Test of low-alkaloid lupine with multi enzyme complex in compound feed as an alternative to soybean in feeding quails

Zinaida Fedorova[1], *Vladimir* Volkov[1*], *Olga* Mishcheryakova[2] and *Vasiliy* Verkhoturov[1]

[1] Kaliningrad State Technical University, 236022, Kaliningrad, Russia
[2] OOO Lupinusagra, 238324, Kaliningrad Region, Gurievskiy district, Russia

Abstract. The article presents data from a study conducted to study the effect of a protein component from low-alkaloid lupine with multi enzyme complex as part of mixed feed on the yield of products when feeding quails from birth to the 45th day. It was established that the possibility of using the lupine component and the level of its inclusion (up to 29%) in the compound feed for birds, completely replacing expensive soybeans in the diet, reducing the cost per 1 kg of feed by 7-8%. The lupine component can be used not only in feeding poultry, but also fish, monogastric animals, due to the reduction in fiber content to 2.3% and the fermentation process, which contributes to a more complete absorption of feed components.

1 Introduction

In the efficiency and competitiveness of animal husbandry, protein and energy-containing feed, balanced nutrition are of paramount importance [1]. Protein is the most valuable component of the feed. Animal productivity depends on the complete protein nutrition. In the current situation, in the production of compound feed for agricultural animals, poultry and fish, it is necessary to replace soy-based protein components with components based on fodder low-alkaloid lupine.

According to the content of anti-nutritional substances, based on the International classifier of the genus *Lupinus L*., it is divided into the following groups:

1) sweet lupine contains less than 0.025% antinutrients in the grain;
2) low alkaloid lupine - from 0.025 to 0.1%;
3) medium alkaloid lupine - from 0.1 to 0.3%;
4) highly alkaloid or bitter lupine - more than 0.3%.

Lupine varieties belonging to the first group can be used in human nutrition after thermal processing (based on GOST R 54632-2011 fodder lupine and descriptions of lupine varieties included in the State Register of the Russian Federation). Lupine from the second group, low alkaloid and medium alkaloid varieties are used for feeding animals. Varieties included in the fourth group have found their purpose as green manure, used as green manure [2-8]. To reduce the concentration of alkaloids and increase the feed value, grain processing is used:

* Corresponding author: vladimir.volkov@klgtu.ru

high-temperature exposure is used - steam, extrusion, roasting, fermentation, etc. The action of cellulolytic enzymes leads to partial destruction of cellulose chains and makes the substrate more accessible to the action of proteases. The composition of lupine kernels includes, first of all, such carbohydrates as pectin substances, therefore, the presence of pectinases was mandatory in preparations of enzymatic action [9-16]. Subsequent treatment with proteolytic enzymes allows to convert long protein chains into more digestible short peptides. For the treatment of lupine kernels, Russian enzyme preparation Protosubtilin A-250 G3Kh (Sibbiopharm LLC) was selected. Protosubtilin makes it possible to reduce the degree of negative effect of inhibitors in lupine on pepsin and trypsin in the digestive system of animals and birds. Also, protosubtilin harmoniously interacts with own proteolytic enzymes of animals and birds.

The data of the laboratory study testify to the nutritional value of the product - the lupine component, created before the start of the study, contains 35.5% of crude protein before fermentation, and 45.5% after fermentation; crude fiber decreased from 6.27 to 2.19%, metabolic energy increased from 12.4 to 12.7 mJ/kg. This means that this product can be included in poultry feed recipes.

2 Material and methods

2.1 Experimental diets

Chickens of all the groups received compound feed. The differences were that the chickens of the control group received standard starter feed with soybean meal, the chickens of I, II experimental groups received feed with a protein component based on lupine without shell, the compound feed for chickens of group II was additionally supplemented with the enzyme complex Protosubtilin A-250 G3X. The duration of the experiment was 45 days.

