Greener Journal of Agricultural Sciences
ISSN: 2276-7770; ICV: 6.15
Vol. 4 (8), pp. 321-325, September 2014

http://gjournals.org/GJAS

Research Article (DOI: http://dx.doi.org/10.15580/GJAS.2014.8.063014285)

Inheritance Analysies of Linoleic Acid Content in Half Diallel Maize Populations

Gül Ebru Orhun*[1] and Kayıhan Z. Korkut[2]

[1]Çanakkale 18 Mart University Bayramiç Vocational College. Çanakkale- Turkey.
[2]Namık Kemal University Tekirdağ Agricultural Faculty Crop Fields Department.

ARTICLE INFO

Article No.: *063014285*
DOI: *10.15580/GJAS.2014.8.063014285*

Submitted: *30/06/2014*
Accepted: *09/09/2014*
Published: *09/09/2014*

****Corresponding Author***
Gül Ebru Orhun
E-mail: *ebruorhun@ comu.edu.tr*

Keywords:
fatty acid, maize, dominance, diallel, ability, inheritance

ABSTRACT

In the last few years, the analysis of fatty acids has gained importance because of their nutritional and health implications. This increased attention led to a half dialell crossing design study during 2006 and 2007 seasons in Edirne -Turkey conditions. In this study, 28 F1 maize hybrids were obtained by 8x8 half diallel crossing. In half –diallel maize population, inheritance of linoleic acid content in grains and combining ability were investigated. Mean squares of inbred lines and hybrids were highly significant for all studies traits, indicating the genetic variance among lines. This study examined inheritance of linoleic acid which is an important unsaturated fatty acid for potential health benefits. Therefore, linoleic acid content and inheritance in maize oil was investigated in this research. The linoleic acid content in grain was under the dominance gene effect. Also linoleic acid content was affected by additive gene effects.

INTRODUCTION

Maize is one of the major cereal crops used as raw material for the industry. The importance of maize is progressively increasing in Turkey and the world. Maize, with a remarkable productive potential among the cereals, is the third most important grain crop after wheat and rice (16). Maize is used for human consumption (20%), livestock feed (66%), and for industrial purposes (10%). On the other hand, maize is also used for industrial purposes such as soap, paint, adhesives, insecticides, shaving cream, toothpaste, molded plastics, rubber, tyres, glue, rayon, fuels and others(3). The ratio of saturated to unsaturated fatty acids in maize kernels strongly affect human and livestock health, but is a complex trait that is difficult to select based on phenotype. The production of 817 million tons of corn in 2009 (3) makes it one of the most important crops in the world, and it is projected to be the largest source of calories in the human diet by 2020 (15). Maize oil is an important product of the maize milling industry. Maize oil production has been increasing rapidly. The proper ratio of unsaturated to saturated fatty acids in maize oil is necessary to maintain lower blood levels of serum cholesterol and low density lipoproteins, and to avoid some immunological diseases. Maize oil is a good source of essential fatty acids. In the last few years, the analysis of fatty acids has gained importance because of their nutritional and health implications. Linoleic acid is an important unsaturated fatty acid for human health (5). Linoleic acid has a variety of salutary biological activities such as the reduction of fatty liver, serum cholesterol and carcinogenesis in animal studies (4). The fatty acid content of kernel lipids is primarily under genetic control. Inheritance studies in maize aimed at enhancing fatty acids were examined in 1970, but the number of studies in this subject was insufficient. So we investigated inheritance of linoleic acid content in maize kernel.

Maize cultivars have a wide diversity of genetic traits. Corn breeders and researchers have long recognized the potential for higher oil and fatty acid concentrations in maize.

Inheritance of maize grain fatty acids depends on knowledge of the genetic mechanism governing related traits. Hayman (9) and Jinks (10) developed diallel cross technique that provides information on the inheritance mechanism. The technique helps the maize breeders to make effective selection. Diallel analysis system is widely and extensively used for estimating the types of gene action (7). Diallel crossing programmes estimates combining ability of parents, gene effects and heterotic effects of population. GCA and SCA are essential in improving breeding strategies. Dominance gene action is desirable for developing hybrids and additive gene action implies that standard selection protocols would be effective enough in breeding aimed at improving the character (6). Combining ability analysis is useful to assess the potential of inbred lines and also helps in identifying the nature of gene action involved in various quantitative characters. This information is helpful to plant breeders for formulating hybrid breeding programmes (1).

