Romanian Biotechnological Letters *Vol. 18, No. 6, 2013*

ORIGINAL PAPER

The effects of enzyme supplementation on bio-productive performance, intestinal viscosity, blood parameters and intestinal microflora of broiler chicken fed with *Triticale* based diets

Received for publication, September 15, 2013
Accepted, November 30, 2013

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Abstract

The purpose of the study was to determine the effects of various types of enzymes, such as xylanase or poly-enzyme complex on productive performance, on intestinal viscosity, intestinal microflora and on some biochemical parameters of the blood. This experiment was carried out on a group of 180 broiler chickens distributed in three experimental groups as follows: EG1 without enzymes, EG2 -100 ppm xylanase/kg complete feed and EG3 - 250 ppm poly-enzymatic complex/kg complete feed. A supplement of xylanase in the complete feed increases body weight ($P < 0.001$). The lowest feed conversion rate was registered on chickens that were feed with xylanase ($P < 0.05$). Xylanase incorporation determines a decrease in viscosity at the duodenal level ($P < 0.05$) and on the jejunum ($P > 0.05$). Poly-enzymatic complex and xylanase increase the number of lactic bacteria ($P < 0.05$) and determines a decrease of coliforms ($P < 0.05$).

Keywords: *broiler, enzymes, non starch polysaccharide, triticale*

Introduction

The existing scientific literature contains insufficient information regarding the using of different enzyme preparations in combined fodder based on triticale. The purpose of this study was to determine the effects of various types of enzymes like mono-enzymes represented by xylanase, or poly-enzyme complex on productive performance as well as on intestinal viscosity, the gastrointestinal ecosystem and on some biochemical parameters of the blood serum.

Triticale is a hybrid between wheat and rye (D. BOROS [1]). Similar to wheat, triticale contains high amounts of pentosans (1.3% soluble pentosans and 9.5% non-soluble) (H.N. ENGLYST and G.J. Hudson [2]. These determine increased viscosity at intestinal level, reducing the assimilation of main nutritional substances. S. AUSTIN & al. [3] considers that increased viscosity is associated with lower apparent energy to be metabolised. Supplementation of broiler diets with appropriate enzymes capable of decreasing the xylan backbone of the arabinoxylans has shown to improve the nutritive value of *triticale* diets (D. JAMROZ [4], D. JAMROZ [5]). L. STEF & al. [6] demonstrates that the use of 600 g of triticale/kg of complete feed on broilers, is possible only through enzyme incorporation; enzymes determine a decrease in intestinal viscosity at duodenum and jejunum level with up to 15%. It has been suggested that performance improvement is due to decreased viscosity (R. LAZARO & al. [7], D. JOZEFIAK & al. [8], D. JOZEFIAK [9]). Non-starch polysaccharides (NSP) that increase viscosity at intestine level are associated with a decrease in productive

performance of broilers (Wagner & Thomas, Choct et al., Langout et al., Hubner et al.) quoted by D. JOZEFIAK [9]. Enzymes added in feed can reduce the microbial activity in the ileum by reducing the available nutrients for microbial fermentation (Silva and Smithard) quoted by D. JOZEFIAK [9]. Food enzymes work in two stages: in the first stage, or ileum stage, they prevent formation of intestinal content with increased viscosity, and in the second stage or cecal stage, decomposed products like xylose (M.R. BEDFORD and J. APAJALAHTI [10].

Material and Methods

Diets and experimental design

This experiment lasted for a period of six weeks and was carried out on a group of 180 broiler chickens distributed in three experimental groups (10 replications with 6 chickens/cage): the experimental group EG_1 - fed with 600g of triticale/kg of complete feed, EG_2 - fed with 600g of triticale/kg of complete feed and 100 ppm of xylanase/kg of complete feed, and finally, the experimental group EG_3 - fed with 600 g of triticale/kg of complete feed and 250 ppm of poly-enzymatic complex/kg of complete feed.

Biological material used in the experiment

The hybrids used for meat production in an intensive production system are tetra-linear biracial, obtained through the simple hybridization of two White Cornish lines (paternal genotype) and two White Plymouth Rock lines (maternal genotype). The experiments were carried out on broiler chickens, hybrid Ross 308, at the Department of Animal Nutrition and Feed, from the Educational Station of Banat University of Agricultural Sciences and Veterinary Medicine of Timişoara.

