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*Original paper*

## ***Camelina sativa: A study on amino acid content***

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### **Abstract**

Camelina, is relatively a new crop though is known for humanity from ancient times. Camelina draw attention for its oil rich in fatty acids therefore researchers began to focus on it in a variety of studies from the growing practices to animal feed and chemical composition of seed and oil and their uses.

This experiment was conducted to determine the amino acids content in the groats of three camelina varieties (Mădălina, created by BIOTEHGEN in collaboration with the University of Agricultural Sciences and Veterinary Sciences of Bucharest, Calena, with Austrian origins and a local population cultivated by Banat University of Agricultural Sciences and Veterinary Medicine from Timisoara). The determination of amino acid was made in the research platform of Banat University of Agricultural Sciences and Veterinary Medicine from Timisoara.

The research material that was used was the resulting groats after Soxhlet oil extraction.

Furthermore, the results were compared between them and between other results obtained by researchers in an attempt to demonstrate the versatility, adaptability and constancy of this crop of the future named Camelina.

**Keywords** Camelina, *Camelina Sativa*, Amino acid, Oil Composition.

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## Introduction

*Camelina sativa* (L.) Crantz also known as gold of pleasure or false flax is an oil crop known from antiquity. According to some researchers *Camelina* was known to humankind 4000 years before Christianity [1] and according to archeologists who made excavations around Europe and Scandinavia *Camelina* seeds were consumed as an ingredient in porridge and bread about 2000 years ago [2].

The seeds are used for oil extraction or directly as animal feed due to its lower content of glucosinolates [3] although that may affect the palatability [4]. For the production of oil, only two species of *Camelina* are used – *Camelina sativa* (with spring and autumn forms) and *Camelina silvestris* (sowed only in autumn) [3]. The oil is having a great range of uses from biofuel production, especially biokerosene to medical and nutritional use due to its low content of erucic acid. *Camelina sativa* was cultivated until the 1950s and oil cakes were used as a protein in fodder for animals [1][5][6].

National efforts are made to obtain a variety with high productivity and resistant to low temperatures specific to continental winters as can occur in Romania [7].

Amino acids are the fundamental structural unit of protein molecules and have an important role in the body. They are the corner stones from which the proteins are formed. They can be converted into other substances in the body (ketoacids, hydroxy acids, alkaloids, amines, hormones, amides, etc.), thus contributing to the establishment of metabolic bonds between different chemical compounds. At present, about 400 amino acids are known, but only 20 to 24 of them are commonly found in natural, plant and animal proteins, and are called proteinogenic or ordinary amino acids; the rest are found in some peptides and in nonprotective substances and are called nonproteinogenic or occasional amino acids.

Essential amino acids are synthesized only by plants, animals cannot synthesize and must obtain them from food. They have a significant role in the growth and development of the animal body in their absence deficiency diseases may occur.

Usually after cold oil extraction *Camelina* groats contains around 40% proteins and because of the seeds low content of glucosinolates recommends the groats as feed. *Camelina* seeds and *Camelina* expellers are usually not included in poultry diets at more than 15%, because products from glucosinolate metabolism may reduce diet palatability and decrease animal performance [8][9].

## Materials and Methods

For this research were used three varieties of *Camelina sativa* coming from three different parts of Romania and Europe with their own pedo-climatic features. First variety was Calena from Austria, the second was Mădălina developed by our colleagues from BIOTEHGEN from Bucharest and the third is a local variety cultivated at Banat University of Agricultural Sciences and Veterinary Medicine (BUASVM) from Timisoara. After extracting the oil from the seeds using a Soxhlet apparatus the groats were further analyzed to determine their amino acid content.

The determination of amino acids content was carried out at the research platform of BUASVM from Timisoara.

The amino acids were assayed using ion-exchange chromatography after hydrolyzing with 6M HCl for 24 h at 110°C. The sample was filtered through a Millipore filter 0,2 mm and diluted 1:10 or 1:100 with 0.1 N HCl depending on the nature of the sample and then was injected into the chromatograph.

