INVESTIGATION OF SOME SEED QUALITY COMPONENTS IN WINTER RAPESEED GROWN IN ÇANAKKALE PROVINCE

Muhammet Kemal GÜL[1 a] Cem Ömer EGESEL[1] Fatih KAHRIMAN[1] Şemun TAYYAR[2]
[1]Field Crops Department, Çanakkale Onsekiz Mart University, 17020 Çanakkale/TURKEY
[2]Biga Vocational College, Çanakkale Onsekiz Mart University, 17200, Biga-Çanakkale/TURKEY

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Abstract

Rapeseed (*Brassica napus* L.) is the most important oilseed crop in temperate climates. In Turkey, rapeseed production is negligible in total vegetable oil supply. Because of the high cost of imports for oilseeds, domestic production of rapeseed is supported by Ministry of Agriculture and Rural Affairs of Turkey. The objectives of this research are: to investigate the seed quality components, including protein, oil, fatty acids; and undesirable substances, sinapine and glucosinolate contents of new rapeseed varieties grown under the ecological conditions of northwest Turkey. Data were collected from 9 winter rapeseed varieties in two growing seasons (2003-2004 and 2004-2005). Seed quality components were analyzed using a monochromator Near Infrared Reflection Spectroscopy. Significant differences were detected among the varieties for all traits investigated. The ranges for the investigated traits were as follows: oil 43.20-47.04%, protein 15.34-20.53%, glucosinolate 7.59-18.55 µmol g-1, sinapic acid esters 0.29-0.40 mg kg-1, oleic acid 56.92-65.71%, and linolenic acid 9.55-11.97%.

Key words: *Brassica napus*, fatty acids, oleic acid, linolenic acid

Çanakkale Yöresinde Yetiştirilen Kışlık Kolza Çeşitlerinde Bazı Tohum Kalite Özelliklerinin Araştırılması

Özet

Kolza (*Brassica napus* L.) serin iklimlerde yetiştirilen en önemli yağ bitkisidir. Türkiye'de toplam yağ üretimi içerisinde kolzanın kayda değer bir önemi yoktur. Yağlı tohumların ithalat maliyetlerinin yüksekliğinden dolayı yerli kolza üretimi Tarım ve Köy İşleri Bakanlığı tarafından desteklenmektedir. Bu çalışmanın amacı, Türkiye'nin kuzey batısında üretilen yeni kolza çeşitlerinde yağ ve protein oranı, oleik ve linolenik asit oranlarının yanında tohumda istenmeyen maddeler sinapin ve glikosinolat oranlarının belirlenmesidir. Veriler 9 çeşitte ve iki yıllık (2003-2004 ve 2004-2005) tarla denemelerinden elde edilmiştir. Kalite analizleri yakın kızıl ötesi yansıma spektroskopisi (NIRS) ile gerçekleştirilmiştir. Kullanılan çeşitler arasında tüm özellikler bakımından önemli farklılıklar saptanmıştır. Elde edilen verilere göre yağ oranı %43.20 (Alesi)-47.04 (Licrown), protein oranı %15.34 (Licrown)-20.53 (Triangle), glikosinolat miktarı 7.59-18.55 µmol g^{-1}, sinapin asit esterleri 0.29-0.40 mg kg^{-1}, oleic asit oranı %56.92-65.71 ve linolenik asit oranı % 9.55-11.97 değerleri arasında değişim gösterdiği saptanmıştır.

Anahtar Sözcükler: Kolza, Tohum, Yağ Asitleri, Oleik Asit, Linolenik Asit

1. Introduction

Rapeseed *(Brassica napus* L.) is the most important oilseed crop of the temperate climates and it takes the second place for the world supply of vegetable oil. Agronomic and quality advantages of new varieties have enlarged their production areas world wide.

The quality of rapeseed is determined mainly by its oil and protein content, while oil quality can be described by fatty acid composition and vitamin content. The new rapeseed cultivars contain 45-48% oil with more than 60% oleic acid (C18:1), 20% linoleic acid (C18:2) and 10% linolenic acid (C18:3) (Schierholt et al, 2002). Research studies have been conducting to change the fatty acid composition in rapeseed oil by several laboratories. Schierholt (2000) found some mutants with oleic acid ratio of about 80%. Oleic acid is more durable than both linoleic acid and linolenic acid and is of great interest for industrial use (Scarth and McVetty, 1999). The quality components are inherited quantitatively. Such traits are influenced easily by cultural and environmental factors (Becker, 1993). Therefore the interactions between

[a] Corresponding author: M. K. Gül, e-mail address: kemalgul@comu.edu.tr

environment and variety will be investigated as a baffling phenomenon continuously.