Analyses of complete feed nutritive content

To determine the nutritive value of the complete feed given to broiler chickens in our experiments, we applied the standard methods according to WEENDE scheme, respectively: dry matter (DM) (g/kg) – stove-drying at 1050C, crude protein (CP) (g/kg) – Kjeldahl method, crude fat (CF) (g/kg) – Soxhlet method, crude fibre (CF) (g/kg) – Van Soest method, metabolisable energy (ME) (MJ/kg) – calculated, Calcium (g/kg), phosphorus (g/kg), total lysine (g/kg), total methionine + cystine (g/kg), calculated.

Analysis of NSP content of raw materials used during the experiment

Determination of the NSP of raw materials was made in the laboratory of the University of Dublin. The procedure is described by G. DUSEL & al. [11] and is based on the methods described by H. ENGLYST [12].

Determination of nutritive, bio-productive and digestive parameters for broiler chickens.

In this experiment carried out on broiler chickens, we determined the following parameters: feed consumption, weight gain, feed conversion rate, and intestinal viscosity.

Analysis of viscosity at intestinal level

The method used for determining the viscosity was described by G. DUSEL & al. [11], H.ENGLYST [12].For determination of digestive viscosity 15 broilers were slaughtered (5 broilers per group) by cervical dislocation at 42 days of age. The broilers were dissected and duodenum and jejunal segments were quickly ligated to prevent postmortem digesta. For viscosity analysis approximately 2 g of the fresh digesta were placed in the centrifuge tube and centrifuged at 10,000 revolutions per minute for 10 minutes. The supernatants were stored on ice until viscosity measurements were made. Viscosity was measured with Brookfield viscosity meter (LD DV II +).

Study of blood serum parameters

Measurements were performed using Fully Vet Analyzer, an automated system for testing the biochemical parameters of blood serum of 13 species of farm animals, laboratory animals, or pets. Results were determined by the presence of cholesterol and triglycerides in the blood serum content. For determination of blood serum parameters 15 broilers were slaughtered (5 broilers per group) by cervical dislocation at 42 days of age.

Determination of the number of lactobacillus and coliforms bacteria

Study material was first germinated in nutritive broth and then kept in thermostat at 37°C for 24 hours. It was then microscopically examined as gram coloured smears. Afterwards, Lactobacillus and Escherichia were germinated in culture media (MRS agar for Lactobacillus and MacConkey agar for Escherichia) than the samples were kept in thermostatic state for 12 hours. Further, the total number of germs was determined by using the Petri dish method of bacteria culture, using serial dilutions for each type of studied bacteria. From each dilution, germination was done in Petri dishes, over which was poured agar, cooled and melted at 45°C spreading it to obtain a uniform environment. The Petri dishes were numbered accordingly, and kept at room temperature for solidification, and then put inside the thermostat at 37°C for 24 hours.

The determination of the number of germs was carried out by counting the developed colonies. The number of colonies read on each Petri dish multiplied by the dilution titre, provides the number of germs for the given dilution.

Statistical methods

Analysis of variance (ANOVA) and comparisons of mean differences between groups (Tukey HSD – Test) were performed using Statistica Soft.

Results and Discussion

Chemical analysis

The nutritional characteristics of the complete feed used in this experiment are presented in table 1.

Table 1. Complete feed nutritional characteristics/kg

Specification	**Period 0-14 days**	**Period 15-24 days**	**Period 25-42 days**
Triticale (g/kg CF)	600	600	600
Corn (g/kg CF)	49.5	32.5	69.9
Soybean meal (g/kg CF)	265	269	240
Fish meal (g/kg CF)	50	35	20
Oil (vegetable fat) (g/kg CF)	0	28	35
DL Methionine (g/kg CF)	2.5	2.5	2.1
Calcium Carbonate (g/kg CF)	12	12	12
Mono-calcium phosphate (g/kg CF)	8	8	8
Salt (g/kg CF)	3	3	3
Vitamin- mineral premix* + poly-enzymes complex** or xylanase*** (g/kg CF)	10	10	10

Nutritional characteristics			
Dry matter (g/kg)	907	912	910
Metabolisable Energy (MJ/kg feed)	12.1	13.14	13.37
Crude protein (g/kg)	229.8	220.4	201
Total Lysine (g/kg)	12.1	11.4	10.0
Total methionine + cystine (g/kg)	9.9	9.5	8.6
Calcium (g/kg)	10.6	9.7	9
Total Phosphorus (g/kg)	6.5	6.0	5.5
Crude fiber (g/kg)	27.7	27.6	26.6

