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STUDIES ON THE INFLUENCE OF THE USE OF WHITE LUPINE SEEDS IN THE FEEDING OF BROILERS ON PRODUCTION PERFORMANCE AND ECONOMIC EFFICIENCY

Mierlita Daniel*, Criste Leontin*, Duminica Anamaria-Gina*

*University of Oradea, Faculty of Environmental Protection, 26 Gen. Magheru St., 410048, Oradea, Romania, e-mail: dadi.mierlita@yahoo.com, ginaduminica98@yahoo.com,

Abstract

The objectives of this study were to determine the effect of the introduction of alkaloid-free white lupine grains in the feed of broiler chickens on weight gain, consumption and feed utilization and on economic efficiency. A total of 200 broiler chickens belonging to the one-day-old commercial hybrid Ross 308 were divided into four groups (n = 50), which were randomly assigned to one of four treatments, consisting of four levels (0, 8, 16 and 20%) of introduction of white lupine grains into food: LC (control batch, 0% lupine); LE8 (8% lupine in food), LE16 (16% lupine in food) and LE24 (24% lupine in food). The introduction of white lupine grains of low-alkaloid varieties in the feed of broiler chickens in proportion of 16% and the corresponding reduction of the weight of soybean meal did not affect the growth rate, consumption and the degree of capitalization of the food, but substantially reduced the value. feed costs related to obtaining a 1 kg weight gain. The increase in the proportion of lupine in the feed of chickens to 24%, led to a decrease in the final average weight by 9.54% (265.8 g / head), a reduction in feed consumption by 3.73% and an increase in the value of the feed index. conversion of food by 6.60%, which led to an increase in food expenditure per kg of weight gain. EEF (European Efficiency Factor) reinforces the conclusion that the optimal proportion of white lupine grains in broiler feed is 16% without significantly affecting production performance, but improves economic efficiency by reducing feed costs for weight gain. 3.67%. We recommend the use of this optimal nutritional solution especially in small and medium farms for raising broilers, which have the opportunity to grow lupine, thus reducing the farm's dependence on the market and trade in soy and soy by-products.

Key words: lupine seeds, broiler, diets, european efficiency factor (EEF)

INTRODUCTION

In the diet of birds, the main source of conventional protein is soybean meal, which has a high protein content (42-46%) with a profile of essential amino acids that corresponds to the nutritional requirements of birds. However, in the context of banning the cultivation of genetically modified plants and limiting the use of genetically modified soy products and by-products, it is necessary to evaluate sources of protein with good biological value that may be available locally and at the same time be economical. Thus, a promising alternative is alkaloid-free white lupine beans.

The introduction of lupine in proportions of up to 25% in the feed of broilers does not affect the performance of growth and recovery of food, nor

the production and quality of meat obtained, compared to diets based on soybean meal (Egorov et al., 2001; Nalle et al., 2010; Suchy et al., 2010; Mierliţă et al., 2014a; 2014b; 2014c). Nalle et al., (2010) concluded that broilers, up to the age of 21 days, cannot tolerate quantities greater than 200 g lupine / kg compound feed.

However Hejdysz et al. (2018) reported that lupine flour can be introduced into the feed of chicken broiler chickens in a maximum proportion of 30%, without affecting the bioproductieve performance, economic and meat quality, but soybean meal can not be completely eliminated from the chicken diet. Increasing the proportion of lupine grains in broiler feed by 35% reduces the rate of growth and feed utilization (Straková et al., 2010) mainly due to the high content of lupine grains in PNA (non-starch polyglucides) (Chandra-Hioe and Arcot, 2015; Grela et al., 2017). Olkowski et al. (2001) reported that some broiler chickens, which were fed a feed containing 40% lupine, showed signs of muscle paralysis and deformity of the long bones in the first week of life, requiring them to be removed from the herd by slaughtering necessity.

The results obtained by Mierlitţă et al. (2013a; 2013b) show that if broiler feed is well balanced in energy, protein and limiting amino acids, soybean meal can be replaced with white lupine grains in broiler feed, up to 30% in the feed phase. starter (1-21 days) and 60% in the growth phase (22-35 days) and finishing (36-42 days), without affecting the weight gain, the degree of capitalization of the food, the quality of the carcass and the meat. A negative influence was found when soybean meal was replaced with lupine in a proportion of 40% in the starter phase and 80% in the growth and finishing phase, respectively.

