masa trupova i pH mesa obavljeno je na cjelokupnom uzorku i to 60' p.m. (pH_1) i nakon 24-satnog hlađenja (pH_2) dok su rasjecanje trupova i analiza fizikalno-kemijskih svojstava prsnih mišića obavljena na po 12 uzoraka iz svake skupine pilića. Istraživani pokazivači kakvoće trupova i mesa, uz primijenjene metode istraživanja, dati su na sljedećoj preglednici.

Metode istraživanje trupova i mesa pilića

Pokazivač	Metoda odnosno uređaj
Masa trupa	Mjerenje (točnost 0,1 g)
Prinosi osnovnih dijelova	Prikazani u % na masu ohlađenog trupa
Prinosi tkiva u dijelovima	Prikazani u % na masu dijelova
pH vrijednost mesa	Digitalni pH-metar »Iskra« MA-5122
Sposobnost vezanja vode	Metoda po Grau-Hammu
Modul impedancije	Meat-Checker uređaj
Sadržaj vode	Sušenje na 105 °C
Sadržaj pepela	Spaljivanje uzorka na 550 °C
Sadržaj bjelančevina	Metoda po Kjeldahlu
Sadržaj masti	Metoda po Soxhletu

Rasjecanje i disekcija trupova obavljeni su prema Pravilniku o kakvoći mesa peradi. Disekcijom osnovnih dijelova raščlanjeni su : mišično tkivo, kosti i koža s potkožnim masnim tkivom. Pomoću »t« testa ispitane su razlike aritmetičkih sredina između skupina pilića.

Rezultati istraživanja

U pokazivačima rasta, konzumacije i iskorištavanja hrane (tab. 3) među skupinama pilića, pokazale su se razlike, iako nije utvrđena statistička značajnost s obzirom na utjecaj dodavanja enzima u smjese. Pilići 2. skupine (Polizym^{R}) imali su za 102 g, 3. skupine (Polizym^{R}-G) za 69 g a 4. skupine. (Polizym^{R}-BX) za 85 g veće prosječne žive mase 42. dana tova. Prosječne stope rasta po grupama pilića, ovisile su o ostvarenim prirastima žive mase. U konzumaciji smjesa, pri hranidbi po volji, nisu ustanovljene razlike između grupa pilića. Sa stanovišta iskorištavanja hrane pokazalo se da su dodani polizimski preparati pospješili pretvorbu hranjivih tvari obroka u prirast žive mase, kod 3. skupine pilića za 3% a 2. i 4. skupine pilića za 4%. Konverzija hrane za kg trupa bila je kod 2. skupine 5%, 4. skupine 4% i 3. skupine 2% bolja u odnosu na 1. skupinu pilića.

Zdravstveno je stanje pilića u svim skupinama zadovoljavalo. Na klaonicu je isporučeno 48 brojlera po skupini, što čini 96% od broja pilića kojim je započeto istraživanje. Izračun proizvodnog broja koji se temelji na obilježjima tovnosti i % preživljavanja brojlera tijekom istraživanja, pokazuje pozitivne efekte kod smjesa sa dodanim polienzimskim preparatima. Najveći efekt (PN = 253) postignut je kod hranidbe pilića s Polizymom^{R}, iako su se i Polizym^{R}-G u Polizym^{R}-BX (PN - 246 odnosno 250) pokazali također djelotvornim u odnosu na kontrolnu skupinu pilića (PN = 231).

Rezultati našeg istraživanja suglasni su s podacima koje navode MOSS i sur. (1977), BROZ i FRIGG (1986a i 1986b) kada je u pitanju pozitivno djelovanje enzima α-amilaze, β-glukanaze i celulaze u hrani koja kao osnovno krmivo sadrži kukuruz. Rezultati istraživanja provedenih na Agronomskom fakultetu u Zagrebu o upotrebi Polizyma^{R} u hranidbi tovnih pilića također se poklapaju s našim podacima i nagovještavaju mogućnost boljeg iskorištavanja genetskog potencijala pilića u tvorbi tjelesne mase a time i efikasnije pretvorbe hranjivih tvari u prirast. RAJMANE (1992) je dodavanjem u smjese 1 g/kg multienzimskog preparata koji je sadržavao proteazu, amilazu, lipazu i pektinazu, postigao poboljšanje tjelesne mase pilića i konverzije za cca 9%. Za pretpostaviti je da bi veća doza polienzimskih preparata u našem istraživanju također dala bolje proizvodne rezultate.

