

The Effect of Replacement of Soybean Meal with Lupine Seed (*Lupinus albus* vr. Energy) on Growth Performance and Carcass Traits in Turkeys

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Abstract

This research has been conducted to check to what extent soybean meal in the turkey broilers meals can be replaced partially by alkaloid free lupine seeds, monitoring the effect of this important alternative source of protein on the production performance, carcass quality and on the economic efficiency. The experiment was made as a fully randomized experimental design which consisted of four treatments which involved a control diet consisting of corn-soybean meal (LC) and three experimental diets (i.e. E1, E2 and E3 lots) in which protein from soybean meal were replaced with alkaloids free lupine flour. White lupine beans (vr. Energy - alkaloids free variety) obtained in specific climatic conditions of the Western Romania, after grinding, were introduced in the structure of mixed fodder at a rate of 20% (in the lot E1), 30% (in the lot E2) and 40% (in the lot E3). Substituting soybean protein meals in turkey broilers by inserting alkaloids free white lupine beans in the structure of mixed fodder at a rate of up to 30% (% by weight) has no adverse effect on the following: weight gain, degree of food recovery, slaughter and carcass quality indices. A significant reduction ($p < 0.05$) of the performance has been found in broilers from the lot E3, where white lupine seeds were introduced in the mixed fodder at a rate of 40%. In comparison with the control group, the final weight of turkey broilers from the lot E3 was lower by 7.80%, the feed intake was lower by 3.71%, the feed consumption per 1 kg gain in weight was higher by 4.42%, and the chest share in the carcass structure was lower by 1.54 percentage points. As against the control lot (LC), in the case of the experimental groups the price of one kg of mixed forage decreased by 14.02% and the feed costs per 1 kg gain in weight decreased by 10.78% (i.e. the case of the turkey broilers in group E2 where food the lupine seeds accounted for 30% - in % by weight of feed). The increase of lupine seeds share in the structure of mixed fodder up to 40% ensure a significant reduction of feed costs per achieving a gain of a single kg (by 10.2% as compared to control lot), but because of the significant reduction in the average weight of turkeys at slaughter age (by approx. 1.5 kg/ turkey versus control group), we assess that this is not an optimal solution for feeding turkey broilers.

Keywords: *alkaloid-free lupine, protein, turkey*

INTRODUCTION

In the context of the prohibition of animal flours in the poultry diet and the high price of soybean products and by-products, the lupine seeds can be a promising alternative for the provisioning from domestic production of plant protein in feeding poultry in our country. Climatic conditions of our country provide the prerequisites for obtaining a proper lupine seeds production both in terms of quantity and quality (Mierlita, 2012).

In Romania, the cultivation and especially the use of white lupine seeds to feeding poultry is not

promoted to the same extent as in other countries, although it is a viable alternative to soy grits from imports, both in bio-productive terms as well as economically and environmentally. From an environmental approach, white lupine seeds have the advantage that they are not genetically modified, and because they can fix atmospheric nitrogen, for fertilization purposes they require small amounts of chemical fertilizers, and thus it is considered as a sustainable culture with positive outcomes on soil fertility and the environment (Vecerek *et al.*, 2008).

The interest in using lupine seeds in broilers diets is justified primarily by its high protein content (40.08% Pb.), but also by its high-energy value (2658 kcal EM/ kg) (Mierlita, 2012). Most studies have shown that, by introducing lupine in shares of up to 25% in broilers meals one reaches similar results to those provided by diets based on soybean meal Brenes *et al.*, 1993; Lettner and Zollitsch 1995; Sitko and Cermac, 1998; Egorov *et al.*, 2001; Nalle *et al.*, 2010; Suchy *et al.*, 2010; Mierlita D., 2012). Mierlita, (2012) concluded that in order to maintain growth performance of broilers, lupine flour can be inserted into broilers food to a maximum of 30% and lupine cannot fully substitute soy grits within the diet of broiler chickens.

The use of lupine as the sole source of protein for poultry is limited on the one hand by the biological value of protein (low content in methionine, lysine, tryptophan and threonine –Strakova *et al.*, 2006), and the high content in NAP (non amidine polyglucides) which adversely affects the processes of digestion and recovery of food (Kocker *et al.*, 2000). Increasing the recovery degree of lupine in broiler nutrition can be achieved by using specific enzyme preparations or by shelling the beans, when the latter can substitute 50% of the soy grits used in combined forage structure without modifying the bio performance of broilers (Suchy *et al.*, 2010).

