# STUDIES ON THE EFFECT OF REPLACING SOYBEAN MEAL IN THE FEED OF SLOW-GROWING CHICKENS ON PRODUCTION PERFORMANCE

**Daniel MIERLIȚĂ#**

*University of Oradea, Department of Animal Science, 410087 Oradea, Romania*

RESEARCH ARTICLE

**Abstract**

*The present work examined the effects of partial or total substitution of soybean meal (SBM) with white lupine meal (LM) in the diet of slow-growing broiler chickens, monitoring the main performance parameters, including body weight gain and feed conversion ratio. The experiment was carried out as a completely randomized experimental design consisting of three treatments, which involved a control diet consisting of corn - soybean meal (LC) and two experimental diets: $L_{50}$ - in which proteins from SBM were replaced with LM in a proportion of 50% throughout the growing period and $L_{100}$ - in which SBM was replaced with LM in a proportion of 100% throughout the growing period. Two types of feed were used, with different nutritional characteristics, corresponding to the age: grower (0-28 days) and finisher (29-63 days). Replacing SBM with LM in the diet of chickens by 50% ($L_{50}$) or 100% ($L_{100}$) resulted in a significant decrease in feed intake and growth rate (both $p<0.01$), compared to chickens fed a standard diet based on corn and soybean meal (LC). In conclusion, although LM has nutritional characteristics close to those of SBM, partial or total replacement of SBM with LM in the diet of slow-growing broilers, especially in the first four weeks of growth, is not sustainable, as it negatively affects growth performance and feed use efficiency. Thus, from a practical point of view, the introduction of LM in the diet of slow-growing broilers in the first 4 weeks of growth is not recommended, and the optimal level of substitution of SBM with LM in the later stages of growth (from 4 weeks onwards) needs to be further studied.*

**Keywords**: lupine meal, slow-growing chickens, performance parameters.
#Corresponding author: daniel.mierlita@uoradea.ro

## INTRODUCTION

Feeding broiler chickens in intensive systems is dependent on soy sources and soy by-products, which have a high protein content (42-46%) with a good balance of essential amino acids that meets the nutritional requirements of chickens (Belayneh et al., 2025). The increasing requirements for these ingredients and their high price, impose the need to evaluate unconventional sources of protein with good biological value, which may be available locally, such as alkaloid-free white lupine beans (Vieira et al., 2023). Previous studies conducted by us have demonstrated that white lupine beans have a high protein content (36.6 - 38.2%) and fat (8.4-10.1%), with a good essential amino acid and fatty acid profile, similar to that of soybeans (Mierliţă et al., 2018). Compared to soybeans, lupine beans do not come from genetically modified organisms (GMOs) and do not contain anti-nutritional substances, thus not requiring heat treatment before being used in animal feed.

The use of white lupine beans in broiler feed, in proportions of up to 60% (substitution rate of proteins from soybean meal) has no negative effect on weight gain, feed conversion, carcass and meat quality (Mierliţă and Popovici, 2013b). In other studies, it has been reported that the introduction of lupin beans in the diet of broiler chickens in proportions greater than 35% reduces their production performance (Roth-Maier and Paulics, 2003; Steenfeld et al., 2003); the negative influence of lupin being attributed to the high amount of NSP (non-starch polyglucosides).

Most studies have shown that lupin cannot completely replace soybean meal in the diet of chickens. Moschini et al., (2004) and Nalle et al., (2010) concluded that broilers, up to 21 days of age, cannot tolerate amounts greater than 200 g lupine/kg compound feed.

The use of lupine as the sole source of protein for raising broiler chickens (chickens and turkeys) is limited on the one hand by the biological value of the protein (modest content in methionine, lysine, tryptophan and threonine - Strakova et al., 2010, 2024), but also by the high content in NPA (non-starch polyglucosides) which negatively influence the digestion and utilization processes of the feed (Kocker et al., 2000; Brenes et al., 2002, 2003, 2005; Steenfeldt et al., 2003; Mieczkowska et al., 2005; Mierliță et al., 2013a, 2013b, 2015).