* Providing per kilogram of complete feed – retinyl acetate 12042.00 UI; cholecalciferol 3010.50 UI; DL α – tocopheryl acetate 40.14 mg; meneadione sodium bisulphite 3.12 mg, thiamin mononitrate 3.01 mg; riboflavin 7.03 mg; niacin 40.14 mg; calcium pantothenate 12.04 mg; pyridoxine 5.02 mg cyanocobalamin 0.03 mg; biotin 0.12 mg; folic acid 1.00 mg, Fe 22.37 mg; Mn 30.00 mg; Zn 21.74 mg; Cu 2.38 mg; Co 0.34 mg; I 0.10 mg; Se 0.15 mg.

** poly-enzymatic complex: minimal guaranteed enzyme actiyity, Endo 1,3(4) beta –glucanase (beta-glucanase) – 2350 Units/g, Endo1,4 beta-glucanase (celulase) 4000 Units /g, Alpha –Amylase 400 Units /g, Bacilolysin (protease) 450Units/g Endo 1,4 beta-xylanase (xylanase) 20000 Units/g

*** xylanase: minimal guaranteed enzyme actiyity 80000 Units/g,

The broiler chickens in the three experimental groups were fed as follows: during the first growth period, namely from hatching to 14 days, the complete diet feed provided was 12.1 MJ and a CP content of 229.8 g/kg. During the second growth period, from 15 to 24 days, the complete diet feed provided was 13.14 MJ ME and 220.4 g CP/kg CF. In the third growth period, from 24 to 42 days, the complete feed provided 13.37 MJ and 201 g CP/kg CF.

The feed contents in soluble, insoluble and total NSP are presented in table 2.

From the data presented in table 2, we can observe that the insoluble NSP content remained constant during the entire period of the experiment, as the weight of triticale in the structure of the complete diet feed did not change.

Table 2. Complete feed content in non-starch polysaccharides (NSP)

Growing period	**Specification**	**NSPs* (g/kg)**	**NSPi** (g/kg)**	**NSPt*** (g/kg)**
Period 0-14 days	600 g triticale/kg complete feed	16.65	130.3	146.95
Period 15-24 days	600 g triticale/kg complete feed	16.7	129.4	146.1
Period 25-42 days	600 g triticale/kg complete feed	16.02	128.2	144.2

***** soluble non-starch polysaccharides

** insoluble non-starch polysaccharides

*** total non-starch polysaccharides

Broiler performance

During the experiment, feed consumption rate, body weight and feed conversion rate were influenced by the type of enzymes used in the structure of the complete feed.

Body weight

Table 3 shows the evolution of body weight in broiler chickens used in the experimental groups.

Table 3. Body weight evolution, feed intake evolution and feed conversion rate evolution of broiler chickens belonging to different experimental groups

	Experimental group (mean ± SD*)			SEM**	P-values
	EG1	**EG2**	**EG3**		
LW, kg					
Initial, hatching	0.040 ± 0.0013 ^{A}	0.040 ± 0.0012 ^{A}	0.040 ± 0.0012 ^{A}	0.0012	1.000
14 days of age	0.370 ± 0.031 ^{A}	0.450 ± 0.040 ^{B}	0.426 ± 0.039 ^{aB}	0.049	0.000
24 days of age	0.930 ± 0.083 ^{A}	1.040 ± 0.088 ^{aB}	0.996 ± 0.072 ^{AB}	0.091	0.003
42 days of age	2.310 ± 0.225 ^{A}	2.633 ± 0.223 ^{aB}	2.570 ± 0.177 ^{aB}	0.251	0.000
Feed intake, kg/d/chicken					
Period 1: age eclosion-14 days	0.429 ± 0.012 ^{A}	0.513 ± 0.016 ^{aB}	0.493 ± 0.011 ^{aB}	0.039	0.001
Period 2: age 15-24 days	0.993 ± 0.020 ^{A}	1.020 ± 0.016 ^{A}	0.993 ± 0.015 ^{A}	0.099	0.171
Period 3: age 25-42 days	3.029 ± 0.273 ^{A}	3.287 ± 0.396 ^{A}	3.280 ± 0.382 ^{A}	0.332	0.621
From hatching to slaughter: age 1-42 days	4.450 ± 0.277 ^{A}	4.820 ± 0.419 ^{A}	4.767 ± 0.380 ^{A}	0.358	0.455
Feed conversion ratio, kg complete feed/kg growth					
Period 1: age eclosion-14 days	1.30 ± 0.021 ^{A}	1.25 ± 0.025 ^{a}	1.28 ± 0.025 ^{a}	0.030	0.005
Period 2: age 15-24 days	1.77 ± 0.024 ^{a}	1.73 ± 0.025 ^{b}	1.74 ± 0.029 ^{ab}	0.227	0.030
Period 3: age 25-42 days	2.20 ± 0.072 ^{a}	2.06 ± 0.080 ^{b}	2.08 ± 0.091 ^{b}	0.103	0.029
From hatching to slaughter: age 1-42 days	1.96 ± 0.053 ^{a}	1.86 ± 0.053 ^{b}	1.88 ± 0.057 ^{b}	0.066	0.017

