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ДОБИВ НА БРУТО ЕНЕРГИЯ И АМИНОКИСЕЛИНИ НА КЮСПЕ И ШРОТ ОТ РАПИЦА, ОТГЛЕДАНА ПРИ АГРОЕКОЛОГИЧНИТЕ УСЛОВИЯ НА ПЛОВДИВСКИЯ РЕГИОН

YIELD OF GROSS ENERGY AND AMINO ACIDS FROM RAPESEED (*Brassica napus ssp. oleifera*) POMACE AND MEAL GROWN UNDER THE AGRICULTURAL AND ECOLOGICAL CONDITIONS OF THE PLOVDIV REGION

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Abstract

An investigation on establishing the composition and the nutritive value of pomace and meal obtained from the seeds of the *Votan* double zero variety of rapeseed, grown under the conditions of the Plovdiv region has been conducted. The following conclusions have been submitted: After processing the seeds, the average yield of pomace (1900 kg) from 1 ha of land is higher and that of meal (1750 kg) – lower. The content of crude protein is higher in the meal (43,52 versus 35,30%), while the content of crude fats – in the pomace (6,52 versus 2,16%). The gross energy yield from 1 ha is higher for the pomace. The meal is much richer in all essential amino acids. The content of glucosinolates in both products is lower than 20 μmol/g.

Key words: canola meal, canola pomace, gross energy, amino acids.

INTRODUCTION

The constant increase of the consumption of proteins worldwide and in our country is the reason for the search of new sources of protein, for the purpose of replacing the expensive soya bean meal.

The meal and pomace obtained after processing of the rape-seeds are a valuable source of complete proteins for the livestock breeding.

The expansion of the biofuels industry leads to significant increase of the lands planted with rape-seed, and respectively – an increase of the rapeseed waste products.

The most important factor which has contributed for the increased use of the rapeseed meal and pomace in the animal rations is the introduction of the canola rapeseed varieties (00).

The canola rapeseed meal is a new type of fodder, but without content of the harmful erucid acid and with minimum quantities of glucosinolates.

In the cases of using the cheaper rapeseed meal, there exists the possibility for lowering the expenses for fodder and reduction of the cost of the animal production. In the separate countries this difference (depending on the state policies) is quite substantial and varies between 40% and 80% (Alexandrov, 2010).

Recommended quantities of canola meal for the calves are 20%, for milking cows 25% and for beef for meat – 20% (Angelov, 1998). In the cases of birds, it is recommended to include the meal within the limits of 10-30% depending on the type and category of the birds (Kellems et al., 2010).

With this study, we are aiming at finding out the content and the nutritional value of canola pomace and meal obtained from the seeds of the double zero variety Votan, grown in the conditions of Plovdiv region.

MATERIALS AND METHODS

The rapeseed was grown in the Experimental base of the Agricultural University in Plovdiv, during the period 2005/2006; 2006/2007; 2007/2008.

The randomized complete block designe at 4 replications and – 20 m^2 plot size was used.

The seeds were planted where previously wheat was grown, after which the land was plowed to a depth of 20-25 cm and it was processed in order to achieve garden conditions by disking and milling. The fertilization was done with P_2O_5 – 120 kg/ha, K_2O – 100 kg/ha and N – 170 kg/ha. The phosphorous and potassium fertilizers were imported before the main cultivation of the soil, while the nitrogen fertilizers – 30 kg/ha – before sowing, and 140 kg/ha as a nutritional dose. The sowings were done in the beginning of 01-05 September, with sowing rate 6,0 kg/ha at distance between the rows – 15 cm.

Before the pre-sowing processing of the soil, the herbicide Devrinol 4F - 3,5 l/ha against grain weeds and some deciduous weeds was used.

During the vegetation period a spraying against the rapeseed blossom-eater with the insecticide Vastak New 100 EK – 200 ml/ha.

As a result of the performed experiment on varieties we took for analysis seeds from the high-oil double-zero German variety Votan (42-45% crude fats).

The waste products and the tested indicators were obtained from average samples of the seeds of variety Votan, which were obtained during the three years of the experiment.