Na tablici 4. prikazani su parametri funkcija - modela rasta za pojedine skupine pilića. Faze progresivnog rasta pilića određene su točkama t_B i t_C.

Faze progresivnog rasta nastupile su ranije i trajale kraće vrijeme kod 2. skupine pilića (Polizym^{R}) u odnosu na kontrolnu skupinu pilića. Dodavanje Polizyma^{R} u smjese dalo je bolje proizvodne rezultate od ostalih enzimskih preparata. Parametri asimetrične S- funkcije pokazuju da bi se genetski potencijal Avian K-24 pilića bolje iskoristio produženjem tova do 9. tjedna. U tom slučaju, djelotvornošću Polizyma^{R} skratila bi se progresivna faza rasta pilića za 1,5 dan. Prognoza prosječnih

masa pilića na kraju 9. tjedna tova je sljedeća: 1. skupina (kontrola) 3526 g, 2. skupina (Polizym^R) 3622 g, 3. skupina (Polizym^R-G) 3556 g, 4. skupina (Polizym^R-BX) 3539 g.

Relativni udjeli osnovnih dijelova u trupu (tab. 5) nisu se signifikantno razlikovali ($P > 0,05$) između kontrolne i pokusnih skupina pilića.

Utvrđena je signifikantnost razlika ($P < 0,05$) u odnosu na 4. skupinu

Međutim, utvrđen je signifikantno veći ($P < 0,05$) udjel prsa kod 4. skupine (Polizym^R-BX) u odnosu na 2. skupinu (Polizym^R) i 3. skupinu (Polizym^R-G). Disekcija je pokazala da su razlike u relativnim udjelima mišićnog tkiva i kože s potkožnim masnim tkivom signifikantne ($P < 0,05$) između 2. skupine (Polizym^R) i 4. skupine (Polizym ^{R}-BX) pilića. Statističkom analizom potvrđene su isto tako signifikantne razlike ($P < 0,05$) u udjelima mišićnog tkiva i kože između 4. (Polizym-BX) i ostalih skupina pilića (tab. 5).

Fizikalno-kemijske osobine i modul impedancije prikazani su na tablici 6. Utvrđene srednje vrijednosti za PH_1 u prsnom mesu bile su u svim pokusnim skupinama pilića niže nego u kontrolnoj skupini, iako je samo razlika između 4. skupine (Polizym^R-BX) i 1. skupine bila signifikantna ($P < 0,05$).

Mjerenje koncentracije vodikovih iona u prsnom mišiću nakon 24- satnog hlađenja trupova, pokazuje da su dodani preparati Polizym^R, Polizym^R-G i Polizym^R-BX utjecali na signifikantno smanjenje pH vrijednosti (pH_2 = 6,9; 5,91; 5,94 i 5,81). Međutim, bitno je istaći da su se analizirali uzorci nalazili u granicama normale. Nisu zabilježene anomalije vezane uz pojavu PSE ili DFD mesa. Sposobnost vezanja vode u prsnom mesu 3. skupine pilića (Polizym^R-G) bila je nešto povoljnija u odnosu na kontrolu i 2. i 4. pokusnu skupinu pilića (sp.v.v. = 5,55; 6,70; 6,96; 6,66 cm^2). Moduli impedancije, kao indikatori kakvoće mišićja, izmjereni 60' p.m. i nakon 24-satnog hlađenja kreću se kod svih skupina pilića u granicama karakterističnim za meso dobrih tehnoloških svojstava (KRALIK i sur. 1993a, 1993b). Testirane razlike između srednjih vrijednosti modula impedancije po skupinama nisu bile statistički signifikantne ($P > 0,05$). Analiza sadržaja bjelančevina u mišićju prsa pokazuje stanovito povećanje ovog sastojka kod pokusnih skupina u odnosu na kontrolnu skupinu pilića (23,33%.; 23,40%; 23,42%: 23,31%) iako nije potvrđena signifikantnost razlika između srednjih vrijednosti (P 0,05). Također nije potvrđena signifikantnost u povećanom sadržaju masti u prsnim mišićima kod pokusnih skupina u odnosu na kontrolnu skupinu pilića. Podaci o fizikalno-kemijskom sastavu mesa, kako pokusnih tako i kontrolne skupine pilića, pokazuju da se radi o mesu zadovoljavajuće kakvoće. Osim toga, ovim se istraživanjem, po prvi put, iznose, predstavljaju klaoničke značajke Avian K-24 hibrida pilića u nas.