The study used diallel crossing technique in maize inbred lines to investigate linoleic acid content and inheritance in maize oil. Linoleic acid inheritance in maize grains was investigated particularly by diallel methods. Furthermore, gene activities that were responsible for inheritance of linoleic acid were also examined.

MATERIALS AND METHODS

In this study, 28 F1 hybrids were obtained by 8x8 half diallel crossing and six inbred dent corn were used as the material. Eight dent corn inbred lines were crossed in a diallel fashion without reciprocal combinations [n (n-1)/2] (n-number of parental lines), which produced 28 F1 combinations. The 28 hybrid combinations and 8 parental lines were included in a randomized block design. Experiments were conducted in randomized block design with 4 replicates. This study was carried out in Edirne ecological conditions from 2006 to 2007 growing season. The plots were represented by 4 m rows, and 5m long. Cultural practices were consistent with the production of maize at this location. Ears of plants were harvested at the time of maturation by hand. Then the grains were separated from the cobs and dried to 15% moisture content. The grains were threshed by hand. % oil content of grains was determined according to the method (TSE-973 EN ISO- 659 February 2000). The oil was extracted from each sample with hexane as a solvent by using Gerdhardt soxhlet. Unsaturated fatty acid compositions were determined by using the UPAC model Gas-Liquid Chromatography (2). Linoleic acid content was calculated from the chromatographic results. The statistical analysis was carried out by the Steel and Torrie (17) method, using the computer packaged program. Correlation coefficients were calculated using the Tarpopgen packaged program. Data obtained from 8 parents and 28 F_1 were analyzed by Jinks-Hayman type diallel analysis for genetic parameters (11). Griffings Method 2 Model 1 was then used to analyze combining abilities (8). Combining ability describes the breeding values of parental lines to produce hybrids. The analysis were performed using the Tarpopgen program (14)

RESULTS AND DISCUSSION

F_1 Hybrids with % linoleic acid content were ranging from 42.23 to 60.97. Inbred parents % linoleic acid content ranged from 52.8 to 59.48. Combining ability analysis of variance and preliminary analysis of variance indicated that genotypes were significantly different for linoleic acid content (Table I). By using the Griffing diallel analysis, the General combining ability (GCA) and specific combining ability (SCA) effects of genotypes were also significantly different for linoleic acid content (Table II).

Table I: Preliminary Analysis of Variance for linoleic acid content

Source of variation	Degrees of freedom	Mean Squares	F
Replication	1	51.020	
Genotype	35	41.838	3.818*
Error	35	10.957	
Total	71		

*; Significant at 0.05 level

Table II: Combining Ability Analysis of variance for linoleic acid content

Source of variation	Degrees of freedom	Mean Squares	F
GCA	7	1070.24	1106.52**
SCA	28	574.394	593.86**
Error	35	0.967	

