The lupine significance for forage production: lupin-and-rape concentrate as a source of valuable nutrients for animal feeding

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Abstract. The article presents a way to solve the problem of protein and energy-rich diets which seems to be the key task for livestock and agricultural science workers. An important place is given to pulses and oilseed forage crops. They are widely used as green forage, native and chopped seeds and products of their processing (oilcake, meal, oil, etc.) for feeding animals and, to a limited extent, as part of compound feeds. A key issue in feed production is the issue of feed protein. The further development of animal husbandry depends on its decision. As a rule, protein deficiency, in diets is up to 30%, and leads to feeds overspending and increases the cost of livestock production by 1.5-2.0 times. The solution for the fodder protein problem should be carried out mainly due to legumes and their mixtures. One of the main tasks of fodder production is the introduction of advanced preparation technologies. Dry feed mixtures’ structure and form meet the physiological needs of animals most fully because of increased nutrients energy and product quality.

1. Introduction
Under the modern economic conditions of the global crisis, increasing of development intensity of animal husbandry plays the most important role. Feeding theme is one of the key conditions for successful development of this branch and for realization of planed production programs to ensure country food security. To solve the task of the animal husbandry it is necessary both to organize forage production system and develop rational methods of their preparation and wide introduction into practice of the latest scientific achievements. The later should contribute to technological, economic and social development of agro-industrial complex [1-7].

First of all the final aim of productive work of agro-industrial complex is to ensure country food security. Taking into account the fact that according to the WHO data less than a third of the world population has sufficient food amount the task to double food amount seems to be difficult enough especially in the case of qualitative protein foods.

The most important for us are protein foods, the most valuable of them are animal proteins. In the case of rapid development of animal husbandry, it is necessary to look for alternative ways for development of forage base where proteins play the most important role. Proteins are the most valuable part in feed, natural protein sources are less than other nutritive substances. According to the
data of home scientists and specialists of the forage industry now the forage protein deficit is about 29% [1; 4].

Under these conditions increase of plant protein production is of paramount importance because this method to improve protein balance is the most efficient and free. A good protein source among forage crops are the legumes. They should be widely used because of their value for farming and animal husbandry. At present there is great experience and good results in legumes cultivation, the most known of which became soybean. Soya takes a monopoly position in the market of protein forage, the last could be explained due to the widely assortment of soya forage differs in composition, properties and purpose use as well as in their availability due to numerous commercial offers. Taking into account the situation in the plant protein market as well as the fact that more than 80% of the imported soya are genetic modified the special attention over the world is paid to the search of new competitive plant protein sources [1; 3; 6]. Lupine’s ability to accumulate and synthesize protein takes the first place among legumes. Lupin feed have high biological value, digestibility, are rich of microelements, vitamins and other biological active substances with low content of antinutritional components. At present lupin is seen as a soy competitor in many countries. Consumer characteristics and technological properties of different lupin species and varieties are under comprehensive research. Lupine’s adaptability to the soil-and-climatic conditions of many regions of Russia is its important competitive advantage compared to soybean. Of particular note are the possibilities of farms of the Non-Chernozem zone to increase forage protein nutrition because of lupin. Proof of this is the experience of farms which cultivate this crop [2; 7].

Biological value of feed protein depends mainly on amino acids’ composition. At protein quality evaluation the great attention is paid to content of essential amino acids (lysine, methionine, cysteine, threonine, tryptophan, phenylalanine, valine, leucine and isoleucine). If one of them is absent or its amount is to low the protein is considered as inferior one. Full value of forage protein also depends on forage species used. Thus, the principle of added action of different protein feeds is used in ration development to increase its full value. By feeds selecting in the diet, it is possible to compensate the lack of some amino acids in some feeds due to others, thus providing high biological protein value of the feed mixture. It allows both to decrease the use of synthetic amino acids for feed diets balance and to eliminate forage and production cost price [1; 3]. The above indicates the relevance and practical importance of our researches aimed for production lupin protein feeds which have high bio-logical value and can partially or completely replace full fat soy in diet structure.

2. Materials and methods

The aim of our tests was to develop an extruded feed based on the narrow-leafed lupin var. Snezhet and the winter ripe var. Severyanin which protein value is close to full fat soy (figure 1).

The test task consists of:

- To develop the optimal components’ ratio in the structure of lupin-and-rape extrudate;
- To develop technological ways for production of lupin-and-rape extrudate;
- To determine the chemical composition of produced extrudate;
- To test the nutritive value of the extrudate.

It’s known that if the diet fiber increases digestibility of feeds nutritive goes down and losses of metabolic energy rise sharply. Especially it occurs at mono-gastric animals which symbioses with cellulolitic microorganisms are weaker. Pigs and poultry are unable to digest high fiber amount and the feed diet fiber should be limited that in turn reduces the percentage of input of legumes.

3. Results

Lupin has been hulled by means of experimental equipment in the Federal Scientific Center for Agro Engineering to decrease the fiber level. As a result the fiber content in lupin decreased by 12.09%, further it allows to increase the lupin input into diets of mono-gastric animals. Hulled lupin increased
crude protein content by 6% and improved respectively its biological value. Crude fat, calcium and phosphorus content of hulled lupin were by 1.34%, 0.20% and by 0.19% respectively higher than the native lupin had.

