Assessment and Control of the Antinutritional Effect Exerted by Non-Starch Polysaccharides from Triticale-Based Combined Forage, in Broilers

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Abstract

The objective of this experiment was to assess and fight against the NSP's anti-nutritional effect from meat chickens' alimentation. The experiment lasted for six weeks and was performed on a number of 120 chickens distributed in four experimental variants (LE1, LE2 and LE3, LE4). The hybrid used was Ross 308. We formed four experimental groups, as follows: the experimental group LE1 fed with a CF containing triticale in proportion of 40 % in its structure, the experimental group LE2 fed with a combined forage in which we had incorporated triticale in proportion of 60%, the experimental group LE3 fed with forage including triticale 60 % with supplementation of xylanase 100 ppm, and the experimental group LE4 fed with forage including triticale 60% and xylanase in a quantity of 250 ppm. We could observe that the NSPs, NSPi and NSP total contents increased with the increase of triticale participation; so, the combined forage including 60 % triticale during the growth period from eclosion to 6 weeks presented up to 1.08 percentage points the NSPs content, up to 0.28 p% the NSPi content and up to 1.36 p% the NSPt content. Xylanase incorporation in a quantity of 250 ppm determines body weight increase with up to approx. 12% in the case of 6-week old chickens and feed conversion ratio reduction with up to 10 %. The utilization of triticale in proportion of 40-60 % in combined forage structure, for broiler chickens, is possible only in association with enzyme incorporation; these determine the reduction of intestinal viscosity at duodenum and jejunum level, with up to 15 %.

Keywords: Broiler chickens, NSP, triticale, xylanase.

1. Introduction

Triticale is a hybrid of wheat (***Triti****cum*) and rye (*Se**cale***) first bred in laboratories during the late 19th century. The grain was originally bred in Scotland and Sweden. Commercially available triticale is almost always a 2nd generation hybrid, i.e. a cross between two kinds of triticale (primary triticales). As a rule, triticale combines the high yield potential and good grain quality of wheat with the disease and environmental tolerance (including soil conditions) of rye. Triticale was created to combine wheat quality with rye winnter hardiness and disease resistence as well as to utilise the hybrid vigour [1].

With respect to the composition of the carbohydrate fraction wheat, rye and triticale all contain arabinoxylans , a soluble fraction of non polysaccharides (NSP). This substances may create a viscous environment within the intestinal lumen [2]. Supplementation of broiler diets with appropriate enzymes capable of degrading the xylan backbone of the AX has been shown to improve the nutritive value oftriticale diets [3,4]; The improvement of performance has been suggested to be due to the lowered viscosity [5-8].

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2. Materials and methods

The experiment lasted for a period of six weeks and was carried out on a group of 120 chickens by S.C. Alis Deva, distributed in four experimental variants (LE1, LE2 and LE3, LE4). We formed four experimental groups, as follows: the experimental group LE1, fed forage with triticale in proportion of 40 % in its structure, the experimental group LE2, fed combined forage with incorporation of triticale in proportion of 60%, the experimental group LE3, fed forage with triticale 60% and xylanase in quantity of 100 ppm and the experimental group LE4, fed forage with triticale in proportion of 60% and addition of xylanase in quantity of 250 ppm. At the ages of 3 and 6 weeks, successive to chicken killing, we took intestinal content samples and determined the intestinal viscosity Viscosity was determined with the help of the Brookfield viscometer. The combined forage content in NSP was determined according to the tabular data [9]; and to some HPLC determinations.

Analyses of combined forages' nutritive content

To determine the nutritive value of the combines forages offered to broiler chickens in our experiments, we applied the standard methods according to WEENDE scheme, respectively:
-DM (%) – stove-drying at 105 ^{0} C
-CP (%) – Kjeldahl method
-CF (%) – Soxhlet method
-CC (%) – Van Soest method.