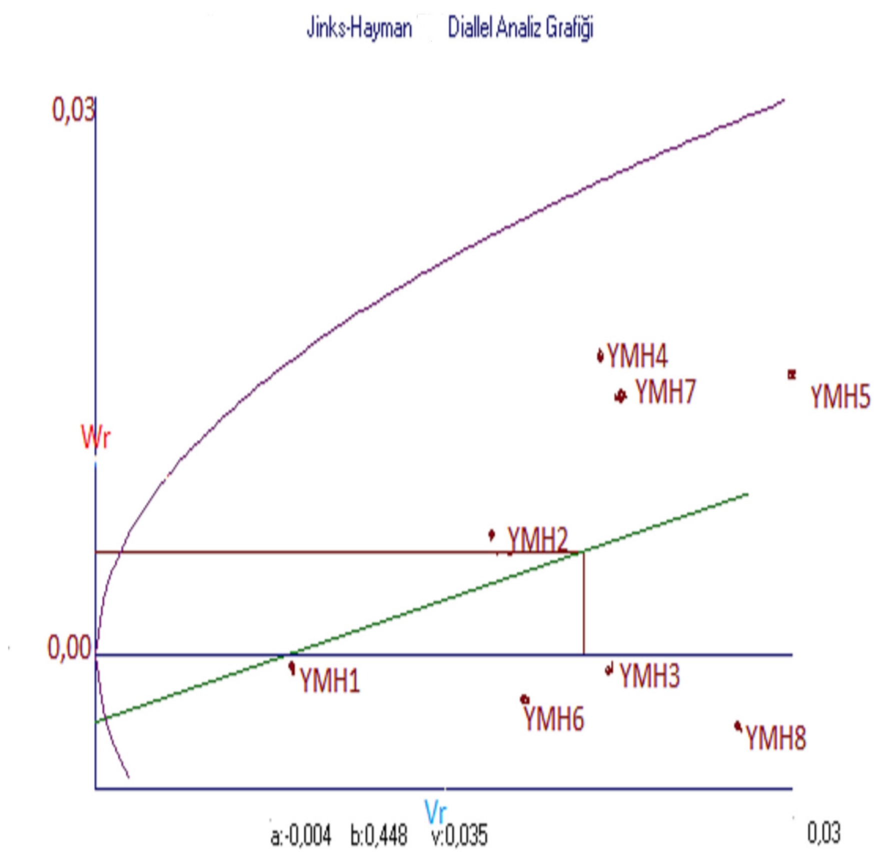
**; Significant at 0.01

As seen in Table II, estimates of GCA and SCA were significant for each trait, showing the importance of both additive and non additive gene effect. Diallel analysis of variance results were shown in Table III. The general combining ability (GCA), which measured the additive effects of genes, was superior in magnitude to the specific combining ability (SCA). The results suggest that inheritance for linoleic acid content is controlled largely by additive gene effects (table II). This result was also supported by some researchers, (12,18). H_1 and H_2 parameters (dominance and corrected dominance variances) were significantly different from zero (Table: III). It may thus be concluded that linoleic acid content is under the largely dominance gene effect. In the same way, linoleic acid content is under the additive gene effects. Since the mean dominance effect of the heterozygote locus (h^2) was significant, high heterotic effect values would be expected for linoleic acid content among crosses. Additionally E (environment) variance was not effective in inheritance of linoleic acid content (Table III). Dominant alleles are more effective than recessive alleles in the formation of this feature because F value is negative (Table III).

Table III: Genetic variances for linoleic acid content

Genetic variances components and regarding ratios	
D (additive genetic variance)	4.163 ± 12.853
H_1 (dominance variance)	70.305 *± 29.548
H_2 (corrected dominance variance)	67.794 *± 25.707
F	-7.516 ± 30.371
h^2 (heterozygote locuse effect)	46.333* ± 17.240
E (environment effect)	6.035 ± 4.284
$D-H_1$	-66.142* ± 25.353
$(H_1/D)^{1/2}$	4.110
$H_2/4H_1$	0.241
KD/KR	0.640
Heritability degree(Broad sense)	0.540
Heritability degree (narrow sense)	0.039
K (gene number)	0.683
Varsayımların geçerlilikleri	$F_{(Wr-Vr)}$ = 0.986 $t_{(b=1)}$ = 4.510
Yr, Wr+Vr	r= 0.244
*) : 0.05 significant	

Narrow and broad sense heritability degree of linoleic acid was estimated 0.039 and 0.540. The inheritance of linoleic acid content is shown in $W_r - V_r$ graph in Figure 1. We can consider over-dominance, since the regression line cut the W_r axis under the origin over-dominance may be the reason. For the linoleic acid content 2, 8 and 1 had more dominant genes 3 and 7 carried more recessive genes (Figure 1).



General combination ability (Dark-colored ones) and special combination ability effects of F_1 and parents are given in Table IV. Significant differences were found for linoleic acid content. GCA and SCA effects for the trait estimated differed significantly from zero as they compared to LSD values at 0.05 and 0.01 level of significance in Table IV. All results showed dominance effect controlling linoleic acid biosynthesis in maize.

Table IV: General and Special Combination Ability Effects for linoleic acid content

	Ymh1	Ymh2	Ymh3	Ymh4	Ymh5	Ymh6	Ymh7	Ymh8
Ymh1	0.73*	-12.89**	-12.57**	-12.54**	-13.09**	-13.30**	-13.67**	-13.16**
Ymh2		-0.247	-11.59**	-11.56**	-12.10**	-12.32**	-12.69**	-12.18**
Ymh3			-0.569	-11.24**	-11.78**	-11.99**	-12.37**	-11.86**
Ymh4				-0.593*	-11.76**	-11.97**	-12.35**	-11.84**
Ymh5					-0.051	-12.52**	-12.89**	-12.38**
Ymh6						0.164	-13.10**	-12.59**
Ymh7							0.537	-12.97**
Ymh8								0.027

$SH(g_i)$ =0.291
$SH(s_{ij})$ =0.776

*,**significant 0.05 and 0.01 levels

Consequently, inheritance for linoleic acid content was controlled by both additive and dominant effects. Similarly, this result was also supported by Jellum and Widstrom (12,18) but dominance gene variance was larger than additive gene variance so with both determinations, it is commented that inheritance for linoleic acid content showed additive and dominant inheritance. Enough studies about the inheritance of linoleic acid content can not be found. Similar results were found for linoleic acid in sunflower by Jocksimovic et. al (13). İn this study, the non-additive component dominance and epistasis, prevailed in the control of inheritance of linoleic acid content in sunflowers.