Consequently, in the research conducted, we followed the effect of partial or total substitution of soybean meal with alkaloid-free lupin beans in the feed of slow-growing broilers, on bioproductive performance and especially on weight gain and feed utilization.

## MATERIAL AND METHOD

The studies were conducted on unsexed Master Gray M dual-purpose hybrid chicks purchased at one day of age from a local commercial farm.

The experiment was conducted as a completely randomized experimental design consisting of three treatments, involving a control diet consisting of corn - soybean meal (LC) and two experimental diets: $L_{50}$ - in which the proteins from soybean meal were replaced with alkaloid-free white lupine meal in a proportion of 50% throughout the growing period and $L_{100}$ - in which the proteins from soybean meal were replaced with alkaloid-free white lupine meal in a proportion of 100% throughout the growing period. In the phase feeding of the chicks, two types of combined feeds were used, with different nutritional characteristics, corresponding to the age: growing (0-28 days) and finishing (29-63 days). The broiler chickens were fed powdered (non-granulated) feeds, as their granulation was not possible. The structure of the compound feeds included: corn, triticale, soybean meal, sunflower meal and a vitamin-mineral premix. In the case of the experimental groups ($L_{50}$ and $L_{100}$) soybean meal was replaced by lupine, which was included in the structure of the compound feed in a proportion of 18% in the first growth phase and 13.0% in the finishing phase in the case of chickens in the $L_{50}$ group and 36.0% and 26.0% respectively in the chickens in the $L_{100}$ group (Table 1). The feeds obtained had the same nutritional characteristics calculated for all groups of broiler chickens, corresponding to the two phases (NRC, 1994).

Table 1

**Composition of diets for slow-growing broilers in this study.**

| Item | 1 - 28 day | | | 29 - 63 day | | |
|---|---|---|---|---|---|---|
| | LC | $L_{50}$ | $L_{100}$ | LC | $L_{50}$ | $L_{100}$ |
| **Ingredient** (%) | | | | | | |
| Corn | 50.50 | 44.75 | 38.50 | 56.00 | 52.00 | 48.00 |
| Weat | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 |
| Soybean meal | 27.50 | 13.75 | - | 20.00 | 10.00 | - |
| Lupine | - | 18.00 | 36.00 | - | 13.00 | 26.00 |
| Sunflower meal | 8.00 | 9.50 | 11.50 | 10.00 | 11.00 | 12.00 |
| Vitamin-mineral premix | 4.00 | 4.00 | 4.00 | 4.00 | 4.00 | 4.00 |
| **Nutrient by calculation** | | | | | | |
| ME* (Kcal/kg) | 3025 | 3000 | 2970 | 3150 | 3120 | 3095 |
| Crude protein (%) | 20.03 | 20.00 | 20.05 | 17.51 | 17.54 | 17.50 |

*ME, metabolizable energy.

In addition to the combined feeds, the following were also used: a vitamin drinkable solution (TraceOral) in the first 3 days after weaning (1 ml/l of drinking water); vaccines - Clone 30 (administered at 9 days of age), Gumboro 28E (administered at 13 days of age), Hipraviar S (administered at 22 days of age).

To evaluate the influence of substituting soybean meal with white lupine in the feed of slow-growing chicks, the following was monitored: the dynamics of body mass and weight gain by individually weighing the chicks every two weeks. In parallel, to assess the degree of feed utilization, the quantities of feed consumed were recorded and based on these, the feed conversion ratio (g feed/g weight gain) was calculated.

The chemical composition of lupine grains was determined using standard procedures (AOAC, 2001) for dry matter (DM) content (gravimetric method); crude protein (CP) (N x 6.25; Kjeltec auto 1030; Tecator Instrumente, Sweden), EE (crude fat) by extraction in petroleum ether, following method 920.39 (SOXTHERM, C. Gerhardt GmbH, Königswinter, Germany). The AMEn (Apparent Metabolizable Energy corrected for nitrogen balance) of lupin was estimated according to the relationship established by Sibbald:

$EMA_n = 3951 + 54.4 EE – 88.7CB – 40.8Ca$;

All chemical analyses were performed in triplicate.