The other components of rapeseed are cholin ester of sinapic acid, sinapine, and an alcoloid, glucosinolate. Phenolic compounds are known to protect plants against pests and diseases (Harbone, 1980), but they are undesirable in feeding animals. They reduce nutritional value of oilcake of rapeseed (Kozlowska et al., 1990).

Sunflower is the main vegetable oil supplier and it can be grown only as summercrop in Turkey. Thrace Region is the main area for the production of this crop. However, this area has some environmental disadvantages for adequate sunflower production. Especially water deficiency and high temperatures during the growing period are the main problems in late spring and early summer months, leading to irregular production from year to year. For this reason, alternative oilseed plants, such as winter rapeseed have been tested as wintercrop in this region (Gül et al., 2005). They reported high yield for some rapeseed varieties. Rapeseed could be an alternative crop to improve vegetable oil production and yield guarantee.

The objectives of this research are to investigate the variety yield (kg ha^{-1}), seed quality components, including protein (P, %), oil (O, %), oleic acid (C18:1, %), linolenic acid (C18:3, %), undesirable substances, sinapine acid esters (S, mg kg^{-1}) and glucosinolate contents (GSL, μmol g^{-1}) of new rapeseed varieties grown under the ecological conditions of northwest Turkey.

2. Material and Methods

Nine new rapeseed varieties (Talent, Aragon, Elan, Rasmus, Viking, Express, Alesi, Triangle and Adder) with a standard variety (Licrown) which provided by Çanakkale Agricultural Management of Ministry of Agriculture and Rural Affairs of Turkey were used in the field experiments. The varieties used in this experiment were kindly provided by KWS Saat AG and NPZ Saatzucht, Germany.

The field trials were conducted during two growing seasons (2003/2004 and 2004/2005) at the Experimental Station of Onsekiz Mart University in Çanakkale, with ten varieties. Planting dates were 20.10.03 and 16.10.04. The experiment was designed in completely randomized block design with 3 replications. Plots consisted of four rows and were 1.20m x 5 m in size. The field was fertilized with 150 kg ha^{1} nitrogen. 1/3 of the nitrogen (15:15:15) was applied with the planting and the remaining N (46 % N) was in March, between the rows. The harvest was done manually and all plants for each plot were threshed together and the yield was measured for each variety. Samples were taken randomly from each plot for quality analysis. The seed samples were analysed at The Institute for Plant Breeding and Plant Production of the University Göttingen, Germany using a monochromator Near Infrared Reflection Spectroscopy (NIRS, Inc., Silver Springs, MD, USA. Model 6500). The sample size scanned was about 3 g intact seeds. NIRS allows a simultaneous analysis for different seed components in intact samples. The analyses were done as described by Reinhard (1992), Tillman (1997), Velasco et al. (1997) and zum Felde et al. (2003).

The variance analysis was done using general linear model and phenotypic correlations were investigated using proc corr of SAS statistical software. Mean separations were done by multiple comparison tests (LSD).

3. Results

The mean values for all traits are presented in Table 1. Statistical analysis showed significant differences for every trait.

The interactions between varieties and year should be considered in the efforts of breeding high quality rapeseed varieties. Variance analysis revealed significant variety x year interaction for all traits except glucosinolat and sinapic acid esters (Table 3).

Significant correlations were found among some traits (Table 4). Oil content is negatively correlated with protein, glocosinolat and sinapic acid esters and

Table 1. Comparision of varietys for measured parameters.