![Native lupin, Soybean, Hulled lupin, Extrudate](image)

**Figure 1.** Narrow-leafed lupin var.

The rape feed value is super compared to many agricultural crops. Its seeds consist of 43.71 % of oil and 23.00 % of protein. Its metabolic energy concentration exceeds soy by 10.30% and hulled lupin – by 35.00%. Rapeseed protein doesn’t yield legumes in essential amino acids amount and surpasses it in some of them.

Excellence of lupin and rape feed value allowed develop a lupin-and-rape extrudate. Then the developed mixture was treated barothermally in the extruder to improve biochemical characteristics. The barothermic treatment resulted in protein metamorphose significantly increased dispersity of protein-and-lipid emulsion and hydration ability and proteins nutritive value. Amount of water soluble substances increased in 10 times, in complex with other processing it results in full sanitary cleanliness of extrudate because of the microorganisms death. This process resulted also in decrease of antinutritional factors. Particularly alkaloid content of the produced extrudate decreased from 0.035 to 0.01% compared to the hulled lupin. In this case there are some undeniable advantages over traditional processing technologies with mono-factorial impact on raw material.

The biochemical analysis of the produced extrudate has shown that the content of the main nutritive substances and protein quality were close or identical to the full fat soy, the data in table 1 indicate it.

Raw protein content in lupin-and-rape extrudate was by 0.33% higher and made 34.33% (34.00% in full fat soy). Raw fat content in the extrudate was higher by 1.93%, raw fiber content was lower by 2.47%. The content of raw ash was higher by 1.49%, calcium – by 0.37%, and the content of phosphorus was at the same level as full fat soy had.

Analysis of the amino acid composition has shown that lysine content was lower by 0.5%, content of isoleucine was higher by 0.06%, content of methionine and cysteine was by 0.01% higher in the extrudate compared full fat soy. The content of other amino acids was at the identical level compared to full fat soy. What about es-sential amino acids so their content is some higher in lupin-and-rape extrudate. Thus the content of histidine was higher by 0.13%, tyrosine – by 0.19%, and arginine – by 0.45%.

4. **Conclusion**

To conclude it’s necessary to mention the possibility of significant increase of protein content in diets as a result of lupin and rape use both in native form and as concentrates developed on their base. The combination of additive protein action and progressive treatment processing will reduce the cost of the received livestock prod-ucts and create worthy competition against high-protein soybean feed.
### Table 1. Structure and nutrition of lupin-and-rape extrudate and soybean, percent

| Characteristics       | Winter rape | Native lupin | Hulled lupin | Lupin-and-rape extrudate | Full fat soy |
|-----------------------|-------------|--------------|--------------|---------------------------|--------------|
| MO, MJ/100 g          | 1.50        | 1.00         | 1.11         | 1.36                      | 1.36         |
| Dry matter            | 88.00       | 90.60        | 90.30        | 89.50                     | 88.00        |
| Crude protein         | 23.30       | 32.00        | 38.00        | 34.33                     | 34.00        |
| Crude oil             | 43.71       | 5.17         | 6.51         | 18.53                     | 16.60        |
| Crude fiber           | 12.40       | 14.00        | 1.91         | 4.53                      | 7.00         |
| Ash                   | 13.00       | 3.30         | 3.45         | 5.69                      | 4.20         |
| Ca                    | 0.51        | 0.41         | 0.61         | 0.59                      | 0.22         |
| P                     | 0.59        | 0.48         | 0.67         | 0.65                      | 0.65         |
| Alkaloids             | -           | 0.030        | 0.035        | 0.01                      | -            |
| Linoleic acid         | 0.62        | 1.47         | 1.50         | 1.30                      | 1.40         |
| Lysine                | 1.24        | 1.45         | 1.72         | 1.60                      | 2.10         |
| Methionine            | 0.60        | 0.33         | 0.39         | 0.44                      | 0.44         |
| Methionine + cysteine | 1.32        | 0.74         | 0.88         | 0.99                      | 0.98         |
| Tryptophan            | 0.19        | 0.21         | 0.25         | 0.23                      | 0.37         |
| Arginine              | 1.50        | 3.03         | 3.60         | 3.07                      | 2.62         |
| Histidine             | 0.89        | 0.96         | 1.14         | 1.08                      | 0.95         |
| Leucine               | 1.79        | 1.82         | 2.16         | 2.07                      | 2.58         |
| Isoleucine            | 1.00        | 1.50         | 1.78         | 1.59                      | 1.53         |
| Phenylalanine         | 1.05        | 1.37         | 1.63         | 1.48                      | 1.70         |
| Tyrosine              | 0.47        | 1.43         | 1.70         | 1.39                      | 1.20         |
| Threonine             | 1.10        | 0.90         | 1.07         | 1.08                      | 1.37         |
| Valine                | 1.27        | 1.13         | 1.34         | 1.32                      | 1.60         |
| Glycine               | 1.23        | 0.90         | 1.07         | 1.11                      | 1.45         |

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