Determination of nutritive, bio-productive and digestive indices in broiler chickens

In this experiment on broiler chickens, we determined the following indices:
-forage intake,
-weight gain,
-specific intake,
-intestinal viscosity.

Biological material used in experiment

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

Result processing methods

The testing of differences between batches, in terms of production indices, was performed with the help of Mann Whitney (Wilcoxon) test and with the software MINITAB 14 as well.

The organization scheme of the experiment is presented in table 1, and the nutritional characteristics of the combined forage used in this experiment are presented in table 1.

Table 1. Organization scheme of the experiment

Period 0-6 weeks			
LE1	LE2	LE3	LE4
CF 40% triticale	CF 60 % triticale	CF 60 % triticale + 100 ppm xylanase	CF 60 % triticale + xylanase 250 ppm

The chickens in the four experimental groups were fed as follows: during the first growth period, namely from eclosion to the age of 3 weeks old, the combined forage provided 3187.7-3200 kcal ME and a CP content of 22.98%-23.15 %. During the second growth period, from 3 to 6 weeks, the combined forage provided 3211.1-3209.47 kcal ME and 20.06-20.07 % CP.

3. Results and discussion

To determine the forage quantity ingested for each period separately, we weighed at the beginning of this experiment the amounts allocated for each variant, and at 3 weeks old we weighed the amounts of feed left. We applied the same method for the period 3-6 weeks, as well. The weight gain was determined by weightings at eclosion, at the age of 3 weeks and at 6 weeks. The structure of combined forage's and the nutritional characteristics are presented in Table 2 [10].

According to the table, we may draw the conclusion that the increase of triticale percentage of participation takes place at the same time with the increase of NSP s, i and total; so, the combined forage that included 60 % triticale during the growth period from eclosion to 6 weeks presented a NSPs content of up to 1.08 percentage points more, a NSPi of 0.28 p% and NSPt of 1.36 p%.

Forage's contents in NSPs, i and t are presented in Table 3.

Table 2. Combined forage's nutritional characteristics

Specification	LE1		LE 2 – LE3- LE4	
	Period 0-3 weeks	**Period 3-6 weeks**	**Period 0-3 weeks**	**Period 3-6 weeks**
Nutritional characteristics				
M E (kcal/kg forage)	3187.7	3211.11	3200	3209.47
Crude protein (%)	22.98	20.06	23.15	20.07
Lysine (%)	1.24	1.02	1.22	0.99
Methionine + cystine (%)	0.91	0.72	0.92	0.72
Calcium (%)	1.1	0.9	1	0.89
Total Phosphorus (%)	0.79	0.7	0.8	0.75

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Table 3. Combined forage's content in non-starch polysaccharides (NSP)

Growth period	Specification	NSPi (%)	Percentage differences P%	NSPs** (%)	Percentage differences	NSPt*** (%)	Percentage differences
	40 % triticale	11.73	-	1.4	-	13.13	-
Period 0-3 weeks	60 % triticale	12.81	**1.08**	1.68	**0.28**	14.49	**1.36**
	40 % triticale	11.75	**-**	1.33	**-**	13.08	**-**
Period 3-6 weeks	60 % triticale	12.8	**1.05**	1.59	**0.26**	14.39	**1.31**

***** soluble non-starch polysaccharides
** insoluble non-starch polysaccharides
*** total non-starch polysaccharides

Body weight evolution in chickens from the experimental variants

By weighing the chickens at eclosion, at 3 and at 6 weeks, we could determine their growth and body weight; these data are presented in table 4. In this table, we may observe that until the age of 3 weeks, the group LE2 records a body weight smaller with 4.2 %, a statistically insignificant difference. With enzyme incorporation in the combined forage structure, the body weight increases with 11.98 %, a statistically significant difference ($p<0.01$ %). From 3 to 6 weeks, the incorporation of triticale in proportion of 60 % in the combined forage structure determines a body weight reduction with 3.21 %, a statistically insignificant difference. The incorporation of this enzyme determines the increase of body weight with up to 11.98 %, a statistically significant difference ($p<0.01$). Consequently, we may conclude that xylanase incorporation in quantity of 250 ppm determines body weight increase with up to 12 % in the 6-week old chickens.