The research has been conducted to check to what extent soybean meal in the turkey broilers meals can be replaced partially by alkaloid free lupine seeds, monitoring the effect of this important alternative source of protein on the production performance, carcass quality and on the economic efficiency.

MATERIAL AND METHODS

The experiment was made as a fully randomized experimental design, which consisted of four treatments which involved a control diet consisting of corn – soybean meal (LC) and three experimental diets (i.e. E1, E2 and E3 lots) in which protein from soy grits were replaced with alkaloids free lupine

flour. This alternative source of protein for feeding turkey broilers was included in the structure of mixed fodder at a rate of 20% (in the lot E1), 30% (in the lot E2) and 40% (in the lot E3); thus the lupine seeds substitute up to 77% (stage 0-3 weeks), 81% (phase 3-9 weeks), 97% (stage 9-12 weeks) and 100% (after 12 weeks until slaughter) of proteins provided by soybean grits (Tab. 1).

In our experiment, we used Energy variety white lupine seeds (improved in France), cultivated in the climatic conditions of the Western Romania, using seeds imported from Netherlands. All diets were formulated to contain similar levels of metabolisable energy, crude protein and limiting amino acids (lysine and methionine + cystine), providing hybrid specific nutritional requirements.

A total of 36 broiler turkeys, male, aged one day (Grade Maker Hybrid, imported from Austria) were divided randomly into four lots. The dynamics of body mass was based on the individual weighing of broilers from each group when populating (one day) and during the breeding period, i.e. at the age of 3, 6, 12 and 18 weeks when the productive experiments were concluded.

Feed was administered at discretion, the amount of feed consumed was determined for each broilers lot and that for each breeding period (0-3, 3-6, 6-12 and 12-18 weeks, respectively) through weighting.

In order to determine the economic efficiency of the partial substitution of soybean grits in the turkey broiler feed with Lupine, we calculated the total costs. In order to calculate the price of one kg of feed, by growth stages individually, we considered raw material prices recorded in December 2013 on the free market. As an indicator of economic efficiency we considered the feed costs per 1 kg increase in weight, given that all other costs were the same in all broilers lots (the one day old broilers value, heating costs and microclimate conditions related costs, labor costs, veterinary actions costs, etc.).

At the age of 18 weeks and in order to assess the quantitative and qualitative indicators of meat

Tab. 1. Experimental design

Group	Treatment	Targets
LC	Soybean meal	Effect of lupine seeds on the main indices of production and consumption (gain in weight, feed use);
E ₁	Lupine seeds – 20%	Effect of lupine seeds on feed related costs relative to 1 kg increase in weight;
E ₂	Lupine seeds – 30%	Effect of lupine seeds on the main slaughter indices and carcass quality (yield at slaughter, the share of main parts cut out of the carcass).
E ₃	Lupine seeds – 40%	

production, seven broilers were slaughtered from each, eliminating the minus variants of the lot. At control slaughter the following indices were determined: carcass mass, edible internal organs mass, slaughter yield, mass of the main parts cut out of the carcass and the share of intra-abdominal and adherent fat in the carcass' structure.

Testing the significance of the differences between groups was made by applying ANOVA testing (Pall, 2007). Differences were declared as being significant at $p < 0.05$.

RESULTS AND DISCUSSION

Out of the analysis of data on the evolution of body mass of turkey broilers, presented in *Table 2* we can draw the following conclusions:

At the age of one day (when populating) the weight of broilers was almost equal in all lots;

At the age of 3 weeks, the average weight of broilers was almost equal to the broilers in the control lot in which food it was used only soybean grits as protein forage with the broilers in the lots E1 and E2 in which food lupine seeds were introduced at a rate of 20% and 30%, respectively, and significantly lower in broilers in group E3 ($p < 0.05$) in which the lupine seeds were supplied in feeding at a rate of 40%, thus substituting 77.5% of the protein provided by the soy grits;