The introduction of white lupine in chicken broiler feed does not affect the meat's protein and fat content (Suchy et al., 2010), but it does improve the nutritional quality of fats due to the decrease in the share of saturated fatty acids with high atherogenic potential (C14:0, C16:0, C18:0) and increase the share of n-3 polyunsaturated fatty acids (especially ALA), positively influencing the ratio of omega-6 / omega-3 fatty acids (Mierliţă, 2015; Șanta et al., 2022) .

The objectives of this study were to determine the effect of the introduction of alkaloid-free white lupine seeds (Amiga variety) in chicken broiler feed on weight gain, consumption and feed utilization and on economic efficiency.

MATERIAL AND METHOD

The experiment of productive effect took place over a period of 42 days, in production conditions at SC Rosbro Avicom SRL. A total of 200

broiler chickens belonging to the one-day-old commercial hybrid Ross 308 were assigned to four groups (n = 50), which were randomly assigned to one of the four treatments, consisting of four levels (0, 8, 16 and 20%) of the introduction of white lupine grains (Amiga variety), as an alternative source of vegetable protein, in the feed of broiler chickens.

Chickens in the control group (LC) were fed a standard compound feed in which soybean meal was the main source of protein. In the structure of compound feeds used in the feeding of experimental batches (LE), soybean meal has been partially replaced by white lupine free of alkaloids, obtained in the pedoclimatic conditions specific to Transylvania, as follows: LE8 (8% lupine in food), LE16 (16% lupine in food) and LE24 (24% lupine in food) (Table 1).

Table 1

Protein sources used to ensure the nutritional requirements of the broilers (%)

Growth period	Protein sources used	Groups			
		LC	**LE_8**	**LE_{16}**	**LE_{24}**
0-14 days	- soybean meals	40.50	35.00	29.70	24.30
	- white lupine	**-**	***8.00***	***16.00***	***24.00***
15-28 days	- soybean meals	36.50	31.00	26.00	20.50
	- white lupine	**-**	***8.00***	***16.00***	***24.00***
29-42 days	- soybean meals	31.40	26.00	20.50	15.20
	- white lupine	**-**	***8.00***	***16.00***	***24.00***

Each batch was housed separately in a pen with a total area of 3.6 m2 (2m x 1.8m) at a density of 14 chickens/m^2, ensuring identical technological conditions for all batches of chickens included in the experiment.

During the experiment, data were recorded on: body mass dynamics and weight gain, and to assess the degree of food utilization, weekly were recorded for each batch of chickens, the amounts of feed consumed weekly. Based on these, the total food consumption and food conversion indices (kg n.c./kg weight gain) were calculated.

At the end of the experimental period (42 days), the European Efficiency Factor (EEF) was calculated based on viability (%), age of chickens at slaughter (42 days), average body weight (kg / chick) and feed conversion rate. (kg n.c./kg weight gain):

$$EEF = \frac{viability\ (\%)\ x\ weight\ (kg/head)}{age\ (days)\ x\ I.C.(kg\ feed/kg\ weight)} x\ 100$$

In the research undertaken, we also tracked the feed costs in relation to 1 kg weight gain (lei/kg weight gain). The market prices of the raw

materials used to obtain the formulated compound feeds were taken into account.

All recorded data were statistically processed in order to establish differences between treatments (batches). To test the homogeneity of the averages, the univariate and factorial ANOVA technique was used as the mathematical calculation model, and the "t" (Tukey) test was used to test the significance of the differences between the averages. The difference between the means of two samples was considered significant for $p < 0.05$.

RESULTS AND DISCUSSION

1. Weight dynamics

The average weights of broilers in the experimental groups, in which lupine was used in food in the amount of 80, 160 and 240 g / kg, respectively (groups LE8, LE16 and LE24) were lower at the age of 7, 14, 21, 28 , 35 and 42 days, except for the control group (LC) (Table 2). However, weight differences between batches were generally statistically assured only in the experimental batch LE24, in which lupine was fed the largest amount (24%) ($p < 0.001$).

At the end of the experimental period, the broiler chickens from the batches in which 8% and 16% white lupine were fed (batches LE8 and LE16, respectively) achieved average final weights close to those of the control batch: 2758.8 g / head and respectively 2728.5 g / head ($p > 0.05$).

