Scientific Papers. Series A. Agronomy, Vol. LXIII, No. 1, 2020
ISSN 2285-5785; ISSN CD-ROM 2285-5793; ISSN Online 2285-5807; ISSN-L 2285-5785

COMPOSITION AND QUALITY OF RAPESEED OIL (*Brassica napus oleifera biennis*) DEPENDING ON SOWING TIME AND TREATMENT WITH LEAF FERTILIZERS

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Abstract

The study was conducted in the period 2012-2015 in the area of Training, Experimental and Implementation centre of the Department of Crop Production at the Agricultural University - Plovdiv. The experiment was based on a block method, in 4 repetitions, with the size of the experimental plot of 20 m^2 with Visby hybrid. The leaf fertilizers Lactofol B, Litovit® and Fertiactyl Starter were applied. The purpose of the study was to determine the content and fatty acid composition of winter rapeseed oil sown at different sowing times and treated with several leaf fertilizers. The fat content is determined by the residual method with the Soxhlet apparatus and the fatty acids - by extraction. Depending on the variants, the crude fat content varies from 29.51 to 35.79. The amount of saturated fatty acids is relatively low from 4.85% to 6.56%. The amount of unsaturated fatty acids was highest in the Fertiactyl Starter treated variants (93.77 to 95.24%), while the lowest was in the controls (93.18 to 93.63%).

Key words*: rapeseed, sowing dates, leaf fertilizers, fats, fatty acids.*

INTRODUCTION

The continuous climate change in recent years leading to global warming in turn has a negative impact on the weather conditions necessary for the optimal development of field crops.

In years with minimal or no rainfall during the sowing and germination of rapeseed, plant development slows down, necessitating the use of different ways to accelerate these processes. The use of leaf fertilizers is one of them.

Rapeseed is a crop that responds very well to foliar fertilization, which is usually applied under stressful conditions during the growing season, or when necessary to stimulate specific growth and physiological processes when they are disturbed. (Gillingham et al., 2011).

That is why we have set ourselves the goal of testing several leaf fertilizers and the stages of their application in rapeseed sown at different times, on the quality of the oil in the seeds obtained in these variants.

MATERIALS AND METHODS

The experiment was conducted during the period 2012-2015 in the area of Training, Experimental and Implementation centre of the Department of Crop Production at the Agricultural University - Plovdiv. The experiment is based on a block method, repeated 4 times, with a plot size of 20 m^2, with Visby hybrid, originating in Germany, in the following variants:

- Factor A - sowing dates;
- Factor B - leaf fertilizers;
- Factor C - phases of treatment.

I. Sowing dates, 1-10.IX.; 1-10.X.

- Untreated variant;
- Spraying with Lactofol B - 400 ml/da, phenophase - 2-4th leaf;
- Spraying with Litovit® - 200 g/da, phenophase - 2-4th leaf;
- Spraying with Fertiactyl Starter - 300 ml/da - 2-4th leaf.

II. Sowing dates, 10–20.X.; 20-30.X.

- Untreated variant;
- Spraying with Lactofol B - 400 ml/da, phenophase - 1-2nd leaf;
- Spraying with Litovit® - 200 g/da, phenophase - 1-2nd leaf;
- Spraying with Fertiactyl Starter Spray - 300 ml/da - 1-2nd leaf.

The study was conducted according to the conventional rapeseed technology following

wheat precursor. The seeds for analysis were obtained from the averaging of seed obtained from rapeseed grown at different sowing times and treated with different leaf fertilizers. The fat content is determined by the residual method with the Soxhlet apparatus, while the fatty acids - by extraction.

The soil on which the experiment was carried out is a former meadow swamp soil, slightly saline, sandy clay with an "A" humus horizon thickness of 25-28 cm. In mechanical composition it is a clayey, heavy soil (Popova et al., 2012).

The agro-meteorological characteristics of the region of Southern Bulgaria show that no significant deviations from the average monthly temperatures are observed compared to the multiannual period. Greater differences are reported in terms of moisture. The years of the study were characterized by a sufficient amount of moisture in the critical phases of rapeseed development, with the exception of the sowing-germination period during the first two years.