*SD –standard deviation;
**SEM –standard error of the mean
A-A, B-B and a-a P>0.05;
a-b P<0.05;
A-a P<0.01;
A-B P<0.001.

The data presented in table 3 shows that the body weight of the broiler chickens in EG_2 following the first growth period (14 days), when fed with complete feed based on triticale and added with xylanase, is higher ($P < 0.001$), and that the chickens in EG_3 fed on complete feed based on triticale and added with poly-enzymatic complex, was higher ($P < 0.001$). The broiler chickens in EG_3 had a lower body weight than those in EG_2, which was insignificant from a statistical point of view ($P > 0.05$). At 24 days, the chickens in EG_2 had a higher body weight ($P < 0.01$) than the chickens in EG_1 experimental group. The difference between EG_3 and EG_1 during this growth period was insignificant from a statistical point of view. Also, the broiler chickens in EG_3 had a lower body weight than the chickens in EG_2 ($P > 0.05$). At 42 days, the broiler chickens in EG_2 had a higher body weight compared to the chickens in EG_1 ($P < 0.001$). The broiler chickens in EG_3 presented a higher body weight when compared to the chickens in EG_1 ($P < 0.001$). The difference between the chickens in EG_2 and EG_3 was not significant ($P > 0.05$).

The conclusion that can be drawn following the study is that when using 600g of triticale/kg of complete feed, it is necessary to add xylanase but not also a poly-enzymatic complex.

A nutritive parameter tested during our study was the feed consumption presented in table 3.

Analysing the data presented in table 3 it can be observed that during the hatching period of 14 days, the feed consumption rate of the EG_2 and EG_3 groups was higher in comparison with EG_1 ($P < 0.05$). During the period between 14 and 24 days, the feed consumption of the EG_2 and EG_3 groups was higher in comparison with EG_1 ($P > 0.05$). During the last growth period (25 to 42 days), the feed consumption of EG_2 and EG_3 groups was higher, in comparison with EG_1 ($P > 0.05$). During the entire growth period (from hatching to 42 days), the feed consumption of EG_2 and EG_3 was higher, in comparison with EG_1 ($P > 0.05$). Thus, it can be concluded that adding enzymes to complete feed can determine the increase of feed consumption of the broiler chickens from experimental groups EG_2 and EG_3.

Feed conversion rate evolution in chickens from the experimental groups

By aligning the feed consumption data with the body weight, a specific feed consumption value can be determined. Feed conversion rate evolution is presented in table 3.

The data presented in the table 3 shows that during the growth period, from hatching to 14 days, feed conversion rate was lower in EG_2 and in EG_3 groups ($P < 0.01$).

The feed conversion rate difference stayed the same during the growth period from 15 to 24 days, thus the broiler chickens in EG_2 and EG_3 had a lower feed conversion rate in comparison with EG_1 ($P < 0.05$). During the last growth period, the feed conversion rate in EG_2 and EG_3 was lower in comparison with EG_1 ($P < 0.05$). During the entire growth period, from hatching to 42 days, chickens in EG_2 and EG_3 groups had a lower feed conversion rate than EG_1 ($P < 0.05$).

The conclusion that can be drawn is that the feed conversion rate is influenced by the enzymes added in the complete diet feed, and is lowest when xylanase is used.

Intestinal viscosity

After collecting and analyzing the intestinal content from the duodenum and the jejunum, the viscosity parameters are presented in table 4.