Zaključak

Rezultati istraživanja utjecaja dodavanja Polizymy^R, Polizyma^R-G i Polizyma^R-BX u smjese za tovne piliće, u količini od 0,5 g/kg, omogućuju definiranje sljedećih zaključaka:

Prosječne žive mase Avian K-24 brojlera u dobi od 42 dana, dodavanjem navedenih preparata u smjese, bile su 2117 g, 2144 g i 2160 g dok je u kontrolnoj skupini (bez dodanih enzima) živa masa iznosila 2075 g. Konverzija hrane g/kg žive mase, istim redoslijedom, iznosila je: 1963 g, 1990 g i 1971 g, za razliku od kontrolne skupine pilića gdje je utvrđena konverzija hrane 2050 g. Utvrđene razlike u obilježjima tovnosti između pokusnih i kontrolne skupine pilića nisu bile statistički signifikantne ($P > 0,05$).

Proizvodni broj, kao indikator djelotvornosti polienzimskih preparata (PN = 253, 246 i 250: 231), opravdava s biološkog stanovišta njihovu upotrebu.

Učinkovitost upotrebe Polizyma^R, Polizyma^R-G i Polizyma^R-BX potvrđena je također povećanim stopama rasta pokusnih skupina u odnosu na kontrolnu skupinu pilića (79,9%, 79,3% i 79,8%: 79,2%).

Primjena asimetrične S-funkcije u istraživanju faza rasta pilića pokazala je da dodani Polizym^R u smjesama potiče progresivnu fazu rasta u pilića.

Analiza kakvoće trupova i fizikalno-kemijskih i bioelektričnih svojstava mesa (pH_1, pH_2, sp.v.v., sadržaja hranjivih sastojaka, impedancije (Ω_1 i Ω_2) pokazuje da je dodavanje navedenih polienzimskih preparata u smjese za tovne piliće dalo meso zadovoljavajuće kakvoće u nutritivnom i tehnološkom pogledu.

LITERATURA

1 Annison, G. (1992): Polizym^R enzyme supplementation of wheat based diets raises ilegal glycanase activies and improves apparent metabolisable energy starch and protein digestibilities in broiler chickens. Anim. Feed Sci. a. Technol. 38, 105-121.

2 Broz, J. and M. Frigg (1986a): Effect of beta-glucanase on the feeding value of broiler diets based on barley and oats. Arch. Geflugelkd. 5, 41-47.

3 Broz, J. and M. Frigg (1986b): Effect of cellulolytic enzyme products on the feeding value of various broiler diets. Arch. Geflugelkd. 50, 104-110.

4 Dierich, N.A. (1989): Biotechnology aids to improve feed and feed dihestion: enzymes and fermentation.

5 Friesen, O.D., W. Gventer, R.R. Marquardt and B.A. Rotter (1992): The Effect of Enzyme Supplementation on the Apparent Metabolizable Energy and Nutrient Digestibilities of Wheat, Barley, Oats and Rye for Young Broiler Chick. Poultry Sci. 71, 1710-1721.