The pomace was obtained by cold-pressing of the seeds by a screw press, while the meal was obtained by extraction of the oil by petroleum ether in accordance with the remains method with the apparatus - Soxlet extractor.

The chemical analyses of the pomace and the meal were performed in accordance with the classical method of Veende - (AOAC-1990), while the amino-acids analyses were performed with the use of an amino-analyzer of the company KNAVER-A-200 Germany, after the preliminary hydrochloric acid hydrolysis.

The yields of pomace and meal from one hectare have been re-calculated on the basis of processed 1 kg of seeds and weighing of the remains from the mechanical (chemical) processing, while taking into account also the losses (extracted oil) during processing.

The content of gross energy was found out according to the formula of (Schiemann et al., 974): G0,0242*CP+0,0366*Eth. Extr.+0,0209*CFib.+0,017*NPE (al the substances are in g/kg DM).

The yield of gross energy and amino acids from one hectare was determined as their content in 1 kg of fodder was multiplied by the yield of the respective raw material.

The content of total glucosinolates was determined in accordance with ISO 9167-1; 9167-2.

RESULTS

The yields from the seeds achieved during the years of the experiment vary depending on the weather conditions (Table 1).

Table 1

Yield of seeds, meal and pomace

Years	Seeds кg/ha	Pomace		Meal	
		кg/ha	% of the seeds	кg/ha	% of the seeds
2006	4700	2440	51.9	2260	48.1
2007	2050	1070	52.2	980	47.8
2008	4190	2180	52.0	2010	48.0
Average	3650	1900	52.1	1750	47.9

The average monthly temperatures during the three years of the experiment were close to the optimal for the development of the rapeseed.

The higher quantity of rainfalls and their equal distribution during the vegetation period define 2005-2006 as the best period for growing of rapeseed. During this year, a largest yield of seeds - 4700 kg/ha was registered.

As a result of the continuous drought during the period of blossoming, the yields achieved during 2007-2050 kg/ha were considerably lower than these achieved during 2006 and 2008.

The average yield during the period of the study amounts to 3650 kg/ha.

The yield of pomace and meal during the years of the study follow the same tendency as of the yield of the seeds.

After processing the seeds, the yield of the waste products varies from 1070 kg/ha pomace and 980 kg/ha meal (2007) to 2440 kg/ha pomace and 2260 kg/ha meal during 2006.

The average yields of pomace (1900 kg/ha) and of meal (1750 kg/ha) were considerable and they can represent a good reserve with regards to feeding both of ruminant animals and pigs, and to more limited extent - of the birds.

These products have high content of protein and other nutritional ingredients, which make them very rich food for animals.

The summarized data of the performed experiments in 9 scientific and research centers in Canada, Germany and France show that most (10%) of canola meal may be included in the daily portions of layer hens, as a result of which there

is a increase of the egg production, the utilization of the fodders and the largeness of the eggs, and also reduces their death rate (Kellems et al., 2010).

The rapeseed meal is the second important protein food in the world after the soybean meal. It contains from 38% to 45% of proteins, more essential amino acids compared to the sunflower meal and higher coefficient of digestibility (71% compared to 56%) (Banaszkiewicz et al., 2008).

Granulated to pellets, it can be used for a longer period of time.

The data in Table 2 shows that the chemical compositions both of the waste products show significant differences.

The proteins of the rapeseed, as well as those of the soya bean have contents close to those of the eggs, milk and the cow butter.

The content of crude protein in the seeds of the rapeseed of variety Votan averagely during the period of the study was 25,33% (Ivanova, 2008).

After the oil extraction, the level of protein in the meal increases to 43,52%.

The content of crude protein in the pomace is lower compared to meal (35,40%).

The yield of crude protein from the products, averagely, for the period of the experiment is 619,5 kg/ha (pomace) and 761,6 kg/ha (meal).

All this makes the canola meal an equal substitute of the soya bean meal and can be used as high-protein component in the preparation and production of concentrated animal feed for all types of farm animals and birds (Georgieva et al., 1996).