In accordance with our results, Kaczmarek et al. (2016a; 2016b) found that the introduction of white lupine grains into the feed of broiler chicks in the amount of more than 200 g / kg, led to a decrease in the final weight and an increase in the value of the feed conversion index, while the amount of 150 g lupine / kg compound feed did not significantly alter the production performance of the chicks. This effect of lupine grains is caused by the decrease in daily feed consumption, due to the high content of crude cellulose but also of non-starch polyglycosides (Suchý et al., 2006a; Sedláková et al., 2016).

Most authors have concluded that the optimal proportion of white lupine grains in the structure of compound feeds for broiler chickens is up to 20%, which is in line with our findings (Suchy et al., 2006b; Nalle et al., 2012; Mierliţă et al., 2013a; 2013b; Sedláková et al., 2016).

2. The evolution of weight gain

In chickens in the groups that received different proportions of white lupine in the feed, a decrease in the average weekly weight gain was observed, compared to the control group; the decreases being directly proportional to the proportion of white lupine introduced in the chick feed.

These differences were more pronounced in the first four weeks of growth, when compared to the control group, the average weekly increases were lower in the experimental groups by up to 17.48% in the first week, 14.48% in the second week. a and respectively 10.64-12.08% in week III and IV of growth. In the last two weeks of the rearing period, the differences between the chicks in the control group and those in the experimental groups were smaller, which suggests that broiler chicks can make better use of white lupine grains, especially when they are introduced into proportion of maximum 16% in the structure of compound feeds.

Table 2

Body mass dynamics (g) of broilers studied (g/head)

Age	Groups	n	$\bar{x} \pm s\bar{x}$	V%	± % realted LC	p^1 - realted LC
Hatching	LC	40	41.60 ± 0,53	7.19	-	-
	LE_8	40	42.18 ± 0,58	7.46	1.39	n.s.
	LE_{16}	40	41.96 ± 0,48	8.15	0.86	n.s.
	LE_{24}	40	41.42 ± 0,55	5.24	-0.43	n.s.
7 days	LC	39	161.86^a ± 3,18	8.31	-	-
	LE_8	40	161.25^a ± 2,95	7.20	-0.37	n.s.
	LE_{16}	40	157.60^b ± 2,70	9.41	-2.63	*
	LE_{24}	39	140.66^c ± 3,41	10.57	-13.10	***
14 days	LC	39	429.68^a ± 6,85	8.80	-	-
	LE_8	40	421.65^a ± 6,40	6.49	-1.87	n.s.
	LE_{16}	39	422.34^a ± 7,35	9.18	-1.71	n.s.
	LE_{24}	39	369.70^b ± 6,37	6.07	-13.96	***
21 days	LC	38	869.75^a ± 13,52	7.20	-	-
	LE_8	39	865.83^a ± 11,78	10.12	-0.45	n.s.
	LE_{16}	38	856.52^a ± 13,17	7.57	-1.52	n.s.
	LE_{24}	39	762.96^b ± 14,05	7.02	-12.28	**
28 days	LC	38	1451.58^a ± 21,09	7.24	-	-
	LE_8	39	1446.63^a ± 20,56	9.79	-0.34	n.s.
	LE_{16}	38	1406.79^a ± 21,48	10.64	-3.08	n.s.
	LE_{24}	39	1274.51^b ± 20,73	8.41	-12.20	**
35 days	LC	38	2095.24^a ± 35,84	7.39	-	-
	LE_8	39	2081.08^a ± 32,17	8.15	-3.20	n.s.
	LE_{16}	38	2046.38^b ± 30,88	7.49	-5.53	*
	LE_{24}	39	1871.12^c ± 27,59	8.35	-10.69	***
42 days	LC	38	2784.31^a ± 34,40	9.10	-	-
	LE_8	39	2758.82^a ± 31,81	6.58	-0.92	n.s.
	LE_{16}	38	2728.52^a ± 25,75	10.24	-2.00	n.s.
	LE_{24}	39	2518.50^b ± 29,15	9.38	-9.54	***

[1]n.s. - p >0,05; * - p <0,05; ** - p <0,01; *** - p <0,001.

[a-c]values in the same column that have different letters differ significantly (p <0,05).

Compared to the whole experimental period, it is noteworthy that the introduction of white lupine in a proportion of 24% in food (LE24) had a negative influence on the average weight gain of broilers (Fig. 1).

