EFFECT OF PARTIAL SUBSTITUTION OF SOYBEAN MEAL WITH LUPINE SEEDS ON GROWTH AND ECONOMIC EFFICIENCY OF BROILERS

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Abstract

The aim of the study was to investigate the effects of different levels of lupin seeds alkaloid-free in the diet on the growth and economics efficiency of broiler chickens. A total of 120 1-day-old Ross 308 chicks were divided into four batches. Batch Lc (the control) was fed on a maize and soybean diet. Different levels of lupin seeds were used in the experimental diets (low, medium and high level in E_1, E_2 and E_3 batches, respectively) instead of a soybean meal. All diets were formulated to contain similar levels of metabolizable energy, crude protein and amino limited. A feeding program was used to offspring in three phases: starter (1-21 days), growth (22-35 days) and finishing (36-42 days). The results show that replacing protein from soybean meal with lupine flour at low or medium (up to 30% in the starter phase and 60% in growing and finishing phase: group E_2) has no adverse effects on growth in weight and feed conversion ratio. Introduction of lupine flour in chickens in high level (40% in the starter phase and 80% in growing and finishing phase: group E_3) had a negative influence on growth performance ($p < 0.05$). Introduction of lupine seed in diet chickens led to decreasing the cost of feed on up to 29,68%, allowing a progressive increase up to 41,90% of profit got the chicken.

Key words: lupine seeds, broiler, performance

INTRODUCTION

The interest in using lupine beans in broiler diets is justified primarily by their high protein content (40.08% Pb.), but also by their high food energy (3030 kcal ME/kg) generated by high fat content (9.74%) [9].

In Romania, the cultivation and use of white lupine beans in poultry diets is not promoted on large scale as in other countries, although it represents a viable alternative to the soybean meals imported, both in terms of bio production as well as in economic and environment protection terms.

Most studies have shown that, by introducing lupine in proportions of up to 25% in the food of broilers one obtains similar outcomes to those provided by diets based on soybean meals. Many researchers concluded that in order to maintain performance in breeding broilers, lupine flour in food can be introduced in the food in a share of up to 30% but the lupine cannot totally replace soybean meals in broilers' diet [3], [1], [7], [15], [4], [10], [18], [5]. Nalle et al., (2010) concluded that broilers aged < 21 days cannot tolerate food concentrations larger than 200g lupine /1 kg combined fodder.

Lupine use as the sole source of protein for poultry is limited one hand by the protein biological value (low content in methionine, lysine, tryptophan and threonine - [17]), and on the other hand by the high content in NSP (non-starch polysaccharides) which adversely affects the food digestion and use processes [6] [2] [16] [8].

Research made had been designed to ascertain whether the soybean meals in broilers food can be replaced partially by alkaloid free lupine beans, while monitoring the effect of this alternative source of proteins on economic production performance and efficiency.

MATERIAL AND METHOD

The experiment was conducted as a completely randomized experimental design made of four treatments, which involve a

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controlled diet consisting of corn - soybean meals (the control group - Lc) and three experimental diets (E_1, E_2, and E_3) in which the protein from soybean meals was replaced by free alkaloids lupine flour at a rate of 20%, 30%, and 40% respectively during the period from 1st to 21st day period, and at a rate of 40%, 60%, and 80% respectively from the 22nd to 42nd day of breeding. By this substitution one ensured a share of lupine flour in the mix fodder varying from 9.4% to 18.7% in the starter phase, from 17.1% to 34.2%, in the breeding phase, and from 14.7% to 29.3% in the growth finishing phase (Table 1).

