THE DETERMINATION OF OLEIC ACID CONTENTS IN SUNFLOWER GENOTYPES

Yalcin KAYA, Trakya University Engineering Faculty, Genetic and Bioengineering Dept, 22100 Edirne, Turkey, yalcinkaya27@gmail.com (coresponding author)
Caglar COLAK, Trakya University Engineering Faculty, Genetic and Bioengineering Dept, 22100 Edirne, Turkey
Veli PEKCAN, Trakya Agricultural Research Institute, PO Box: 16, 22100 Edirne, Turkey
Mehmet Ibrahim YILMAZ, Trakya Agricultural Research Institute, PO Box: 16, 22100 Edirne, Turkey
Goksel EVCI, Trakya Agricultural Research Institute, PO Box: 16, 22100 Edirne, Turkey

High oleic sunflower is new trend both in Turkey and also in the world due to that it present healthy vegetable oil and also higher standing ability for frying. Higher oleic acid also affects from environment especially nigh temperatures during the grain filling period but genetic contribution is also important. High oleic acid content comes from Pervenent mutation in sunflower and it controlling Ol genes. However, because of being a seed trait which is determining after harvest, it is so difficult and unnecessary works (waiting even low oleic ones until seed treshing, etc) to select high oleic sunflower genetic materials. Therefore, selection utilization of molecular markers for determining of higher oleic types help breeders a lot to select accurately high oleic ones and also reduce costs both workers, isolation material, etc… The study covers determining of higher oleic type sunflower genetic materials developed in National Sunflower Hybrid Breeding Project conducted by Trakya Agricultural Research Institute. To screen of high oleic acid genotypes, around 400 sunflower F2 and F3 individuals obtained from crosses between high oleic acid and low oleic acid lines were used in TUBITAK (The Scientific and Technological Research Council of Turkey) Project 1003-1140971. Fatty acids of sunflower genotypes were determined by Agilent 6850 Gas Chromatography in Trakya University Lab. Based on the study results, oleic acid contents of sunflower genotypes were changed between 21.9-91.8 %, linoleic acid contents of them between 1.1-66.5 %, palmitic acid contents of them were between 3.4-8.0 % and stearic acid contents of genotypes were changed between 1.1-9.7 %. The higher oleic types were selected based on the study results for further generations.

Keywords: sunflower, oleic acid, quality, hybrid breeding

INTRODUCTION

Sunflower is one of the major oil crops in the world and mostly consuming as vegetable oil in frying, cooking or margarine. Normal sunflower oil (as called linoleic type) fatty acid composition is saturated acids 11% (stearic, palmitic), and unsaturated ones as oleic 20% and linoleic acid 69% (Baydar and Erbas, 2005; Lacombe et al., 2004). However, due to its high oxidative stability, higher stability in the frying process and exposure to high temperatures then more appropriate for frying and beneficial to health, mid (60-70%) or higher (over 80%) oleic type sunflower oil increase its importance year by year in the world. Oleic type sunflower production reached over 50% in Spain and France, almost 100% in US, but it was just started recently in Turkey and some Eastern European countries too (Kaya et al., 2008, 2015; Kaya 2016). Oleic type sunflower oil commonly uses especially fast food and snack sector currently and will be demanded more and more in other sectors in the world. It is also so suitable for biodiesel due to higher oxidative stability and also higher flash points, etc. (Vannozzi, 2006). Due to this healthy vegetable oil use trend especially in frying, higher oleic varieties will be enlarged frequently soon both in Turkey and also in the world (Kaya et al., 2008, 2015; Kaya 2016).

High oleic sunflower is firstly discovered in Russia and obtained by treating the seed of VNIMK 8931 by Soldatov utilizing from chemical mutations with 0.5% DMS solution in Pervenent sunflower populations (Soldatov, 1976; Demurin and Borisenko, 2011). Oleic acid content is determined by Ol genes exhibiting dominant mode of inheritance with the non-additive gene action and in addition to genetic factors it is also influenced highly by environmental factors (mainly night temperatures during grain filling period) (Fick, 1984; Urie, 1984; Andrich et al., 1992; Osorio et al., 1995; Demurin and Škorić, 1996; Fernández et al., 1999; Pacureanu-Joita et al., 1999, 2005; Demurin et al., 2000; Lacombe et al., 2000, 2002, 2004; Izquierdo et al., 2006; Joksimović et al., 2006; Škorić et al., 2007; Izquierdo and Aguierrezába, 2008; Velasco et al., 2008; Bervillé et al., 2009; Evci et al., 2009; Fernandez-Martinez et al., 2009; Lacombe et al., 2009; Kaya et al., 2010, 2012;
Leon et al., 2013; Cvejić et al., 2014a, b; Ferfuia and Vannozzi, 2015; Jocic et al., 2015; Regitano Neto et al., 2016; Alberio et al., 2016; Angeloni et al., 2016; Cvejić et al., 2016; Dimitrijević et al., 2016; Hlśnikovský et al., 2017).

Pervenent mutations used widely in oleic type sunflower breeding programs. On the other hand, Ol gene detection with molecular markers tightly linked to this Pervenent mutations were also developed and used for determined higher oleic type genotypes but they are mostly genotype dependent and some these markers are used commonly in the sunflower breeding programs (Dehmeyer and Fried, 1998; Hongtrakul et al., 1998; Lacombe and Bervillé, 2001; Martínez-Rivas et al., 2001; Pérez-Vich et al., 2002; Varès et al., 2002; Schuppert et al., 2006; Nagarathna et al., 2011; Singchait et al., 2013; Van der Merwe et al., 2013; Ferfuia et al., 2015; Bürgen, 2016; Dimitrijević et al., 2017, Rauf et al., 2017).