RESULTS AND DISCUSSIONS

The fat content of the seeds depends on the type of plant, the degree of ripening of the seeds and also on the growing conditions of the plants. A number of studies show that both the fat content and the qualitative composition are influenced by humidity, temperature, and geographical factor, chemical and physical properties of the soil, organic and mineral fertilizers, and the whole system of agrotechnical activities.

Data on the percentage fat content in the variants tested are presented in Table 1. It can be seen that the crude fat content is low and ranges from 29.51 to 35.79%.

The lowest fat content was observed in control variants and later sowing dates, while highest - in the first sowing date (30.45%). A decrease was observed in the second (30.24%) and third sowing date (29.51%), while the last (20-30.10.) there were no plants.

The reduction of fat at later sowing dates is most likely due to the later entry of the plants into the developmental stages and the poor maturation of the seeds.

In all variants treated with leaf fertilizers, the values of fatty acids increase. The strongest stimulating effect on seed quality is that of the leaf fertilizer Lactofol B, where the fat content is highest and ranges from 35.07 to 35.79%. Both in the control variant and in these variants, at later sowing dates, the values slightly decrease, and in the last sowing date, there are no plants.

The stimulating effect on plant development is strongest in the variant treated with Fertiactyl Starter leaf fertilizer. It is the only variant in which at the latest sowing date the plants pass through all the stages up to ripening.

Differences in the fat content of this variant between the different sowing dates are minimal, from 33.44% at the first date; 32.99%, at the second; 32.77%, at the third date, to 32.57%, at the latest date.

The ratio of saturated and unsaturated fatty acids determines the line of use of the oil obtained. The low content of saturated fatty acids (6-11%) makes rapeseed oil one of the most preferred vegetable oils in the world.

The meta-analyses carried out by Mitrović, P. et al. (2009) have found a close relation between high consumption of these fats and elevated levels of "bad" cholesterol in the blood and the risk of ischemic heart disease. However, the consumption of small amounts of saturated fat is extremely important, both for the proper functioning of the body and brain and for optimizing metabolism.

The data in Table 1 shows that in the variants studied the amount of saturated fatty acids is relatively low and meets the quality standards. In the variants tested, their oil content varies from 4.85% to 6.56%, indicating that it can be used for nutritional purposes without any health problems. The highest content of saturated fatty acids was recorded in the control variants, from 6.14% to 6.56%.

Foliar fertilizer treatment has a positive effect on reducing their content. This is most strongly influenced by the treatment of plants with Litovit®. In this variant, the saturated fat values are the lowest (5.04; 4.90 and 4.85%). The content of saturated fat does not differ significantly between the different sowing dates.

The fatty acid composition of rapeseed oil in terms of saturated fatty acids is presented in Table 2.

The data in the table shows that the share of the palmitic acid (4.02-4.36%) is the largest, followed by stearic (0.27 to 1.61%).
A number of studies have found that amounts of 2.5 to 7.0% for palmitic and 0.8 to 3% for stearic acids do not have a harmful effect on human (Shpaara, 2007).
In the variants we tested we did not find quantity above these values.
In the control variants, the palmitic acid content ranged from 4.17% to 4.36% and the stearic acid - from 1.31% to 1.61%. The difference in content at different sowing dates is negligible.

Table 1. Fat content, saturated and unsaturated fatty acids in the oil of the tested variants

Content of fat, saturated and unsaturated fatty acids, %	VARIANTS			
	Control	Fertiactyl Starter	Litovit ®	Lactofol B
1-10.IX.				
Crude fat content	30.45	33.44	32.15	35.79
Saturated fatty acids, %	6.56	5.23	5.04	5.15
Unsaturated fatty acids, %	93.18	94.53	94.28	93.35
1-10.X.				
Crude fat content	30.24	32.99	31.75	35.31
Saturated fatty acids, %	6.14	5.00	4.90	6.03
Unsaturated fatty acids, %	93.01	95.24	94.01	93.63
10-20.X.				
Crude fat content	29.51	32.77	30.44	35.07
Saturated fatty acids, %	6.23	5.11	4.85	6.13
Unsaturated fatty acids, %	92.40	94.86	94.66	93.46
20-30.X.				
Crude fat content	-	32.57	-	-
Saturated fatty acids, %	-	5.13	-	-
Unsaturated fatty acids, %	-	93.77	-	-