Table 5 presents the significances of the differences between means.

Table 4 Body weight evolution in chickens from the experimental variants

Specification	LE1	LE2	LE3	LE4
n				
Weight at eclosion (g)	39	40	39	39
Weight at 3 weeks (g)	**787±60.90**	**754±76.76**	**808±69.2**	**840±76.95**
CV (%)	7.7376	10.1550	8.5671	9.1583
Percentage differences	100	**95.8**	102.66	**106.73**
Percentage differences		100	107.16	**111.4**
n				
Weight at 6 weeks (g)	**2430±169.104**	**2352±232.64**	**2432±231.35**	**2634±224.52**
CV (%)	6.96023	9.89018	9.51236	8.52248
Percentage differences	100	**96.79**	100.08	**108.39**
Percentage differences		100	103.4	**111.98**

Table 5 Significance of the body weight differences at the ages of 3 and 6 weeks

Specification	V2	V3	V4
V1	ns	ns	ns
V2		0.049 *	0.0036 **
V3			ns

Specification	V2	V3	V4
V1	Ns	Ns	0.0154 *
V2		Ns	0.0054 **
V3			0.0258 *

Forage intake evolution in chickens from the experimental variants

To determine the forage intake, we weighed the forage amounts offered each experimental variant, and also the amount of feed left at the age of 3, respectively 6 weeks. We calculated the forage intake/individual/period and the mean daily intake for each period. The data obtained are presented in table 6. In this table, we may observe that, during the first growth period, from eclosion to 3 weeks, the most reduced forage intake was recorded in the case of group LE4, smaller with 1.47 % compared with LE1, fed forage with 40 % triticale, and smaller with 0.74 % compared with LE2, fed forage with 60 % triticale. During the second growth period, from 3 to 6 weeks, the most reduced forage intake was recorded in LE 1, fed forage with 40 % triticale.

For the entire growth period, the most reduced forage intake was recorded in LE3; this was 4.79 % smaller than in LE2.

Feed consumption ratio evolution in chickens from the experimental variants

By corroborating the forage intake data with the body weight ones, we could determine the specific intake. Feed consumption ratioevolution is presented in table 7.

Table 6 Forage intake evolution in chickens from the experimental variants

Specification	**LE1**	**LE2**	**LE3**	**LE4**
Period 0-3 weeks				
Intake per period/chicken (kg/chicken)	0.958	0.951	0.977	0.944
Daily mean intake/chicken/period (g)	45.62	45.28	46.52	44.95
Percentage differences	**100**	**99.25**	**101.97**	**98.53**
		100		**99.26**
Period 3-6 weeks				
Intake per period/chicken (kg/chicken)	3.24	3.52	3.28	3.59
Daily mean intake/chicken/period (g)	154.28	167.61	156.19	170.95
Percentage differences	**100**	**108.64**	**101.23**	**110.8**
Period 0-6 weeks				
Intake per period/chicken (kg/chicken)	4.198	4.471	4.257	4.534
Daily mean intake/chicken/period (g)	99.95	106.42	101.35	107.95
Percentage differences	**100**	**106.47**	**101.4**	**108**
		100	**95.21**	**101.4**

Feed consumption ratioevolution in chickens from the experimental variants

By corroborating the forage intake data with the body weight ones, we could determine the specific intake. Feed conversion ratio evolution is presented in Table 7. During the growth period 0-3 weeks, the most reduced feed conversion ratio was recorded in LE4 (1.17), fed combined forage with addition of enzyme in quantity of 100 ppm. The same situation may be observed during the second growth period, 3-6 weeks (2.001). During the entire growth period, the most reduced Feed consumption ratiowas recorded in LE4 (1.74 kg). LE2 and LE3 presented a feed conversion ratio that was bigger than in LE1 (1.75 kg CF/kg growth).

