Bulletin UASVM Animal Science and Biotechnologies 70(1)/2013, 37-44
Print ISSN 1843-5262; Electronic ISSN 1843-536X

Effect of Partial Substitution of Soybean Meal with Lupine Seeds in Feeding Laying Hens on Production and Economic Performance

Daniel MIERLIȚĂ

University of Oradea, Department of Animal Science, 26 Magheru Blvd., 410087 Oradea, Romania.
dadi.mierlita@yahoo.com

Abstract. Research has aimed to establish the effect of partial substitution of soybean meal protein with lupine flour free of alkaloids in feeding laying hens on egg quantity and quality of consumption, and the economic efficiency of application of this new feeding solutions. The experiment was conducted as a completely randomized experimental design consisted of four treatments randomly assigned to four groups of hens in the shed for 34 weeks. Lot Lc (control) was fed a diet of corn and soy srot. The experimental diets were used with different levels of substitution of soy protein meals lupine beans (-40% low, medium and high -60% -80% for groups E1, E2 and E3 respectively). We have used white lupine beans, variety Energy (coming from France), grown in specific climatic conditions of the western part of Romania. All diets were formulated to contain similar levels of metabolizable energy, crude protein and amino acids boundaries. The results show that substituting soy protein lupine meals in proportion of 40%, 60% and 80% (corresponding batches E1, E2 and E3) in feed for laying hens for egg consumption had negative effects on quantitative indicators egg production, egg size except that significantly ($p<0.05$) when soy protein meals were substitued to 80% of protein from lupine beans (for E3). Lupin negatively affected feed intake, the effects being more evident in the experimental group E3. Decreased food intake was accompanied by a corresponding reduction in the size of eggs, so that the degree of recovery of the food did not register differences between groups. Introducing lupin hens feeding and reduce the loss caused soybean cakes cost price of fodder by 20%, leading to an increase in net profit in the experimental groups, with up to 36.11% compared with controls (LC).

Keywords: lupine seeds, laying hens, performance

INTRODUCTION

In the context of flours ban in food animal and poultry by-products and the high price of soy, lupine beans may represent a promising alternative for providing own production of vegetable protein in poultry feed in the country. Data from the literature mentions that new varieties of lupine beans made productions of 3500-3800 kg/ha, containing 31-48% protein and 6-10% fat (depending on weather conditions), but the need to improve the biological value of protein by adding synthetic amino acids. Climatic conditions of our country provide the prerequisites to obtain a proper lupine grain production quantity and quality. Lupin beans are recognized as an alternative source of nutrients and especially protein to bird feeders, especially lately when they were free of alkaloids derived varieties (less than 20 mg/kg) (Milford and Shield, 1996; Petterson, 2000). Laudadio *et al.* (2010) demonstrated that sweet lupine beans shelled can totally replace soybean cakes hens feeding, significantly improving eggs yield (percentage of lay), but decreased the average weight of eggs and forage consumption combined on 1 kg egg mass increased.

Introducing lupine beans in a proportion of 15% in laying hens diet did not affect egg production, their quality and degree of recovery of any food (Hammershøj and Steenfeldt, 2005). Instead, lupine diet weight increase up to 25-30% of hens had a negative influence on

the number of egg production, egg size, and degree of recovery intake of food (Watkins and Mirosh, 1987; Perez-Maldonado *et al.*, 1999 Hammershøj and Steenfeldt, 2005). Contrary to these results, Prinsloo et al. (1992) mentions that the hens feed intake increased with increasing weight in the structure of fodder lupine. Decreased production performance in laying hens, when used in high proportions in lupine hens feeding methionine is due to deficiency of food (Pourreza and Smith, 1988; Harns and Russell, 1996; Hsu *et al.*, 1998). Research has aimed to establish the effect of partial substitution of soybean meal protein with lupine flour free of alkaloids in feeding laying hens on egg production and consumption economical efficiency of this new feeding solutions.

MATERIAL AND METHODS

The experiment was conducted as a completely randomized experimental design consisted of four treatments involving a control diet consisting of corn – sunflower meal and soybean meal (Lc) and three experimental diets (E1, E2 and E3) that proteins derived from soy meals was replaced with lupine flour free of alkaloids in proportion of 40%, 60% and 80%. By substituting made to secure a share in the structure of lupine flour fodder of 9.2, 13.7 and 18.2% of the weight of the feed (*Tab. 1*). In experiment were used white lupine beans, variety Energy (improved in France), grown in specific climatic conditions of the western part of Romania, using seed imported from Holland.