Methionine and cystine were analyzed by using formic acid protection prior to acid hydrolysis. Tryptophan was determined by the alkaline hydrolysis method.

The chromatographic conditions were: DIONEX ICS-3000 Amino Analyzer, AMINOPAC PA10 Analytical Column (2x250 mm, P/N 055406), AMINOPAC PA10 Analytical Guard Column (2x50 mm, P/N 055407), Mobile phase: E1: water, E2: NaOH 250 mM, E3: NaAc 1 M, Reference electrode: pH/Ag/AgCl, Flush volume: 250 µL, Flow rate: 0,25 mL/min, Column temperature 30°C.

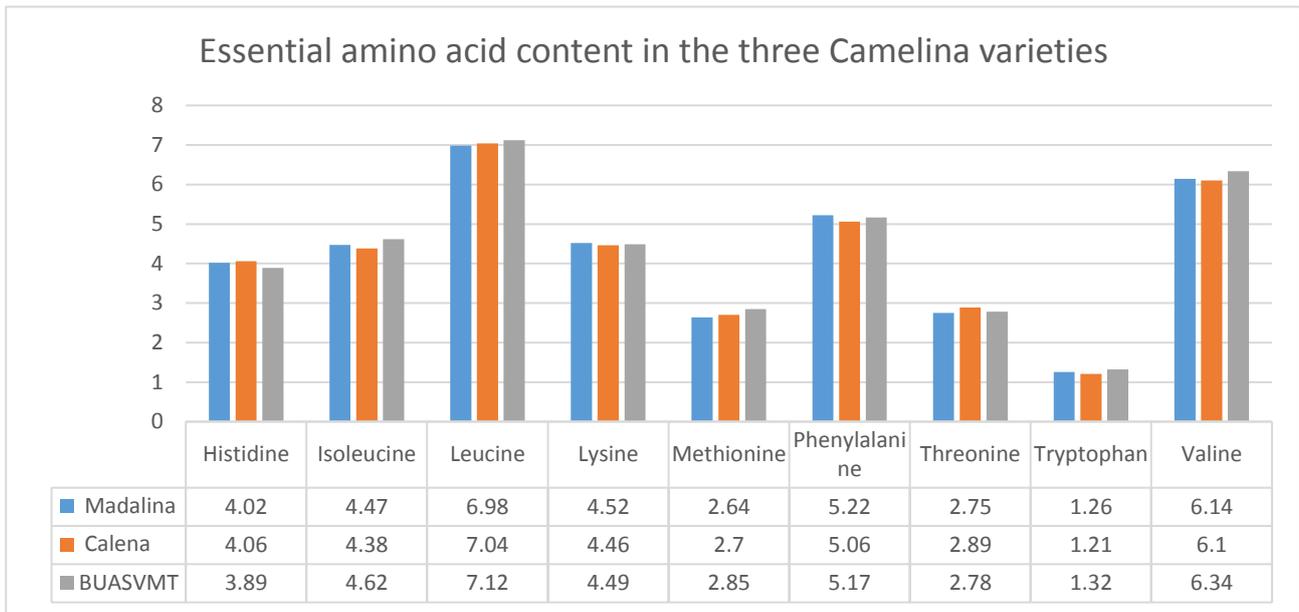
The minimum detection level of standard was 5 ng/L for each of the amino acids and have been established based on signal to noise ratios of 3:1. The linear dynamic range of the detector response was checked. The average correlation coefficient was between 0,9884-0,994.

## Results and Discussions

*Camelina* groats were high in essential amino acids with values ranging from 3.89% to 16.12%. Another aspect is that all nine essential amino acids were found in all three varieties summing 38% for Madalina 37.9% for Calena and 38.58% for the BUASVM's local variety alongside another 9 non-essential amino acids.

