



## Protein profile of some genotypes of flax (*Linum usitatissimum* L.) manufactured in the Strumica region, Republic of Macedonia

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### ABSTRACT

Flax (*Linum usitatissimum* L.) is an industrial crop and has great importance for humans and economy. Analysis of five different flax genotypes, produced in the Strumica region, Republic of Macedonia, in 2014 and 2015 is made, with regard to the content of protein in the flaxseed. The experiment consisted of five variants in three repetitions, divided by the method of randomized block system. During the vegetation, standard farming practices for field flax production were used. Analysis of the protein content in flaxseed was made in the Laboratory for plant and environmental protection, at the Faculty of Agriculture, “Goce Delcev” University – Stip (Standard: ISO 20483:2006). The content of protein in flaxseed was analyzed by Kjeldahl method. The results were statistically processed by the method of analysis of variance, and the differences were tested by LSD – test.

The content of protein in flaxseed of the tested genotypes ranged from 26.9% to 29.4%. All flax genotypes had higher percentage of proteins in the seed. But, the genotypes *Belinka* (29.3%) and *Velušina* (28.5%) are characterized by the highest average content of protein in the seed, regardless the year of production. *Belinka* and *Velušina* are perspective genotypes for the food industry, as they have higher content of protein in the seed than the other analyzed genotypes.

**Key words:** Flax, Seed, Content, Genotype, Percent, Protein

### 1. Introduction

Flax or linseed is among of the oldest crop plant cultivated for the purpose of oil and fiber [1]. From the large number of species (200) of flax, the most important for production has one species - *Linum usitatissimum* L. [2]. The flax is an industrial crop and it's grown for fiber, seed and combined fiber and seed [3]. Almost every part of the flaxseed plant is utilized commercially, either directly or after processing [4]. Seeds from flax are crushed to produce linseed oil and linseed meal. Flaxseed is emerging as one of the key sources of phytochemicals in the functional food arena. In addition to being one of the richest sources of  $\alpha$ -linolenic acid oil and lignans, flaxseed is an essential source of high-quality protein and soluble fibre and has considerable potential as a source of phenolic compounds [5]. In many countries around the world, flax is one of the most important crops in healthy human consumption, due to the high content of dietary fiber, omega - 3 fatty acids and anticancer lignin [6].

The production of flax in the Republic of Macedonia it is grown on small surfaces for it seed (as bird food) and in 2005-2006 is grown on the Faculty of Agricultural Sciences and Food in Skopje as a research project [7]. Interest for flax in recent years has increased as a result of the increased capacity of oil and protein production. Starting from that point, reintroducing of the flax surfaces in Republic of Macedonia imposed the need for an investigation of the characteristics of certain varieties of flax, their acclimatization, production and quality characteristics.

Main aim of this examination is to determine the content of protein in the seeds of different genotypes of flax, produced in agro-ecological conditions of the Strumica region of Macedonia and to offer better information to manufacturers and industry who genotype of flax to be used if the same time protein content in the seed is a priority factor.

On the size of content of protein in the flaxseeds largely influence had a specificity variety, soil and climate conditions, the applied agro-technical measures, method of storage and more. General average protein content in the seeds of the flax, was 28.3%.

### 3. Results and discussion

**Table 1. Content of protein in flaxseed presented in percent (%)**

Genotype	Year		Average on genotype
	2014	2015	
	28,5	28,6	28,5
<i>Velušina</i>	27,8	26,9	27,3
<i>Duferin</i>	27,8	28,2	28,0
<i>Bellan</i>	27,9	28,4	28,1
<i>Viking</i>	29,3	29,4	29,3
<i>Belinka</i>	28,3	28,3	28,3
Average on year	28,5	28,6	28,5
LSD	0,05	n.s.	
	0,01	n.s.	