Tab. 1

Structure and calculated nutritional value of compound feeds tested in feeding laying hens

Issue	Lc	E_1	E_2	E_3
a) Structure fodder (% by weight)				
Corn	56.23	56.10	56.15	55.90
Sunflower meal	10.0	10.0	10.0	10.0
Soybean meal	***20.5***	***12.3***	***8.2***	***4.2***
Lupin meal	**-**	***9.,2***	***13.7***	***18.2***
Fat comercial	3.0	2.0	1.5	1.2
Calcium carbonate	8.0	8.0	8.0	8.0
Calcium phosphate	1.0	1.0	1.0	1.0
Synthetic lysine	0.05	0.15	0.19	0.23
Synthetic methionine	0.22	0.25	0.26	0.27
Vit.-mineral premix	1,0	1.0	1.0	1.0
TOTAL	100.0	100.0	100.0	100.0
b) The nutritive value calculated				
EM (kcal/kg)	2820	2821	2826	2823
Crude protein, %	18.07	18.11	18.09	18.08
Lysine total, %	0.85	0.85	0.85	0.85
Met. + Cist. total, %	0.72	0.72	0.72	0.72

All diets were formulated to contain similar levels of metabolizable energy, crude and limiting amino acids protein (lysine and methionine). Experiences productive effect were performed on four groups of laying hens aged 34 weeks, the hybrid Hisex Brown and extended over a period of 183 days, which included a habituation phase (preexperimental - they have not productive parameters were registered) for 30 days and an experimental phase that lasted five months (October 2012 - February 2013). In the period of adjustment were

made lots of body mass hens and egg production as close. In this period, lupine flour was introduced gradually in experimental poultry feed. Batches, each consisting of 40 heads were maintained on permanent litter the ground, with maintenance and microclimate conditions identical. Feed and water were provided at discretion.

Body mass dynamics was based on weighing individual chickens from each group at the beginning of the experiment and at the end of each month. The amount of feed consumed was determined for each batch of chickens for each month of experience, by weighing. During the experiment, all the groups were tracked and recorded the number and mass of eggs produced daily and biweekly individual egg weight was determined. Egg quality was determined monthly, is determined: weight component (shell, albumen and yolk) and chemical composition of the white and the yolk (n=10) using established laboratory techniques. In order to determine the economic efficiency of partial substitution of soybean cakes hens feeding with lupine, we calculated the total costs and revenues that the lot (40 hens). To calculate the price of a kg of feed, we considered the prices recorded in November 2012 on the open market them. The price of a kg of lupine grain was determined taking into account the expenses recorded for the cultivation and harvesting them to add value to specific lease area west of the country, resulting in a production cost of 0.82 Ron/kg (excl. TVA).

Testing the significance of the differences of experimental groups compared to the control group was done by applying the test "t". Differences were considered significant at $p<0.05$.

RESULTS AND DISCUSSIONS

Data on monthly evolution of digital production and egg laying intensity that are presented in *Table 2*. From their analysis shows that during the experimental period in all groups of hens, egg production recorded a slight decrease from the first experimental month to month will, which is part of the normal evolution of the laying curve using hybrid feature. Compared to the control group (Lc) who used a combined basis soybean in food experimental groups receiving soybean meal protein was substituted by up to 60% lupine flour (for batch E2) there were no differences in egg production, laying intensity being 84.78 to 84.13%. Increasing rate of substitution of soy protein meals to 80% lupine flour (if E3) resulted in decreased intensity of laying hens by 2.7 percentage points, although this difference from the control group (Lc) was not statistically ($p>0.05$).