The main task was to study the effect of the lupine component with a biologically active additive - with and without the enzyme complex Protosubtilin on the gain in live weight of young quails, and also whether it is possible to reduce the cost of the feeding ration by eliminating expensive soybean from the recipe, replacing soybean meal with a lupine component. Table 1 shows the feed recipe by groups.

Table 1. Composition of compound feed of the starting period by groups, %

Component	Control	Group 1	Group 2
Wheat	38.00	25.00	25.00
Corn	10.00	25.00	25.00
Sunflower cake	2.00	7.00	7.00
Soybean meal	29.00	-	-
Lupine component	-	29.00	29.00
Rape	3.40	-	-
Peanut	4.00	-	-
Molasses	4.00	2.53	2.53
Fish meal	8.00	9.50	9.50
Limestone flour	0.40	0.40	0.4
Salt	0.10	0.07	0.07
Monocalcium phosphate	0.10	-	-
Premix 1%	1.00	-	-
Lupine complex 1,5%	-	1.5	-
Lupine complex 1,5% +Protosubtilin	-	-	1.5

The table shows the compound feed formula for three groups. The recipes are nutritionally balanced for growing quails. The poultry received compound feed with a content of metabolizable energy of 299–300 kcal and crude protein of 25.33–25.43%.

Table 2. Feed nutrition by groups

Name	Unit	Control	Group 1	Group 2
Exchange energy	Kcal / 100g.	300	300	301
Crude protein	%	25.34	25.33	25.33
Crude fiber	%	3.36	3.18	3.18
Lysine	%	1.39	1.39	1.39
Methionine	%	0.42	0.51	0.51
Methionine + Cystine	%	0.81	0.85	0.85
Threonine	%	0.93	0.95	0.95
Ca	%	1.0	1.01	1.01
P	%	0.74	0.71	0.71
Na	%	0.16	0.16	0.16

Due to the use of 1.5% premix of own development and production, it has become possible to balance the feed for the experimental groups in terms of amino acid composition, according to the recommendations of [5] by adding essential synthetic amino acids lysine, methionine, threonine.

The feed had a fine fraction, homogeneous, it did not differ in appearance by groups, corresponded to the category - “starter”, is shown in Figure 1.

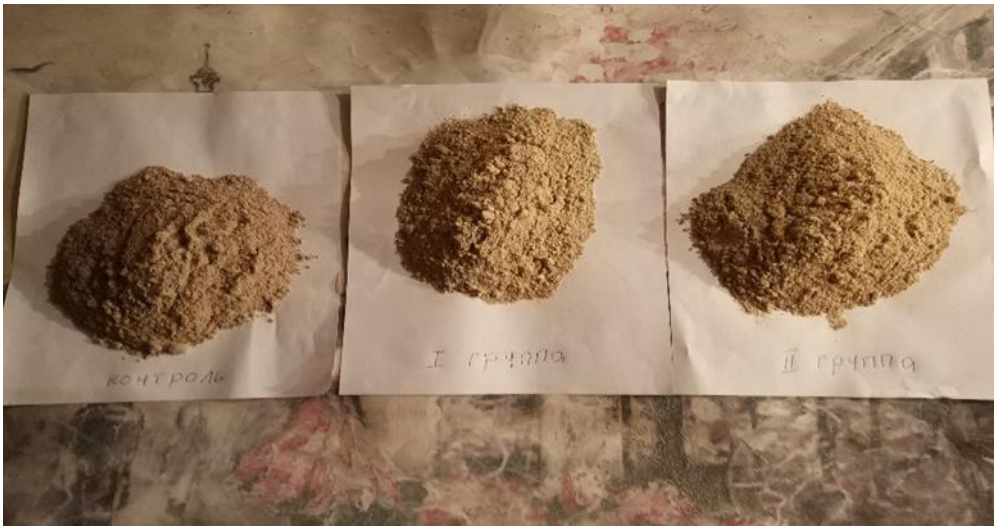

Fig. 1. Compound feed for control and experimental groups

2.2 Quails and feeding

For testing the feed product was carried out a scientific experiment with young quail birds. To do this, on a private quail farm located at the address: the village of Dorozhny, Guryev district, Kaliningrad region, according to the principle of analogues, three groups of quail chickens were formed; of them, one control and two experimental, at the age of 1 day. 80 heads in each group, Texas breed, from April to May. The average weight of a hatching egg