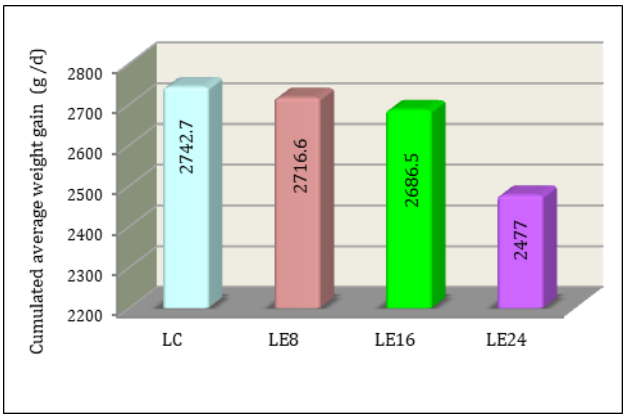

Fig. 1. Cumulated average weight gain in the broilers studied (g/d)

The results obtained in this study are in agreement with those reported by Suchý et al., (2006a) and Rutkowski et al. (2016) and demonstrate that lupine grains can replace soybean meal in broiler chickens to provide protein and energy requirements, provided that limiting amino acids (methionine, lysine and threonine) are supplemented with synthetic amino acid sources.

3. Food consumption and utilization

From the data presented in Table 3 it can be seen that, in general, compared to the case of the control group (LC), food consumption in the first three weeks of the experimental period did not change significantly when lupine was introduced into the food in proportion. of 8% or even 16% (in the case of chickens in groups LE8 and LE16), but there was a significant decrease when lupine was introduced into the feed in proportion of 24% (in the case of chickens in group LE24).

Table 3

Average of fodder intake (weekly and daily) in the broilers studied (g/ d / head)

Period (days)	**LC**	**LE_8**	**LE_{16}**	**LE_{24}**
0 – 7 d	23.14	23.14	23.21	22.89
8 – 14 d	48.50	48.61	48.67	47.25
15 – 21 d	94.46	94.03	94.60	91.00
22 – 28 d	140.03	138.89	137.21	129.82
29 – 35 d	165.86	166.75	163.39	160.18
36 – 42 d	204.39	203.75	202.57	200.00
0-42 days	112.73	112.53	112.13	109.71

Compared to the whole experimental period, the average total food consumption in the experimental groups was 0.18% lower in LE8, 0.53% in LE16 and 2.68% in LE24 compared to the control group (Fig. 2).

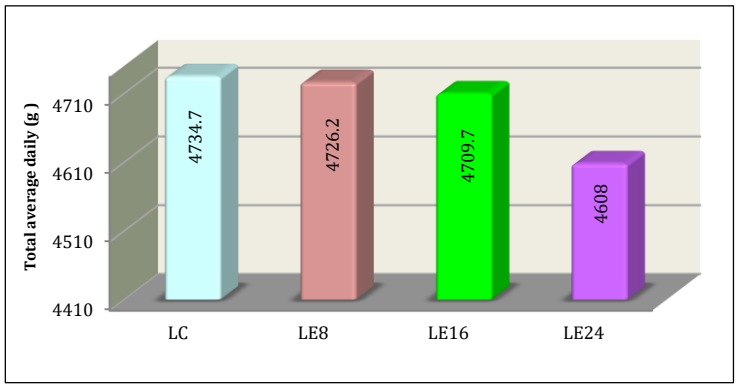

Fig. 2 Total average daily fodder intake in the broilers studied (g/head)

The partial replacement of soybean meal with lupine in broiler feed led to an increase in the value of the feed conversion index, directly proportional to the share of white lupine in the structure of the compound feed, both weekly and reported for the whole experimental period (Table 4). With age, the value of the food conversion index (Kg feed/Kg increase) increased due to the increase in caloric gain of the weight gain achieved, and the differences found between the control group and the experimental groups decreased, probably due to morpho-physiological adaptation. of the digestive tract and increased digestibility of the chemical compounds in lupine grains (Erbas et al., 2001; Faligowska et al., 2017; Criste, 2020).

Table 4

Feed conversion index in the broilers studied (Kg feed/Kg weight gain)

Period	**LC**	**LE_8**	**LE_{16}**	**LE_{24}**
1-7 days	1.347	1.360	1.405	1.614
8 – 14 days	1.267	1.306	1.287	1.444
15 – 21 days	1.502	1.482	1.525	1.619
22 – 28 days	1.685	1.674	1.745	1.776
29 – 35 days	1.804	1.840	1.788	1.879
36 – 42 days	2.076	2.104	2.079	2.163

Compared to the whole experimental period, the introduction of white lupine in the structure of the combined fodder led to an increase in the value of the feed conversion index in parallel with the increase in the replacement level of soybean meal (fig. 3).