The data obtained were subjected to analysis of variance using the ANOVA test, and multiple comparisons between mean values were made with the Tukey test. The significance level was set at $p < 0.05$.

## RESULTS AND DISCUSSIONS

Lupine grains (whole grains) had a high content of crude protein (35.21%), crude fat (10.58%) and crude fiber (13.72%) (Table 2). The high proportion of the grain shell is the main cause of the high crude fiber content, so removing the shell would significantly reduce the crude fiber content (Struți et al., 2021), making the nutritional content of lupin grains comparable to that of soybeans (Vecerek et al., 2008; Nalle, 2009, 2011).

Table 2

**Chemical composition and energy value of lupine grains (% of DM)**

| | Mean | Max. | Min. |
|---|---|---|---|
| Crude protein (CP) | 35.21 | 40,90 | 31,93 |
| Rther extract (EE) | 10.58 | 13,27 | 9,59 |
| Crude fiber (CB) | 13.72 | 15,46 | 10,31 |
| Nitrogen-Free Extract (N-FE) | 23.81 | 26,51 | 20,38 |
| Crude ash (Ca) | 4.27 | 4,94 | 3,66 |
| MEAn (kcal/kg) * | 3135 | 3381 | 3056 |

*AMEn: Aparent Metabolizable Energy corrected for nitrogen balance

The average weights of the chicks in the experimental groups, in which lupine was used in the feed (groups $L_{50}$ and $L_{100}$) were significantly lower ($p<0.01$) at the age of 14, 28, 35, 42, 56 and 63 days, than in the control group (LC) (table 3). At the end of the experimental period, the broiler chicks in the experimental groups achieved average weights of 3288.96 g/head in the control group, 2913.13 g/head in the $L_{50}$ group in which lupin proteins replaced 50% of the proteins provided by soybean meal and 2595.84 g/head in the group in which soybean meal was completely replaced by lupine (fig. 1). Some authors believe that this decrease in the average final weight of chickens fed large amounts of lupine is caused by the decrease in daily feed consumption, as a result of the high content of crude cellulose but also of non-starch polyglucosides (especially those soluble in water) (Suchý et al., 2006; Mierlita, 2015). Most studies have reported that white lupin grains can be introduced in a maximum amount of 20% in the feed of intensively raised broiler chickens without affecting growth performance and carcass and meat quality. However, studies on the use of lupine grains in the feed of slow-growing chickens are lacking, so comparisons cannot be made (Suchy et al., 2006; Nalle et al., 2012; Mierliţă, 2015; Sedláková et al., 2015; Boguslaw, 2018).

In agreement with our results, Boguslaw (2018) found that the total replacement of soybean meal with lupine in the feed of slow-growing chickens, at different ages, led to a decrease in final weight and an increase in the value of the feed conversion index.

In chickens that received white lupine in their feed, a decrease in average weight gain was observed, compared to the control group; the decreases being directly proportional to the proportion of white lupine introduced into the chicken feed. These differences were more pronounced in the first growth phase, when compared to the control group, the average weekly gains were lower in the experimental groups by up to 20% in the chickens in the $L_{50}$ group and by up to 40% in the chickens in the $L_{100}$ group, respectively. In the last weeks of the finishing period, the differences recorded between the chickens in the control group and those in the experimental groups were smaller. Thus, in the last week of the experimental period, compared to LC chicks, the average daily weight gain was lower by 11.7% in the $L_{50}$ group and by 14.9% in the $L_{100}$ group, respectively. All this suggests that chicks can better utilize white lupine grains after the age of four weeks.

Compared to the entire experimental period, it is noteworthy that the introduction of white lupine in the feed of slow-growing chicks had a negative influence on the average weight gain (fig. 1).

