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# Rape as a source of vegetative protein in Ukraine

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**ABSTRACT**

The objective of this research is to determine the role of cultivation, processing and usage of rapeseed in Ukraine. To reach the aim used biochemical, analytical and statistical methods. The study has shown that within recent year's increased sown areas, crop capacity and gross rapeseed yield. Variety composition of rapeseed represented by over 300 varietal numbers and over 100 hybrids: just 3 with low erucic acid/high glucosinolate content, single with high erucic acid/low glucosinolate and the rest – «double-zero» (low erucic acid, low glucosinolate). According to biochemical analysis of rapeseed, by-products (press cake and meal) can be useful as fodder all species of animals and poultry. Biochemical evaluation of seed and their processing products from registered in Ukraine rapeseed varieties and hybrids indicates their high quality. Therefore, it is possible to increase the introduction of rapeseed press cake and meal from "00" varieties into diets of farm animals and poultry in 1.5-2 times compared with "0" varieties.



## 1. INTRODUCTION

Rape growing is a traditional industry for Ukraine. A new stage in its development - creation and implementation of varieties suitable for obtaining food oil and high-quality concentrated fodder - began in early 80's of the last century. Nowadays such varieties have been created and widely distributed in production around the world and, in particular, in Europe. With every other year the area under this crop was expanded, yielding capacity of the seed increased. Now rape takes the second place among oil crops, following after only soybean, and its gross production exceeded 70 million tons [1]. Among the main agricultural crops grown in Ukraine rape also takes a special place. On one hand it is a powerful source of vegetative oil used in many industries, on the other - a valuable animal fodder: its seeds contain 40-47% of fat and more than 20% of protein. Production increase of livestock products requires fodder production (primarily concentrated), improvement of their quality and reduction of grain proportion in them. This can be achieved through wide usage of complete feeding additives, with the help of which one can solve the known problem of feeding protein deficiency. High-protein resources of animal origin (meat, bone, blood and fish meal, skimmed milk powder) as well as the products of microbiological synthesis are very limited and expensive. In this regard special attention is paid to the production of vegetative fodder protein, in particular the rape one, which has high nutritional value and relatively low cost. Nowadays rape is grown on almost all continents. The main world producers of rape are China, EU countries, India, Canada, countries of Eastern Europe. Increased interest in rape is stipulated by good adaptation of this plant to temperate

climate, high productivity of modern varieties, progressing need for vegetative oil and high-protein fodders. The latter are well balanced in amino acid composition and their biological value, as well as methionine and cystine content predominate over even soy. However, when feeding animals, it should be taken into account that rape fodders contain toxic substances and therefore their introduction into the diet should be limited. Availability of different rape varieties which are characterized by different levels of anti-nutrients as well as selection work aimed at reduction of their content require analysis of rape products for the content of these compounds and deprivation of harmful effect on animals [2], [17].

## 2. MATERIALS AND METHODS

Rapeseeds varieties, which are zoned in Ukraine, were presented by originator institutions. Meal and mill cake obtained from rapeseeds processing were selected at processing plants in Ukraine. Zootechnical evaluation of fodders - dry matter, fat, fiber, protein, ash, phosphorus, calcium was conducted by conventional methods [3], the content of glucosinolates was determined photo-colorimetrically [4]. Fatty acid composition of rape oil was determined by gas chromatograph "Chrom-5". Amino acid composition of rape protein was determined according to SSTU ISO 13903: 2005 "Fodder components for animals - Determination of amino acid content". For analysis of the obtained results were used calculation and analytical research methods.

## 3. RESULTS

Rape growing in Ukraine. One of the factors broadening areas under rape is the increase in demand for it from world agricultural market. In this regard, the areas under rape are broadening in Ukraine too (Table 1).

**TABLE 1.** Sowing area, yielding capacity and gross harvest of rape in Ukraine [6].

| Indices | Years | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 2000 | 2005 | 2010 | 2014 | 2015 | 2016 | 2017 | 2018 |
| Sowing area, thousand hectares | 214 | 207 | 907 | 882 | 682 | 455 | 789 | 1042 |
| Yielding capacity, c/ha | 8.4 | 14.6 | 17.0 | 25.4 | 25.9 | 25.7 | 27.9 | 26.5 |
| Gross harvest, thousand tons | 131.8 | 284.8 | 1469.7 | 2198.0 | 1737.6 | 1153.9 | 2194.8 | 2750.6 |