It is known that only plants can synthesize essential amino acids and animals must obtain them from food and their lack in diets leads to certain illnesses therefore their importance ought not be neglected.

In Fig. 1 the content of essential amino acids that were found in these three *Camelina* varieties is presented.



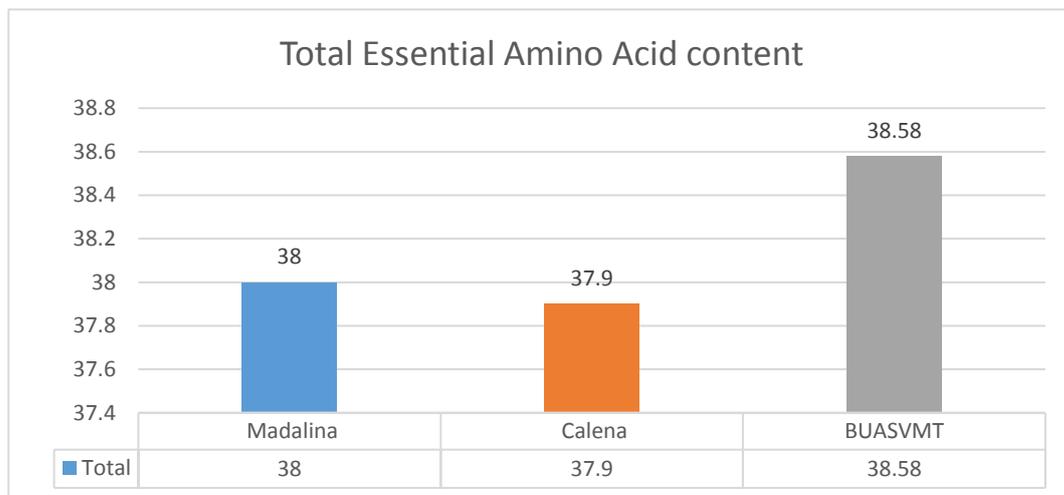
**Figure 1.** Essential amino acid content in the three *Camelina sativa* varieties.

The values obtained for essential amino acids are very similar, with no significant differences. Leucine has the higher proportion of 7.12% in BUASVMT’s local variety, 7.04% in Calena and 6.98% in Madalina. The difference between the highest and the lowest value of Leucine is just 0.14%. As far as other amino acids are concerned, one can notice a similar trend, in the sense that there were no differences higher than 1%, which shows a good constant throughout varieties. The highest difference is a mere 0.24% for Isoleucine. Tryptophan has the lowest proportion, with

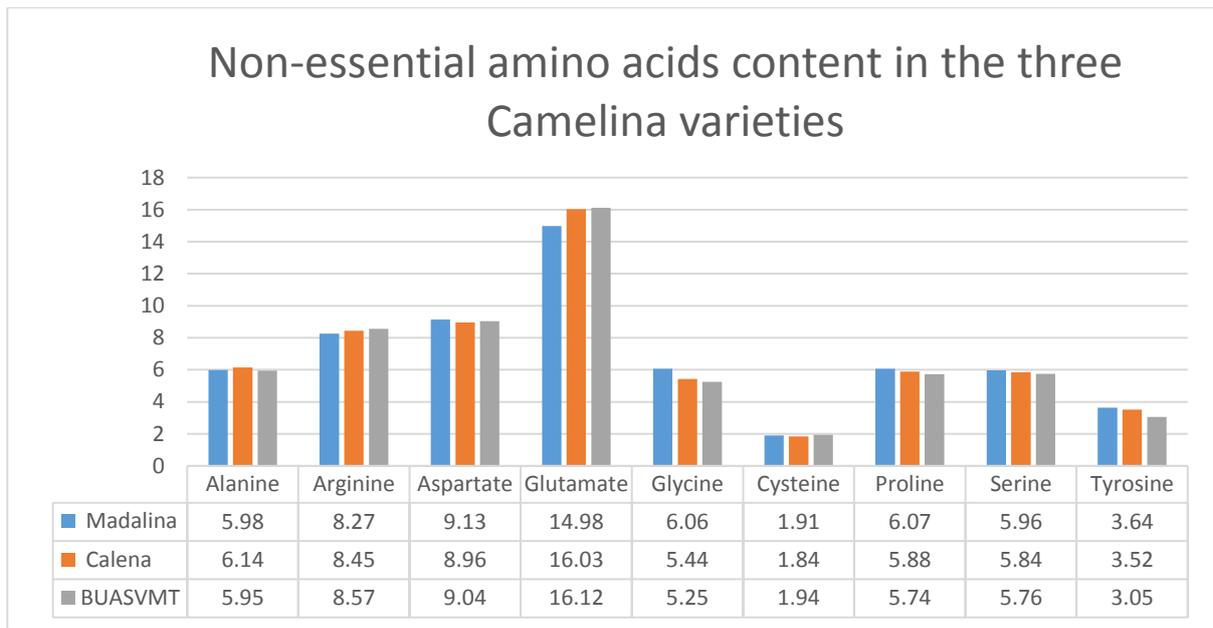
no more than 1,32% in either of the varieties, but yet again the difference in between varieties is minimal.