Tab. 2

Evolution of the average daily production of eggs compared the groups (n = 40)

Month		Group				Difference		
		Lc	E_1	E_2	E_3	Lc-E_1	Lc-E_2	Lc-E_3
I	abs.	36.46±0.27	37.07±0.24	37.29±0.36	35.90±0.43	ns	ns	ns
	%	91.15	92.68	93.23	89.75			
II	abs.	35.47±0.63	35.27±0.44	35.36±0.53	34.20±0.86	ns	ns	ns
	%	88.68	88.18	88.40	85.50			
III	abs.	33.88±0.74	33.77±0.39	32.51±0.71	33.27±0.58	ns	ns	ns
	%	84.70	84.43	81.28	83.18			
IV	abs.	32.56±0.30	32.72±0.57	31.79±0.84	31.01±0.38	ns	ns	ns
	%	81.40	81.80	79.48	77.53			
V	abs.	31.19±0.52	30.67±0.29	31.31±0.47	29.78±0.73	ns	ns	ns
	%	77.98	76.68	78.28	74.45			
Mean	abs.	33.91±0.38	33.90±0.41	33.65±0.54	32.83±0.48	ns	ns	ns
	%	84.78	84.75	84.13	82.08			

Differences between groups of chickens, eggs yield on intensity and laying both on Monday and reported the entire experimental period are not statistically significant, which means that lupine can replace up to 80% soy protein meals provided by in diets of laying hens, egg production without modification. A similar evolution shows and daily egg mass production (*Tab. 3*) recorded experimental values E1 and E2, compared to the control group (LC), are very close to both the five months separate experimental and reported to the entire experimental period. Therefore, compared to the entire experimental period, compared with controls, daily egg mass was lower by 7.1 g (0.33%) in group E1 and 13.1 g, respectively (0.61%) in E2 group. These differences are not statistically, which demonstrates that substituting soy protein lupine meals by up to 60% in laying hens diet does not affect egg mass production. Substituting soy protein meals in 80% lupin in feeding laying hens (for E3) resulted in a significant decrease ($p<0.05$) egg mass production, which is lower by 5.23% compared of the recorded throughout the experimental period in the control group (Lc).

Tab. 3

Evolution of average daily egg mass (g / group) compared to group (n=40)

Month	Group				Difference		
	Lc	E_1	E_2	E_3	Lc-E_1	Lc-E_2	Lc-E_3
I	2297.1±47.4	2260.9±64.3	2288.5±86.5	2185.2±28.7	ns	ns	ns
II	2260.6±59.8	2269.0±45.7	2239.1±67.2	2107.4±37.3	ns	ns	*
III	2167.4±39.5	2173.3±81.4	2097.7±40.1	2071.4±67.2	ns	ns	ns
IV	2016.2±81.7	2015.3±49.2	2074.5±32.7	1935.1±89.2	ns	ns	*
V	2010.4±51.6	1997.5±36.5	1986.0±29.3	1890.2±56.4	ns	ns	*
Mean	2150.3±58.2	2143.2±42.7	2137.2±61.6	2037.8±41.5	ns	ns	*

ns – not significant ($p>0.05$); * - $p<0.05$

Egg size, determined gravimetrically (*Tab. 4*), an increase in all groups during the experimental period, which is characteristic this character (Van I, 2009). Compared to the batch of eggs registered a size similar to that described for daily egg mass production, both on Monday and reported separately from the entire experimental period. Notable is that substituting soy protein lupine meals by up to 60% in laying hens diet does not affect egg weight (for groups E1 and E2), but increasing the rate of substitution of soy protein meals in lupine 80% results in a significant decrease in egg size (for E3). Thus, compared to the control group, the average weight of eggs decreased by 2.13% (62.96 g / ou vs. 61.62 g / egg).

Tab. 4

Evolution of egg weight (g) (n=40)

Month	Group				Difference		
	Lc	E_1	E_2	E_3	Lc-E_1	Lc-E_2	Lc-E_3
I	61.66±0.19	61.54±0.38	60.44±0.56	60.28±0.83	ns	ns	ns
II	63.07±0.32	63.55±0.19	62.00±0.72	61.49±0.37	ns	ns	*
III	63.57±0.57	63.00±0.35	62.25±0.40	62.26±0.53	ns	ns	ns
IV	63.18±0.30	64.46±0.57	62.87±0.36	62.76±0.28	ns	ns	ns
V	63.32±0.43	63.60±0.24	63.00±0.61	61.34±0.62	ns	ns	*
Mean	62.96±0.34	63.23±0.29	62.11±0.42	61.62±0.35	ns	ns	*

ns – not significant ($p>0.05$); * - $p<0.05$

Decreased production performance in laying hens, when used in high proportions in lupine hens feeding is probably due to amino acid imbalance in nutrition emerged as a result of methionine deficiency (Pourreza and Smith, 1988; Harns and Russell, 1996; Hsu *et al.*, 1998).