Table 1 Structure of mix fodder put to test

Specification	Starter (1-21 days)				Breeding (22-35 days)				Finishing (23-42 days)			
	Lc	E_1	E_2	E_3	Lc	E_1	E_2	E_3	Lc	E_1	E_2	E_3
Structure of mix fodder (% of body weight)												
Corn	52.0	51.9	52.4	52.3	55.5	55.6	55.6	55.8	50.5	50.1	50.5	50.8
Triticale	-	-	-	-	-	-	-	-	10.0	10.0	10.0	10.0
Soybean meals	42.0	33.5	29.3	25.3	38.5	23.1	15.4	7.7	33.0	20.0	13.2	6.6
Lupine	-	9.4	14.0	18.7	-	17.1	25.7	34.2	-	14.7	22.0	29.3
Synthetic lysine	-	0.10	0.10	0.15	-	0.10	0.15	0.15	-	0.10	0.15	0.15
Synthetic methionine	-	0.10	0.10	0.15	-	0.10	0.15	0.15	-	0.10	0.15	0.15
Fat	4.0	3.0	2.1	1.5	4.0	2.0	1.0	-	4.5	3.0	2.0	1.0
Vitamins – minerals premix.	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
TOTAL	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Nutritional characteristics (calculated values)												
E.M. (kcal/kg)	3042	3052	3035	3034	3082	3079	3084	3088	3144	3153	3149	3145
Proteine (%)	23.37	23.37	23.39	23.44	22.13	22.13	22.16	22.16	20.37	20.44	20.38	20.39
Lysine (%)	1.25	1.25	1.25	1.25	1.17	1.17	1.17	1.17	1.05	1.05	1.05	1.05
Met.+Cist. (%)	0.60	0.60	0.60	0.60	0.56	0.56	0.56	0.56	0.52	0.52	0.52	0.52

In the experiment there were used white lupine beans, Energyl variety (improved in France), cultivated in the climatic conditions specific to the Western Romania area, using seeds imported from Holland [9]. All diets were designed to contain similar levels of metabolizable energy, and amino acids gross protein and limiting amino acids (lysine and methionine).

A total of 120 Ross 308 one day broilers were divided into four groups, following the dynamics of body weight and feed consumption.

Testing the significance of the differences between groups was made by applying ANOVA testing [12]. Differences were declared as being significant at $p < 0.05$.

RESULTS AND DISCUSSIONS

From the analysis of data on the evolution of body mass of broilers, shown in Table 2 bellow, one can drawn the following conclusions:

- At the age of one day (populating) broilers body weight was almost equal in all groups;

- At the age of 21 days (end of starter phase) the average body weight was significantly higher ($p < 0.05$) in the case of control group of broilers in which food there were used only soybean meals as protein fodder. The lowest body weight was recorded in broilers in group E_3 in which food there was used in food highest proportion of lupine flour, this substituting 40% of protein provided by soybean meals;

- At the age of 35 days (the end of breeding period) there were not recorded significantly differences between the broilers in the four groups surveyed, but it is worth to notice the body weight of the broilers in group E_3 which is substantially lower than in the case of other groups (by approx. 140.7 g / capita, compared with Lc);

Final body weight of broilers surveyed varied 2598.73 g / capita in case of Lc and 2411.83 g / capita in case of E_3 lot. As compared with broilers in control group (Lc) which recorded the highest final body weight,

this was lower by 0.07% in the group E_1; by 4.04% in the group E_2, and by 7.19% in the group E_3, these differences being statistically ensured only for the group E_3 ($p < 0.05$).

Based on the results obtained we can estimate that substituting the protein from soybean meals by white lupine flour in a share of up to 30% in the starter phase and up to 60% in the breeding and finishing phases does not significantly influence ($p > 0.05$) the level and dynamics of body weight (for the groups E_1 and E_2). Increasing the rate of substitution of protein from soybean meals by lupine flour to 40% in the starter phase and by 80% afterwards plays negative role on body weight gain by reducing significantly ($p < 0.05$) the average body weight of broilers at slaughter age (for the group E_3).

Table 2 Evolution of body weight and average daily gain (g / capita)

	Group			
	Lc	E_1	E_2	E_3
Body weight (X ± sd)				
-initial	41.6 ± 0.67	41.4 ± 0.54	41.9 ± 0.49	41.4 ± 0.66
-at 21 days	917.5 ± 13.88^{a}	901.53 ± 11.94^{ab}	884.70 ± 14.33^{ab}	854.97 ± 14.59^{b}
- at 35 days	1997.17 ± 44.64	1990.50 ± 33.34	1928.00 ± 39.59	1856.50 ± 36.05
- at 42 days	2598.73 ± 42.99^{a}	2596.83 ± 46.14^{a}	2493.83 ± 48.16^{ab}	2411.83 ± 51.26^{b}
Average daily gain:				
- 1 - 21 days	41.65	40.88	40.10	38.67
- 22 – 35 days	77.12	77.78	74.52	71.53
- 36 – 42 days	85.94	86.57	80.83	79.33
- 1 – 42 days	60.85	60.80	58.36	56.40

Similar features are found in the data on average daily gain, shown in Table 3 bellow. Throughout the breeding period, as compared with the control group (Lc) which recorded an average gain of 60.85 g / day, the experimental groups reached slightly smaller body weight gains, with values ranging from 60.80 g / day in group E_1 down to 56.40 g / day in group E_3.