Likewise, when analyzing the total amount of essential amino acids, there were small differences in between varieties. The highest value was obtained for the BUASVMT variety (38.58%), closely followed by Madalina (38%) and Calena (37.9%) (Figure 2).

Alongside the essential amino acids another nine non-essential amino acids were found. They are presented in Figure 3.



**Figure 2.** Total essential amino acid content in the three *Camelina sativa* varieties.



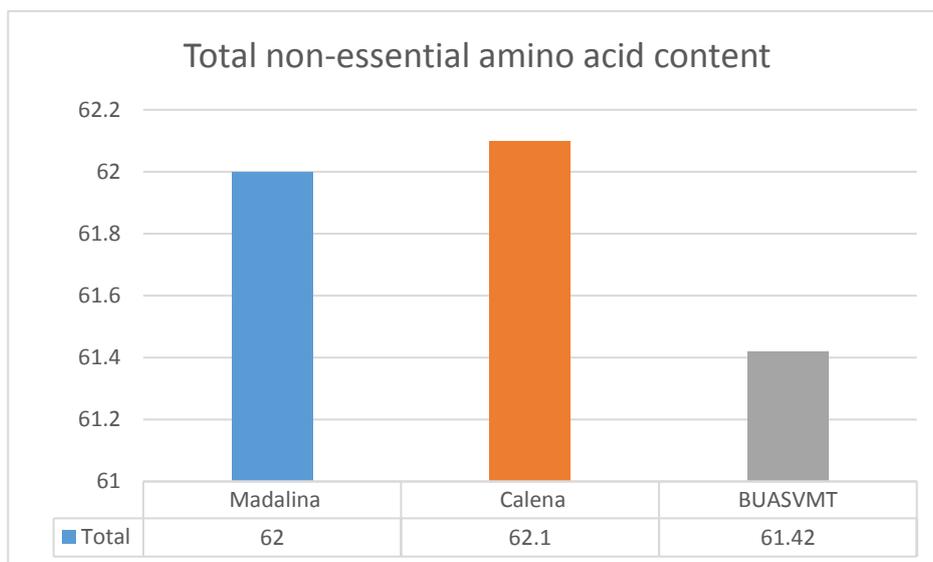
**Figure 3.** Non-essential amino acid content in the three *Camelina* varieties.

Studying the non-essential amino acids results, the values that are obviously highest are those of Glutamate, which have a maximum of 16.12% for BUASVMT local variety, followed by Calena (16.03%) and Madalina (14.98%).