Table 2. Fatty acid composition of rapeseed oil - saturated fatty acids

Content of saturated fatty acids , %	VARIANTS			
	Control	Fertiactyl Starter	Litovit ®	Lactofol B
1-10.IX.				
C16:0- Palmiticacid	4.36	4.11	4.12	4.12
C18:0- Stearic acid	1.61	0.63	0.37	0.55
C20:0- Arachidic	0.59	0.49	0.55	0.48
C22:0- Behenic acid	-	-	-	
1-10.X.				
C16:0- Palmitic acid	4.29	4.12	4.13	4.10
C18:0- Stearic acid	1,41	0.45	0.29	0,42
C20:0- Arachidic	0.46	0.49	0.48	0.52
C22:0- Behenic acid	0.59	-	-	
10-20.X.				
C16:0- Palmitic acid	4.17	4.12	4.02	4.01
C18:0- Stearic acid	1,31	0.39	0.27	0,28
C20:0-Arachidic	0.61	0.49	0.56	1.11
C22:0- Behenic acid	-	-	-	-
20-30.X.				
C16:0- Palmitic acid	-	4.19	-	-
C18:0- Stearic acid	-	0.38	-	-
C20:0- Arachidic	-	0.46	-	-
C22:0- Behenic acid	-	-	-	-

In the variants treated with foliar fertilizers, the content of these acids decreases compared to the control crops.

The palmitic acid values of the treated variants of all sowing dates are almost the same and the differences with the control crops are minimal. In the case of stearic acid, the treatment with leaf fertilizers has a stronger effect on reducing its values. Its content in the oil of the control variants exceeds several times that of the treated variants.

Rapeseed oil is a high quality vegetable oil characterized by its low content of saturated and high content of unsaturated fatty acids.

Unsaturated fatty acid content data are reported in Table 1. They show that at all sowing dates their content is the lowest in the
control variants, from 92.40% to 93.18%. Their decrease at later sowing dates is negligible.

Their quantity in all fertilized variants increased, with the highest value reported in the variant treated with Fertiactyl Starter, from 93.77% - at the latest sowing date to 95.24% - at the second sowing date, followed by the variant treated with Litovit®. The least stimulating effect was achieved in the treatment of the plants with Lactofol B, where the values of unsaturated fatty acids were almost as high as in the control crops (93.35% to 93.63%).

The high quality of rapeseed oil is guaranteed by the high content of oleic and linoleic acid and the low content of linolenic and erucic acid (Table 3).

High levels of oleic acid are very important for human health. It participates in the composition of the cell membranes, stimulates the cell receptors for "bad" cholesterol and reduce its amounts in the blood, participates in the formation of the protective envelope of nerve endings, improves the immune function, protects the body from the development of cardiovascular disease, reduces insulin resistance thus increasing glucose metabolism (Gillingham, LG et al., 2011). Therefore, the purpose of the selection is to continuously increase it to that of olive oil, above 80%.

In other experiments in the region, Visby varieties reported oleic acid values, from 69.70% to 76.8% (Todorov et al., 2012)

In this variants, oleic acid ranges from 63.04% to 68.21%. Its lowest values are in the control crops, from 63.04% to 66.90%. It is noteworthy that treating the variants with foliar fertilizers increased its content.

At the first sowing date, the highest amount of oleic acid was reported in the variant treated with Fertiactyl Starter, 67.54%, in the other variants the effect of the treatment was not reported.

At the second sowing date, the treated variants most strongly exceeded the oleic acid content compared to that of the control crops, by 4.51% when treated with Fertiactyl Starter, by 4.29, when treated with Litovit® and by 1.98%, with Lactofol B.

At the third sowing date, the strongest stimulation effect was observed in the Litovit ® treated variant, in which the oleic acid content exceeded the control by 2.44%.

At the latest sowing date, oleic acid content was reported only in the Fertiactyl Starter treated variant (66.54%).

The second most important unsaturated fatty acid is linoleic acid. Due to its high specific biological activity, it is often called vitamin F in dermatology. Certain minimal doses of linoleic acid, introduced into the body, regulate hormonal metabolism, have antagonistic action on cholesterol, are important in the prevention and treatment of atherosclerosis and other heart disease.

When testing different varieties of rapeseed its content varies from 12.3% to 17.7% (Mariana Petkova-Andonova et al., 2012).