At the age of 6, 12 and 18 weeks there were recorded similar aspects to those previously reported; it is once again remarkable the significantly lower weight ($p < 0.01$) of the broilers from the lot E3 as against the control lot and even against the broilers in the groups E1 and E2 where lupine was 20% and 30%, respectively, of the food structure;

The final weight of the experimental broilers recorded at the age of 18 weeks was between 19.87 kg/head in case of control lot LC and 18.32 kg/in the case of the lot E3. Unlike broilers from the control lot LC, which recorded the highest final body weight, the body weight was less by 0.28 kg (1.41%) in lot E1; 0.80 kg (4.03%) in lot E2 and 1.55 kg (7.80%) in lot E3, the differences being statistically significant only for the lot E3 ($p < 0.01$).

Based on the results achieved we can assess that substituting soy protein grits with white lupine flour does not have a significant effect ($p > 0.05$) on the value and the dynamics of turkey broiler's body weight, provided that the share of lupine seeds in the structure of mixed fodder does not exceed 30% (in the case of lot E1 and E2). Increasing the share of lupine seeds in the structure of mixed fodder over 30% (% of the feed weight) has a negative impact on weight gain, thus reducing significantly ($p < 0.05$) the average body

Tab. 2. The effect of partial substitution of soybean grits with white lupine seeds on turkey broiler weight gain.

	Group			
	LC	E ₁	E ₂	E ₃
	$\bar{X} \pm s_x$	$\bar{X} \pm s_x$	$\bar{X} \pm s_x$	$\bar{X} \pm s_x$
a) Evolution of body weight (g/capita)				
1 day	50.7 ± 0.02	51.1 ± 0.01	50.4 ± 0.03	50.1 ± 0.01
3 week	691.8 ± 0.31	697.6 ± 0.50	672.7 ± 0.37	653.2 ± 0.41*
6 week	2.70 ± 0.11	2.78 ± 0.09	2.68 ± 0.14	2.50 ± 0.12*
12 week	9.27 ± 0.20	9.20 ± 0.17	8.87 ± 0.19	8.33 ± 0.14**
18 week	19.87 ± 0.28	19.59 ± 0.32	19.07 ± 0.25	18.32 ± 0.35**
b) Average total gain				
0-3 week (g)	641.1	646.5	622.3	603.1
3-6 week (g)	2.012	2.086	2.010	1.849
6-12 week (g)	6.570	6.418	6.190	5.830
12-18 week (g)	10.600	10.388	10.197	9.989
Total gain (kg)	19.819	19.539	19.020	18.270
c) Average daily gain				
0-3 week	30.52	30.78	29.63	28.72
3-6 week	95.79	99.32	95.73	88.02
6-12 week	156.43	152.81	147.37	138.80
12-18 week	252.29	247.34	242.79	237.82
Average (0-18 week)	157.29	155.07	150.95	145.00

LC – Control; E₁ – 20% lupin seed; E₂ – 30% lupin seed; E₃ – 40% lupin seed. * $p < 0.05$; ** $p < 0.01$.

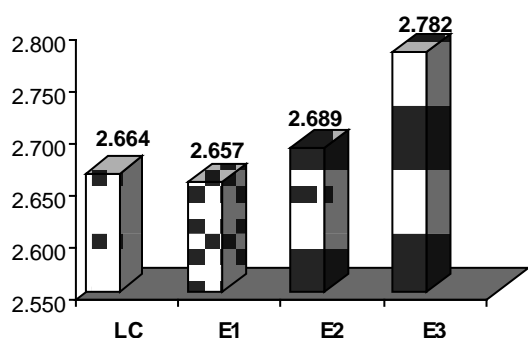
Tab. 3. The effect of partial substitution of soybean grits with white lupine seeds on feed consumption.

Group	g feed/day/bird				Average for the period (0-18 week)
	0-3 week	3-6 week	6-12 week	12-18 week	
LC	46.1	162.3	364.0	788.7	419.0
E ₁	47.1	172.1	359.9	766.8	412.1
E ₂	45.3	168.9	346.5	764.1	405.9
E ₃	45.6	160.5	333.5	773.9	403.5

LC – Control; E₁ – 20% lupin seed; E₂ – 30% lupin seed; E₃ – 40% lupin seed.

weight of turkey broilers when reaching slaughter age (in the case of the lot E₃).