### 2. Material and methods

The research was conducted in the field and laboratory conditions. Field examinations were set up at the experimental field in Strumica at Uniservice - Agro D.O.O.E.L., Faculty of Agriculture, University „Goce Delcev” - Stip. The research was conducted in the period of two years (2014 and 2015).

As a work material were used five flax genotypes:

*Velušina*, *Duferin*, *Bellan*, *Viking* and *Belinka*.

Four of which are domestic intermediate flax genotypes (*Velušina*, *Duferin*, *Bellan* and *Belinka*) and one is a French introduced fiber flax variety (*Viking*).

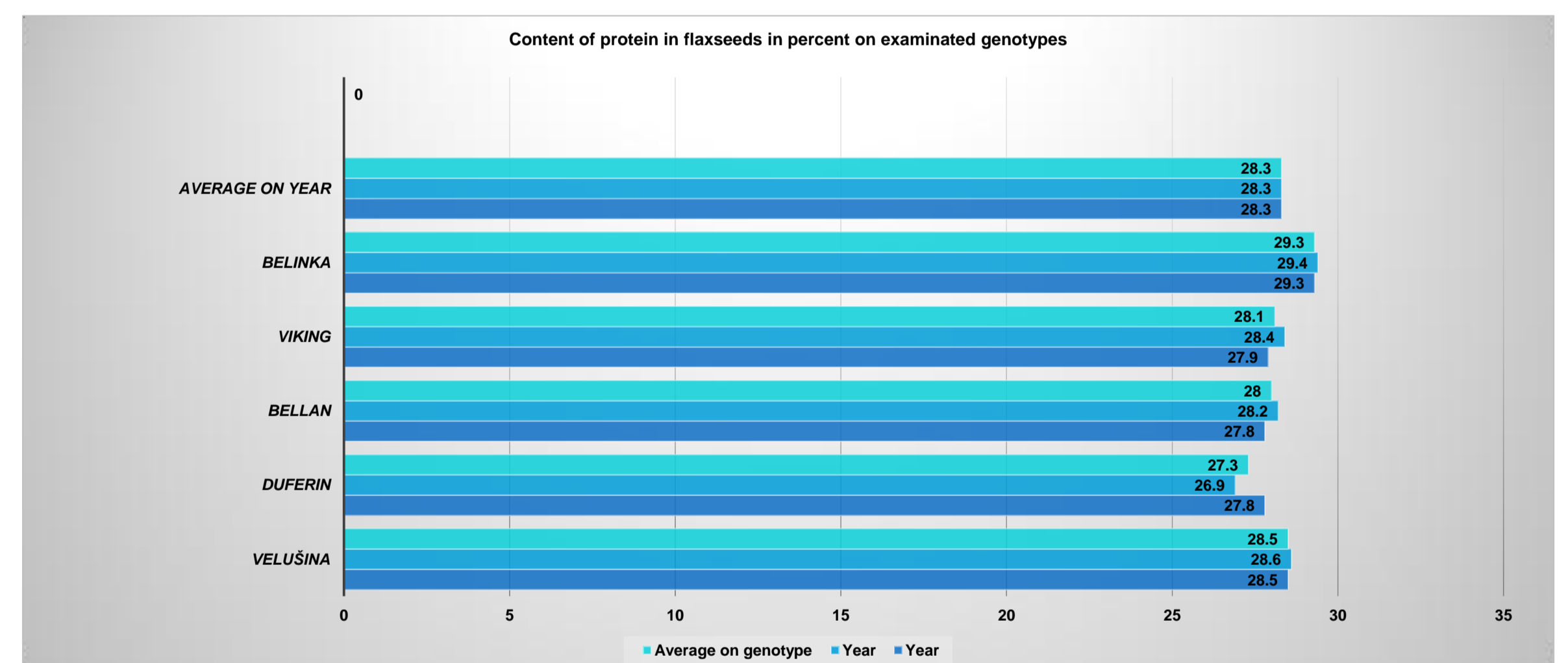
The experiment consisted a five variants in three repetitions, divided by the method of random block system with the basic dimension of the parcel of 10 m<sup>2</sup>. The distance between the variants was 50 cm and 100 cm between repetitions. The distance between rows was 30 cm.