Table 3.

**Productive performance in slow-growing broilers**

| Item | Wek | Groups | | | p-values |
|---|---|---|---|---|---|
| | | LC | L50 | L100 | |
| Live weight (g) | initial | 40.12 | 39.98 | 40.07 | NS |
| | 2w | 274.48[a] | 242.28[b] | 210.45[c] | *** |
| | 4w | 778.20[a] | 644.78[b] | 511.73[c] | *** |
| | 6w | 1690.16[a] | 1441.80[b] | 1193.81[c] | ** |
| | 8w | 2715.24[a] | 2406.54[b] | 2107.59[c] | *** |
| | 9w | 3288.96[a] | 2913.13[b] | 2595.84[c] | *** |
| Average daily gain (g/day) | 2w | 16.74[a] | 14.45[b] | 12.17[c] | ** |
| | 4w | 35.98[a] | 28.75[b] | 21.52[c] | ** |
| | 6w | 65.14[a] | 56.93[b] | 48.72[c] | * |
| | 8w | 73.22[a] | 68.91[b] | 65.27[b] | * |
| | 9w | 81.96[a] | 72.37[ab] | 69.75[b] | * |
| Feed intake (g/d) | 2w | 32.76 | 33.00 | 33.23 | NS |
| | 4w | 82.44 | 79.64 | 77.07 | NS |
| | 6w | 157.29[a] | 143.71[b] | 128.43[c] | * |
| | 8w | 194.95[a] | 172.27[ab] | 154.91[b] | ** |
| | 9w | 233.81[a] | 212.72[b] | 196.18[b] | ** |
| Feed conversion ratio (g/g) | 2w | 1.957[c] | 2.283[b] | 2.730[a] | *** |
| | 4w | 2.291[c] | 2.770[b] | 3.581[a] | *** |
| | 6w | 2.514[b] | 2.524[ab] | 2.636[a] | ** |
| | 8w | 2.662[a] | 2.500[ab] | 2.373[b] | ** |
| | 9w | 2.852 | 2.939 | 2.813 | NS |

NS - p >0.05; *- p <0.05; **- p <0.01; ***- p <0.001

From the data presented in Table 3, it can be seen that, in general, compared to the case of the control group (LC), feed consumption in the first two weeks of the experimental period did not register significant changes, but it registered a significant decrease, especially when lupine completely replaced soybean meal in the chicks' feed.

Compared to the entire experimental period, the average daily feed consumption in the experimental groups was lower by 8.45% in the $L_{50}$ group and by 15.85% in the $L_{100}$ group compared to the control group (fig. 1).

Partial or total replacement of soybean meal with lupine in the feed of slow-growing chicks led to an increase in the value of the feed conversion index, directly proportional to the share of white lupin in the structure of the combined feed. With advancing age, the differences found between the control group and the experimental groups decreased, probably due to the morpho-physiological adaptation of the digestive tract and the increase in the digestibility of chemical compounds in lupine grains (Mierliță, 2015). Compared to the entire experimental period, the introduction of white lupine in the structure of the combined feed led to an increase in the value of the feed conversion index, the increase being directly proportional to the degree of replacement of soybean meal in the feed (fig. 1).

From the analysis of the main production indices, it results that the best bioproductive results were obtained by the chickens in the control group (LC) in whose feed only soybean meal was used as protein feed. The introduction of lupine in the feed of broiler chickens led to a decrease in growth rate and feed consumption with a negative impact on the value of the feed conversion index. The lowest bioproductive performances were recorded by chickens in whose feed soybean meal was completely replaced with white lupin.