Genotip	O(%)	P(%)	GSL (μmol g^{-1})	S (mg kg^{-1})	C18:1 (%)	C18:3 (%)
Talent	45.10 b	19.92 ab	11.52 c	0.33 bcd	61.92 bcde	10.93 b
Aragon	45.12 b	17.94 c	10.71 cd	0.32 bcde	64.30 ab	10.70 b
Elan	43.48 dc	20.01 ab	10.69 cd	0.34 cb	65.71 a	10.91 b
Rasmus	43.63 cd	19.61 abc	9.51 d	0.32 bcde	60.72 de	10.81 b
Viking	45.55 b	19.77 ab	7.59 e	0.31 cde	61.23 cde	11.97 a
Express	44.18 bcd	19.67 abc	11.50 c	0.33 bcd	63.56 abcd	10.70 b
Alesi	43.20 d	18.69 cb	9.77 d	0.30 de	62.56 bcde	9.84 c
Triangle	43.63 cd	20.53 a	18.55 a	0.40 a	60.54 e	11.00 b
Adder	43.63 cd	19.53 abc	14.91 b	0.36 b	56.92 f	11.06 b
Licrown	47.04 a	15.34 d	10.57 cd	0.29 e	63.91 ab	9.55 c
LSD % 5	1.45	1.81	1.71	0.04	3.00	0.74

Mean values with different letters are significantly different from each other (P<0.01

Table 2. Mean values for seed quality components measured in each growing season

Year	O(%)	P(%)	GSL (μmol g^{-1})	S (mg kg^{-1})	C18:1 (%)	C18:3 (%)
1	44,10 b	22,26 a	13,42 a	0,37 a	62,67 a	12,12 a
2	45,01 a	15,94 b	9,65 b	0,29 b	61,60 b	9,37 b
LSD 5 %	0.65	0.81	0.77	0.02	1.34	0.33

Mean values with different letters are significantly different from each other (P<0.01)

Table 3. Results of the variance analysis for the interactions.

Source	DF	O(%)	P(%)	GSL (μmol g^{-1})	S (mg kg^{-1})	C18:1 (%)	C18:3 (%)
Replication	2	0,961	0,665	0,372	0,422	0,069	0,010
Year	1	0,008	0,000	0,000	0,000	0,115	0,000
Variety	9	0,000	0,000	0,000	0,000	0,000	0,000
Variety x Year	9	0,041	0,018	0,179	0,247	0,024	0,032

Table 4. Correlation coefficients for some seed related parameters based on 2-year data

Traits	O(%)	P(%)	GSL (μmol g^{-1})	S (mg kg^{-1})	C18:1 (%)
P(%)	-0.429**				
GSL (μmol g^{-1})	-0.349**	0.590**			
S (mg kg^{-1})	-0.484**	0.826**	0.807**		
C18:1 (%)	0.549**	-0.010 ns	-0.217ns	-0.164ns	
C18:3 (%)	-0.345**	0.870**	0.446**	0.698**	0.078ns

linolenic acid. Protein is positively correlated with glucosinolat, sinapic acid esters and linolenic acid, while glucosinolate is positively corelated with sinapic acid esters.

4. Discussion

The results show that the new rapeseed varieties exhibit significant differences in terms of yield and seed quality traits. This suggests a good level of variation is still available in rapeseed germplasm and breeding efforts may yield superior varieties with higher yield and seed quality.

Improving the yield is the major aim for plant breeding. But the inheritance of this trait is very complicated and affected by environmental factors (Becker, 1993). Previous studies showed a negative relation between oil and protein ratios in rapeseed (Gül, 2002). These two seed stored compounds are competitively synthesized through photosynthesis. Our results agrees with this expectation (r=-0.429**). Oil ratio had correlations with all the other traits in this study. Among these, only oleic acid ratio was positively correlated with oil, agreeing with earlier reports (Weissleder, 1996; Schierholt, 2000). Differences in oil and protein ratios of the varieties between the two years can be explained by the climatically differences shown in Table 5.

There was no correlation observed between yield and the other traits. Protein ratio showed positive correlation with all traits and but not oleic acid. Therefore, the protein oil correlation observed in this study results from the correlation with other fatty acids which are about 25% of total oil. QTL studies in rapeseed showed that some mapped QTLs other than the locus responsible for oleic acid content are present in the same or neighbouring intervals as QTLs mapped for protein and oil contents. (Weissleder, 1996; Gül, 2002). In this situation, it is possible to observe similar correlations between protein and other fatty acids as observed for protein and linolenic acid.