The seeding rate was 50 kg/ha or 50 g per parcel. In two years of testing, a pre-culture of flax was wheat. The soil was prepared in the same way. Primary tillage was plowing at a depth of 35 cm and the surface was fertilized with granulated NPK 15:15:15 fertilizer in an amount of 300 kg/ha and also a pre-sowing tillage was performed with a tiller. Sowing was performed manually in rows at a depth of 2-3 cm.

After sowing and before germination, the parcels was treating with herbicide DUAL GOLD 960 EC, against certain annual and perennial broadleaf weeds in an amount of 3 l/ha.

During the vegetation, standard farming practices for field production of flax were used.

Analysis of the protein content in flaxseed was made in the Laboratory for plant and environmental protection, at the Faculty of Agriculture, “Goce Delcev” University - Stip (Standard: ISO 20483:2006). The protein content of the flaxseed was analyzed by Kjeldahl method. The results were statistically processed by the method of analysis of variance, and the differences were tested by LSD - test.



**Figure 1. Content of protein in seeds (%) of examination genotypes of flax**

The results of content of protein in flaxseed are shown in Table 3 and Figure 1. The ranges of content of proteins was from 26.9 to 29.4%. The general average content of protein in the seeds of the flax, was 28.3%. The size of this parameter largely influence have specificity variety, soil and climate conditions, the applied agro-technical measures, method of storage and more.

In our tests, the genotype for fiber - *Viking*, had lower content of protein in the seeds of the remaining intermediate genotypes, other than *Duferin* and *Bellan*. Comparing the average content of protein in the flaxseeds in 2015 (28.3%) with protein content separately in tested genotypes, can be concluded that *Belinka*, *Velušina* and *Viking* have a greater percentage of protein in the seed in this year, while *Bellan* and *Duferin* smaller.

Comparing the average protein content in the flaxseeds from both years (28.3%) with a two-year average protein content separately in tested genotypes, may be said that *Belinka* and *Velušina* have a greater percentage of protein in the seeds, while *Duferin*, *Bellan* and *Viking* smaller.

From the received information can be concluded that the greatest percentage of protein in flaxseed had genotype *Belinka* (29.4%) in 2015 year.

Statistically significant difference on the level of probability of 0.05 and 0.01 doesn't exist between examined genotypes.

The food industry should be processed and used flaxseed from genotypes *Belinka* and *Velušina*, who have more protein content, regardless of the year of manufacture, and which is produced in climate conditions like Strumica region in Republic of Macedonia. Depending on the years of production, varieties and soil and climatic characteristics of the region, the protein content in the seeds of the flax is 28.3%.

### 4. Conclusions

Based on results of the content of protein in the seeds of the five examined genotypes of flax, produced in 2014 and 2015 in the Strumica region, Republic of Macedonia, may be concluded the following: The content of protein in the seeds of flax ranges is from 26.9% to 29.4%. On the size of this parameter largely influence had a specificity variety, soil and climate conditions, the applied agro-technical measures, method of storage and more.

The genotypes *Belinka* (29.3%) and *Velušina* (28.5%) are characterized by the highest average content of protein in the seeds, regardless of the year of production. The lowest content of proteins in the seeds had genotype *Duferin* (27.3%).

Independently of the year of examination, all genotypes have a greater percentage of protein content in the seeds. The differences in the percentages of protein in flaxseed in tested genotypes is due to the variety specificity.

The food industry should be processed and used flaxseed from genotypes *Belinka* and *Velušina*, who have more content of proteins, regardless of the year of manufacture, and which is produced in climate conditions like Strumica region in Republic of Macedonia.

The examinations on this field should to continue with another genotypes and to give a recommendation for genotypes with better properties for yield and content of proteins for growing in Republic of Macedonia.

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