Table 4. Intestinal viscosity values measured at duodenum and jejunum level, evolution of the number of *Lactobacillus* and coliform bacteria and biochemical parameters of blood serum from broiler chickens (mg/100 ml)

	Experimental group (mean ± SD*)			SEM**	P-values
	EG1	**EG2**	**EG3**		
Intestinal viscosity values in 6-week old broiler					
Intestinal viscozity at duodenum	2.72 ± 0.085^{a}	2.51 ± 0.056^{b}	2.62 ± 0.061^{b}	0.109	0.025
Intestinal viscozity at jejunum	2.59 ± 0.261^{a}	2.31 ± 0.045^{a}	2.42 ± 0.103^{a}	0.185	0.216
Number of *Lactobacillus* and coliform bacteria					
Lactobacillus	$4.81x10^{8} \pm 0.16x10^{8\,A}$	$9.75x10^{8} \pm 0.11x10^{8\,B}$	$8.81x10^{8} \pm 0.21x10^{8\,B}$	$227.62x10^{6}$	0.000
Coliform bacteria	$9.65x10^{5} \pm 0.85x10^{5\,A}$	$4.94x10^{5} \pm 0.10x10^{5\,B}$	$2.65x10^{5} \pm 0.30x10^{5\,B}$	$3.16x10^{5}$	0.000
Biochemical parameters of blood serum [1)], mg/100 ml					
Cholesterol	110 ± 16.05^{a}	111 ± 5.15^{a}	91.5 ± 5.50^{b}	13.26	0.018
Triglicerides	69.50 ± 10.01^{a}	70.50 ± 14.26^{a}	64.00 ± 10.00^{a}	11.13	0.647

*SD –standard deviation;
**SEM –standard error of the mean
[1)] Reference values cholesterol 105 ± 15 mg
triglycerides 60 ± 20 mg.
A-A and a-a P>0.05;
a-b P<0.05;
A-B P<0.001.

From the data presented in table 4 it is clear that by adding enzymes to complete diet feed, changes in viscosity within the intestine take place. Thus, the viscosity of duodenum in broiler chickens from EG_2 and EG_3 groups was lower than in broiler chickens from EG_1 ($P < 0.05$). At the jejunum level, a similar situation is reported; broiler chickens from EG2 and EG_3 had a lower viscosity value than those from EG_1 ($P > 0.05$). Therefore, the conclusion is that by adding xylanase to the complete feed, a lower viscosity at the duodenum and the jejunum level can be achieved, in comparison with adding a poly-enzymatic complex.

Complete feed NSP effect on the intestinal micro-flora

Samples were collected from the caecal content in order to establish the microflora and number of lactic acid bacteria and coliforms. These values are shown in table 4.

The data presented show that addition of xylanase to complete feed based on triticale increases the number of lactic acid bacteria in caecums (9.75 x 10 8) in comparison with broiler chickens fed with feed not containing xylanase (4.81 x 10 8), ($P < 0.05$). The same result is obtained when a poly enzymatic complex is added (8.81 x 108) ($P < 0.05$). In the case of coliforms, the situation is the opposite - the number decreases when xylanase (4.94 x 105) ($P < 0.05$) or the poly-enzymatic complex (2.65 x 105) ($P < 0.05$) is added, in comparison with the broiler chicken group which was not fed enzymes in the complete feed (9.65 x 105).

Biochemical parameters of blood serum in broiler chickens

Blood serum was collected from a total of five broiler chickens from each experimental variant or group, and cholesterol and triglyceride values were measured; they are shown in table 8. The data shows that addition of triticale in the complete feed does not modify the cholesterol and triglyceride values in the blood, these remaining within the limits according to cited literature. Adding xylanase (EG_2) does not lead to changes in blood cholesterol content in comparison with EG_1 group which consumed feed without enzyme, while adding the poly-enzyme complex (EG_3) lowers cholesterol level ($P < 0.05$) compared with broilers that have consumed feed without enzymes. Adding xylanase or a poly enzyme complex does not lead to great changes in the content of blood triglycerides ($P > 0.05$).