In the mentioned aspects, we conclude that substituting soy protein lupine meals in proportion of 40%, 60% and 80% (corresponding batches E1, E2 and E3) in feed for laying hens for egg consumption had negative effects on quantitative indices of egg production, egg size except that significantly ($p<0.05$) when soy protein meals were substitued to 80% of protein from lupine beans (for E3). The introduction of lupine flour in laying hens diet negatively influenced feed intake, the effects are more evident when the experimental group E3 was used the highest proportion of lupine in food, it substitued 80% soy protein meals provided. Compared to the entire experimental period, compared to the control group (Lc) of food intake fell 0.94%, 1.65% and 4.94% in the experimental groups E1, E2 and E3 respectively. This negative infuence lupine flour on food intake is due this PNA in high volume, reducing nutrient digestibility and intestinal peristalsis (Kocher *et al.*, 2000; Steenfelddt *et al.*, 2003).

Decreased food intake in chickens in batches in food which was introduced lupine flour was accompanied by a corresponding reduction in the size of eggs, so that the degree of recovery of the food did not register differences between groups, both in terms of egg consumption as combined harvesters and the reported per kg egg mass (*Tab. 5*). Our results are in agreement with those obtained in previous studies by other authors mention the use of lupine in the diet of hens in large proportions (25-30%) adversely affects eggs yield, egg size, intake and degree of recovery of food (Watkins and Mirosh, 1987; Perez-Maldonado *et al.*, 1999; Hammershøj and Steenfeldt, 2005). Contrary to these results, Prinsloo *et al.* (1992) mentions that the hens feed intake increased with increasing weight in the structure of fodder lupine. The data presented in *Table 6*, the average body mass of chickens at the beginning and end of the experiment, proving that it fits on all lots in standard hybrid, with an increasing trend specific to this character. Statistical analysis showed no significant differences between groups on body mass of chickens, suggesting that partial substitution of soy protein meals lupine flour does not affect the evolution of body weight hens.

Tab. 5

Evolution combined forage intake and the degree of recovery of the food

Issue		Group			
		Lc	E_1	E_2	E_3
Month I	g/day	120.5	119.3	120.1	116.8
	g/egg	132.20	128.72	128.82	130.14
	kg/kg egg	2.098	2.111	2.099	2.138
Month II	g/day	122.3	120.7	118.1	115.7
	g/egg	137.91	136.88	133,60	135.32
	kg/kg egg	2.164	2.128	2.110	2.196
Month III	g/dayi	125.8	126.7	122.5	118.3
	g/egg	148.52	150.06	150.71	142.2
	kg/kg egg	2.410	2.332	2.336	2.284
Month IV	g/day	130.6	128.4	129.7	124.1
	g/egg	160.44	156.97	163.18	160.1
	kg/kg egg	2.591	2.548	2.500	2,565
Month V	g/day	138.8	136.9	137.1	131.6
	g/egg	178.0	178.53	175.14	176.76
	kg/kg egg	2.762	2.741	2.761	2.785
Mean	g/day	127.6	126.4	125.5	121.3
	g/egg	150.5	149.1	149.1	147.8
	kg/kg egg	2.374	2.359	2.349	2.381

Analyzing the influence of partial substitution of soybean meals for egg laying hens feed intake with lupine flour, the main economic indicators, it is clear superiority in food E3

which was used the highest proportion of lupine (*Tab. 6*). Thus, compared with controls (LC), the experimental forage combined price of a kg decreased by 20% and feed costs have dropped by 23.8%. The net profit from chickens in the experimental groups compared with the control group (Lc) were higher by 24.79% in group E1 to E2 group with 33.66% and 36.11% in group E3 (*Tab. 7*).