Adding lupine flour in large proportions in the food of broilers (i.e. the group E_3) had a negative impact on both the intake of fodder but also on the degree of diet use (Table 3). Thus, the daily intake of fodder, reported to the entire experimental period, decreased in groups where lupine flour was introduced in the food as compared with the control group (Lc), by up to 5.5%. Moreover the average consumption of mix fodder to reach a one kg gain in weight throughout the whole breeding period (1-42 days) was higher in the experimental groups as against the control group (Lc) by 0.28% in the case of group E_1; by 1.23% in the case of group E_2, and by 1.96% in the case group E_3.

Table 3 Evolution of fodder consumption and the degree of food use

		Group			
		Lc	E_1	E_2	E_3
1-21 days	- mix fodder total consumption (g)	1213.4	1195.6	1179.2	1147.8
	- mix fodder average daily consumption (g)	57.78	56.93	56.15	54.66
	- body weight gain (g/capita)	874.69	858.6	842.14	812.10
	- specific consumption (kg/kg gained)	1.387	1.392	1.400	1.413
22-35 days	- mix fodder total consumption (g)	1934.8	1958.4	1917.9	1858.5
	- mix fodder average daily consumption (g)	138.20	139.88	136.99	132.75
	- body weight gain (g/capita)	1079.67	1088.97	1043.3	1001.53
	- specific consumption (kg/kg gained)	1.792	1.798	1.838	1.856
36-42 days	- mix fodder total consumption (g)	1414.4	1417.0	1333.4	1306.5
	- mix fodder average daily consumption (g)	202.06	202.43	190.49	186.64
	- body weight gain (g/capita)	601.56	606.0	565.83	555.33
	- specific consumption (kg/kg gained)	2.351	2.338	2.356	2.352
1-42 days	- mix fodder total consumption (g)	4562.6	4571.0	4430.5	4312.8
	- mix fodder average daily consumption (g)	108.63	108.83	105.49	102.69
	- body weight gain (g/capita)	2555.92	2553.57	2451.27	2368.96
	- specific consumption (kg/kg gained)	1.785	1.790	1.807	1.820

The substitution of the protein from soybean meals with lupine flour in a share of 20% during the starter phase and 40% in the breeding and finishing phases is recommended without adverse effects on weight gain, food consumption and use. Increased share of lupine in food (30%, and 60% of protein provided by soybean meals in the case of the group E_2) slightly decreased ($p > 0.05$) the final weight of broilers and feed intake and increased the specific consumption of mix fodder for one kg increase in body weight. A significant reduction ($p < 0.05$) performance was found in broilers in group E_3, where the substitution of soybean meal protein with lupine was 40% in the starter phase and 80% in the breeding phase and finishing phases. Thus, comparatively with the control group, the final weight of broilers in group E_3 was lower by 7.19%, the feed intake was lower by 5.47%, and the feed consumption for one kg increase in body weight was higher by 1.96%.

In most studies published in international literature it is mentioned that the adding lupine beans in the food of broilers in the amount of up to 250 g/ kg (without shelling beans and without using enzyme preparations), does not affect breeding performance and the use of food, if the diet is balanced in essential amino acids and mainly in sulphur-containing amino acids [19] [11] [13], considering that the amount of sulphur-containing amino acids in lupine beans is only 30% of the amount found in soybean meals [17].

Adding lupine beans in the diet of broilers in proportion > 35%, reduce their production performance [13] [16]; the negative impact of lupine being attributed to the large amount of NSP (non-starch polysaccharides).