is 15 grams. The average weight of a chicken is 10 grams. Figure 2 shows chickens at the beginning of the experiment.

Fig. 2. Quails at the beginning of the experiment

For testing the feed product was carried out a scientific experiment with young quail birds. To do this, on a private quail farm located at the address: the village of Dorozhny, Guryev district, Kaliningrad region, according to the principle of analogues, three groups of quail chickens were formed; of them, one control and two experimental, at the age of 1 day. 80 heads in each group, Texas breed, from April to May. The average weight of a hatching egg is 15 grams.

One day old quails were placed in brooders - boxes with special internal equipment, optimal conditions for keeping chicks in the first days of their life, so that they could gain strength and prepare for further cage keeping. After 15 days, all young animals were transferred to the cells of the upper tier of a three-tier cell battery for keeping quails.

The quails were fed with compound feed in accordance with the developed own recipe, according to the recommendations of scientists from the All-Russian Research and Technological Institute of Poultry Scientific Centre. Feeding was every 3 hours, watering from automatic drinkers. Table 3 shows the scheme of the experiment.

Table 3. Test scheme

Groups	**Number of heads**	**Features of feeding**
Control	80	Standard starter feed based on soybean meal (29%), 1% premix.
I – test	80	Compound feed with a protein component based on lupine (29%) without shell, 1.5% premix with amino acids, additives developed by the authors.
II - test	80	Compound feed with a protein component based on lupine (29%) without shell + Protosubtilin - an enzyme complex with proteolytic activity of domestic production
Duration, days		45

Chickens of all the groups received compound feed. The differences were that the chickens of the control group received standard starter feed with soybean meal, the chickens of I, II experimental groups received feed with a protein component based on lupine without shell, the compound feed for chickens of group II was additionally supplemented with the enzyme Protosubtilin A-250 G3X. The duration of the experiment was 45 days.

The main task was to study the effect of the lupine component with enzyme complex with and without the enzyme Protosubtilin on the gain in live weight of young quails, and also whether it is possible to reduce the cost of the feeding ration by eliminating expensive soybean from the recipe, replacing soybean meal with a lupine component. Table 2 shows the feed recipe by groups.

Statistical processing of the data obtained during the research period was carried out according to the method of the authors N.I. Korosteleva, I.S. Kondrashkova, N.M. Rudishina, I.A. Kamardina in [17], using the capabilities of Microsoft Office Excel 2010 on a personal computer.

3 Results and discussion

The productivity of quail chicks is influenced by many factors. One of the main ones is the correct organization of feeding the birds with full-fledged nutritionally balanced complete feeds, in which the genetically inherent potential of cross-country productivity and high product quality are manifested. The usefulness of diets is regulated by biologically active feed additives. They have a significant impact on the functioning of individual body systems and, in general, on the metabolic processes occurring in it. Due to the introduction of feed additives into the composition of the diet of animals and birds, it is possible to control the rate of their growth and development, as well as the level of productivity.

In the world, the soybean culture is generally recognized as the leader in the protein component of animal feed [18-19]. In order to replace soybeans with lupine, we had to show in our experiment on poultry that the lupine component we obtained, when fed to quails, starting from the day old, would be no less effective than feeding soybeans [20-23]. To draw a conclusion about the effect of the lupine component without the enzyme and with the enzyme Protosubtilin on the growth energy of quails and compare the indicators with the control, we analyzed changes in live weight, absolute and average daily gain of Texas white broiler quail birds.