Tab. 6

Evolution of body weight of hens during the experiment (g/head)

Specification	Group			
	Lc	E_1	E_2	E_3
Initial weight	1968±53.4	1945±82.3	1962±74.1	1985±38.7
Final weight	2298±82.6	2220±95.4	2247±68.3	2184±49.3

Tab. 7

Economic analysis of the partial substitution of soybean meal with lupine in hens feeding (values without VAT)

Issue		Group			
		Lc	E_1	E_2	E_3
COSTS					
	Price feed (lei/kg)	1.245	1.116	1.051	0.997
	Combined daily forage consumption (kg/lot)	5.104	5.056	5.020	4.852
	Feeding daily expenses (lei/lot)	6.354	5.642	5.276	4.837
	Other costs (energy, vaccines, drugs, labor, etc.).	3.5	3.5	3.5	3.5
	Daily expenses depreciation hens (lei/lot)	4.2	4.2	4.2	4.2
Total costs (lei/head)		14.054	13.342	12.976	12.537
REVENUE:					
	Average daily production of eggs (buc/lot)	33.91	33.90	33.65	32.83
	Revenue from the sale of eggs (lei/lot)[1]	15.259	15.255	15..142	14.773
	Income from grants (lei/lot)	1.65	1.65	1.65	1.65
Total revenue (lei/lot)		16.909	16.905	16.792	16.423
PROFIT GENERATED (lei/lot)		2.855	3.563	3.816	3.886
Differences profit from Lc					
	- (lei/lot)	-	+ 0.708	+ 0.961	+ 1.031
	- %	100.0	+ 24.79	+ 33.66	+ 36.11

[1]0.45 lei/egg; The calculation refers to a group of 40 chickens on a one month period.

The data analysis on macrostructure eggs (*Tab. 8*) a partial substitution of soy protein meals lupine flour by up to 80% did not significantly affect egg quality macrocomponentelor terms, the share structure of the egg white and the yolk in framing at all loads within the limits cited in the literature and specific hybrid (Van, 2009).The chemical components of whites (*Tab. 9*) were not influenced by the introduction of lupine, even in high proportions in the feed of laying hens. In contrast, introduction of lupine flour in hens feeding in high proportions that the replacement of soy protein meals in 60% and 80% (for consignments E2 and E3) resulted in a significant increase in fat content yolk ($p<0.01$), without affecting the protein content. We believe that this increase in the level of lipids in the yolk is due to the high level of fat in lupine, and especially of high levels of unsaturated fatty acids (monounsaturated and polyunsaturated) that use high matabolica (Mierlita, 2012).

Tab. 8

Egg components (n=10)

Issue		Group			
		Lc	E_1	E_2	E_3
Egg weight (g)		61.39±0.37	60.83±0.71	63.40±0.50	62.91±0.54
Compo-nents	White - %	61.55	61.40	61.11	61.00
	Yolk - %	26.34	26.09	26.86	26.59
	Bark - %	12.11	12.51	12.03	12.41

Tab. 9

The chemical composition of the white and the yolk (n=10)

Issue		Group			
		Lc	E_1	E_2	E_3
White	**Dry matter** - %	11.38	11.78	11.42	11.51
	Crude protein - %	86.62	86.53	86.44	86.76
Yolk	Dry matter - %	45.66	46.71	46.92	46.80
	Crude protein - %	31.60	31.40	31.05	31.17
	Crude fat - %	54.01	55.13	55.37*	56.08**

CONCLUSION

Lupin beans can substitute 60% of protein from soyben meals hens feeding (13.7% lupine grain fodder in structure), without affecting the intensity of laying, egg size, structure and composition.

Acknowledgements. This work was supported by a grant of the Romanian National Authority for Scientific Research, CNDI – UEFISCDI, project number PN-II-IN-CI-2012-1-0257.

REFERENCES

1. Egorov, I.A.; Chesnokova, N.Y.; Takunov, I.P. (2001). Feed value of lupin for broiler chickens and laying hens. Kormoproizvodstvo 1: 28-30.

2. Erbas, M.; Certel, M.; Uslu, MK. (2005). Some chemical properties of white lupine seeds (*Lupineus albus* L.). Food Chem 89: 341-345.

3. Faluyi, M.A.; X.M. Zhou, F. Zhang, S. Leibovitch, P. Migner, D.L. Smith. (2000). Seed quality of sweet white lupin (*Lupinus albus*) and management practice in eastern Canada. European Journal of Agronomy 13: 27–37.