Using triticale in complete feed in the amount of 600 g/kg reduces the productive performance of broiler chickens. The results obtained through this experiment show that adding enzymes to complete feed has a positive effect on productive performance. These results are supported by those obtained by D. JOZEFIAK & al. [9]. Reduced viscosity at duodenum and jejunum level is the effect of enzymes added to complete feed (Steenfeldt et al., Bergh et al., quoted by D. JOZEFIAK & al. [9], S.S.P. SILVA and R.R. SMITHARD [13]. In this experiment, the broiler chickens fed with complete feed based on triticale and enzyme-free addition had a lower body weight. Triticale contains a high amount of arabinoxylan that determines an increased viscosity at intestine level (D. BOROS [1]). The question remains whether or not it is necessary to use poly-enzymes or mono-enzymes in triticale-based complete feed. The results obtained through this experiment suggest that a poly-enzymatic complex is not needed when using triticale in amounts of 600 g/kg complete feed, because of the use of xylanase that would decrease viscosity in the intestine. The same results were obtained by I. CIFTCI & al. [14] regarding viscosity reduction ($P < 0.05$) by adding xylanase in the complete feed for laying hens. To date, studies regarding the use of enzymes are not focused on adding mono-enzymes or poly-enzymatic complexes to the triticale based complete feed. M.R. BEDFORD [15] shows that enzyme addition is mediated through improvements in nutrient extraction in the small intestine through accelerated digestion and reduced microbial activity as a result of substrate limitation in the ileum. The caecum is the main place where fermentation takes place within the broilers' gastrointestinal

tube. The undigested carbohydrates can be fermented in the presence of microflora down to lactic acid, short chains of fatty acids and gases D. JOZEFIAK [8]. By feeding broiler chicken fibre diets, the impact on performance is observed by increased fermentation in the caecum that can lead to caecal hypertrophy P. REDIG [16]. The consequences of a poorly digested diet and therefore the benefits of enzyme addition to the diet are more apparent in conventional growth, compared with germ-free chickens ((Langhout, Schutte and Langhout quoted by P. REDIG [16]). Lindemann & al., quoted by P. REDIG [16] suggest that until the broilers reach 8 days of age, the output of pancreatic enzymes can limit digestion. The addition of exogenous enzyme is likely to improve the digestive capacity of the younger bird. Broiler chicken intestines are generally populated by lactobacillus, about 108 -109 CFU/g of intestinal content. Most of lactobacillus is represented by Lactobacillus acidophilus I.E.L. GUAN & al. [17]. The present experiment shows that the addition of xylanase and a poly-enzymatic complex increases the number of lactobacillus and decreases the number of coliforms. M.R. BEDFORD and J. APAJALAHTI [10], show that enzyme addition to complete diet feed can influence fermentation in the caecum. Positive influence on the productive performance of broiler chickens of enzyme addition to complete feed may be explained by the increase of food consumption and digestibility (M. ALMIRALL and E. ESTEVE-GARCIA [18], C. SMITS and G. ANNISON [19], R. LAZARO & al. [20]). The hyper-cholesterol effect of soluble fibres was established by Davidson et al. as well as by Miettenen and Tarpila quoted by L.WANG & al. [21]. Guar gum, a soluble fibre source, breaks down lipid connections as shown by Gallaher and Schneeman quoted by L.WANG & al. [21], and reduces the cholesterol and lipid assimilation in rats. The present experiment shows that the increased levels of arabinoxylan determine a stabile level of cholesterol and triglycerides within the limits cited in literature (105±15 mg/100 ml for cholesterol and 60±20 mg/100 ml for triglycerides). Adding a poly-enzymatic complex to complete feed lowers cholesterol and triglycerides levels (cholesterol 91.5, slightly below the limits cited in literature). It can be observed that, in the case of this experiment, adding triticale does not change the triglyceride and cholesterol content outside the normal range for these biochemical parameters. Changes to the cholesterol content below the limits specified in literature may be associated with adding of enzymatic complex.

Conclusion

When using *triticale* in quantities of 600 g/kg complete feed with xylanase, a higher body weight ($P<0.001$) compared to chickens that were not fed with enzymes can be obtained.

The feed conversion rate is influenced by the addition of enzymes to the complete feed and is greatly reduced when using xylanase ($P < 0.05$).

The addition of xylanase to complete feed based on *triticale* determines a decrease of viscosity at duodenum and jejunum level in comparison when adding poly-enzymatic complex ($P < 0.05$).

The addition of xylanase to complete feed based on triticale determines an increase of lactic acid bacteria and a decrease of the number of coliforms ($P < 0.05$).

Adding triticale does not modify the triglycerides and cholesterol content outside the normal limits for these biochemical parameters; adding an enzyme complex causes changes in cholesterol content below the limits specified in literature, and adding xylanase maintains both biochemical parameters within the limits specified in literature.

In order to prevent the anti-nutritive effect of soluble NSP in triticale, it is recommended that xylanase be used instead of poly enzyme complexes.

Acknowledgements

This research was funded by the Romanian Ministry of Education and Research / IDEI grant no. 1115/2009-2011, code CNCSIS 895

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