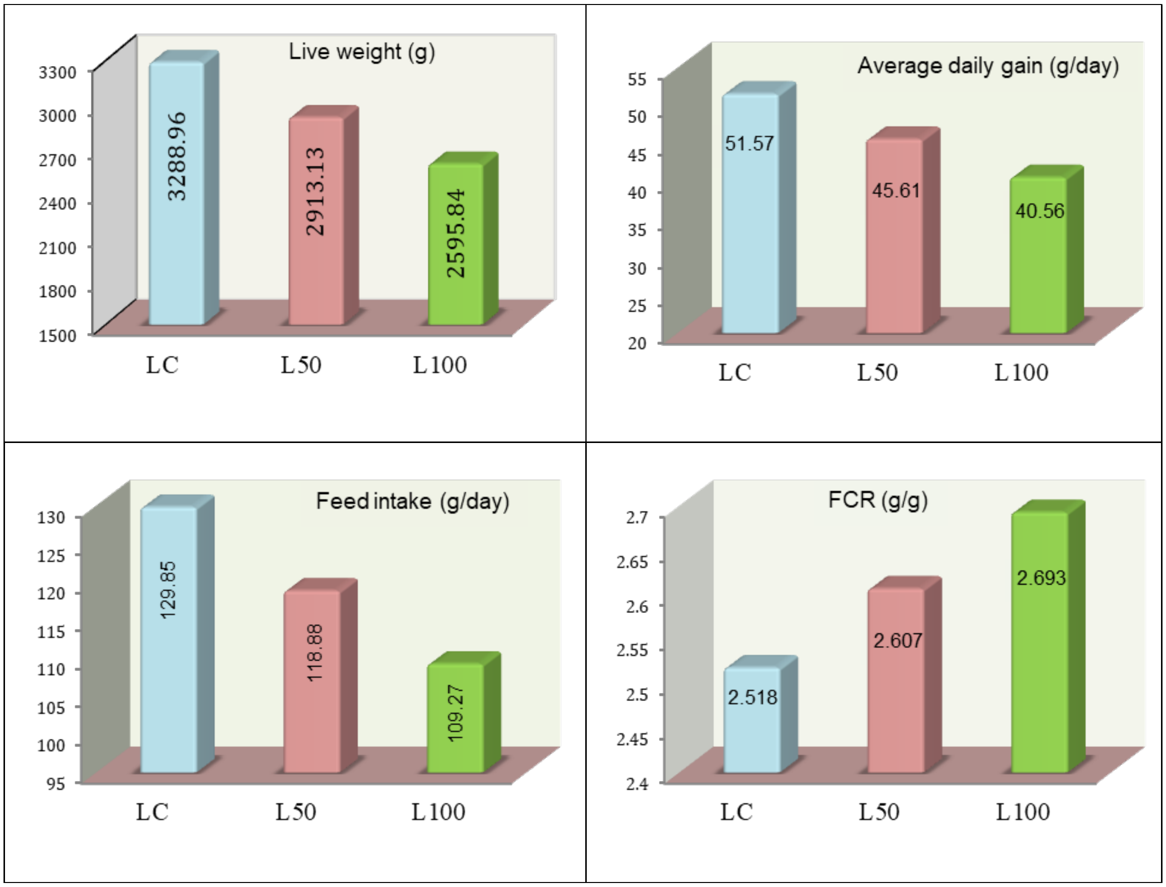


Figure 1. **Average production indices recorded over the entire experimental period (1 - 63 days) in slow-growing broilers (Master Gray M hybrid)**

## CONCLUSIONS

Replacing SBM with LM in a proportion of 50% ($L_{50}$) or 100% ($L_{100}$) in the diet of slow-growing, dual-use broilers resulted in a significant decrease in feed consumption and growth rate ($p < 0.01$), compared to chickens fed a standard diet based on corn and soybean meal (LC).

In conclusion, although LM has nutritional characteristics close to those of SBM, partial or total replacement of SBM with LM in the diet of slow-growing broilers, especially in the first four weeks of growth, is not sustainable, as it negatively affects growth performance and feed use efficiency. Thus, from a practical point of view, the introduction of LM in the diet of slow-growing broilers in the first 4 weeks of growth is not recommended, and the optimal level of substitution of SM with LM in the later stages of growth (from 4 weeks onwards) needs to be further studied.

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