The provisioning of lupine flour in large proportions in turkey broilers' food (i.e. 40% in the case of the lot E₃) had a negative impact on feed intake but also on the degree of recovery of the food (Tab. 3 and Fig. 1). Thus, the daily feed intake relative to the entire experimental period, decreased in the lots to which food it was introduced lupine flour compared with control group, by up to 3.7%. Moreover, the average consumption of mixed forage to achieve one kilo in weight based on the whole growth period (0-18 weeks) was almost equal to that recorded in the control group, the experimental lots E₁ and E₂

**Fig. 1.** The effects of alkaloids free white lupine seeds on the food recovery degree.

to which Lupine seeds were within 30% of food structure and increased by 4.43% when lupine accounted for 40% of mixed fodder structure (in the case of the group E₃).

The provisioning of alkaloids free white lupine seeds in the structure of mixed fodder for the turkey broilers food by stages in a share of up to 30% (as % of feed) is recommended without adverse effects on weight gain, consumption and the degree of food recovery. Increasing the proportion of lupine in food to 40% (in the group E₃) has significantly reduced ($p < 0.01$) the final weight of broilers and feed intake and increased

the consumption of specific mixed forage per 1 kg gain in weight.

In most studies published in the international literature it is mentioned that the provisioning of lupine seeds in broiler food in the amount of up to 250 g/kg (without shelling the seeds without using enzyme preparations) does not affect the growth performance and feed recovery if the diet is balanced in essential amino acids and mainly in sulfur amino acids (Teixeira and Dos, 1995; Olver and Jonker, 1997; Roth-Maier and Paulicks, 2003), considering that the amount of sulfur amino acids in lupine seeds are just 1/3 of that found in soybean grits (0.5 vs. 1.5 g/100 g protein, Sujak *et al.*, 2006). Provisioning lupine beans in the diet of chicken broilers, in shares exceeding 35%, reduce their production performance (Roth-Maier and Paulicks 2003 Steinfeld *et al.*, 2003); the negative influence of lupine is attributed to the large amounts of NAP (non amidine polyglucides).

Despite its high fat content, the lupine has a low energy value due to the high content in NAP (Kocker *et al.*, 2000). It was calculated that for every percentage of lupine in the diet of broilers, its energy value decreases by 0.288 MJ ME / kg (Sipsas and Glencross, 2005) and by adding specific enzymes in food, the apparent digestibility of energy increased by 3.2 percentage points (Froidmont *et al.*, 2004) and the use of proteins and amino acids improves (Nalle, 2009).

Analyzing the influence of partial substitution of soybean grits in the food of broilers with lupine flour on the average cost price of the mixed fodder, one can perceive the net superiority of the lot E₃ in which food it was used the highest proportion of lupine i.e. 40% (Tab. 4). Thus, in comparison with the control lot (LC), in the case of experimental lots, the price per 1 kg of mixed forage decreased by up to 14.02% and the broilers feed costs dropped by up to 17.23%.

Introducing lupine seeds in the food of turkey broiler at a rate of 30% and a corresponding

Tab. 4. The impact of provisioning white lupine on the price of feed and feed costs per 1 kg weight gain

	LC	E1	E2	E3
Fodder cost (RON/kg)*	1.612	1.491	1.425	1.386
Feeding costs (RON/bird) (0-18 week):				
- RON	85.111	77.403	72.874	70.442
%	-	90.94	85.62	82.76
Feeding costs (RON/kg gain)	4.294	3.961	3.831	3.856
Differences from LC: - RON/kg	-	-0.333	-0.463	-0.438
- %	-	-7.75	-10.78	-10.20

LC – Control; E1 – 20% lupin seed; E2 – 30% lupin seed; E3 – 40% lupin seed.

* Specific prices for the month of December, 2013.

reduction in the share of soybean grits resulted in lower feed costs per 1 kg gain in weight by 10.78% and 0.463 RON/kg gain, thus totaling savings of approx. 9 RON on each slaughtered turkey. Increasing the share of lupine in the structure of mixed fodder to 40%, ensuring a significant reduction in feed costs for achieving 1 kg gain (by 10.2% as compared to control lot), but due to significant reduction in the average weight of turkeys at slaughter age (with approx. 1.5 kg/turkey from the control group), we assess that this is not an optimal solution for feeding broiler turkeys.