In recent years, Ukraine has increased not only sowing area but also yielding capacity and gross harvest of this crop, and for the harvest of 2019 the area under the crop was 1.3 million hectares, which is 28% higher than for the previous year [5]. In fact, rape yielding capacity in EU for the last 10 years was 28.5-35.9 c/ha, while in Ukraine - 17.0-27.9 c/ha. With stabilization of average yielding capacity in Ukraine at the level of 25-26 c/ha and the area under rape within 2 million ha, it will be possible to obtain annual gross harvest at the level of more than 5 million tons of seeds [7], [18]. Unfortunately, predominant majority of Ukrainian rapeseeds is exported, but not processed into oil and biodiesel as in the world's leading countries. We remain a raw material appendage of Europe supplying not finished products but raw materials with lower added value, potentially losing significant funds [8]. *Varietal composition of rapeseeds produced in Ukraine.* Analysis of State Register of Plants in Ukraine for 2018 showed that it includes 262 varieties and 114 hybrids of winter rape, of which only 3 are single-zero, that is eruca free, but with high glucosinolate content and 1 - with high eruca content. The rest of all varieties are of double-zero type, i.e. eruca free and with low glucosinolate content. All varieties (57 pieces) and hybrids (16 pieces) of spring rape included in the register are double-zero. The share of winter rape varieties of domestic selection in the State Register is 18.6%, spring rape varieties - 26.0% [9], [19]. In order that glucosinolate content in rapeseeds of commercial category would not exceed 25 μMol/g, glucosinolate content in the sowing material should not exceed 18 μMol/g. Practically all "00" varieties of winter and spring rape selected by Pre-Carpathian State Agricultural Research Station of the Institute of Agriculture in Carpathian Region NAAS (former Ivano-

Frankivsk Research Station of Cruciferous Crops, Institute of Cruciferous Crops, Ivano-Frankivsk Institute of Agro-industrial Production) - Tysmenytsky, Sveta, Dangal, Dembo, Cheremosh, Dema, Modelini, Smaragd, Mykytynetsky, Arion, Luzhok, Maryne, Liga, as well as other varieties and hybrids of domestic and foreign selection cultivated in Ukraine meet indicated requirements. It is confirmed by the results of glucosinolate content analysis conducted on samples of commercial seeds which were sent for processing to three main enterprises processing rapeseeds in Ukraine - ViOil, Oliyar, LLC "Agrotechnica", which ranged from 19.4 to 25.5 μMol/g.

**TABLE 2**. Biochemical composition of rape varieties selected in Pre-Carpathian State Agricultural Research Station of the Institute of Agriculture in Carpathian region NAAS

| Variety name | Fatty acid composition, % | | | | | | Oil content, % | Glucosinolate, μMol/g |
|---|---|---|---|---|---|---|---|---|
| | $C_{16:0}$ | $C_{18:1}$ | $C_{18:2}$ | $C_{18:3}$ | $C_{20:1}$ | $C_{22:1}$ | | |
| Winter rape | | | | | | | | |
| Tysmenytsky | 4.18 | 66.88 | 19.07 | 9.22 | 0.65 | no | 44.5 | 22.1 |
| Ivanna | 3.25 | 69.12 | 17.41 | 9.20 | 1.02 | no | 43.8 | 25.0 |
| Sveta | 6.25 | 69.40 | 18.22 | 5.58 | 0.55 | no | 45.0 | 18.0 |
| Galytsky | 4.43 | 70.59 | 19.04 | 5.68 | 0.26 | no | 43.8 | 60.0 |
| Dangal | 5.55 | 70.58 | 14.86 | 8.08 | 0.93 | no | 44.5 | 18.5 |
| Demerka | 2.25 | 18.04 | 12.22 | 8.71 | 5.69 | 53.09 | 44.0 | 8.2 |
| Dembo | 4.75 | 70.75 | 20.02 | 3.54 | 0.94 | no | 46.9 | 20.0 |
| Cheremosh | 3.90 | 67.65 | 21.25 | 6.68 | 0.52 | no | 47.0 | 11.8 |
| Dema | 5.74 | 70.19 | 18.18 | 5.39 | 0.50 | no | 46.5 | 16.0 |
| Modelini | 2.81 | 68.61 | 23.93 | 3.85 | 0.80 | no | 42.3 | 18.4 |
| Smaragd | 3.39 | 67.27 | 20.69 | 7.40 | 1.29 | no | 41.5 | 18.7 |
| Spring rape | | | | | | | | |
| Mykytynetsky | 3.09 | 69.63 | 19.40 | 7.42 | 0.46 | no | 42.0 | 19.0 |
| Arion | 5.94 | 64.85 | 21.29 | 7.26 | 0.66 | no | 41.8 | 16.5 |
| Luzhok | 4.19 | 68.87 | 16.61 | 9.84 | 0.49 | no | 43.0 | 20.0 |
| Maryne | 2.80 | 70.14 | 21.05 | 5.61 | 0.40 | no | 43.0 | 18.6 |
| Liga | 5.19 | 69.59 | 15.87 | 8.56 | 0.71 | 0.08 | 42.5 | 15.0 |