Throughout all age periods of the experiment, the young animals of the three groups developed almost evenly. In terms of increasing live weight, it should be noted that the replacement of soybean meal with a lupine component had a positive effect on the birds from the experimental groups. Individuals of the experimental groups were not inferior to their peers from the control group. So, on the 45th day of the experiment, the average live weight was 278.00±3.47 and 281.00±3.51 years. ($P<0.01$); - in the control 280.00±13.41 g, respectively.

Thus, having studied the gain in live weight in a sample of 80 quails in each group presented in Table 4, we can make a reasonable conclusion that the average gain of a bird will reliably be within the limits: in the 1st experimental group $264.65 \leq X (268) \leq 271.35$; in the 2nd experimental group $267.62 \leq X (271) \leq 274.38$, with a probability $P \leq 0.01$.

Table 4. Main zootechnical indicators of growing chickens

Charscteristic	Groups		
	Control	**Group 1**	**Group 2**
One day chick, g	10±0.12	10±0.12**	10±0.12**
Live weight gain, g:			
Day 1-15	76.67±0.96	76.75±0.96**	75.28±0.94**
Day 15-25	63.00±0.78	65.47±0.82**	63.22±0.79**
Day 25-35	88.97±1.11	87.47±1.09**	97.11±1.21**
Day 35-45	41.36±0.51	48.31±0.60**	35.42±0.44**
For the whole period 45, g:	**270±3.37**	**268±3.35****	**271±3.38****
Average daily gain, g	6.00±0.075	5.9±0.074**	6.0±0.075**
Preservation, %	100	100	100
Conversion per 1g. growth	3.65	3.69	3.56
Feed consumption per 1 head, g	986	990	967
Meat productivity index	17.68	17.35	18.15

Note: ** P <0,01

According to tables 4 the replacement of soybean meal with a lupine component did not lead to a decrease in the gross weight gain of quails in the experimental groups. Growth in almost all groups of the same level. By the middle of the 7th week of the experiment, it was obtained: in the control group, 270 g of gross gain per 1 head, in the 1st experimental group, the increase was 268 g, the addition of Protosubtilin to the feed contributed to a slight increase in this value by 1 g or 1.00% in relation to to the control and by 3 g or 1.01% in relation to the 1st experimental group and in the 2nd experimental group it amounted to 271 g. Feed conversion was the best in the second experimental group, which received feed containing the lupine component with Protosubtilin - 3.56. Figure 3 shows a bird at the age of 45 days.

Fig. 3. Quail of the experimental group 2

Based on the experimental data, it can be concluded that the experimental variant in relation to the control during the experiment (45 days) showed a positive result in terms of productivity, the cost of feed and the resulting products, the individuals of the experimental group not only did not yield to the control variant, but also in 2 in the experimental group were slightly ahead of their peers from the control. The growth rate and gross live weight gain were uniform in all groups, which indicates the equal nutritional value of the feed. When

replacing soybean meal with a component of lupine, the productivity of the bird was at the same level as with the classical composition of compound feed with soybean meal.

4 Conclusion

The results of the experiment on quails showed that the young animals reacted positively to the replacement of soybean meal with a lupine component; the intensity of growth of quail in the experimental groups was not inferior to individuals in the control, and in the group that received the enzyme supplement Protosubtilin, the growth rate was the highest, the highest gross weight gain of 271 g was obtained. Due to the fact that the use of compound feed with a content of 29% of the lupine component, when growing quails, made it possible to reduce the cost of feed production by 8 % without enzyme complex and 7 % with Protosubtilin. The cost of 1 kg of products decreased, which confirms the expediency of using the lupine component with Protosubtilin in the diets of quails, moreover, as a complete replacement for soybean meal in feeding quails as part of starter feed.