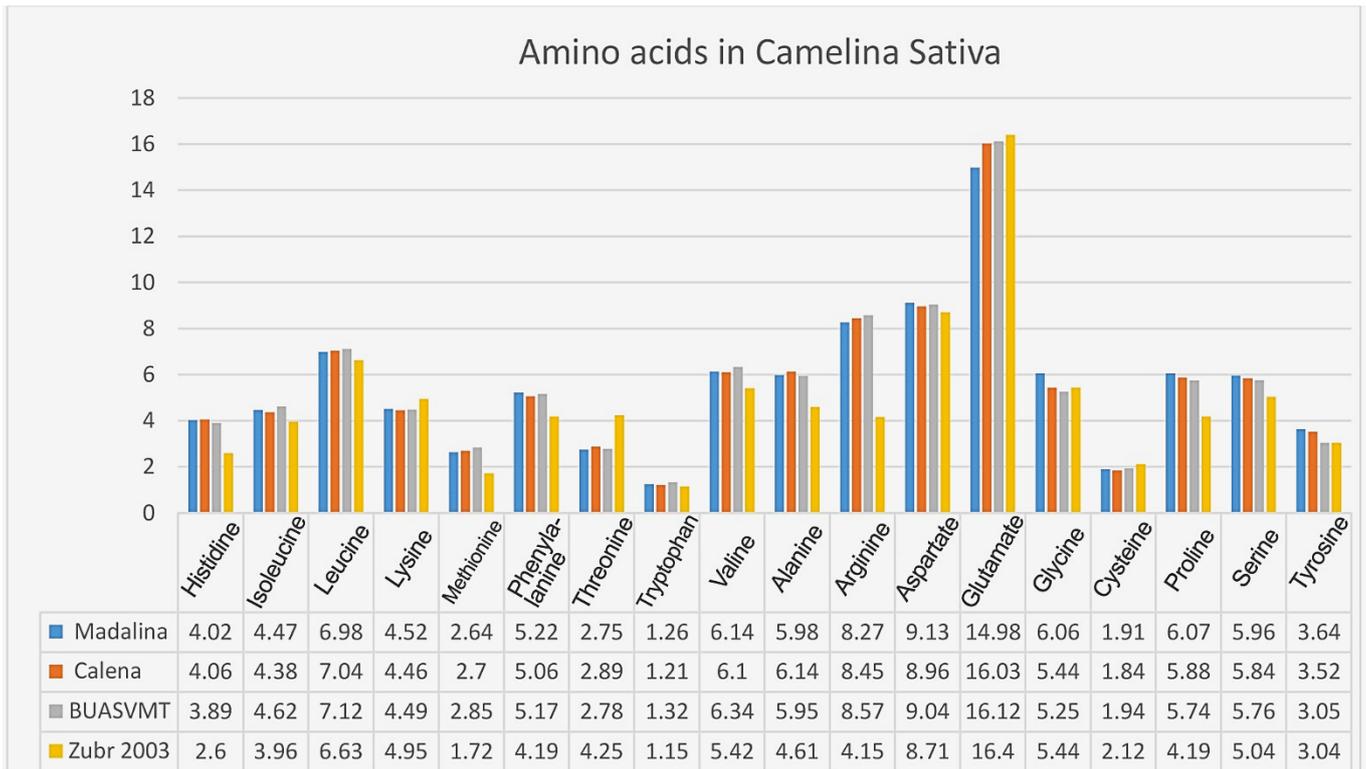
Once again, the trend seems to apply also for non-essential amino acids with no big differences of the values with a few exceptions like Glutamate and Glycine where the differences between maximum and minimum are 1.14% respectively 0.81%.

Overall Calena variety has a higher ratio of non-essential amino acids (62%) immediately followed by Madalina (62%) and BUASVMT (61.42%), as can be seen in Figure 4.