In this experiment, the linoleic acid content of the various variants varied from 16.89% to 19.04%.

At the first sowing date, better results for the linoleic acid content were obtained from foliar fertilization than the control. The strongest stimulating effect was observed with the variant treated with Lactofol B, which exceeded the control with 1.34 %.

At the second sowing date, the highest linoleic acid content was reported in the control variant (19.04%). In the treated variants, no stimulating effect was reported and the values of this acid were significantly lower (17.85; 17.46; 17.30%).

At the third sowing date, there was almost no difference in content between the variants.

Almost the same amount (17.89%) was reported for the last sowing date in the only

Table 3. Fatty acid composition of rapeseed oil - unsaturated fatty acids

Content of unsaturated fatty acids , %	VARIANTS			
	Control	Fertiactyl Starter	Litovit ®	Lactofol B
1-10.IX.				
C18:1-Oleicacid	66.90	67.54	66.71	66.51
C18:2-Linoleic acid	16.89	17.69	17.39	18.23
C18:3-Linolenic acid	6.53	7.87	7.69	7.98
C18:3-3-Alpha-linolenic acid	-	-	-	-
C 20:1-Gadoleic acid	1.24	1.16	1.04	1.18
C20:2- Eicosadienoic acid	1.34	-	-	0.10
C22:1- Erucic acid	-	-	-	-
1-10.X.				
C18:1-Oleicacid	63.04	67.55	67.33	65.02
C18:2-Linoleic acid	19.04	17.85	17.46	17.30
C18:3-Linolenic acid	7.21	7.80	7.83	7.53
C18:3-3-Alpha-linolenic acid	-	0.49	-	-
C 20:1-Gadoleic acid	1.13	1.10	1.12	2.90
C20:2- Eicosadienoic acid	2.95	0.22	-	-
C22:1- Erucuc acid	-	-	-	-
10-20.X.				
C18:1-Oleic acid	65.77	67.40	68.21	63.58
C18:2-Linoleicacid	17.23	17.87	17.49	16.90
C18:3-Linolenic acid	7.10	8.0	7.49	7.31
C18:3-3-Alpha-linolenic acid	-	-	-	0.55
C 20:1-Gadoleic acid	2.83	1.13	1.33	-
C20:2- Eicosadienoic acid	0.26	-	-	3.81
C22:1- Erucic acid	-	-	-	-
20-30.X.				
C18:1-Oleic acid	-	66.54	-	-
C18:2-Linoleic acid	-	17.89	-	-
C18:3-Linolenic acid	-	7.87	-	-
C18:3-3-Alpha-linolenic acid	-	-	-	-
C 20:1-Gadoleic acid	-	1.09	-	-
C20:2- Eicosadienoic	-	0.10	-	--
C22:1- Erucic acid	-	-	-	-

variant that reached full maturity phase treated with Fertiactyl Starter

Another fatty acid present in rapeseed oil is linolenic acid. It is a valuable fatty acid, but it is easily oxidized and reduces the quality of the food when stored. Reducing its content makes rapeseed oil more resistant to rancid. A high-linolenic fat oil is better used for technical purposes and combustion mixed with other oils. The purpose of selection for this acid is to reach the theoretically desired "0".

Although the content varies slightly between variants, the amount is much higher than other studies of the same variety (3.7%), (from 6.53% to 8%). (Todorov et al., 2012; Ivanova et al., 2009; Perfanova & Mechenov, 2001).

The content of the other two unsaturated fatty acids (Gadoleic and Eicosadienic) in all tested variants and sowing dates is insignificant.

The variants we tested did not account for the presence of harmful erucic acid.

CONCLUSIONS

The content of fat and unsaturated fatty acids was the lowest in the control variants and higher in the treated variants.

The strongest stimulating effect on fat content was observed in Lactofol B treated variant (from 35.07% to 35.79%) and on the unsaturated fatty acids in Fertiactyl Starter treated variant (from 93.77 to 95.24%).

The tested variants did not account for the presence of harmful erucic acid.

In all variants, the content of saturated fatty acids is low and varies from 4.85% to 6.56% and can be easily used for nutritional purposes.

The only variant where the plants go through all the stages to full maturity is the one treated with the leaf fertilizer Fertiactyl Starter.

The highest content of all indicators studied was reported at the first sowing date, 1-10.IX.

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