Table 2

Chemical content of canola pomace and meal

Indicators (%)	Meal		Pomace	
	%	g/kg	%	g/kg
Dry matter – DM (105°C)	89,93	899,3	91,05	910,5
Crude protein	43,52	435,2	35,40	354,0
Crude fats	2,16	21,6	6,52	65,2
Crude fibers	12,53	125,3	14,52	145,2
NPE	35,77	357,7	39,41	394,1
Gross energy - MJ/kg	20,02		20,69	
Yield of meal and pomace kg/ha, averagely for the period of the study	1750,0		1900,0	
Yield of gross energy - MJ/ha	35035		39311	
Yield of crude protein kg/ha, in the raw materials, averagely for the period	761,6		619,5	
Yield of crude fats kg/ha, in the raw material, averagely for the period	728,0		1141,0	

The main factor that influences the energy value of the waste products is the quantity of the residual oil.

The most part of the rapeseed products are suitable food for milking cows as the high content of fats increases the production of milk (Boychev, 2004).

The higher the fat content is, the higher is the energy value of the products.

Averagely for the period of the experiment the content of crude fats in the seeds is 43,38 % (Ivanova, 2008).

Usually, after the extraction of the oil from the seeds by a solvent, about 2% oil remains in the obtained meal, which is very close to our results (2,16% in DM).

When the oil is extracted though cold pressing, about 7,8% in DM fats remain in the waste product pomace (Sibbald and Slinger, 1963).

The higher quantity of the pomace and the higher residual contents of fats in it are the reason also for the higher yield of crude fats 1141,0 kg/ha compared to the meal - 728,0 kg/ha.

In the case with the mechanically pressed seeds (pomace), the content of the residual fat is 6,52%, which makes it a relatively good source of gross energy – 20,69 MJ/kg / DM (or about 18,7 MJ/kg fodder).

The energy values of the fodder are a function of protein level, residual content of oil and the existent carbohydrates (Schiemann et al., 1974).

As a result of this, the yield of gross energy form a hectare is 35035 MJ/ha meal, and 39311 MJ/ha – pomace.

Data from several studies show that the energy values of the canola meal are the highest for pigs, then follow the cattle, and the lowest are for the birds (Todorov et al., 2004).

The metabolic energy of the canola meal is with 10-20% lower that of the soya bean meal, which is due to the higher content of cellulose.

After processing the seeds, the quantity of crude fibers in the pomace prevails and reaches 145,2 g/kg, while in the meal, these values are with about 19,9 g/kg lower.

This is due to the fact that the crude fibers are found in larger quantities in the sheath of the seeds, therefore their content in the pomace is higher.

Poultry birds, aqua-cultures, as well as special animals also can be fed with these products, as a source of proteins, although to a limited extent, as the high content of fibers and the suppressing of appetite reduces the nutritional value of the food.

The removing or reducing the sheath reduces the crude fibers and improves the digestibility and the metabolism of feeding.

In Canada, Switzerland, Germany and other European countries people make efforts to produce canola meal with quality and metabolic energy, close to these of the soybean meal (Kellems et al., 2010).

For this purpose two methods are used: removal of part of the flakes prior or after processing, through peeling, or creation of varieties of yellow grains in which the sheath is thinner compared to the varieties with brown seeds.

More important indicators, especially for non-ruminant animals, are the content and yield of amino-acids in the meal and pomace (Table 3).

Being a high-protein culture with well balanced amino acid content, the rapeseed is a perspective source of complete proteins for the livestock breeding.

Worldwide for the purposes of the production of meat, about 60% of the produced grain is used. For the USA this figure is about 90%, while for India it is only 20%.

Both the content and the yield of protein from a hectare have higher levels for the meal compared to the pomace, which correlates also with the amino acid content.

The data in Table 3 shows that the amino acid content of the canola meal is close to that of the canola pomace, although their values for the meal are higher.

The quantity of the valuable essential and semi-essential amino acids in the meal is higher (211,9 g/kg) compared to that of the pomace (194,2 g/kg).