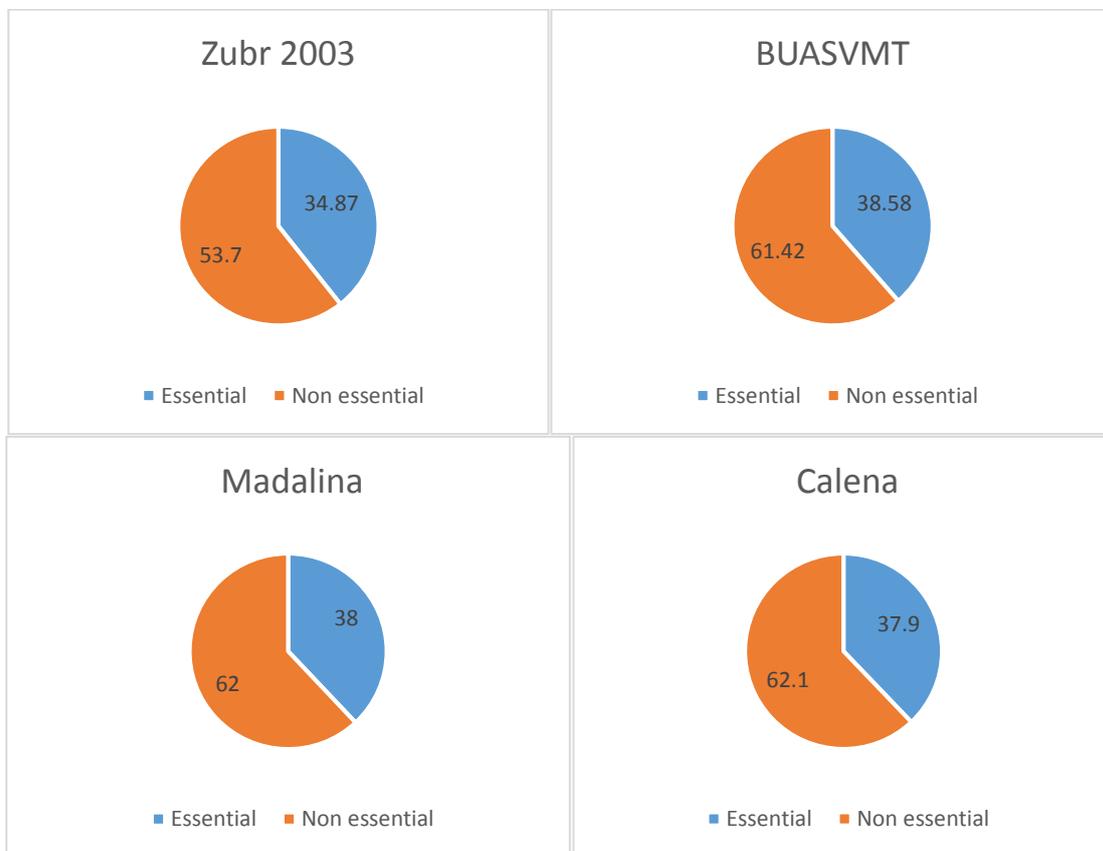
Figure 5 and Figure 6 presents comparative data between this study and the study carried out by J. Zubr in 2003. [10]



**Figure 4.** Total non-essential amino acid content in the three *Camelina sativa* varieties.



**Figure 5.** Compared values of amino acids found in this research with another study – detailed.



**Figure 6.** Compared values of amino acids found in this research with another study.

Out of all the amino acids, the most notable differences were found for Threonine, with Zubr obtaining as much as double the amount (4,25%), compared with Madalina, Calena or BUSMVT variety (2.78). Inversely, Methionine had the lowest values for Zubr, whereas a higher content was found in BUASMVT, Calena and Madalina. The same goes for Histidine, that had a lower value of 2.6 in Zubr's study, while the varieties included in this study ranged between 3,89% for BUASMVT, 4.02 for Madalina and 4.06 for Calena. All in all, it is expected to obtain slight differences between these values, especially due to climatic conditions, as a higher content of some

amino acids will invariably be compensated with lower values in others, when measuring them out of 100%.