The results of control slaughter conducted at the end of the breeding period are shown in Table 5. The indicators analyzed shows generally statistical differences only in the broilers in the lot E3, in which food the highest proportion of lupine was provisioned. The highest values of slaughter indices submitted for analysis were recorded in the control lot (LC) and the lowest in the lot E3, while in

the case of the lots E1 and E2 there were recorded values very close to those found in broilers from the lot in which food it was used only soybean grits as a source of vegetable protein. These results lead to the conclusion that lupine seeds can be added in the structure of mixed fodder to feed in stages the turkey broilers in a share of up to 30%; the shares of white lupine exceeding 30% in the fodder play a negative impact on carcass features. Thus, compared to the control lot LC, the carcass yield was lower by 1.52 percentage points (i.e. 72.47 vs. 71.37%) in the case of broilers from the lot E3 and differences were statistically based ($p < 0.05$).

Except for the chest share in the carcass structure, which recorded significantly lower values in lot E3 ($p < 0.05$) in comparison with the other lots, the remaining portions cut from the carcass showed no significant differences in the experimental lots compared to control lot.

The results of our study show that inclusion of lupine flour in large proportions in the food of

Tab. 5. The impact of partial substitution of soybean grits with white lupine seeds on main indices of slaughter and carcass quality of turkey broiler (n = 7).

	Group			
	LC X ± s x	E1 X ± s x	E2 X ± s x	E3 X ± s x
a) Evolution of the main indicators of slaughterhouse				
The weight (kg)	19.38 ± 0.34	19.12 ± 0.54	18.76 ± 0.37	18.11 ± 0.12*
Carcass weight (kg)	14.05 ± 0.21	13.92 ± 0.33	13.61 ± 0.18	12.92 ± 0.47*
The yield of the casing (%)	72.47 ± 0.57	72.82 ± 0.89	72.54 ± 0.72	71.37 ± 1.07*
Edible offal (heart, gizzard, liver) (%) ¹	2.24 ± 0.11	2.14 ± 0.17	2.10 ± 0.12	2.79 ± 0.14*
Commercial yield (%)	74.71 ± 0.62	74.96 ± 0.76	74.64 ± 0.64	74.16 ± 0.55
b) Share the trans main housing (% of carcass weight)				
Chest (%)	37.08 ± 2.05	37.66 ± 1.12	36.43 ± 0.77	35.54 ± 1.21*
Chicken drumsticks (%)	17.59 ± 0.67	18.32 ± 0.91*	18.74 ± 0.52*	17.30 ± 0.61
Thighs (%)	12.70 ± 0.39	12.89 ± 0.61	13.06 ± 0.39	12.47 ± 0.84
Wings (%)	10.93 ± 0.27	11.57 ± 0.38	11.87 ± 0.30	11.60 ± 0.52
Fat deposit	2.24 ± 0.11	2.14 ± 0.17	2.10 ± 0.12	2.79 ± 0.14*

LC – Control; E₁ – 20% lupin seed; E₂ – 30% lupin seed; E₃ – 40% lupin seed. * $p < 0.05$; ** $p < 0.01$.

¹ % of live weight; ² – intraabdominal fat and fat adherence gizzard.

turkey broiler (40% of the feed weight) can have a negative impact of some performance indicators and carcass value. The results are consistent with the findings reported by Egorov *et al.* (2001), which noticed that the best results were obtained when lupine flour was up 20% from the structure of the chicken broilers diet. Similar studies, which reached at the same findings were run by Roth-Maier and Paulicks (2003) and Suchy *et al.* (2010). Suchy *et al.* (2010) reported that by replacing nitrogen in soybean at a rate of up to two-thirds do not affect the content in protein and fat of breast and thigh muscles, but it only increases the crude ash contents in the chest.

CONCLUSION

Substituting soy protein meals in the food of turkey broilers by provisioning alkaloids free white lupine seeds in the structure of mixed fodder at a rate of up to 30% (% by weight) has no adverse effect on weight gain, the degree of food recovery, slaughter and carcass quality indices; however it has the advantage that feed costs per 1 kg gain in weight decreases by up to 10.78%.

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