The amino acid content of the canola meals is close to that of the soya bean meal, but the content of methionine and cystine is lower, while in fact, they are the limiting amino acids in the rapeseed.

Table 3

Content and yield of amino-acids in the canola meal and pomace

Amino-acids	Meal			Pomace		
	g/kg	g/100g crude protein	kg/ha	g/kg	g/100g crude protein	kg/ha
Cystine*	1,9	0,44	3,3	1,8	0,51	3,4
Asparagine acid	37,5	8,62	64,7	34,6	9,77	65,7
Threonine*	18,7	4,30	32,7	18,4	5,20	34,9
Serine	21,3	4,89	37,2	16,8	4,75	31,9
Glutamic acid	70,0	16,08	122,5	66,5	18,79	126,3
Glycine	21,9	5,03	38,3	19,4	5,48	36,8
Alanine	22,3	5,12	39,0	18,0	5,08	34,2
Valine*	30,2	6,94	52,8	27,2	7,68	51,6
Isoleucine*	18,8	4,32	32,9	16,6	4,69	32,9
Leucine*	32,7	7,51	57,2	29,1	8,22	52,3
Phenylalanine*	20,2	4,64	35,3	18,3	5,17	34,7
Histidine*	15,4	3,54	26,9	12,7	3,59	24,1
Lysine*	28,0	6,43	49,0	26,7	7,54	53,0
Arginine*	26,0	5,97	45,5	25,0	7,06	47,5
Proline	19,7	4,53	34,4	18,2	5,14	34,5
Methionine*	0,30	0,08	0,5	0,20	0,08	3,8
Glucosinolates mkM/g	19,23					

Note: * Essential and semi- essential amino acids

Due to the high content of methionine and cystine (2-2,2 g/kg), the rapeseed waste products are a very good nutritional supplement for the sheep.

The content of methionine and cystine in the rapeseed pomace obtained from one hektar is 3,8 kg/ha.

Particular advantage of the soya bean meal is the higher level of lysine which is the most important essential amino acid.

Rapeseed is a source of proteins for the animals, characterized by lower energy content and lysine.

Numerous studies in Canada and Europe have shown that the actual content of lysine in the canola meals is with about 10% lower, compared to that of the

soybean meal. Therefore, these protein rich fodders show a tendency of complementing each other, when they are used together in the rations of the animal (Degussa, 2006).

In several countries people achieve a successful selection aiming to change the ratio of the amino acids, contained in the protein of the rapeseed meal.

The varieties created in Poland contain up to 30% lysine, 14% glutamic acid, 31% asparagine acid and 28% arginine more, compared to the initial forms.

In our studies the quantity of lysine in the meal is 28,0 g/kg meal, while in the pomace it is 26,7 g/kg pomace.

The content of the three most important amino acids in the rapeseed waste products has higher levels in the meal (30,2g/kg) compared to the pomace (28,7g/kg).

The glucosinates in the defatted seeds are most toxic for the animals.

Glucosinates in the rapeseed meal are below the value of 20 μmol/g meal, while in the old rapeseed varieties they used to reach from 300 to 400 μmol/g meal.

This minimal content of glucosinates in the canola meals practically, does not cause enlarging of the thyroid gland and affects slightly the biotransformation of iodine in the eggs and milk.

Our analyses show that the content of glucosinates in the meal of variety Votan is within the limits of the requirements (19,23 μmol/g), which is an indicator, that these products can be used as fodder for the animals without any healthy problems.

CONCLUSIONS

1. After processing the seeds, averagely from one unit of land we achieved higher yield of pomace (1900 kg/ha) and lower yield of meal (1750 kg/ha).
2. The content of crude protein has higher values in the meal, while the content of crude fats and fibers – in the pomace.
3. The gross energy of both waste products is almost equal, but the yield of gross energy by the pomace is higher.
4. The valuable essential amino acids in the meal have higher quantities compared to the pomache.
5. The content of glucosinates in the defatted seeds is within the limits of the requirements.
6. Both of the products could be used as compounds in the combined fodders not only for ruminants, but also for swine and poultry.

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