Table 7 Feed conversion ratio evolution in chickens from the experimental variants

Specification	LE1	LE2	LE3	LE4
Period 0-3 weeks				
Intake per period / chicken (kg)	0.958	0.951	0.977	0.944
Growth / period / chicken(g)	748	714	769	801
Feed consumption ratio(kg forage / kg growth)	1.28	1.33	1.27	1.17
Percentage differences	**100**	**103.9**	**99.21**	**91.4**
		100	**95.48**	**87.96**
Period 3-6 weeks				
Intake per period / chicken (kg)	3.24	3.52	3.28	3.59
Growth / period / chicken(g)	1643	1598	1624	1794
Feed consumption ratio(kg forage / kg growth)	1.97	2.2	2.019	2.001
Percentage differences	**100**	**111.67**	**102.48**	**101.57**
		100	**91.77**	**90.95**
Period 0-6 weeks				
Intake per period / chicken (kg)	4.198	4.471	4.257	4.534
Growth / period / chicken(g)	2391	2312	2393	2595
Feed consumption ratio(kg forage / kg growth)	1.75	1.93	1.77	1.74
Percentage differences	**100**	**110.28**	**101.14**	**99.42**
		100	**91.7**	**90.15**

Compared with LE2, the Feed consumption ratioof the chickens in LE3 was 8.3 % smaller, and the one of the chickens in LE4, 9.85 % smaller. Consequently, we may conclude that the enzyme incorporation in quantity of 250 ppm determines the reduction of Feed consumption ratiowith up to 10 %. Table 8 presents the viscosity values at intestinal level, in chickens from the experimental variants.

According to this table, we may conclude that, during the period from eclosion to 3 weeks, enzyme incorporation in quantity of 100 ppm determines viscosity reduction at intestinal level with 7.67 %, and in quantity of 250 ppm with 3.84 %. During the second growth period, xylanase incorporation generates the reduction of viscosity with approximately 14.23 %.

Table 8. Intestinal viscosity evolution at duodenum and jejunum level in 6-week old chickens

Experimental variant	Triticale percentage of participation	Viscosity cP	Percentage differences	Percentage differences
		Duodenum		
LE1	40	2.35	100	
LE2	60	2.61	111.06	100
LE3	60 plus + 100 ppm	2.41	102.55	92.33
LE4	60 xylanase 250 ppm	2.51	106.8	96.16
		Jejunum		
LE1	40	2.08	100	
LE2	60	2.53	121.63	**100**
LE3	60 plus + 100 ppm	2.20	105.76	86.95
LE4	60 xylanase 250 ppm	2.17	104.32	**85.77**

Consequently, the utilization of triticale in proportion of 40-60 % in the combined forage structure, in broilers, is possible only with enzyme incorporation; enzymes determine the reduction of intestinal viscosity at duodenum and jejunum level as well, with up to 15 %. In general the results obtained from the present experiment demonstrated that the adequate enzyme

supplementation of the triticale-based diets had a positive effect on the performance of broiler chickens. This is in agreement with experiments carried out by other authors [11-16].

Conclusions

- the increase of triticale percentage of participation generates the increase of NSP s, i and total, so that the combined forage including 60 % triticale during the growth period from eclosion to 6 weeks presented a NSPs content with up to 1.08 percentage points bigger, a NSPi content with 0.28 p% bigger and a NSPt content with 1.36 p% bigger;
- for the entire growth period, the most reduced forage intake was recorded in LE3, and this was 4.79 % smaller than in LE2;
- xylanase incorporation in quantity of 250 ppm determines body weight increase in the 6-week old chickens with up to approximately 12 % and the reduction of Feed consumption ratiowith up to 10 %;
- the utilization of triticale in proportion of 40-60 % in the combined forage structure, in broilers, is possible only with enzyme incorporation; enzymes determine the reduction of intestinal viscosity at duodenum and jejunum level as well, with up to 15 %.

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