References

1. Artyukhov A., Gaponov N., Compound Feed magazine, **3**, (2010)
2. Cultivation and use of fodder narrow-leaved lupine. Practical recommendations. All-Russian Research Institute of Lupine. All-Russian Research Institute of Lupine, Bryansk, 57p (2001).
3. Kosolapov V.M., Fitsev A.I., Gaganov A.P., Mamaeva M.V. Peas, lupins, vetch, beans: assessment and use in feeding farm animals. - Ugresh Printing House LLC - 2009. P. 373 (2009)
4. Gataulina G.G., Medvedeva N.V. Achievements of science and technology of the agro-industrial complex, **10**, (2008)
5. Kalashnikov A.P., Fisinin V.I., Shcheglov V.V., Kleymenov N.I. Norms and diets for feeding farm animals. Reference manual. –p. 455 (2003).
6. Buyankin N.I., Krasnoperov A.G., Fedorova Z.N. Lupine for fodder and green manure in the Kaliningrad region. Kaliningrad,. p. 148, (2018)
7. Buyankin N.I., Fedorova Z.N. Cultivation of narrow-leaved lupine for fodder and green manure. In the collection: Multifunctional adaptive fodder production collection of scientific papers. pp. 5-14 (2018).
8. Fedorova Z.N., Ezhelev A.V., Tkachenko Yu.G. Chief livestock specialist. **10**. pp. 31-41 (2018)
9. Maksimyuk N.N. Development of enzymatic hydrolysates and the effectiveness of their use in animal husbandry / N.N. Maksimyuk. - Veliky Novgorod, p. 208, (2006)
10. Movsum-Zade K.K. Protein hydrolysates in veterinary medicine. - 2nd ed., revised. / K.K. Movsum-Zade, V.A. Berestov. - Petrozavodsk: Karelia, p. 158, (1989)
11. Vasyutin A.S. Kormoproizvodstvo. **4**. pp. 26-28, (1996).
12. Kosolapov V.M., Fitsev A.I., Gaganov A.P. et al. Non-traditional grain and leguminous crops and their use in feeding farm animals and poultry. - M.: FGU RTsSK, p. 30, (2009)
13. Merkuryeva E.K. Biometrics in breeding and genetics of farm animals. - M.: Kolos, p. 424, (1970)

14. Polyakov V.A., Rimareva L.V. Promising enzyme preparations and biotechnological processes in food and feed technology: Collection of scientific papers / ed. V.A. Polyakova, L.V. Rimareva. M.: VNIIPBT, p. 432, (2012)
15. Egorov I., Chesnokova N., Andrianova E., Anchikov E. Mixed feed, **1**, pp. 67-68, (2009).
16. Kisluhina O.V. Enzymes in the production of food and feed. – M.: DeLi print, p. 336, (2002)
17. Korosteleva N.I., Kondrashkova I.S., Rudishina N.M., Kamardina I.A. Biometrics in animal husbandry. Study guide. - Barnaul.: AGAU, p. 210, (2009)
18. Novozhilov E.V., Poshina D.N. Chemistry of plant raw materials, **3**, pp. 15-32, (2011)
19. Yagovenko T.V., Rudometkina M.V., Rudometkin S.V., Troshina L.V. Feed production, **3**, pp. 27-29, (2005).
20. Guidelines for the determination of antinutritional substances in leguminous crops, Moscow, Russian Agricultural Academy, All-Russian Research Institute of Feeds. V.R. Williams, pp. 12 – 14, (1999).
21. Artyukhov A.I., Yagovenko T.V., Afonina E.V., Troshina L.V. Quantitative determination of alkaloids in lupine Guidelines. Bryansk: publishing house "Chitay-gorod". 16, (2012)
22. Golubov I.I., Krasnoyartsev G.V. Poultry and poultry products. **5**. pp. 27–29, (2012)
23. Pigareva M.D. Recommendations for the production of eggs and quail meat. — M.: VNIIPP, p. 14, (1971)