In the case of broilers the NSP (non-starch polysaccharides) of lupine seeds resulted in increased digestive contents viscosity in jejunum and ileum ($p < 0.05$), with a negative effect on feed intake and food use (Table 4). Similar results were obtained by Kocher et al., [6] and Steenfelddt et al., [16] in their previous research conducted on broilers. Lupine, although it has a high fat content, it has however a low energy value because it NSP (non-starch polysaccharides) content [6]. It was calculated that for every percentage of lupine in the broilers diet, its energy value decreases by 0.288 MJ EM/kg, and by adding specific enzymes in food, apparent digestibility of energy increased by 3.2 percentage points and protein and amino acids use improves [14].

Table 4 Impact of lupine seeds on intestinal content viscosity (cP)

Specification	Group			
	Lc	E_1	E_2	E_3
Jejunum	5.54 ± 0.96^{c}	6.31 ± 1.98^{b}	6.85 ± 1.75^{ab}	7.39 ± 2.14^{a}
Ileum	10.07 ± 2.90^{b}	10.41 ± 2.34^{b}	10.60 ± 1.12^{b}	12.43 ± 3.41^{a}

While assessing the impact of partial substitution of soybean by lupine flour in the meals of broilers on the main economic indicators, the superiority of broilers in group E_3 is clear, as in the later food one used the highest proportion of lupine (Table 5). Thus, as compared with control group (Lc), in the case of experimental groups the price of one kg of mix fodder drop by 30.5%, while expenditures on broilers feeding drop by 29.7%. Thus, the net profit obtained at experimental groups compared with the control group (Lc) was higher by 27.6% in the group E_1, 34.3% in group E_2 and by 41.9% in the group E_3 (Table 5).

Table 5 Economic assessment of partial substitution of soybean meal with lupine in broiler nutrition values (excluding VAT)*

			Group			
			Lc	E_1	E_2	E_3
EXPENDITURES						
	Cost per one day broiler		1.65	1.65	1.65	1.65
	Fodder cost (RON/kg)	Starter	1.614	1.491	1.408	1.347
		Breeding	1.582	1.343	1.223	1.099
		Finishing	1.545	1.352	1.243	1.131
	Feeding costs (RON/broiler)	Starter	1.958	1.782	1.660	1.546
		Breeding	3.060	2.630	2.345	2.042
		Finishing	2.185	1.915	1.657	1.477
		TOTAL	7.203	6.327	5.662	5.065
	Other costs (energy, vaccination, medicines, labour force, etc.)		1.60	1.60	1.60	1,60
	Total expenditures (RON/broiler)		10.453	9.577	8.912	8,315
	Final body weight (kg/capita)		2,598	2.596	2.493	2.411
INCOME OBTAINED:						
	- broilers sales (4.4 RON/kg)		11.431	11.422	10.969	10,608
	- subvention (RON/capita)		2.16	2.16	2.16	2,16
	TOTAL INCOME		13.591	13.582	13.129	12,768
PROFIT OBTAINED (RON/broiler)			3,138	4.005	4.217	4.453
Profit variations as compared with Lc						
	- (RON/broiler)		-	+ 0.867	+ 1.079	+ 1.315
	- %		100.00	+ 27.6	+ 34.38	+ 41.90

* Specific prices for the month of November. 2012

CONCLUSIONS

The study results show that when mix fodder is properly balanced in energy, proteins and limiting amino acids, the substitution of soy protein meals in broilers food by lupine flour by up to 30% in the starter phase (1-21 days) and 60% in the breeding (22-35 days) and finishing (36-42 days) phases, has no adverse effect on body weight gain, the use of diet, and carcass and meat quality.

A significant drop of performance ($p < 0.05$) was found in broilers in group E_3, where the substitution of soybean meal protein with lupine was 40% in the starter phase and 80% in the breeding and finishing phases. As compared with the control group, the final body weight of broilers in group E_3 was lower by 7.19%, feed intake was lower by 5.47%, and the feed consumption for one kg increase in body weight was higher by 1.96%.

Adding lupine in broilers feeding and reducing soybean meals accordingly had a positive impact on the key economic indicators. Thus, as compared with the control group (Lc), in the case of experimental groups the price of a kg mix fodder drop by 30.5%, leading to an increased profit in broilers from experimental groups up to 34.3% as compared with the control group (Lc).

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