Overall, amino acid content is similar in all three Camelina varieties included in this study, as well as the variety used by Zubr (2003). There is a likeness in the essential: non-essential amino acid ratio, with approximately 38% essential and 62% non-essential.

The values were also interpreted statistically. The values of Madalina camelina variety of essential and non-essential amino acid were compared to the average of the other three varieties values. The results were as shown in Table 1 and Table 2.

**Table 1.** Statistical comparison of essential amino acid content

	Histidine	Isoleucine	Leucine	Lysine	Methionine	Phenylalanine	Threonine	Tryptophan	Valine
<b>Calena</b>	4.06	4.38	7.04	4.46	2.70	5.06	2.89	1.21	6.10
<b>Usamvbt</b>	3.89	4.62	7.12	4.49	2.85	5.17	2.78	1.32	6.34
<b>Zubr 2003</b>	2.60	3.96	6.63	4.95	1.72	4.19	4.25	1.15	5.42
<b>Sum</b>	10.55	12.96	20.79	13.90	7.27	14.42	9.92	3.68	17.86
<b>Average</b>	3.52	4.32	6.93	4.63	2.42	4.81	3.31	1.23	5.95
<b>Madalina</b>	4.02	4.47	6.98	4.52	2.64	5.22	2.75	1.26	6.14
<b>Difference</b>	-1.09	-0.78	-0.33	0.71	-0.61	-1.33	1.18	-0.67	-0.68

**Table 2.** Statistical comparison of non-essential amino acid content

	Alanine	Arginine	Aspartate	Glutamate	Glycine	Cysteine	Proline	Serine	Tyrosine
<b>Calena</b>	6.14	8.45	8.96	16.03	5.44	1.84	5.88	5.84	3.52
<b>Usamvbt</b>	5.95	8.57	9.04	16.12	5.25	1.94	5.74	5.76	3.05
<b>Zubr 2003</b>	4.61	4.15	8.71	16.40	5.44	2.12	4.19	5.04	3.04
<b>Sum</b>	16.70	21.17	26.71	48.55	16.13	5.90	15.81	16.64	9.61
<b>Average</b>	5.57	7.06	8.90	16.18	5.38	1.97	5.27	5.55	3.20
<b>Madalina</b>	5.98	8.27	9.13	14.98	6.06	1.91	6.07	5.96	3.64
<b>Difference</b>	-0.86	-0.83	-2.28	<b>10.80</b>	<b>-10.79</b>	0.69	-1.48	-1.62	-2.76

As resulted from the statistical interpretation there were no differences higher than 5% between the amino acid values of Madalina and the average of the other three varieties that were compared, meaning that the differences are not significant except for Glutamate and Glycine.

## Conclusions

The first obvious conclusion one can draw from these numbers is that camelina maintains its versatility, with overall similar values for amino acids throughout different varieties and climatic conditions.

Due to the presence of all essential amino acids, which as pointed out earlier are only synthesized by plants, camelina proves its worth as a good option for animal feed. Furthermore, the presence of non-essential amino acids alongside the essential ones, such as Glutamate, Cysteine or Tyrosine, make it eligible for use in human nutrition. These amino acids are of great importance in the metabolic processes in the human body and their imbalance may cause diseases, this is why further research of their involvement in these processes might prove their usefulness.

*Camelina sativa* is known to have lower glucosinolates levels than other crops in Brassicaceae family. Due to low Tryptophan and Phenylalanine content, the levels of glucobrassicin is expected to be also low, while other glucosinolates can be derived from Alanine, Leucine, Isoleucine or Valine in higher amounts. Glucosinolates can be toxic to animals in extremely high amounts, therefore it is recommended to ensure a balanced feed for them – in other words, it is recommended to combine the useful properties of camelina that were described earlier in this paper, with other feed plants and seed.

There is a balance between essential and non-essential amino acid content, which appears to be fairly constant in all the varieties included in this study, as well as other studies (Zubr, 2003).

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