The analysis of the main production indices that characterize the biological-productive effect of a compound feed (average weight gain, average compound feed consumption and feed conversion index) (Table 5) shows that the best bioproductive results were obtained by chickens in the control group (LC) in which only soybean meal was used as protein feed.

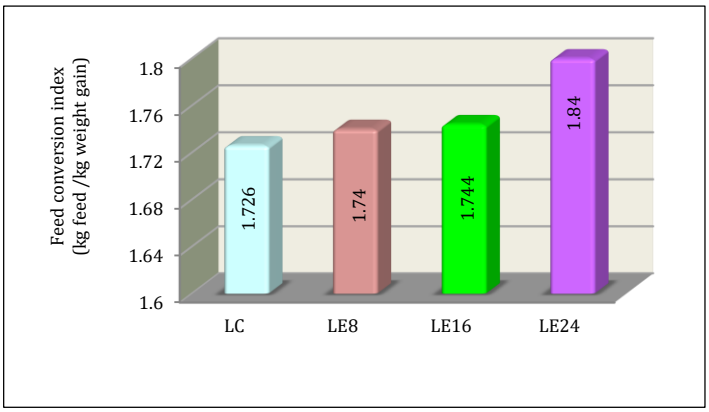

Fig. 3 Total feed conversion index in the broilers studied (kg feed/kg weight gain)

The introduction of lupine in broiler feed has led to a decrease in growth rate by up to 9.68%; to the decrease of feed consumption by up to 3.73% and implicitly to the increase of the value of the feed conversion index by up to 6.60%. The lowest bioproductive performance was recorded by the chickens from the experimental group LE24, in the food of which the highest proportion of white lupine was used. Compared to chickens in the control group (LC), in the experimental groups LE8 (8% lupine in feed) and LE16 (16% lupine in feed) the total weight gain and feed conversion index did not change significantly, which allows us to conclude that the introduction of lupine in the feed of broiler chicks up to 16% does not significantly influence their bioproductive performance.

Table 5

Average production indices recorded during the experimental period in the broilers

Groups	Average total growth gain		Average total feed intake		IC	
	g/head	± % related LC	g/head	± % related LC	Kg feed/Kg weight	± % related LC
LC	2742.71	-	4734.75	-	1.726	-
LE_8	2716.64	-0.95	4726.25	-0.18	1.740	0.81
LE_{16}	2686.56	-2.05	4686.75	-1.01	1.744	1.04
LE_{24}	2477.08	-9.68	4558.00	-3.73	1.840	6.60

IC – feed conversion index.

The studies conducted by Kaczmarek et al. (2016) who showed that the introduction of white lupine grains into the feed of broiler chickens in excess of 200 g / kg, led to a decrease in feed consumption and final weight and an increase in the value of the feed conversion index, while the amount of 150 g lupine / kg combined forage did not significantly alter the production performance of the chicks. Kaczmarek et al. (2016) recorded a decrease in feed consumption only when white lupine was introduced into the feed of broiler chickens in the amount of 250 or 300 g / kg.

4. European Economic Efficiency and Efficiency Factor (EEF)

In broiler farms, a major objective is to reduce production costs, the structure of which has the largest share of feed costs.

The gradual replacement of soybean meal in broiler feed with lupine grains has led to a gradual decrease in the price of one kg of compound feed in all three stages of growth. Thus, compared to the control group, in which only soybean meal was used as protein feed, in the experimental groups the price of the combined feed (lei / kg) decreased by values between 2.58 and 7.34% by introducing the grains. of white lupine in the structure of the combined fodder in proportion of 8%, 16% and 24%, respectively, with the corresponding decrease of the weight of soybean meal (Table 6).