Gül (2002) reported earlier a positive correlation of protein with glucosinolate, in agreement with our study (r=0.590**). Although the phenolics play a great role in plant protection against insects and diseases, they are considered as undesirable substances since they reduce the nutritive value of oilcake (Kozlowska et al. 1990). Glucosinolate levels were lowered in the new varieties; however, still there is an important amount of variation (7.59-18.55 µmol g^{-1}) in the studied varieties. Glucosinolate level is controlled by a few genes, and effect of environment on this trait is considered to be relatively small (Gül, 2002). Protein and sinapin are positively correlated (r=0.826**). Hüsken et al. (2003) reported that sinapic acid esters consisted of 3 fractions, and one of these is controlled by a major gene.

No correlation is expected between oleic acid and protein content. Linolenic acid and protein showed a positive correlation. This may be explained by a pleitrophic effect of the genes controlling these traits. Oleic acid and linolenic acid were also non-related based on our results . Analysis of variance revealed a variety x year interaction (P< 0.05) for both these fatty acids. Similar results were presented in different studies.

Studies in soybean have showed that the temperatures, years and locations play a great role in the synthesis of unsaturated fatty acids (Cherry e al., 1985; Schnebly and Fehr, 1993). It is known that oleic acid, the dominant fraction in rapeseed oil, is controlled by a major gene, while many genes control the synthesis of the other fatty

Table 5. Climatological data for the Experimental Station of Çanakkale Onsekiz Mart University in 2003-2005

Wheather data	Months												
	Years	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Average temperatures (°C)	2003	16.9	11.2	7.5	8.5	2.2	5.5	9.8	18.5	24.0	25.6	26.4	20.2
	2004	18.0	12.7	9.0	5.4	6.5	7.6	12.7	17.1	22.6	25.3	24.8	21.5
	2005	-	-	-	6.8	6.0	8.2	12.8	17.9	21.9	-	-	-
Maximum (°C)	2003	21.2	15.0	10.8	11.7	5.5	10.2	14.7	24.7	30.1	30.9	32.3	25.8
	2004	22.6	17.0	12.3	8.4	10.2	13.4	16.2	21.1	27.3	30.2	30.1	26.4
	2005	-	-	-	10.0	8.4	12.6	17.2	22.7	27.1	-	-	-
Minimum (°C)	2003	13.3	8.2	4.7	5.5	-0.3	1.6	5.9	13.3	17.8	19.8	20.8	15.5
	2004	14.3	9.3	6.3	2.5	3.0	6.4	9.5	13.1	18.2	20.8	19.5	17.5
	2005	-	-	-	4.0	3.7	4.5	9.2	14.0	16.6	-	-	-
Rainfall (mm)	2003	87.6	6.9	119.1	55.2	103.4	15.9	83.2	14.9	0.0	0.0	0.0	22.9
	2004	6.1	45.9	62.9	218.4	50.3	28.3	51.3	14.0	21.9	1.3	4.4	0.2
	2005	-	-	-	90.1	143.5	27.3	7.7	73.2	4.9	-	-	-

acids (Schierholt, 2000; Gül, 2002). The other fatty acids are affected more by environment. It was stated that the proportion of these fatty acids is about 20% in the total oil content, thus their individual effects on the total oil content are limited. (Mekki, 2003). These fatty acids are known to have negative correlations each other. In addition, their levels change depending upon environmental conditions. Oleic and linolenic acid ratio determined in this study, was 75% in the first year and 71% in the second year.

Velasco et al. (1998) reported that, sinapin negatively correlated with protein and GSL contents, but positively with oil content. Our results indicate highly significant correlations for sinapin with protein and GSL in positive direction and with oil in negative direction, contrasting with the results by Velasco et al.(1998). This may be because we have used a small number of varieties, or spontaneous correlations emerged due to very small amounts of sinapic acid esters (0.29-0.40 mg kg^{-1}) in the samples. Velasco et al. (1998) used much more varieties (1361 samples), presenting a wide range of variation for sinapic acid esters (5.0-11.1 mg kg^{-1}).

In conclusion, rapeseed will be poruduced in Marmara Region with a seed yield of 3000 kg h^{-1}. Our two-year results of this study suggest that rapeseed with adequate high oil quality could be succesfully grown in nortwestern Turkey. Varieties with short vegetation period could be more suitable for an adequate production. In comparison with other oil crops, rapeseed is the only variety, which can be sown and grown as wintercrop in our condition. Additional research studies would reveal the best management practices for rapeseed cultivation in this region.

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