National Sunflower Research Project conducted by Trakya Agricultural Research Institute (TARI) in Edirne is primary public breeding program in Turkey. Many oleic type sunflower hybrids and inbred lines have been developed until today in National Sunflower Project with genetically resistant to dominant races of downy mildew and new races of broomrape parasite in Trakya Region which has 60% of sunflower production in Turkey. The aim of this study is to screen of high oleic acid genotypes belonging to this National project based on TUBITAK (The Scientific and Technological Research Council of Turkey) Project 1003-114O971.

MATERIAL AND METHODS

The study is covered of screening of around 400 sunflower F2 and F3 generation high oleic acid individuals obtained from crosses between high oleic acid and low oleic acid lines were used in TUBITAK (The Scientific and Technological Research Council of Turkey) Project 1003-114O971.

Oleic acid and other fatty acid contents of sunflower genotypes were measured utilizing from Agilent 6850 Gas Chromatography (GC) in Trakya University Food Engineering Lab with using HT 88 type colon in the study. Samples for GC analysis were pressed and their oil extracted with a hydraulic press. About fourteen or fifteen grams of seeds of sunflower genotypes were pressed to obtain crude sunflower oil then two drops of crude oil (approximately 0.5 ml) that was used for GC analysis were taken and put into 13 ml bottles. Then 10 ml methanol and 0.5 ml (2 moll) methanol KOH was added to this bottle.

After adding all liquids, it was well shook in the vortex 2-3 minutes, and then kept at room temperature for an hour. The results were processed by the current software in GC and expressed as the percentage of individual fatty acids in the oil sample. Oleic acid and other three major fatty acid contents are shown as the percentage of the content of the total fatty acids. After this waiting period, 2 ml crude oil samples were taken from over parts of crude oils in the vials for GC analysis then put into 2 ml vials to measure of fatty acid contents in GC. All samples were analyzed with two replications in the study.

Oleic acid was identified by use of a reference mixture of fatty acids methyl esters (FAME) containing the methyl esters of other fatty acids was used to confirm the retention times, as well as to confirm that the peak areas reflected the actual composition of these mixtures. After processing by software and stated as the individual fatty acids percentage in the samples, the obtained data were analyzed statistically with JUMP statistical program.

RESULTS AND DISCUSSION

Four major fatty acids of sunflower genotypes in the segregation generations as F2 and F3 levels were measured by GC. The percentage of fatty acid contents of genotypes were counted and analyzed statistically. Based on the study results, oleic acid contents of sunflower genotypes were changed between 21.9–91.8%, linoleic acid contents of them between 1.1–66.5%, palmitic acid contents of them were between 3.4–8.0% and stearic acid contents of genotypes were changed between 1.1–9.7% (Table 1).

Oleic acid contents of genotypes were measured mostly over 75% as called higher oleic acid types as expected so it refers to efficient selection for higher oleic types in the project. Furthermore, other genotypes existed commonly in mid oleic type group (Figure 1). On the other hand, there is a diverse relationship between oleic and linoleic acid contents. Therefore, linoleic acid contents of sunflower genotypes were observed under 10% linoleic contents as requested in the study (Figure 2).

Table 1. Fatty acid distributions of genetic materials (%).

<table>
<thead>
<tr>
<th>Fatty Acids</th>
<th>Maximum</th>
<th>75% Quartile</th>
<th>Median</th>
<th>25% Quartile</th>
<th>Minimum</th>
<th>Mean</th>
<th>Standard Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oleic Acid</td>
<td>389</td>
<td>91.8</td>
<td>89.0</td>
<td>84.6</td>
<td>56.5</td>
<td>21.9</td>
<td>71.7</td>
</tr>
<tr>
<td>Linoleic Acid</td>
<td>389</td>
<td>66.5</td>
<td>33.7</td>
<td>3.7</td>
<td>2.2</td>
<td>0.0</td>
<td>18.6</td>
</tr>
<tr>
<td>Palmitic Acid</td>
<td>362</td>
<td>8.0</td>
<td>4.8</td>
<td>4.5</td>
<td>4.1</td>
<td>3.4</td>
<td>4.6</td>
</tr>
<tr>
<td>Stearic Acid</td>
<td>362</td>
<td>9.7</td>
<td>3.6</td>
<td>2.9</td>
<td>2.2</td>
<td>1.1</td>
<td>3.1</td>
</tr>
</tbody>
</table>

The palmitic and stearic acid contents of sunflower genotypes were observed less than 8-9% of fatty acid contents as expected (Graph 2 and 3). While stearic acid contents of genotypes were accumulated around 4-5%, stearic acid contents of sunflower genotypes were observed around 1–4%. Of course, lower contents of these two saturated fatty acids in sunflower genotypes is the requested goal in the study.
The research results mean that breeding efforts for high oleic selection in the sunflower breeding was successful in the project. Especially the developed of over 80–90% high oleic acid content of sunflower genotypes is final goals of the study. The study results exhibited similarities with other studies on improving oleic contents of sunflower genotypes. Furthermore, the developing of lower saturated fatty acids such as palmitic and stearic acids showed that the performed a successful selection over improving oil quality of sunflower genotypes in the study.

CONCLUSIONS

The higher oleic type sunflower genotypes were determined via GC analysis in the study and they were mostly found as higher oleic contents over 80% as expected. These ones were selected for further generations in National Sunflower Breeding Program based on the study results.

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REFERENCES


Helianthus annuus - conference