### *3.1 Biochemical composition of meal produced in Ukraine.*

**TABLE 3.** Chemical composition of meals from major oil crops in Ukraine

| Indices | Meals | | |
|---|---|---|---|
| | Sunflower | Rape | Soy |
| Humidity, % | 7.56 | 7.32 | 8.80 |
| Dry matter, % | 92.44 | 92.68 | 91.20 |
| Crude protein, % | 34.63 | 34.63 | 39.57 |
| Crude fat, % | 1.20 | 2.71 | 4.13 |
| Crude fiber, % | 13.06 | 12.50 | 5.52 |
| Crude ash, % | 7.75 | 6.80 | 7.91 |
| Calcium, % | 0.43 | 0.80 | 0.33 |
| Phosphorus, % | 0.88 | 0.90 | 0.66 |
| Amino acid composition, mg/100 g of natural moisture | | | |
| Aspartic acid | 2.22 | 2.05 | 3.99 |
| Threonine | 0.74 | 0.89 | 1.54 |
| Serine | 1.05 | 0.81 | 1.97 |
| Glutamic acid | 4.68 | 3.87 | 6.58 |
| Proline | 1.44 | 1.27 | 1.23 |
| Cystine | - | 0.31 | 0.33 |
| Glycine | 1.29 | 1.27 | 1.88 |
| Alanine | 1.65 | 1.09 | 1.98 |

| | | | |
|---|---|---|---|
| Valine | 1.46 | 1.29 | 0.28 |
| Methionine | 1.87 | 2.69 | 1.74 |
| Isoleucine | 2.13 | 2.30 | 1.39 |
| Leucine | 2.05 | 2.26 | 1.66 |
| Tyrosine | 0.49 | 1.33 | 1.29 |
| Phenylalanine | 0.74 | 1.21 | 1.97 |
| Histidine | 0.46 | 0.53 | 0.91 |
| Lysine | 4.27 | 2.63 | 2.44 |
| Arginine | 2.74 | 3.70 | 2.44 |
| TOTAL | 29.28 | 29.50 | 33.62 |

### *3.2 Usage of rape meal/mill cake in feeding farm animals and poultry*

Based on many year research conducted by scientists of Pre-Carpathian State Agricultural Research Station of the Institute of Agriculture in Carpathian region and a number of other authors effective ways of using rape meal and mill cake of domestic production in feeding cattle, pigs and poultry were identified [11- 16]. Glucosinolate content in the products of rape processing was 25-53 μMol/g.

**TABLE 4.** Recommended inclusion levels of rape meal/mill cake of domestic production in feeding diets

| № b/n | Species and groups of animals | The share of rape meal/mill cake in the diet, % |
|---|---|---|
| 1. | Calves | 20.0 |
| 2. | Milk cows | 25.0 |
| 3. | Meat cattle | 20.0 |
| 4. | Starter piglets | 8.0 |
| 5. | Piglets on growing | 8.0 |
| 6. | Piglets on fattening | 10.0 |
| 7. | Pedigree pigs | 8.0 |
| 8. | Starter poultry | 5.0 |
| 9. | poultry on growing | 10.0 |
| 10. | Egg laying hens and pedigree hens | 5.0 |

## 4. DISCUSSION

These indices affirm intensification process of rape production in Ukraine. However, the average level of rape yielding capacity in practice is twice lower than the potential level of plants. Thus, according to our data, as well as data from selection companies and producers of original seeds, the potential yielding capacity of modern rape varieties of domestic selection can reach more than 50 c/ha, foreign hybrids of rape - more than 65 c/ha. Among the main reasons of low rape yields in Ukraine are: unfavorable weather conditions, low equipment level of agricultural producers, non-compliance with the technology of rape growing, using seed material of poor quality, rape growing in unsuitable natural and climatic conditions. The main ways of solving the problem of reducing content of anti-nutrients in the products of rapeseed processing are technical and selective. Thanks to the latter, it was possible to create varieties and hybrids with low content of glucosinolates (so-called "00" varieties), which contributes to significant expansion of their usage in fodder procurement and fattening sectors of agricultural production. This allows to increase introduction norm of rape meal/mill cake in the diets of farm animals and poultry by 1.5-2 times comparing with single-zero varieties, but it is necessary to continue looking for ways of reducing glucosinolates to the level below 20 μMol/g [10]. Biochemical analysis of meal showed that rape protein contains a set of all amino acids and many of them are close to soy, and the ratio of irreplaceable amino acids to replaceable ones even slightly higher than in soy. So, by-products of rapeseeds of modern "00" varieties for oil – mill cake and meal - can be effectively used in feeding all species of animals and poultry. Thus, one ton of rape mill cake or meal can balance the protein content of, in average, 8 tons of grain forage and provide high productivity of livestock breeding.

## 5. CONCLUSION

Thus, analysis of indices of sowing areas and gross harvest indicates the process of rapeseed production intensification in Ukraine. Biochemical evaluation of seeds, mill cake and meal from varieties and hybrids of rape which are registered and grown in Ukraine indicates their high quality, which allows to increase introduction norm of rape mill cake and meal in the diets of farm animals and poultry by 1.5-2 times comparing with single-zero varieties. However, it is necessary to search the ways for further improvement of nutritional value of rapeseed products.

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