CONCLUSION

In this study, inheritance of linoleic acid for maize genotypes has been investigated by using diallel crossing methods. We have been determined that inheritance for linoleic acid content was controlled by both additive and dominant effects. And also our results have showed that additive gene action was more important than non-additive gene action in controlling this trait. This study can be a preliminary model for inheritance studies about fatty acids in future.

ACKNOWLEDGEMENTS

This study has been done for dissertation research.

COMPETING INTEREST

There is no competing interest.

AUTHORS' CONTRIBUTION

This article is extracted from the doctoral thesis. This article is part of the doctoral thesis of Gul Ebru ORhun who is supervised by Prof. Kayıhan Korkut at Trakya University Tekirdağ Agricultural Faculty.

REFERENCES

Alam AKKM, S Ahmed, M Begum and M K Sultan, (2008). Heterosis and Combınıng ability for grain yield and ıts contributing characters in maize. Bangladesh J. Agril. Res. 33(3) : 375-379, September.

Anonymous (2000). Animal and vegetables fats and oils-analysis by gas choromatography of methyl esters of fatty acids. TS 4664, EN ISO 5508. Turkish Standarts Institute Publications, Ankara.

Anoumyous (2009). FAO http://faostat.fao.org

Banni S, J C Martin 1998. Conjugated linoleic acid and metabolites In: Se´be´dio J-L, Christie WW(eds) Trans fatty acids in human nutrition. The Oily Press, Dundee, pp 261–302

Burlingame B, C Nishida, R Uauy, R Weisell (2009). Fats and fatty acids in human nutrition: introduction.Am Nutr Metab. ;55: 1–3.

Edwards JH, SA Barber (1976). Nitrogen uptake characteristics of corn roots at low N concentration as influenced by plant age. Agron. J., 68, 17-19.

El-Badawy MELM (2013). Heterosis and Combining Ability in Maize using Diallel Crosses among Seven New Inbred Lines. Asian Journal Crop Sciences 5(1):1-13

Griffing, B (1956). Concept of general and specific combining ability in relation to diallel crossing system. Australian J. of Biological Sci. 9: (463-493).

Hayman B I (1954). The teory and analysis of diallel cross-I. Genetics, 32: 789-809.

Jinks, J L (1954). The analysis of continuous variation in a diallel crosses of *Nicotiana rustica* varieties. Genetics: 39, 767–788.

Jinks J L and B. I. Hayman (1953). The analysis of diallel crosses. Maize Genetics Cooperation News-Letter 27: (48-54).

Jellum M. D. and N.Widstrom (1983). Inheritance of stearic acid in germ oil of the maize kernel. Journal of Heredity, 74(5):383-384.

Joksimović, J., A. Jovanka, R. Marinković , D. Jovanović (2006). Genetic Control of Oleic and Linoleic Acid Contents in sunflower,Helia, 29(44):33-38

Özcan K. and N. Açıkgöz. (1999). A statistical analysis program for population genetics. 3. the symposisum of computer applications for agriculture. 3-6 October, Çukurova University, Adana-Turkey.

Rosegrant M.W, M.S Paisner, S. Meijer, J Witcover (2001). Washington, D. C: International Food Policy Research Institute. Global food projections to 2020: Emerging trends and alternative futures.

Saleem M, M Ahsan, M Aslam, A Majeed (2008). Comparative evaluation and correlation estimates for grain yield and quality attributes in maize. Pak. J. Bot., 40: 2361-2367.

Steel RGD, J H Torrie (1960). Principles and Procedures of statistics. McGraw Hill Book Co. Inc. NewYork, USA, pp. 107-109

Widstrom N W and M. D. Jellum (1975). Inheritance of kernel fatty acid composition among six maize ınbreds. Crop Science Society of America 15:44-46

Cite this Article: Orhun GE, Korkut KZ, 2014. Inheritance Analysis of Linoleic Acid Content in Half Diallel Maize Populations. Greener Journal of Agricultural Sciences. 4(8):321-325, http://dx.doi.org/10.15580/GJAS.2014.8.063014285.