4. Hammershøj, M.; Steenfeldt, S. (2005). Effects of Blue Lupin (*Lupinus angustifolius*) in Organic Layer Diets and Supplementation with Foraging Material on Egg Production and Some Egg Quality Parameters. Poultry Science 84:723–733

5. Lettner, F.; Zollitsch, W. (1995). Lupins in broiler feeds. Forderungsdienst 43: 285-288.

6. Mieczkowska, A.; A.J.M. Jansman, R.P. Kwakkel and S. Smulikowska. (2005). Effect of dehulling and alphagalactosidase supplement on the ileal digestibility of yellow lupin based diets in broiler chickens and adult roosters. Journal of Animal and Feed Sciences 14: 297-304.

7. Mieczkowska, A.; Smulikowska, S.; Nguyen, C.V. (2004). Effect of enzyme supplementation of white lupin (*Lupinus albus* var. *Butan*) - containing diets on performance, nutrient

digestibility, viscosity, pH, and passage rate of digesta in broiler chickens. J Anim Feed Sci 13: 475-486.

8. Mierlita, D. (2012). Studies on cultivation suitability and nutritional characterization of lupine alkaloid-free varieties. Analele Univ. din Oradea, Fascicula: Ecotoxicologie, Zootehnie si Tehnologii de industrie alimentara, ISSN 1583-4301; vol. XIB: 501 – 507.

9. Nalle, C.L. (2009). Nutritional Evaluation of Grain legumes for Poultry. Ph.D. Thesis. Massey University, Palmerston North, New Zealand.

10. Petterson, D.S. (2000). The use of lupins in feeding systems − review. Asian-Australasian Journal of Animal Sciences, 13: 861-882.

11. Ruitz, L.P. Jr. (1997). A rapid screening for lupine alkaloids. N.Z. J. Agric. Res. 20:51–52

12. Sipsas, S.; Glencross, B. (2005). Implications of variability amongst Lupin cultivars in processing. Proceedings of the third workshop for Seeding a Future for Grains in Aquaculture Feeds. Fremantle, Western Australia. P: 8-13.

13. Steenfeldt, S.; Gonzalez, E.; Knudsen, K.E.B. (2003). Effects of inclusion with blue lupins (*Lupinus angustifolius*) in broiler diets and enzyme supplementation on production performance, digestibility and dietary AME content. Anim. Feed Sci. Technol. 10:185-200.

14. Straková, E.; Suchý, P.; Šugerková, M.; Macháček, M. (2007). Positive Effect of Plant-Based Diet on the Performance and Health of Laying Hens. ACTA VET. BRNO, 76: 31–37.

15. Straková, E.; Suchý, P.; Večerek, V.; Šerman, V.; Mas, N.; Jůzl, M. (2006). Nutritional composition of seeds of the genus *Lupineus.* Acta Vet Brno 75: 489-493.

16. Suchý, P.; Straková, E.; Herzig, I.; Steinhauser, L.; Vopálenský, J.; Kroupa, L. (2010). Effect of Replacing Soybean Meal with Lupin Seed-based Meal in Chicken Diet on Performance, Carcass Value and Meat Quality. ACTA VET. BRNO, 79: 195-202.

17. Sujak, A.; Kotlarz, A.; Strobel, W. (2006). Compositional and nutritional evaluation of several lupine seeds. Food Chem 98: 711-719.

18. Teixeira, A.S.; Dos, R. (1995). Replacement of soyabeans by lupins (*Lupinus luteus*) in the feeding of broiler fowls. Rev Portug Ciênc Veter 90: 20-28.

19. Van I. (coord.). (2009). Cresterea si exploatarea pentru oua a gainilor ouatoare. Total Publishing, Bucuresti

20. Vecerek, V.; P., Suchý; E., Straková and M., Machácek. (2008). Nutritive composition of seeds of the lupin varieties registered in the Czech Republic. IN J.A. Palta and J.B. Berger (eds). 2008. 'Lupins for Health and Wealth' Proceedings of the 12th International Lupin Conference, 14-18 Sept. 2008, p: 123-126, Fremantle, Western Australia. International Lupin Association, Canterbury, New Zealand.