6 Hesselman, K. and P. Aman (1985): Analysis of cereal grains and the influence of b-glucanase on digestion of broilers. New Agroaches to Research on Cereal Carbohidrates, 363-372.

7 Hesselman, K. and P. Aman (1986): The effect of β-glucanase on the utilization of starch and nitrogen by broiler chickens fed on barley of low or high-viscosity. Anim. Feed Sci. and Technol. 15, 83- 93.

8 Hotten, P. (1991): Why condsider enzymes as a feed additive? World Poultry 9, 13-15.

9 Isshiki, J. and Y. Nakahiro (1983): Effect of pectinase, xylanase and cellulase supplements on the utilization of feed in chicks. Nutr. Abstr. Rew. 54, 5, 235, 1984.

10 Kralik, G. (1993): The influence of initial pH-value in broiler breast on other meat caracteristics. 11th European Symposium on the Quality of Poultry Meat, 1-4, Tours.

11 Kralik, G., A. Petričević, S. Jovanovac and T. Takacs (1993): Impedance module and pH value in quality evaluation breast muscle of chickens. Kaposvar.

12 Matošić-Čajavec, V. (1982): Enzimi u hranidbi životinja. I Hranidba peradi. Krmiva 5, 97-101.

13 Matošić-Čajavec, V. (1987): Prikaz rezultata primjene celulolitičkih enzima u hranidbi životinja. Krmiva, 29, 8, 181-187.

14 Moss, B.R., A.F. Beecker, C.W. Newman and A.M. El-Negoumy (1977): Enzyme supplementation on broiler rations. Poultry Sci. 56, 1741.

15 Rajmane, B.V. (1992): Duirect fed enzymes for broilers. Feed International 5, 32-34.

16 Rotter, B.A., R.R. Marquardt and W. Guenter (1990): Enzymes in Feed - They Really Can Made to Work. Winnipeg 1-7.

17 Salobir, J., M. Štruklec, S. Hergouth, A. Malenšek and Č. Bogdanić (1991): Vpliv encimskega preparata »Polizym^R« na prebavljivost in energijsko vrednost krme na osnovi ječmena in pšenice pri brojlerjih. Zb. Biotehniške fak., Univ. v Ljubljani, 58, 167-178.

18 Schoner, F.J., P.P. Hoppe and G. Schwarz (1991): Vergleich der Effecte von mikrobieller Phytase und anorganischem Phosphat auf die Leistungen und die Retention von Phosphor, Calcium und Rohasche bei Masthuhnerkuken in der Aufangsmast. J. Anim. Physiol. a. Anim. Nutr. 66, 248-255.

19 Scitovski, R. (1993): Problemi najmanjih kvadrata - Financijska matematika. Ekonomski fakultet, Elektrotehnički fakultet, Osijek.

20 ..... Utjecaj preparata Polizym^R na rezultate tova pilića. Agronomski fakultet Zagreb, 1-4, 1991.

21 ..... Prirodni proizvod za bolje iskorištavanje hrane i bolje proizvodne rezultate.: Polizym^R - polienzimski dodatak hrani. Krka, Novo Mesto, 1990.

SUMMARY

The purpose of the research was to establish the effect of polyenzymatic preparations /Ist group controls, 2nd group Polizym^R, 3rd group Polizym^R -G, 4th group Polizym^R-BX added into the feed on the fattening and slaughtery properties of chickens. The research was started on 200 one day old sexed male chickens of the Avian K-24 provenance and continued until the 42nd day of their age. The average live mass of the control group was 2075 g and the average mass of the experimental groups were 2117, 2144 and 2160 g. The feed conversion was 2050 g, 1963 g and 1971 g, in that order. The calculations of the production number, average rates and stages of growth in the process of fattening confirm the efficacy of additional polienzymatic preparations in the feed. The best results were obtained by adding Polizym^R into the feed. By studying the quality of carcasses and physical and chemical properties of brest muscles and upper legs it was found that the polienzymatic preparations added into the feed produced meat of satisfactory quality.