Table 6

Cost of combined fodders used in the broilers feeding (lei/kg feed)

Groups		Periods		
		Starter (0-14 days)	**Growth** (15-28 days)	**Finishing** (29-42 days)
LC	- lei/kg	1.729	1.702	1.649
LE_8	- lei/kg	1.682	1.658	1.605
	± % related LC	-2.72	-2.58	-2.66
LE_{16}	- lei/kg	1.43	1.628	1.564
	± % related LC	-4.97	-4.35	-5.15
LE_{24}	- lei/kg	1.602	1.590	1.534
	± % related LC	-7.34	-6.58	-6.97

The introduction of white lupine in the feed of broiler chickens has substantially reduced the value of the feed costs related to obtaining a kg of weight gain (fig. 4). Thus, compared to the control group (LC), the introduction of lupine in the feed of broiler chickens in proportion of 8%,

16% and 24%, respectively, led to a decrease in feed costs related to one kg of weight gain by 1.66%; 3.67% and 0.55%.

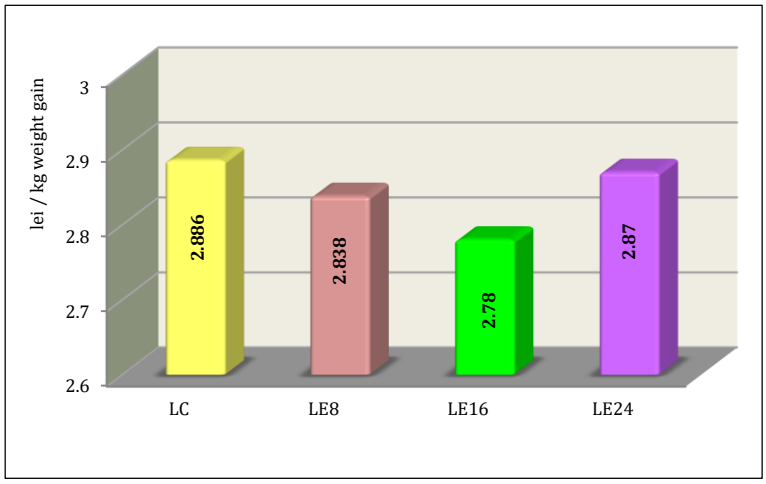

Fig. 4 Feed costs related to obtaining one kg weight gain in the broilers studied (lei/kg weight gain)

These results are in accordance with those previously reported by Mierliță et al. (2013a; 2013b), which states that the substitution of 40%, 60% and 80% protein in soybean meal with white lupine in soybean feed has had a positive influence on the main economic indices, with the price of one kg of fodder combined falling by up to 26.8%, and feed costs related to obtaining one kg of weight gain being reduced by up to 24.19% (Table 7).

Table 7

European efficiency factor (EEF)

Groups	Age (days)	Average body weight (Kg)	Viability (%)	I.C. (Kg feed/Kg weight gain)	EEF	
					absolute	relative
LC	42	2.784	96.00	1.726	368.6	-
LE_8	42	2.758	98.00	1.740	369.8	0.32
LE_{16}	42	2.728	98.00	1.744	365.0	-0.97
LE_{24}	42	2.518	96.00	1.840	312.7	-15.16

For a more complex quantification of the efficiency of partial replacement of white lupine soybean meal in broiler feed, at the end of the experimental period (42 days), the "European efficiency factor - EEF" was calculated. This indicator assesses the growth efficiency of broiler chickens taking into account: viability (%), age of chickens at slaughter (days), their average live weight (Kg / head) and feed conversion rate (Kg n.c./Kg

increase). EEF's data show again that white lupine can be introduced into broiler feed by 16% without significantly affecting the final average weight of the chicks and the feed conversion rate, but it improves economic efficiency by reducing feed costs by 3, 67% for one kg weight gain.

CONCLUSIONS

The introduction of white lupine grains of low-alkaloid varieties in the feed of broiler chickens in proportion of 16% and the corresponding reduction of the weight of soybean meal did not affect the growth rate, consumption and the degree of capitalization of the food, but substantially reduced the value. feed costs related to obtaining a 1 kg weight gain. The increase in the proportion of lupine in the feed of chickens to 24%, led to a decrease in the final average weight by 9.54% (265.8 g / head), a reduction in feed consumption by 3.73% and an increase in the value of the feed index. conversion of food by 6.60%, which led to an increase in food expenditure per kg of weight gain. EEF (European Efficiency Factor) reinforces the conclusion that the optimal proportion of white lupine grains in broiler feed is 16% without significantly affecting production performance, but improves economic efficiency by reducing feed costs for weight gain. 3.67%. We recommend the use of this optimal nutritional solution especially in small and medium farms for raising broilers, which have the opportunity to grow lupine, thus reducing the farm's dependence on the market and trade in soy and soy by-products.

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